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Sustainable Agriculture: Development of an On-Farm Assessment Tool

Report prepared for
Ben and Jerry's Homemade, Inc.
South Burlington, Vermont

Carey Bylin, Ruchi Misra, Mindy Murch and Wendy Rigterink

SUSTAINABLE AGRICULTURE: DEVELOPMENT OF AN ON-FARM ASSESSMENT TOOL

PREPARED FOR
BEN & JERRY'S HOMEMADE INC.
SOUTH BURLINGTON, VERMONT

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ABSTRACT

Agricultural practices can create significant negative environmental, social and economic impacts. These impacts are becoming increasingly important for companies that rely upon agricultural inputs for their products. Ben & Jerry's, led by its deeply rooted company mission, is interested in exploring a broader understanding of sustainable agriculture and sharing the knowledge with Vermont dairy farmers. Sustainable dairy farming strives to protect and enhance the natural environment, animal welfare, and conditions of the local communities, while simultaneously ensuring profitability and providing a high quality of life for farmers and their families. To this end, Ben & Jerry's engaged four masters degree students from the University of Michigan's Corporate Environmental Management Program, associated with the School of Natural Resources & Environment, to develop a comprehensive, yet implementable set of economic, environmental, and social indicators for dairy farming. The purpose of this project was to: 1) provide an on-farm assessment tool; 2) educate/communicate sustainable dairy farming practices; and 3) create a foundation for on-going work in sustainable agriculture. The creation of a self-assessment tool seeks to develop farm management strategies to include environmental, social and economic goals. The self-assessment tool is made up of 10 modules that encompass social, environmental and economic indicators. This report details the methodology used to create the self-assessment tool, supporting research for each module, and the final version of the on-farm self-assessment tool.

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I. EXECUTIVE SUMMARY

INTRODUCTION

Agricultural practices in the United States are responsible for multiple positive and negative economic, environmental, and social impacts. Companies that rely heavily on agricultural inputs for their products are beginning to scrutinize the impacts of agricultural production in their supply chain as a means of strengthening their positions as 'corporate citizens.' Ben & Jerry's Homemade Inc. (Ben & Jerry's), led by deeply rooted social and environmental missions, is one such company. The Company has undertaken several 'responsible purchasing' initiatives and strives to include socially and environmentally responsible ingredients in its products. However, Ben & Jerry's lacks a systematic process to evaluate the economic, social and environmental impacts of their ingredients, including dairy. The goal of the project is to provide a basic framework, for farmers, that defines sustainable agriculture (as it relates to economic, social and environmental impacts) and to allow farmers to self assess their progress. To do so, it is necessary to go to the source of the ingredient and work with the farmers to identify and develop sustainable agriculture guidelines. Ben & Jerry's engaged the School of Natural Resources Masters Project Team (Team) to develop a set of sustainability indicators for dairy, the Company's largest input. The Team's objective was to create a set of Educational Modules that could be utilized by farmers to self-assess both best management practices and performance over time.

METHODOLOGY

In order to develop Educational Modules for sustainable dairy farming, the Team first conducted a broad literature search from which ten overarching sustainable agriculture indicators were identified. The Team next identified and selected parameters that were the best measures for assessing a given indicator. The Team used the parameters as a basis for developing assessment questions to measure performance in the Educational Modules. The Educational Modules, which also include a description of the indicator, farmer benefits of improving practices, descriptions of best practices, and references to additional resources, were reviewed by an Advisory Board (comprised of industry experts) as well as by farmers. As a last step, the Team created an introduction to the set of ten Educational Modules as well as a scoring methodology for each module which rolled up to provide an overall sustainable agriculture 'score' for each farm. The Team named the compiled end-product The Dairy Farm Sustainability Toolkit. In addition to this effort, the Team created an implementation plan for the modules as well as a methodology for applying this process to other ingredients.

INDICATORS AND FOCUS OF EDUCATIONAL MODULES

The following describes the focus of the ten Educational Modules.

- ***Animal Welfare.*** This module examines animal welfare from three perspectives: 1) nutrition, 2) living conditions, and 3) herd health. Animal nutrition includes the type and quality of feed that are provided to the dairy cows; living conditions refers to the general comfort of the animal; and herd health refers to incidence of diseases. Using these three foci as a guide, this module assesses management practices according to the following topic areas: 1) herd nutrition, 2) overall health, 3) health of incoming/outgoing animals,

4) milk quality, 5) lactations, 6) housing/handling areas, 7) stalls, 8) pasturing, 9) milking equipment and parlor, and 10) calf raising conditions.

- ***Biodiversity.*** The Convention on Biological Diversity defines biological diversity in terms of genetic, species, and ecosystem diversity.[1] While all three measures are necessary for providing a complete understanding of the level of biodiversity in a given area, biodiversity at the genetic and species level is complex and difficult to measure at the farm level. Therefore, the Team worked to identify proxy measures for assessing genetic and species biodiversity on a farm through 'ecosystem' measures. The module focuses on the 'ecosystem' level measures of biodiversity, which provide more general indications of a farmer's conservation and biodiversity protection practices. Specifically, questions for this Educational Module center around: 1) genetic diversity of crops, 2) natural area conservation, 3) management of riparian areas, 4) pasture management, 5) crop field management, 6) adjacent area management, and 7) the use of GMOs.

- ***Community Health.*** Decisions made on the farm have effects on the local community. Similarly, the support received from the community can significantly impact a farmer's job satisfaction.[2] Farm labor also plays an important role in the maintenance of a healthy community. Ensuring the health and safety of the employees is an important social concern leading to the advent of worker safety programs and standards.[3] Other areas of importance include fair wages and compliance with child labor laws. Given these concerns, this module focuses on the two main topics: community relations and protection of labor supply. Questions within the module to assess these topics focus on: 1) community involvement, 2) protection of the labor supply, 3) child labor, 4) base wage, and 5) worker health and safety.

- ***Energy.*** Agricultural production systems are energy intensive, accounting for 20% of all energy use in U.S. food system (includes agriculture production, processing, distribution, refrigeration, etc.).[4] Within dairy farms, there are four main areas of high energy usage including ventilation, vacuum pumps, milk cooling, and lighting.[5] Research shows that using alternative, energy efficient systems can significantly reduce the costs of electricity to farmers as well as the amount of greenhouse gases emitted through electricity usage. This module, therefore, focuses on two parameters: energy conservation measures and renewable energy technologies. Assessment questions related to these two categories were developed for the Educational Module and include: 1) percentage of gross income spent on energy, 2) lighting system, 3) vacuum pumps, 4) ventilation system, 5) cooling equipment, and 6) renewable energy sources.

- ***Farm Financials.*** Farm Financials refer to a farmer's financial performance as well as his or her quality of life. Financial performance is measured in terms of profitability, efficiency, debt load, and other factors. Once farmers understand their financial position, the expectation is that they can create appropriate business plans for managing or growing their operations. Appropriate business management also affects a farmer's work-life balance and overall quality of life. Quality of life is not only influenced by personal wealth, but also by a farmer's ability to spend time with family, friends or helping the community. Together, financial performance and quality of life represent the cornerstones of the Farm Financials Educational Module. To assess financial performance, the Team relied upon accepted industry standards developed by the Farm

Financial Standards Council. These measures include: 1) term debt & lease coverage ratio, 2) current ratio, 3) equity to asset or debt to equity, 4) return on assets; and 5) operating expense/revenue ratio. Quality of life is assessed through different parameters including: 1) farm income, 2) work/life balance, and 3) planning for the future.

- ***Nutrient Management.*** Nutrients, such as nitrogen, phosphorus, potassium, calcium, magnesium and sulfur, are necessary for plant and animal growth and are therefore an integral part of any agricultural system, including dairy. At the same time, excess levels of the nutrients nitrogen and phosphorus can be detrimental to environmental health, particularly water quality. Adopting best practices for nutrient management is important to preventing leaching or runoff of nutrients to ground and surface waters. Because healthy farm systems normally recycle nutrients via soil, crops, cows and manure, the focus of this module is on managing nutrient imports, such as purchased feed and fertilizer, which serve as additions to these natural processes and often are the cause of nutrient buildup on a farm. Proper nutrient management in this module is assessed through the following parameters: 1) nutrient management and record keeping, 2) manure application rate, 3) commercial fertilizer application rate, 4) manure and fertilizer application timing and techniques, and 5) use of phosphorus supplements.

- ***Organic.*** Organic farms are those certified under the USDA National Organic Program. The National Organic Program requires that farmers meet certain criteria with regard to planning, producing, handling, labeling, and record keeping for plant and animal products. Overall, these standards require a 'natural' approach to farming in which ecosystem processes drive growth as opposed to 'man-made' inputs such as synthetic fertilizers, pesticides, and other chemicals. In order to sell products as organic, a producer must meet ALL of the requirements laid out in the USDA National Organic Program guidelines. Given the number of requirements outlined in the guidelines, this module differs from other modules in that it provides a summary of the organic standards rather than assessment questions. In general, the module focuses on three primary categories: 1) general farm management requirements, 2) livestock-specific requirements, and 3) cropping-specific requirements.

- ***Pest Management.*** Pesticides include herbicides, insecticides, fungicides, rodenticides, and plant growth regulators. Since their introduction to agriculture in the 1940's,6 chemical pesticides have become the dominant approach to controlling and eliminating pests, resulting in more consistent crop yields as well as a reduction in labor needed to manage the crops. However, increased use (and additional costs to the farmer) has led to decreased effectiveness of pesticides as well as concerns regarding the effect of pesticides on human health and the environment.[7] These factors have led to an alternative approach, called Integrated Pest Management (IPM). IPM focuses on the long term prevention of pest problems through a series of primarily non-chemical controls—leveraging physical controls and natural ecosystem balance strategies instead. Given these different strategies, this module focuses on both traditional pesticide use and IPM. Best management practices for each are evaluated through a series of questions including: 1) pesticide identification, 2) pest selection, 3) timing of pesticide application, 4) weather conditions, 5) record keeping, and 6) fly and weed control.

- ***Soil Health.*** The USDA Natural Resources Conservation Service defines soil quality as "the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation."[8] The essence of soil health is its ability to perform these functions simultaneously. Under current production methods, soil health and its corresponding contribution to farm production is under threat due to erosion, soil compaction, and overuse. These factors can contribute to water and air pollution, added costs for farmers and degraded crop yields. This module focuses on best management practices to maximize soil quality and health. Specific parameters to assess soil health include: 1) soil organic matter, 2) use of cover crops and vegetative areas, 3) crop rotation, 4) tillage practices, and 5) soil conservation/erosion protection and 6) soil quality monitoring.

- ***Water Management.*** The availability of clean, high quality water is essential to sustaining plant, animal and human life. Surface and ground waters provide drinking water, municipal and industrial water supplies, support terrestrial and aquatic ecosystems, and provide recreational enjoyment. These resources, however, are threatened. The most recent National Water Quality Inventory indicates that agricultural nonpoint source (NPS) pollution is the leading source of water quality impacts to surveyed rivers and lakes, the third largest source of impairments to surveyed estuaries, and a major contributor to ground water contamination and wetlands degradation.[9] Management practices on dairy farms can lead to increased water pollution from a variety of sources including pesticides, fertilizers, manure, soil sediment runoff, and disposal of water used to clean milking equipment. This module helps farmers assess their water management practices and identify areas where they can minimize and prevent water pollution and, to a lesser extent, promote appropriate water use. Parameters covered to assess water quality include: 1) livestock yard management, 2) manure, fertilizer and silage storage, 3) milkhouse waste management, 4) protection of on-farm water sources, 5) water use plan and 6) water use management strategies.

IMPLEMENTATION

In addition to developing the Educational Modules, the Team created recommendations for implementing these modules on Vermont dairy farms. While the implementing organization and actual mechanisms and logistics around implementation are still under consideration, this section provides guidance based on the Team's research and interactions with various stakeholders. Recommendations cover characteristics of the implementing organization, goal setting and some key elements of the program. Some of the major recommendations include:

- ***Implementing organization.*** Due to the number and variety of stakeholders associated with this project, the implementing organization should have wide-ranging areas of expertise and the capacity to work effectively with a variety of stakeholder groups. The implementing organization should also have access to and rapport with a number of representative stakeholder groups such as farmers, state and federal agencies, and local non-governmental organizations.

- ***Goal setting.*** Prior to actual implementation, goals of the program must be established to ensure that implementation strategies are appropriate and achievable. The Team recommends that goals be set around farmer improvements as well as around assessing and reporting overall program progress.

- ***Implementation recommendations.*** The Team recommends that the implementation plan address outreach and farmer selection, financial incentives to reward farmers for changing their practices, and program size. The Team envisions that program implementation should include multiple visits to individual farms to ensure that farmers are making changes on an on-going basis. Moreover, the Team recommends that the implementing organization initially launch the program with a small group of farmers due to geographic considerations, potentially limited resources, and the potential need to 'work the bugs out' of the program.

- ***Updating and maintaining the modules.*** Over time, the modules will need to be updated to reflect best practices and more current information. The Team recommends that the implementing organization update the modules annually based upon stakeholder feedback.

APPLICATION TO OTHER PRODUCTS

As a separate deliverable, Ben & Jerry's requested the delineation of a generic process to develop indicators and modules for other agricultural inputs. While results of this project are not directly transferable to other situations, the overall methodology is transferable with slight alterations. Using key learnings, the Team modified the original methodology in three ways to create a process for developing modules for other inputs.

First, the Team added a new first step to the methodology called "Establish goals and objectives of the program." By identifying and articulating the purpose of the program, future parties will be able to determine and communicate end-goals and objectives. Moreover, development of end goals at the start of the project allows future parties to better compare their progress to expected outcomes throughout the project. Second, the Team recommends using the literature review from this project as a starting point for research on other ingredients. The list of resources found in Appendices 2 and 5 provides a solid foundation for identifying major indicators and parameters. While additional research related to the specific agricultural input will be required, the extensive list provides a baseline of information. Finally, the Team recommends forming the Advisory Board earlier in the process, perhaps immediately after the indicator and parameter screen. Early formation of the board will introduce members to the project goals and allow for immediate feedback and increased commitment to the project. The Advisory Board should include members from various stakeholder groups, such as representatives from governmental, non-profit, academic, farming, and corporate organizations. It is hoped that this revised methodology will allow future parties to develop similar tools for other inputs.

CONCLUSION

This project has resulted in the development of ten Educational Modules which may be used by Vermont dairy farmers to self-assess their performance over time. The ten Educational Modules have been compiled into one tool entitled: Dairy Farm Sustainability Toolkit. In

addition, the team has developed recommendations for an implementation program and a methodology for replicating this process for other agricultural inputs. Through the course of this project, the team encountered repeated feedback on the need for financial incentives for farmers to participate in the program. As such, the team identified several areas in which further research is needed. The first is the investigation of grants or other funding available for a program such as this one. Second, future research efforts should focus on quantifying potential economic benefits that farmers can reap by altering specific management practices. While the Team found occasional examples of such quantification, they were relatively few in occurrence and often not of significant magnitude or credibility to convince farmers of the benefits. The development of case studies that profile significant environmental and/or social gains combined with economic savings are one way to demonstrate to farmers that implementing sustainable dairy projects is beneficial. In this way, increasing research, documentation, and communication of such quantifiable benefits can increase interest in and adoption of corresponding farm practices.

Moving forward, the Team anticipates that the Educational Modules will serve as the basis for a successful, dynamic program that inspires farmers to improve their on-farm processes economically, environmentally, and socially. Moreover, it is hoped that the benefits achieved through this program may be applied to other products in different geographic regions over time, resulting in an overall improvement on farms, in communities, and for the environment.

II. INTRODUCTION

"One of the world's greatest challenges is to feed a growing population while sustaining the global natural resource base. How the relationship between human needs and natural resource requirements will balance depends largely on livestock management and agricultural production practices."

The World Bank[10]

OVERVIEW

When farms are operated in balance with the earth's natural systems such as air, water, energy and nutrients, a farm's natural resources are sustained. Sustainable dairy farming strives to protect and enhance the natural environment, animal welfare, and conditions of the local communities, while simultaneously ensuring profitability and providing a high quality of life for farmers and their families.

However, current agricultural practices in the United States are responsible for many positive and negative environmental, social and economic impacts. Companies that rely heavily upon agricultural inputs for their products are beginning to scrutinize the impacts of agricultural production as a means of strengthening their positions as 'corporate citizens.' Ben & Jerry's, led by deeply rooted social and environmental missions, is one such company. Dedicated to conducting business with economic, environmental, social goals, the Company has undertaken several 'responsible purchasing' initiatives and prides itself on selecting socially and environmentally responsible ingredients in its products. For example, the Company's milk program will only purchase bovine growth hormone-free (rBGH-free) milk primarily due to the lack of concrete science validating the hormone's safety. For rBGH-free milk, Ben & Jerry's pays premium prices to the farmers of St. Albans Cooperative Creamery. This is an example of a company-led initiative impacting sustainability at the farm level. While this is an example of one sourcing consideration, Ben & Jerry's lacks a comprehensive set of indicators by which to assess all of the environmental, social, and economic impacts of each of its ingredients. With the dual purposes of educating and encouraging farmers to adopt sustainable farming practices, Ben & Jerry's seeks to identify indicators by which to assess the economic, environmental, social performance of their suppliers. As such, Ben & Jerry's engaged the School of Natural Resources Masters Project Team (Team) to develop a set of sustainability indicators for dairy, the Company's largest input. The Team was called upon to create a set of Educational Modules that could be used by farmers to determine the best management practices while also providing a means of assessing farmer performance in order to track improvements over time. The use of a balanced set of environmental, social and economic best practices is expected to help achieve 'sustainable' dairy farming.

AGRICULTURAL TRENDS

The advent of new farming technologies after World War II led to an increase in efficiency, economies of scale, and a subsequent rise of large, specialized plantations, which required less labor. With each passing decade, farmers continued to expand operations while many of those who could not went out of business. According to the USDA, the number of total farms in the US fell 69% from 1940 to 1997, while the number of farms with milk cows decreased by over 97%.[11] Economic pressures, exacerbated by widening gaps between the

average prices paid and received per crop as well as a decrease in government grants,[12] have contributed to the rise of harmful economic, environmental, social impacts that are only recently being understood.

Agriculture accounts for forty five percent of water used in the U.S., and sixty percent in nine out of ten OECD countries. [13] Agricultural practices are the "largest polluter of rivers and streams in the United States, fouling more than 1,730 miles of waterways with chemicals, erosion and animal waste runoff."[14] It is estimated that over 40% of nitrogen and over 30% of phosphorus emissions to surface waters is the result of agriculture, in many OECD countries.[15] Meanwhile, soil loss is occurring at significant rates. The 1999 National Resources Inventory of the USDA reports that 1,700 megatonnes (million metric tonnes) of soil eroded from U.S. land in 1997.[16] This amount would fill a fully loaded freight car train that would encircle the planet seven times.[17] From a Community Health perspective, technological innovation led to a reduction in the amount of farm labor needed per farm.[18]

The above can be contrasted to farms that are built around and utilize earth's natural systems such as air, water, energy and nutrients, applying nature's principles to sustain a farm's natural resources. Sustainable farming involves protecting and improving the natural environment, animal welfare, and conditions of the local communities, while simultaneously ensuring profitability and providing a high quality of life for farmers and their families. The economic component of sustainability requires implementing measures that will ensure financially stable endeavors, such as selecting profitable investments, conducted through financial planning. The social component of sustainability involves maintaining or enhancing the quality of life for the farm families, farm workers and the surrounding community. The environmental component of sustainability includes maintaining the health of ecosystems, their inhabitants and their processes.[19]

EXISTING FRAMEWORKS

Based on the Team's findings, it appears that dairy farmers in Vermont have differing levels of understanding of sustainable dairy practices. Some are well aware of the issues and are operating in a way that is near the ideal. Others may be aware of such issues but lack the time and resources to make changes on their farms. Still others may be completely unaware of sustainable agriculture best management practices. As such, there is a need for an on-farm self assessment tool to educate/motivate change. In response to this need, several organizations have created frameworks that evaluate and aim to improve farming practices. A few of those organizations are listed below:

- Appropriate Transfer of Technology for Agriculture (ATTRA) - Funded by the US Department of Agriculture, ATTRA is a national sustainable agriculture information service managed by the National Center for Appropriate Technology. It provides information and technical assistance to farmers, ranchers, Extension agents, educators, and others involved in sustainable agriculture in the United States.[20]

- Environmental Quality Improvement Program (EQIP) – Implemented through the Department of Agriculture, this voluntary program designed to provide technical, financial, and educational assistance to farmers to address soil, water, and related natural resource concerns.[21]

- Food Alliance (FA) - This non-profit organization that promotes sustainable agriculture by rewarding farmers who produce food in environmentally and socially responsible ways. Additionally, they educate consumers about the benefits of sustainable agriculture.[22]

- Organization for Economic Development (OECD) – A multilateral organization comprised of thirty member countries that discuss, develop and refine economic policies. The organization is committed to being at the forefront of efforts to help governments understand issues regarding sustainable development. [23]

- Sustainable Agricultural Research and Education Program (SARE) - The Sustainable Agriculture Network (SAN), funded by SARE, is a cooperative effort of university, government, farm, business and nonprofit organizations dedicated to the exchange of scientific and practical information on sustainable agricultural systems. Developed by a committee from diverse organizations, SAN encourages the exchange of information with a variety of printed and electronic communications tools.

- Unilever (UNI) – As the parent company of Ben & Jerry's, this company has already begun the sustainable production of agriculture products including peas, carrots, and tea. While sources of sustainable dairy products are only recently being sought by European Suppliers, no such data exists for its U.S. operations.[24]

While there was some variation between frameworks, ten major indicator categories appeared multiple times and had significant relevance to dairy farming in Vermont. These categories include animal welfare, nutrients, biodiversity, organic, soil quality, energy, water, pest management, farm financial health and community health. Major sustainable agriculture assessment tools and the indicator categories used by these different organizations are summarized in Table 1.

Table 1: Indicators by Organization

	Animal Welfare	Nutrients	Bio-diversity	Organic	Energy	Water	Pest Mgmt	Soil	Financial Health	Community Health
ATTRA	X	X	X			X		X	X	X
EQIP		X	X			X	X	X		
FA	X	X	X	X		X	X	X		X
OECD	X	X	X	X	X	X	X	X	X	X
SAN	X	X	X			X	X	X	X	X
UNI		X	X		X	X	X	X	X	X

Though these frameworks are extremely valuable to the project in combination, none was able to satisfy the need of Ben & Jerry's. For example, Unilever, has defined ten sustainability indicators including: biodiversity, energy, local economy, nutrients, pest management, product value, soil fertility/health, social/human capital, soil loss and water. It has begun field-testing these indicators on several products including: peas, palm oil, spinach, tea and tomatoes. However, many of the parameters used to measure each indicator are technically complex and difficult for farmers to understand and measure. For instance, a parameter to measure soil fertility involves counting the actual number of predatory mites in a soil sample. Not only is this a difficult measure for the typical farmer to

see, it is also difficult to quantify. This model is therefore better suited for implementation by a technical expert rather than the average farmer.

In other cases, indicators were not always specifically tailored to dairy production in the Northeast. For example, ATTRA has a tool designed to assess sustainability of dairy farms, but was not tailored to the specific needs of Vermont. Since farming practices vary across the country, this specificity is necessary to ensure that the tool is applicable to a particular region. Given these reasons, Ben & Jerry's sought different means by which to help St. Albans farmers assess their farming practices.

SELF ASSESSMENT TOOL

Ben & Jerry's sought the help of a University of Michigan School of Natural Resources & Environmental Master's Project Team to develop a comprehensive, yet implementable set of sustainability indicators for dairy and create a set of educational modules to help farmers assess their economic, environmental and social impacts. The methodology was conducted in a replicable manner that Ben & Jerry's may apply to other products. Ultimately, the Company wants to include evaluations of sustainable agriculture in their vendor survey. The following describes how the University of Michigan developed these indicators and educational modules. This report includes:

- A scope and methodology section which details the process used to create the indicators and educational modules;
- chapters on each indicator which provides background on the indicator, the focus of the educational module for that indicator, and a description of the parameters used to assess performance for that indicator;
- a complete Toolkit with educational modules;
- implementation steps;
- application to other products; and
- appendices.

III. SCOPE AND METHODOLOGY

This section details the scope and methodology used to identify sustainability indicators and develop Educational Modules for dairy farming in Vermont.

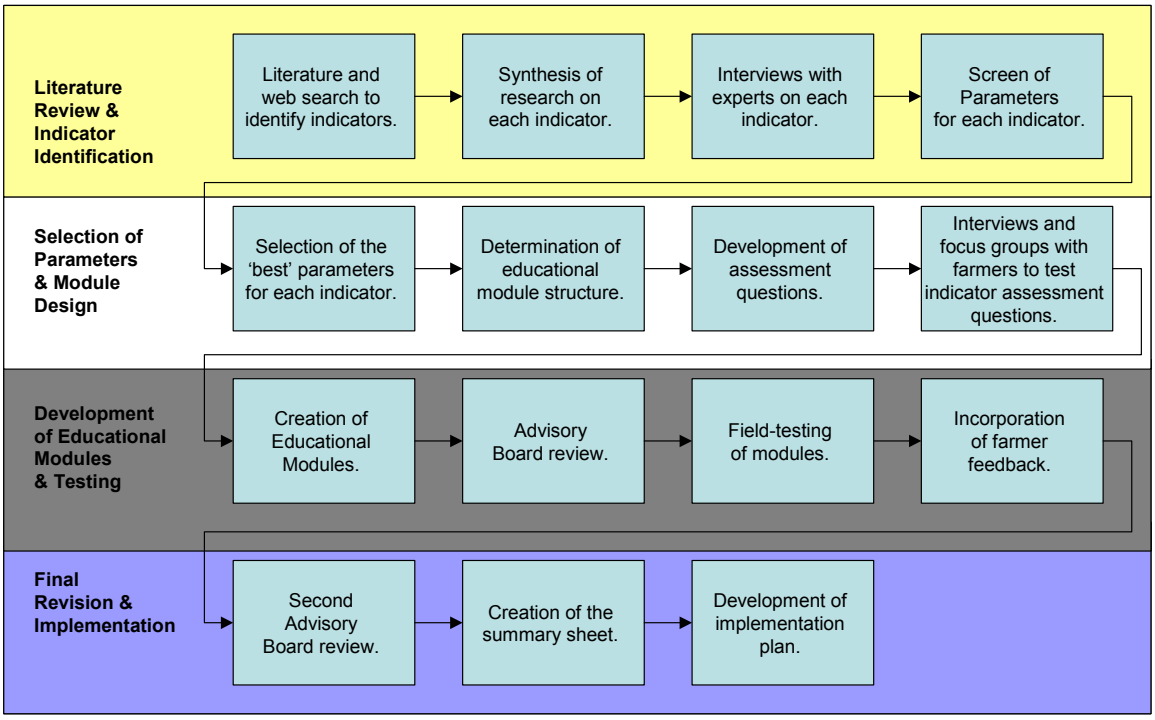
SCOPE

The scope of this project, *Sustainable Agriculture: Development of an On-Farm Assessment Tool for Dairy Farmers*, is to develop sustainable agriculture self-assessment modules specifically for Vermont dairy farmers and their operations. The purpose of the tool is three-fold: 1) to help farmers assess their own performance; 2) to assist farmers in understanding a broader definition of sustainable dairy farming practices; and 3) to create a foundation for continued work on sustainable agriculture. It is important to stress that the tool is only for assessing impacts that occur on the farm. Other production steps in the dairy production process, such as the production of fertilizer and pasteurization, are not included in this assessment. By limiting the scope to only on-farm actions, farmers will be better able to assess their production impacts and to prioritize areas for improvement.

METHODOLOGY

In order to develop Educational Modules for sustainable dairy farming, the Team utilized the following 15-step methodology. A schematic of the methodology is below (see Figure 1).

Figure 1: Methodology Process Map



In addition, the Team modified this methodology to provide a process by which Ben & Jerry's, or another organization, could create modules for other ingredients.

1. **Literature and web search to identify indicators.** The Team conducted a literature review and web search to identify the universe of economic, environmental, and social indicators for dairy farming. The Team began by reviewing global frameworks for sustainable agriculture including those of Unilever, the Food Alliance, the OECD, the ATTRA, Farm*A*Syst, the Sustainable Agriculture Network, and the Environmental Quality Incentives Program. This review, summarized in the introduction, resulted in a list of the major indicators for sustainable dairy farming. These major indicator categories are summarized below (see Table 2).

Table 2: Major Indicator Categories

Social	**Environmental**	**Economic**
Farmers & Families	Air Pollutants	Farmers & Families
Communities	Animal Welfare	Communities & Employees
	Biodiversity	Environmental
	Ecosystem	
	Energy	
	Nutrient Management	
	Organic	
	Pest Management	
	Soil Health Management	
	Water Management	

The Team next undertook an extensive literature and web review to understand how to define and assess each indicator. The literature review included a search of academic journal articles and books as well as governmental and non-governmental organizations (NGOs) publications. The web search included a review of academic, governmental, and non-profit agriculture programs (focusing on both traditional and 'sustainable' dairy and agriculture management), best practices, and publication reference lists. The result was an extensive list of parameters by which to measure or assess each indicator category.

The findings from this search were organized into a spreadsheet using the following structure:

- Column 1: Category. Each entry was first classified under a sustainable development category: economic, environmental, or social;
- Column 2: Indicator. Each entry was then assigned to an indicator category for sustainable dairy farming (per the chart above);
- Column 3: Sub-Indicator. Each entry was next organized into a sub-indicator category (in order to sort the parameters into major topics under each indicator); and
- Column 4: Parameter. Finally, each parameter was listed and defined the specific metrics that could be used to assess farm performance for a given indicator category.

For example, a parameter under the indicator category of Water Management was classified as follows:

- Category: Environmental
- Indicator: Water Management
- Sub-Indicators: Water Quality and Water Use
- Parameters: Water Quality parameters included "Management of Barnyard Areas" and "Manure Management." Water Use parameters included "Irrigation Use" and "Stability of Water Sources."

Table 3 is a visual representation of how the same information is presented in the spreadsheet in the appendix.

Table 3: Spreadsheet Example

Category	Indicator	Sub-Indicator	Parameter
Environment	Water Management	Water Quality	Management of Barnyard Areas
Environment	Water Management	Water Quality	Manure Management
Environment	Water Management	Water Use	Stability of Water Sources
Environment	Water Management	Water Use	Irrigation Use

Through this effort, the Team generated a spreadsheet of parameters to measure the different indicators and indicator sub-categories. In addition, the Team created a reference document to identify the articles and websites in which each parameter had been found. This spreadsheet is found in Appendix A.

It is important to note that this search was not limited to a particular region of the world; therefore the identified indicators and parameters portray a wide array of measures used at the global, national, and regional level to assess sustainable dairy farming. The list also includes measures for practices related to cropping, since many dairy farms also raise their own feed or cash crops. Therefore, this list may be used to create Educational Modules for other products.

2. **Synthesis of research on each indicator.** For each indicator, the Team synthesized research identified through the literature and website review. During this process, the Team also conducted an extended literature and web review on any new facets of the indicators that emerged. The results of this analysis are summarized in Appendix B of this document. For each indicator category, the Team:
   - defined the indicator;
   - summarized the main environmental, social or economic issues surrounding each indicator category;
   - listed all the parameters for assessing a given indicator;
   - described how easily data for the indicator may be collected, measured and verified;

- described relevance of the indicator category to dairy; and
- presented the business case as to how the farmer could benefit by monitoring his or her performance regarding the indicator category.

3. **Interviews with experts on each indicator.** The Team conducted interviews with experts in the field for almost all indicator categories. Experts were identified through the literature review or through recommendations from other experts. All of the experts interviewed work at one of the following entities: a university with an agricultural department, a government agency, a sustainable agriculture non-governmental organization (NGO), or an agricultural producer or service provider. Experts provided insight into the:
   - main environmental, social or economic issues surrounding each indicator category;
   - best parameters for assessing a given indicator;
   - scales or ranges of acceptable performance; and
   - differences (geographical, political, environmental, and/or social) within the US and abroad.

   The results of these interviews were also incorporated into the analysis of each indicator. Interview write-ups can be found in Appendix C.

4. **Screen of parameters for each indicator.** The Team next screened each parameter to assess: 1) how well it describes performance on a given indicator, and 2) how appropriate its use is within the Educational Modules. To narrow the list, the Team identified the following broad-brush criteria by which to eliminate any unusable parameters (i.e., parameters that were too complex, expensive, and time consuming compared to other parameters for the same category). Table 4 summarizes the methodology used to eliminate unusable parameters.

Table 4: Methodology Used to Eliminate Parameters

Question	Action
Is the parameter data comparable across farms?	If 'no', eliminate.
Is the time investment to collect and interpret the data worth the amount or quality of information gained?	If 'no', eliminate.
Is the cost to collect and interpret the data worth the amount or quality of information gained?	If 'no', eliminate.
Is adequate information available on the parameter to ensure scientific credibility of its use?	If 'no', eliminate.
Does the parameter provide little information compared to other parameters?	If 'yes', eliminate.
Did an expert recommend that the indicator be dropped?	If 'yes', eliminate.
Are there alternative parameters that are easier to understand and interpret?	If 'yes', eliminate.
Is the parameter relevant to dairy farming?	If 'no', eliminate.
Is the parameter relevant to dairy farming practices in Vermont?	If 'no', eliminate.

It is important to note that one criteria question relates to Vermont dairy farming practices. Due to the geographic and socio-political differences in farming practices around the world, the Team identified the need to tailor the module to a specific location. Since the majority of dairy sourced by Ben & Jerry's is produced in Vermont, the Team decided to eliminate those parameters, which were less relevant to the Vermont area.

The Team discussed each eliminated parameter to ensure consistency across indicator categories. A spreadsheet containing eliminated parameters is located in Appendix D.

5. **Selection of the 'best' parameters for each indicator.** The remaining parameters were all assumed to be viable parameters for inclusion in an Educational Module. However, given the large number of parameters still remaining, the Team sought to further narrow the list by evaluating each parameter in more detail.

   Some of the parameters required the collection of multiple pieces of data. For example, the Economic parameter, current ratio, required two pieces of information: Total current farm assets and total current farm liabilities. To evaluate whether each piece of information needed for a given parameter could be easily collected at the farm level, the Team developed Farm-Level Questions and used the following criteria to assess the appropriateness of each question (see Table 5).

Table 5: Farm-Level Questions

Evaluation Criteria	Response
Type of measurement	M = Specific Management Practice (utilized practice) D = Data (quantitative data points) O = Observation (qualitative assessment based upon observation)
How measured? What are discrete measurement units?	Insert Unit
Estimated time required for data collection /at point of survey?	Total # of Minutes
Additional time required for record keeping (during the year or at the time of collection)?	L = Low M = Medium H = High
Outside agency needed to answer the question?	Y or N
Cost for measurement?	Dollars
Is there an "acceptable" scale for assessing performance?	Y or N, define if possible
Ease of verifiability?	E = Easy M = Medium D = Difficult

Based upon this analysis, the Team could then determine which parameters would provide the best information for any given indicator at the lowest cost in terms of time, effort, and money.

Using the results of this Farm Level Question Screen, the previous parameter screen, and knowledge gained from interviews and research on which parameters are most important in assessing a given indicator, the 'best' parameters for inclusion in the Educational Modules were selected.

6. **Determination of Educational Module structure.** As a means of determining the appropriate number of parameters to include in an Educational Module, the Team next defined the Educational Module structure. It was decided that each Educational Module should be structured as a stand-alone document so that farmers could work through the modules individually per their available time and interest with regard to the different indicator areas. As such, each module would include a description of the indicator; a description of the benefits gained by the farmer for improving performance in that area; a short set of assessment questions; an explanation of the relevance of these questions and interpretation of the results; information on how the current module relates to other modules; and resources for additional information for improving performance. Moreover, the Team wanted to create modules that were short (around five pages), easy to understand (free of technical jargon), and compelled the farmer to take action. In addition to each stand-alone module, an overall introductory and summary sheet would be used to introduce the goals and structure of the modules and provide a means of gathering total responses from each Educational Module to provide an overall picture of sustainable agriculture performance on the farm.

   Since the majority of dairy sourced by Ben & Jerry's is produced in Vermont, the Team focused on those parameters most important and relevant to the Vermont area. For instance, nutrient runoff is a particular concern in Vermont due to eutrophication problems in Lake Champlain. Water shortages, however, are generally not a large problem in Vermont, so parameters associated with water use would be viewed as a lower priority for a Water Management Education Module.

   At this time, the Team also evaluated the number of Educational Modules that should be created. Through group evaluation by the Team, the academic advisor and the Ben & Jerry's client, the Team recognized that there was overlap among several indicator categories: between Biodiversity and Ecosystem; between Air Pollutants, Energy and Environmental (indicator in the Economic section); between Farmers & Families in the Social and Economic Sections; and between Communities in the Social section and Communities & Employees in the Economic section. To avoid unnecessary duplication while retaining the most critical indicator categories, the Team decided to combine categories with the greatest overlap. A final set of ten indicators were defined:
   - Animal Welfare;
   - Biodiversity;
   - Community Health;
   - Energy;

- Farm Financials;
- Nutrient Management;
- Organic;
- Pest Management;
- Soil Health Management; and
- Water Management.

7. **Development of assessment questions.** The Team selected a few parameters from each indicator category to develop draft assessment questions. Some of the questions were based on existing sources such as the Farm Financial Standards Council, The Food Alliance, the ATTRA, and Farm*A*Syst. Others were created by the Team, utilizing a compilation of various sources. The Team structured the questions in different ways (multiple choice, fill in the blank, select all that apply, etc.) to test which questions were most easily understood by the farmer while providing the best information regarding their performance. The Team agreed that questions that allowed the farmer to rate his or her performance on a scale (from a marginal practice to best practice) provided the farmer the most information on his or her performance relative to best management practices. Therefore, the majority of the questions were structured to reflect performance along a scale, from lowest acceptable or sub-standard practice (option #1) to best practice (option #4). This method also allowed for points to be easily assigned to each answer for use in the summary sheet.

8. **Interviews and focus groups with farmers to test indicator assessment questions.** To test questions for each indicator, the Team conducted on-farm interviews and a focus group with farmers. The Team visited three farms north of Burlington, Vermont. The owners of these farms all supplied milk to the St. Albans Cooperative Creamery, the primary supplier of cream to Ben & Jerry's. The Team presented a series of questions to each farmer to gauge the effectiveness of the different question formats. The Team conducted a similar exercise with a focus group comprised of seven more farmers that supply milk to St. Albans Cooperative Creamery. Feedback from this visit can be found in Appendix E.

9. **Creation of Educational Modules.** Based upon the farmers' review of the questions, the Team created draft Educational Modules for each indicator. Using the five-page limit as a guide, the Team developed an introduction to define the indicator and describe its relevance to social, economic and/or environmental performance, as appropriate to the specific circumstances in Vermont. An "Incentives for Change" section was also included to describe the additional benefits a farmer could gain by improving management practices in this area. The benefits related to areas such as regulations, cost savings, performance improvement, positive community relations and marketing opportunities for the farm and its products. This was followed by assessment questions and a discussion of the best management practices for each question. The Team focused on questions for parameters that would provide the best information on a given indicator at the lowest cost in terms of time, effort, and money. The Team concluded each Educational Module with a description of how the current Educational Module related to other topic areas and references to additional resources that the farmer could use to improve performance. These

resources included relevant papers, websites, and organizations. In order to be sensitive to farmers needs, references included both websites and contact names with telephone numbers. Also, an effort was made to maximize the number of local references.

10. **Creation of Advisory Board and review.** In addition to individual expert interviews, the Team determined the need for an Advisory Board that could provide a perspective on our overall approach and identify linkages between the different indicator categories. The Team contacted individuals representing a diverse set of expertise. Members of the Advisory Board are listed in Table 6.

Table 6: Advisory Board Members

Name	Occupation	Organization
Diane Bothfeld	Cooperative Relations Manager	St. Albans Cooperative Creamery
Cornelia Flora	Professor of Sociology/ Director of North Central Regional Center for Rural Development	Iowa State University
Marie Guay	Loan Officer	Yankee Farm Credit
Deborah Kane	Executive Director	Food Alliance
Allen Matthews	Program Coordinator	Center for Sustainable Agriculture at University of Vermont
Samantha Sturhahn	Associate, Corporate Responsibility	McDonald's Corporation
Ann Wells	Veterinarian and Technical Specialist in Herd Health	ATTRA

The Team facilitated a conference call in which Advisory Board members gave feedback on the first three sections of each module (the indicator description, benefits to the farmer, and assessment questions) as well as identified new linkages between the modules. The Team incorporated the feedback into the modules (see Appendix F).

11. **Field-testing of modules.** The Team field-tested each Educational Module with nine farmers that supply milk to the St. Albans Cooperative Creamery. Modules were sent to farmers in advance with specific instructions on how to evaluate the modules and prepare for the feedback discussion. In addition to actually answering the assessment questions for their own practices, farmers were instructed to evaluate each module's overall clarity, appropriateness of the questions, degree to which the module compelled them to change their practices, and informational content. Due to time constraints, five of the ten modules were reviewed by three farmers, while the remaining five were reviewed by two farmers. Modules that were only reviewed by two farmers were selected on the basis that they had received previous review in the earlier farm visits and focus group. The Team modified each Educational Module based upon feedback from suppliers' regarding the usability, clarity and effectiveness of the template.

12. **Incorporation of farmer feedback.** The Team incorporated farmer feedback into each module. In doing so, the Team carefully weighed the feedback against research as well as expert and advisory board advice. If a comment from multiple farmers contradicted these sources, the Team would either modify the module or counter the point with scientific findings. Feedback from this visit can be found in Appendix G.

13. **Second Advisory Board review.** The Team sent the revised modules to the Advisory Board members for a second review. The Team asked each member to review those modules for which they have expertise, but also asked them to review the remaining modules if possible. The Team incorporated Advisory Board member feedback into each module, carefully weighing the feedback against research as well as expert and farmer advice (see Appendix H).

14. **Creation of the score sheets and module summary sheet.** The Team developed scoring sheets for each module. Scoring was based upon the following methodology:
    - A scoring system for each type of question was developed.
        - For multiple-choice questions: the response number served as the score for that question (i.e. choice # 2 is worth 2 points).
        - For "check all that apply questions," one point was added for each check, where the response improved sustainability, and one point was subtracted for each check where the response decreased sustainability. Total points were added, resulting in the overall question score.
    - Scores for all questions were then totaled.
    - The total score was evaluated using a red, yellow, and green scale as described in the Table 7 below.

Table 7: Module Scoring for Nutrient Management Module

	Point Range	Percentage Range	Interpretation
Green	21 – 25	81%-100%	Best practices regarding Nutrient Management are currently being employed on this farm.
Yellow	16 – 20	50%-80%	Farm is using some good practices regarding Nutrient Management; however there are some key areas that should be improved upon.
Red	7 – 15	<50%	Nutrient Management should be carefully evaluated and a strong effort should be made to adopt improved practices in several areas.

Point ranges were tabulated using weighted averages. To create the weighted average, the Team subtracted the minimum module score from the maximum module score to arrive at the total number of base points for the module. The Team then calculated 81%, 80%, and 50% of the total number of base points. For each result, the Team added back the minimum score to arrive at the point range

boundaries for each category. For example, to determine the green point range for a module with a maximum of 23 points and a minimum of 4 points (show in Table 6 above), the Team subtracted the minimum score (4) from the maximum score (23) to arrive at 19. The Team then multiplied 19 by 80% to arrive at 15.2 and added back the minimum score (4) to determine the lower boundary of the green range (19 points). The green point range was therefore 19 to 23 points. The questions and results were then formatted into the scoring module template attached at the end of each module. The Team also developed an introduction to the modules, which includes an explanation of how to use the modules as well as a summary sheet in which participants may record their scores (green, yellow, or red) for each module.

This scoring method gives each question within of the Educational Modules equal weight. Furthermore, the color scheme gives each Educational Module equal weight when compared to one another. While the team recognizes that there are differences in the relative importance of questions within modules or between modules in assessing the overall social, economic, and environmental sustainability of a dairy farm, no weighting scheme was attempted. No well developed method exists for weighting these diverse issues, and therefore the team did not wish to complicate the scoring process by implementing a arbitrary weighting scheme. One approach for weighting would be to convene and expert panel to design a weighting system. The results, however, would be expected to be highly dependent on the backgrounds and perspectives of the individual panelists.

It should also be noted that the Organic Educational Module does not have a scored set of questions, because only an accredited agent may certify a farm as organic under the USDA National Organic Program guideline standards. This certification is in part based upon empirical data, but also in part upon the agent's interpretation of practices, which may vary by inspector. Therefore, the team did not develop a set of questions or scoring methodology for this module. Instead, the team anticipates that the positive benefits of organic farming will be reflected by high scores in other modules, especially for environmentally-oriented topics which overlap with the guideline standards.

15. **Development of implementation plan.** The Team developed a plan to assist Ben & Jerry's with implementation of the Educational Modules. The plan includes details on the implementing organization, goal setting (including farmer performance and program reporting goals), implementation recommendations (including outreach, farmer selection, financial incentives, and program size), and details on updating the modules.

16. **Process for developing modules for other inputs.** In addition to the methodology described above, the Team defined a process for developing modules for other inputs. This process is slightly changed from the project methodology in that it was modified to take into consideration 'key learnings' that the Team gathered throughout the project as described in Application to Other Products section.

IV. DAIRY FARM SUSTAINABILITY TOOLKIT

DESCRIPTION

The primary audience for the Educational Modules is the Vermont dairy farmer. This report is all exclusive, in that it contains the Educational Modules that were created for farmer-use as well as additional information which was relevant to the creation of the modules. Within each indicator chapter is a sub-section consisting of the Educational Module, as denoted by a different font. These Educational Modules have been consolidated into a separate document, the Toolkit, with the intent of distributing to farmers. The following section contains the introduction to the Toolkit for farmers, by providing relevant background information, the structure of each Educational Module, and an introduction to the sponsoring organization.

INTRODUCTION TO DAIRY FARM TOOLKIT

INTRODUCTION

This Toolkit is designed to provide the Vermont dairy farmer with information on how his or her current practices compare economically, socially and environmentally to best management practices. Additional resources are provided on how to improve upon these practices, if desired.

UNDERSTANDING THE TOOLKIT

When farms are operated in balance with the earth's natural systems such as air, water, energy and nutrients, nature's principles are applied to sustain a farm's natural resources. Sustainable dairy farming strives to protect and enhance the natural environment, animal welfare, and local communities, while simultaneously ensuring profitability and providing a high quality of life for farmers and their families. This Toolkit contains ten Educational Modules, each of which covers a topic critical to sustainable dairy farming in Vermont. Modules focus on:

Animal Welfare	Nutrient Management
Biodiversity	Organic
Community Health	Pest Management
Energy	Soil Health
Farm Financials	Water Management

These modules are designed to be reviewed one by one, and in no particular order. This way, you have the flexibility to focus on areas of interest as time permits. Each module focuses on either an economic, environmental, or social issue and has the following parts:

- **Description.** Provides an explanation of the topic and its relevance to dairy farming. Also, any unusual terms that may be used are clarified in this section.
- **Incentives for Change.** This section addresses the benefits you can expect by improving practices within this area. Such benefits may include cost savings, improved human health and environment, improved public image, and regulatory compliance.
- **Assessment Questions.** You will be asked to answer approximately five to ten questions regarding the topic area. The majority of questions are multiple-choice with the first possible answer a status quo baseline practice and the last possible answer, a best practice. Each question or set of questions is followed by a brief discussion that provides an explanation of desirable practices and connections between the listed practices in relation to the indicator topic.

- **Linkages to Other Modules.** The topics in a given module are often linked to topics in other modules. This section outlines where related topics are covered in different modules. A chart displaying the linkages can also be seen below:

	Animal Welfare	Biodiversity	Community Health	Energy	Farm Financials	Nutrient Management	Organic	Pest Management	Soil Health Management	Water Management
Animal Welfare	X	X			X	X	X		X	X
Biodiversity		X	X		X	X	X	X	X	X
Community Health			X		X		X	X		X
Energy				X	X	X	X			X
Farm Financials					X	X	X	X	X	X
Nutrient Management						X	X		X	X
Organic							X	X	X	X
Pest Management								X	X	X
Soil Health Management									X	X
Water Management										X

- **Further Information.** After completing these short Educational Modules, you may find that you would like to gain additional information on the subject. This section includes additional information including helpful websites, organizations, and other resources.
- **Summary of Results.** This section summarizes your responses and rates your overall performance according to a 'stop light' system. A "Green" score means that you are utilizing best practices; a "Yellow" score means that while some good practices are being used, there are some key areas to improve upon; and a "Red" score means that you should carefully review your practices and make an effort to improve your practices in the topic area.

The goals of this program are to introduce farmers to best management practices as they relate to sustainable dairy farming. While many farmers may already be operating at a 'best practice' level, others may benefit from making changes to existing practices. Given that farmers' have limited time for other endeavors, when farmers do find that they could improve their processes, the anticipation is that this program will be a continual work in progress and may run for numerous years, as change, especially on a farm, takes time. The general process is anticipated as the following:

1. Evaluate your farms on a module-by-module basis, as time permits.
2. Meet with a representative from Organization X to review assessment results and discuss which areas are of top importance and to discuss alternative practices within the specific area of focus. Discuss limitations or concerns that are specific to your farm.
3. Make modifications to farm practices with assistance from the representative and/or additional information sources.
4. Steps 2 – 5 continue on an on-going basis, with periodic updates to the modules.

These steps and resulting changes in on-farm practices will help to transition the farm from existing practices to desirable practices or sustainable dairy farming. Gradual change is anticipated.

Sponsor Organizations

The development of the Educational Modules was sponsored and initiated by Ben & Jerry's, as they recognize the importance of dairy farmers to their product and want to

help create value for the dairy farmer. Part of their corporate mission is to improve the quality of life locally, nationally, and internationally and to use natural ingredients and conduct business in a way that promotes respect for the Earth's natural resources.[25]

TOOLKIT SUMMARY RESULTS

After you have answered the questions and filled in the summary sheet for each educational module, record your results from each in the Table 8 below by placing a checkmark in the appropriate column. By recording how you performed for all of the modules on this page, you can easily identify the key topic areas to address.

Please note, the Organic Module provides guidance into what practices are required to be certified organic and does not contain Assessment Questions, hence the "N/A" as noted below.

Table 8: Overall Summary of Results

	Green	Yellow	Red
1. Animal Welfare			
2. Biodiversity			
3. Community Health			
4. Energy			
5. Farm Financials			
6. Nutrient Management			
7. Organic	N/A	N/A	N/A
8. Pest Management			
9. Soil Health			
10. Water Management			

Areas to Focus on Immediately (Red):

_____

_____

_____

_____

Areas to Focus on in Near Future (Yellow):

_____

_____

_____

_____

V. ANIMAL WELFARE

INTRODUCTION

Animal welfare is defined by the American Veterinary Medical Association as the "human responsibility that encompasses all aspects of animal well-being, including proper housing, management, nutrition, disease prevention and treatment, responsible care, humane handling, slaughter and, when necessary, humane euthanasia."[26] While organic production has certain stipulations regarding appropriate treatment of cows, at this time, there is not any upcoming legislation regarding animal welfare. Rather, animal activist groups are causing a number of organizations, such as Heifer International, to take independent steps to outline acceptable animal welfare practices.

Dairy farmers inherently know that animal welfare should be a top concern. But significant pressure to increase profits may encroach on this consideration as a trade-off for short-term gain. As illustrated in Table 9, production per cow has more than doubled over the past 40 years. Unnatural methods to increase milk production, such as rBGH or an unbalanced diet, has increased milk production, but also increased operating costs associated with production, health care treatment and management.[27] For example, as milk yield increases, costly diseases, such as lameness, mastitis or fertility problems, also increases.[28]

Table 9: Vermont Dairy Production[29]

Year	No. Dairy	No. of	Avg.	Total Milk	Production	FEDERAL ORDER BLEND PRICE	
	Farms	Cows	Herd Size	Production (billion lbs.)	Per Cow (lbs.)	Current $ ($/cwt.)	1994 $ ($/cwt.)
1954	10,622	279,000	26	1.7	6,000	$4.04	$22.20
1964	6,687	241,000	36	2.0	8,420	$4.43	$21.20
1974	3,709	193,000	52	1.9	10,078	$8.60	$25.83
1984	3,170	183,000	58	2.3	12,628	$13.38	$19.09
1994	2,187	160,000	73	2.5	15,707	$13.10	$13.10
1995	2,056	157,000	76	2.5	16,166	$12.66	$12.30

To be successful in the long term, a farmer must provide for appropriate animal welfare, as "any animal will perform well below potential wherever under nutrition or stress is present."[30] The key when talking about increased profits while improving animal welfare is to focus on decreasing operating costs (as opposed to increasing milk production and revenue). Decreasing operating costs may be done through proper nutrition and living conditions, as these two areas also affect disease incidence, which is a costly expense. Many research articles discuss how improved herd health will decrease vet visits and may also increase milk production, however specific dollar amounts have not been calculated. Also numerous studies explore the benefits of animal welfare when comparing organic versus non-organic. However, these studies are larger in focus and do not break out benefits

associated with specific alterations in practice. Therefore, cost savings are addressed at a high level within the Educational Module. Ideally, additional studies will be performed that attach monetary benefits to improve animal welfare practices.

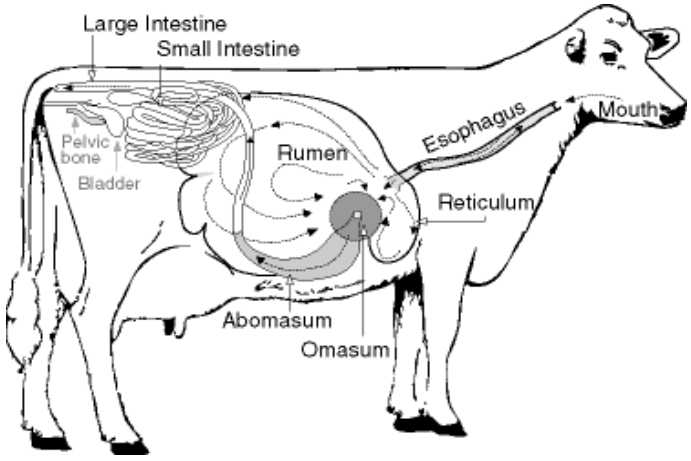
As outlined above, there are three main areas that should be reviewed in order to ensure optimal performance: nutrition, living conditions, and overall health.

Nutrition

Animal nutrition refers to the type and quality of feed that are provided to the dairy cows. They should receive a well-balanced portion of grain to ensure enough energy for milk production and fiber to ensure proper digestion process.[31] An imbalance will result in poor milk production and/or health concerns. A few of resulting health concerns include fat cow syndrome, ketosis, retained placenta, infertility problems, laminitis (foot problems), and displaced abomasums (DA).[32]

What is the proper "balanced" diet for a cow?

Cows are herbivores, meaning that they eat plants for nutrition. A further distinction within herbivores, that describe cows, are "ruminants." The easiest way to identify a ruminant is by the chewing activity that they are commonly seen doing. When a cow is "chewing her cud," she is breaking down the fiber part of the plant. In order to maintain a cow in top physical health, her diet must consist of fiber for the rumen stomach (cows have four stomachs – one of them being the rumen). Farmers are very aware of the amount of grain that must be fed to cows, as grain provides the energy that is required for milk production. The same is not true for fiber. While fiber is essential to keep the rumen working, it does not directly impact the volume of milk production, and therefore farmers may tend to overlook its importance. Cows with diets that lack the proper fiber, may develop acidosis, which is similar to heartburn in humans. In more extreme cases, a variety of metabolic diseases may occur. One such example is a displaced abomasums (DA),[33] which typically requires abdominal surgery to fix. Therefore, to maximize optimal health and comfort of the cow, a balanced diet that includes both grain and fiber, is required.



http://babcock.cals.wisc.edu/de/html/ch1/nutrition_eng_ch1.html

Living Conditions

Living conditions refer to the general comfort of the animal. This includes the quality, size, and cleanliness of the living and milking space. Living conditions are critical to consider, because they significantly impact the stress on a cow, which in turn affects productivity as well as overall health. Basic considerations, such as texture and slant of floor, ventilation and dry, clean bedding, are easy to overlook, but have important ramifications on herd health. Lameness affects 7 – 60% of cows with costs estimated to be more than $200/cow, plus lost milk.[34] The texture and slant of the floor, along with duration of standing on concrete, contribute to development of lameness. Social behavior also contributes to lameness in some cows; the lower the social status of the cow, the more time she stands and the higher the likelihood that she becomes lame.[35] Finally, the incidence of mastitis, one of farmers' top concerns,[36] can be reduced by providing clean, dry bedding.

Herd Health

Herd health can be assessed in terms of the incidence of diseases, such as mastitis, lameness, infertility, and metabolic disorders. Nutritional intake and living conditions are important determinants of herd health. Another important consideration is monitoring the health condition of animals coming onto the farm, as they could introduce diseases into the receiving herd. In addition to disease entering via animals coming onto the farm, humans can also transfer diseases to cows, if proper bio-security measures are not in place.

GLOBAL, NATIONAL AND REGIONAL TRENDS

On a global level, there is growing concern regarding the treatment of any domestic animals. International organizations, like Heifer International, that are active in developing countries, are creating standards to ensure that heifers that are given to families through their program will be properly nourished, treated, and housed. In developed countries, like the European Union, more stringent regulations exist to ensure improved animal welfare. One example is the prohibition of the use of rBGH, which causes cows significant discomfort and potential health damage, although it increases milk production by 10 – 15%.[37]

Ever increasing amounts of milk produced per cow is a trend that is not only seen in Vermont (see Table 10), but also nationally. Table 10 shows about a tripling in milk production per cow from 1950 to 2000. While some of this increase may be within the capability of a healthy animal, there is concern that the use of rBGH or other unnatural management practices to increase milk production are being used to the detriment of the health of herds. This increased milk production makes the animals more susceptible to diseases, mastitis and metabolic diseases and may also shorten their productive life.

Table 10: Milk Cows and Production of Milk in the US and CA[38]

Year	Milk Cows (1,000 head)		Milk Per Cow (pounds)		Total Milk Production (million pounds)	
	U.S.	California	U.S.	California	U.S.	California
1950	21,944	777	5,314	7,710	116,602	5,991
1960	17,515	824	7,029	9,800	123,109	8,075
1970	12,000	755	9,751	12,384	117,007	9,350
1980	10,799	896	11,891	15,153	128,406	13,577
1985	10,981	1,041	13,024	16,102	143,012	16,672
1990	10,127	1,135	14,642	18,461	148,313	20,953
1995	9,466	1,294	16,405	19,573	155,292	25,327
2000	9,210	1,523	18,204	21,169	167,658	32,240

Across the US, there is wide variation in the practices employed and types of dairy farms. Table 11 provides the average herd sizes for the US and two of the big dairy producing states: California and Wisconsin. A typical California dairy farm has large numbers of cows and maintains them in a dry lot environment. A dry lot environment consists of a large, outside, dirt paddock with a central milking parlor. Recently, concern has arisen "regarding the time period animals in large groups stand on hard surfaces while waiting to be milked and its association with increased lameness and culling rates for lameness in these herds."[39] There is also concern regarding the animal's ability to cope with heat and stress in these situations.

Table 11: Average Herd Size: US, CA, WI[40]

Year	U.S.	California	Wisconsin
1959	9	39	20
1964	13	63	24
1969	20	98	28
1974	26	134	33
1978	33	173	37
1982	39	204	42
1987	50	295	47
1992	61	400	50
1997	78	530	59

On the other hand, Wisconsin and Vermont tend to have smaller herd sizes (and dairy farms) as well as weather conditions that do not allow open, year-round, outside lots. In general, animal welfare tends to be better at smaller farm operations found in the Northeast as compared to the large, dirt paddocks that are typically in the Western US.[41] However, even for smaller operations, nutrition and living conditions are both important criteria that need to be carefully reviewed, especially since they have significant impacts on herd health.

FOCUS OF THE ANIMAL WELFARE EDUCATIONAL MODULE

Animal welfare is critical for a dairy farm. As discussed above, animal welfare can be broken into herd health, nutrition, and living conditions. Herd health is primarily a result of nutritional input and living conditions. The focus of the animal welfare module is on prevention and the majority of questions and best practices focus on nutrition and living conditions.

PARAMETERS SELECTED

The following Parameters were selected by means of two screening processes, as outlined in the Methodology section. For a listing of parameters that were not used, please see Appendix D.

Balanced Nutrition: The best way to tell if cows are receiving the appropriate nutrition is by ascertaining if they are receiving properly balanced feed. A number of Vermont farmers indicated that they rely on the feed supplier to provide information regarding proper nutrition. Proper nutrition impacts herd health and milk production.

On-Farm Health: To gain insight into the health of the cows, it is essential that the current level of health be understood. This includes understanding the prevalence of diseases, such as mastitis, lameness, and metabolic diseases. It also includes measures such as the body condition of cows, the type and frequency of vaccines, and the preventative measures that are in place to encourage healthy cows.

Incoming Animals: The health of the animals on the farm must be protected from diseases that may enter the farm via animals or humans. The Mad Cow disease outbreak increased awareness about how easy it is to spread diseases from one farm to another. Since then, there has been increased attention to the practices used by farmers and visitors who go onto multiple farms. There are also specific best practices regarding the entry of new animals onto the farm.

Production Amounts: As discussed above, there is a strong connection between the level of milk production and the likelihood of disease. Therefore, it is important to understand the milking demands that are placed on cows on a given farm. There is concern that increased milk production per cow is causing shorter average life-spans due to a rapid decline in milk production (as well as a higher culling rate, because of lower production volumes).[42]

Housing/Stall/Pasture: This is an important parameter for living conditions as well as for herd health. The type of housing has significant impact on sanitation and cow comfort, which both influence overall animal health. Housing may be provided in many forms, including open grazing, stanchion barn, and free stall systems. Research and conversations with experts indicated that there is not one method that is widely accepted as the best practice. For example, pasturing cows requires additional stockmanship skill and additional attention to nutrition and environmental considerations, such soil loss. If these requirements are not provided, this practice may be worse than a confinement operation that provides a balanced diet and stores manure and silage appropriately. Thus, instead of accessing what type of housing is provided, questions were created to address components of outcomes that may result from use of different housing systems.

Milk Parlor and Equipment: Cows are typically milked two times per day for about 10 minutes per milking (however, the standing and lining up time may be substantially longer). They are also typically milked for about 300 days per year. That means, they spend a significant amount of their time either attached to the milking machine or waiting to be milked. The conditions of the equipment and the milking parlor, therefore, have significant impact on the cow, primarily from a health perspective.

EDUCATIONAL MODULE

Combining research on the Animal Welfare indicator, global, national, and local trends and the most appropriate parameters, the Team developed the following Educational Module.

ANIMAL WELFARE EDUCATIONAL MODULE

Description

Animal welfare is defined by the American Veterinary Medical Association as the "human responsibility that encompasses all aspects of animal well-being, including proper housing, management, nutrition, disease prevention and treatment, responsible care, humane handling, slaughter and, when necessary, humane euthanasia."[43] While dairy farmers inherently know that animal welfare should be a top concern, significant pressure to increase profits may encroach on this consideration as a trade-off for short-term gain. To be successful in the long term, a farmer must provide for appropriate animal welfare, as "any animal will perform well below potential wherever under nutrition or stress is present."[44]

Three main areas should be reviewed in order to ensure optimal performance: nutrition, living conditions, and overall health. Animal nutrition refers to the type and quality of feed that are provided to the dairy cows. They should receive a well-balanced portion of grain to ensure enough energy for milk production and fiber to ensure proper digestion.[45] An imbalance will result in poor milk production and/or health concerns. Living conditions refer to the general comfort of the animal. This includes the quality, size, and cleanliness of the living and milking space. Herd health refers to incidence of diseases, such as mastitis, lameness, infertility, and metabolic disorders will be used as a way to assess herd health. Nutritional intake and living conditions are important determinants of herd health.

Incentives for Change

- **Cost savings.** When pressured to increase profits, farmers tend to focus on increasing volume rather than on decreasing operating costs. By increasing milk volumes through unnatural means (rBGH, unbalanced feed, encouraging higher consumption, etc.), animal welfare may suffer and cost as much or more than the increase in profits due to associated production costs, health treatment costs and management demands.[46] For example, as milk yields increase, diseases, such as lameness, mastitis or fertility problems, also increase.[47] The greater the work demands on the cow, the more susceptible they are to disease and stress. Proper nutrition and living conditions can stave off disease, via prevention. Given the high costs associated with disease, such as vet costs, and lost revenues due to decreased milk production, farmers should investigate ways to prevent disease or other detriments to herd health. It is important to balance and understand the connection between high production and healthy cows.

- **Improved public image.** Farmers are unfortunately under critical review by the public that may or may not truly understand the actual needs of the animals. Due to the increasing threat of unwanted attention from animal activist groups, a number of organizations are taking independent steps to ensure they do not come under scrutiny. One such example is Heifer International. This non-profit group provides a heifer to a family that is struggling to make ends meet. They recently developed guidelines regarding animal welfare practices for the receiving families. Similarly, the farmer that proactively modifies his or her practices not only avoids this potential negative publicity, but may also receive positive responses.

Assessment Questions

For all questions, please choose the categories that best identify your current management practices. Use the summary sheet on the last page of this module to evaluate overall performance.

- **HERD NUTRITION**[48]
  1. Herd nutrition is inadequate or not monitored.
  2. Farmer works with off-farm organization that has nutritional expertise and determines appropriate balance for cows.
  3. In addition to #2, farmer understands connection between metabolic diseases (such as ketosis, retained placenta, infertility, etc.) and nutritional needs. Records are kept regarding rations and nutritional value.
  4. In addition to #3, rations are modified/reduced based on excess nutrients passing through cows into the manure.

The level of understanding and monitoring involved in herd nutrition is important because it has significant implications for milk production and herd health.[49] By keeping records regarding changes in diet, patterns may emerge that will help to identify best nutrients for a specific herd. The closer the farmer and/or nutritionalist can get to meet each cow's exact needs, the more cost-effective the process will be.

- **OVERALL HEALTH**[50]
  1. Herd health is inadequate.
  2. Herd health is recorded for each cow, by milk production, body condition, diseases, foot and leg problems, vaccinations and medications. Veterinarians make monthly visits to inspect animals and sick animals are given appropriate vaccinations and antibiotics.
  3. In addition to #2, herd health is visually checked daily. Sick cows are housed and milked separately from the herd.
  4. In addition to #3, farmer focus to determine causes of sub-optimal health issues and implement preventative measures, with help from specialists, like veterinarians.

Understanding and monitoring herd health is critical to understand the condition of your cows. It is important to analyze and track cows individually, to ensure each cow is in optimal health and producing high quality milk. Similarly, it is important to separate sick cows from the rest of the group to minimize the spread of disease. Taking preventative measures is a best practice as problems are corrected before they start.

- **HEALTH OF INCOMING/OUTGOING ANIMALS**[51]
  1. Incoming animals without known health histories are brought directly onto farm.
  2. Incoming animals are from herds with known health status and effective vaccination programs.
  3. In addition to #2, incoming animals are carefully examined for health concerns and are thoroughly washed before bringing them onto the farm. Visitors wear booties or clean their boots prior to entering the barn.

4. In addition to #3, animal delivery to renderers and cattle dealers is done outside of barns, without contact between these individuals and other animals. Additional bio-security measures, such as farm signage instructing visitors how to proceed onto the farm, are taken.

Just as there is concern regarding the spread of disease within the farm, steps should also be taken to decrease the chance of spreading disease among farms. A few simple precautions regarding animal transportation and integration can minimize the potential risk.

- **MILK QUALITY**
  1. While milk quality, as measured by somatic cell count (SCC), is reported, there is no time to review this information.
  2. Milk quality is periodically monitored through SCC. Farmer understands milk quality and health implications of high SCC, and monthly average is less than 350,000.
  3. SCC counts are monitored regularly, and farmer has acceptable target range of SCC. Average monthly SCC is less than 250,000.
  4. In addition to #3, the average monthly SCC is less than 150,000.

An economic consideration via price premiums is determined in part by SCC, as set by the St. Albans Co-op. SCC indicates the presence of mastitis, which decreases milk production and may be contagious. In terms of managing mastitis, early identification is best to prevent spreading, and various management practices can reduce the likelihood of this infection. For example, farmers have seen a decrease in mastitis incidence when they increase the amount of time their cows are outside (to be more than 50% of the time). This pasturing assumes optimal outdoor conditions, such as well-drained pastures to minimize mud. This deals effectively with environmental pathogens that cause mastitis. The other cause of mastitis, contagious pathogens, can be decreased by correctly managing milking procedures.[52]

- **LACTATIONS**[53]
  1. Farmer does not monitor the number of lactations per cow.
  2. Farmer monitors number of lactations per cow and herd averages less than 3 lactations per cow.
  3. Farmer monitors number of lactations per cow and herd averages 3 to 5 lactations per cow.
  4. Farmer monitors number of lactations per cow and herd averages more than 5 lactations per cow.

"Most modern dairy cows have a life span of less than four lactations."[54] Cows that are stressed or treated only to optimize milk production typically have a shorter productive life span. A farm that consistently has younger herds may produce more milk, but with higher operating costs related to more frequent heifer replacement.

- **HOUSING/HANDLING AREAS**[55]
  1. Housing and handling areas are inadequate, causing undue stress. Walking areas are poor quality, either slippery or too rough. Cattle spend over 4 hours/day standing.
  2. Housing and handling areas are maintained in clean and dry conditions with adequate clean bedding, feeders and water stations.
  3. In addition to #2, housing and handling areas are large enough to allow normal social behaviors and minimize cow stress.
  4. In addition to #3, new or renovated housing/handling areas implement advanced design features to minimize stress by aligning cow movement patterns to match a cow's own natural tendency.

Stress levels of a cow can not only impact productivity and depressed social behavior, but also overall health. Housing features significantly impact stress levels. The type of flooring in walking and standing areas, as well as the amount of time standing on concrete, also have large impacts on the incidence of lameness. Additionally, clean, dry bedding is critical to prevent mastitis.

- **STALLS**
  1. Stalls are inadequate, causing undue stress.
  2. Stall dimensions are large enough for cows to lie comfortably, including sufficient width, headroom and clean bedding.
  3. In addition to #2, cows use stalls as designers intended. Each stall has TWO of the following attributes: slight slope to the stall, applied lime to base, appropriate lighting or sufficient ventilation.
  4. In addition to #3, there are 5% more stalls in the barn than there are cattle, enabling normal social behaviors and minimizing cattle stress.

Cows, especially in confinement operations, spend a significant amount of time in their stalls. Ensuring that the cow can maneuver around comfortably is critical to its health. If a stall is not designed properly, the cow may be forced to behave in non-natural ways (such as standing for long time periods). Sometimes the physical design of the stall is sufficient, however, social relations among cows may disrupt optimal behavior. For example, it is not uncommon to see lower social standing cows forced to stand for long periods of time, mainly because the only place to lay down is close to a dominant cow. This, too, results in an increase in health problems and a decrease in milk production. By providing additional stalls, the farmer allows a comfortable place for these lower social standing cows.

- **PASTURING**[56]
  1. Pastures are open-grazed, undivided and inadequate for all pasturing cows.
  2. Pastures are adequate for all pasturing cows. If cows are wintered outside, conditions are carefully monitored and provisions are made to ensure adequate food, water, bedding and shelter during severe weather; shelter and teat care are adequate to prevent frostbite; sufficient extra feed is provided to maintain body condition; cows are clean and dry when turned out after milking; and manure from wintered cattle is not allowed to contaminate surface water.

3. In addition to #2, at least four paddock divisions are maintained. Rotations are scheduled to maintain adequate re-growth.
4. In addition to #3, forage species are managed for maximum, vegetative production. Forage stubble heights are maintained by cows. Supplemental feed, water and shelter sites within paddocks are also rotated to prevent erosion and reduce compaction in these areas.

While mixed opinions exist regarding herd health benefits of pasturing, this topic was included for completeness as optimal pasturing conditions lead to improved herd health. Pasturing cows allows them the freedom to exercise and live in a more natural environment. Again, as with confinement, certain provisions must be considered for this method to be optimally beneficial for both the cows and the land.

- **MILKING EQUIPMENT AND PARLOR**[57]
  1. Milking equipment and facilities are not in good operating order.
  2. Milking equipment and facilities are adequate and in good working order.
  3. Milking equipment is tested for proper function. Facilities are designed and maintained for animal comfort. Milking area is clean and well ventilated.
  4. In addition to #3, newborn calves are monitored in the first 48 hours to ensure they consume sufficient colostrum.

Given that cows are typically milked twice a day, it is critical to the comfort of the animal that the milk equipment is functioning properly. The milking facility is also an area where contagious diseases can be spread. By increasing the cleanliness and ventilation in these areas, the likelihood of spreading diseases is decreased.

- **CALF RAISING CONDITIONS** (Please check all that apply)
  - ❑ Calves consume colostrum during the first 48 hours.
  - ❑ Calves receive roughage by two weeks of age.
  - ❑ Sufficient space is provided for calves to lie comfortably, with legs stretched out.
  - ❑ Calves are provided clean, dry, and well-ventilated housing.
  - ❑ Calves' navels are dipped in iodine.

Special attention is required early in the life of a cow in order to ensure an optimally healthy life. Just as with mature cows, the three things that must be considered for calves are: nutrition, living conditions and overall health. For calves, nutritional concerns revolve around consuming colostrums shortly after birth and roughage within the first two weeks. Living conditions for calves should be clean, dry and well ventilated with sufficient room for movement and to lie comfortably. Just as for older cows, living conditions can help to discourage (or encourage if not appropriate) disease incidence. One final practice to ensure optimal health for the calf is dipping the umbilical cord in iodine. The umbilical cord is a hallow tube and if not treated properly, pathogens which cause disease can enter the calf's circulatory system. This can result in mortality or naval infection. Iodine serves to clean, sanitize and dry the end of the umbilical cord, which in turn closes the tube quicker, thereby decreasing the chance of pathogens entering the calf's system.[58]

Linkages to Other Modules

While the questions above cover the basics of animal welfare, other practices also have impacts. Please review your practices regarding the following topics in the Educational Modules listed below.

ANIMAL WELFARE TOPIC	OTHER MODULE(S)
Manure Management	Nutrient Management
Clean Water	Water Management
Genetic Diversity	Biodiversity
Potential Erosion	Soil Health
Living Conditions and Nutrition	Organic

Further Information

Additional details and information on the above can be obtained through the following programs.

- **Appropriate Technology Transfer for Rural Areas (ATTRA).** "Sustainable Agriculture: An Introduction." http://attra.ncat.org. ATTRA specializes in developing sustainable agricultural information and tools. For a summary of the practices they advocate regarding animal welfare, see "Sustainable Agriculture: An Introduction" at http://attra.ncat.org/attra-pub/PDF/sustagintro.pdf. Contact: Ann Wells, phone: 1-800-346-9140.

- **The Food Alliance.** http://www.thefoodalliance.org/. This organization certifies producers, which use socially and environmentally responsible farming practices. The certification process includes sections on natural area management, watershed management, crop management, pest management, pastureland management, and animal welfare. Details on animal welfare are included under animal husbandry.

- **Farm Animal Welfare Council (FAWC).** This organization was established by the United Kingdom government but is an independent advisory board that is active in reviewing the welfare of farm animals. They produced a report, "Report on the Welfare of Dairy Cattle by Farm Animal Welfare Council," which identifies a number of concerns and solutions regarding dairy cattle. http://www.fawc.org.uk/reports/dairycow/dcowrtoc.htm.

- **Facility Designs that Minimize Stress.** Dr. Temple Grandin, as Associate Professor of Animal Science at Colorado State University, has conducted research regarding the design of cow facilities and how to minimize stress on the animal. While she has focused more on beef cattle, there are crossover learnings. Specific topics and links with additional information are:
  - Non-slip flooring: http://www.grandin.com/design/non.slip.flooring.html
  - Livestock handling systems: http://www.grandin.com/design/design.html
  - Handling and transport: http://www.grandin.com/behaviour/transport.html

- **Cooperative Extension, Institute of Agriculture and Natural Resources, University of Nebraska - Lincoln.** www.ianr.unl.edu/pubs/animaldisease/g1032.htm#nutritionally. This website, titled "Dairy Cow Health and Metabolic Disease Relative to Nutritional Factors," contains

information provided by a veterinarian and dairy specialist. It focuses on the interconnections between herd health and metabolic diseases.

Summary of Results For Animal Welfare

Instructions: In the table below, please record the score for the answer you selected for each question. For multiple-choice questions, the response number serves as your score for that category (i.e. choice # 2 is worth 2 points). For "check all that apply questions," please see scoring criteria for each question in the chart below. Once all responses have been completed, add up the answers and record the total.

QUESTION	ANSWER/SCORE
1. Herd Nutrition	
2. Overall Health	
3. Health of Incoming/Outgoing Animals	
4. Milk Quality	
5. Lactations	
6. Housing/Handling Areas	
7. Stalls	
8. Pasturing	
9. Milk Equipment	
10. Calf Raising Conditions (Add 1 for each box checked)	
Total Score	
Total Possible Points	41

Interpretation: The next step in understanding your farm's performance in the category of Animal Welfare is to compare your results to best practices. Below is a table that ranks your performance from best practices (green) to practices that require improvement (red). Compare the number of points you received for your farm compared to optimal practices.

	Point Range	Interpretation
Green	35 - 41	Best practices regarding Animal Welfare are currently being employed on this farm.
Yellow	25 - 34	Farm is using some good practices regarding Animal Welfare, however there are some key areas that should be improved upon.
Red	9 - 24	Animal welfare practices should be carefully evaluated and a strong effort should be made to adopt improved practices in several areas.

VI. BIODIVERSITY

INTRODUCTION

As defined by Article 2 of the Convention on Biological Diversity (CBD), biological diversity is "the variability among living organisms from all sources including…terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems."[59] The CBD recognizes that interactions between bio-diverse species provide "life sustaining systems" such as oxygen cycling and sustenance as well as "social, economic, scientific, educational, cultural, recreational and aesthetic values." It also recognizes that human activity has the ability to negatively impact biodiversity and that humans should make efforts to conserve biodiversity.

The three levels of biodiversity identified by the CBD (diversity within species, between species and of ecosystems) provide the primary focal points for most research and conservation efforts surrounding biodiversity today:

- Genetic diversity refers to the genetic variation within species. Chromosomes, genes, and DNA "determine the uniqueness" of each individual within a species.[60] Genetic diversity is important to protect crops and food systems from disease and other natural events such as drought that may wipe them out.[61] Many natural populations have diverse genetic pools, creating traits that allow the species to survive these changing conditions. Species become susceptible to extinction when genetic homogeneity increases within the species. This is becoming more the case as farmers rely on a limited gene pool for artificial insemination of cows or seeds of the same genetic make-up from centralized suppliers. Scientists conserve genetic diversity of crops, livestock, and wild species through "ex-situ" conservation (such as through gene banks) or through "in-situ" conservation (by sustainably managing genetic diversity of crop varieties within traditional agricultural, horticultural or agri-silvicultural cultivation systems).[62]

- Species diversity refers to the variety of species within an ecosystem. Species interactions continually affect ecosystem processes and shape ecosystem structures. According to the CBD, "1.75 million species have been identified" thus far, but scientists estimate that there are actually about 13 million species, with estimates ranging from 3 to 100 million."[63] Every species has evolved to fulfill a particular niche in the ecosystem. As humans change the environment, some species are unable to adapt to the new circumstances and go extinct. Species diversity can be measured in a number of ways. The two most common are richness (number of species) and evenness (abundance of species within a given ecosystem), though more detailed indices have also been developed.[64]

- The CBD defines 'ecosystem' as "a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit."[65] Ecosystems generally contain a number of different landscape types including woodland, wetlands, prairies and scrubland. These units can be at any range or scale, but generally transcend political or socio-economic boundaries, and often include diverse

functional and structural components that naturally change over time. As the diversity of the landscape increases, the habitat types available for biodiversity also increase in an ecosystem.

Agriculture, no matter how small the farm, alters the biodiversity in a landscape through the development of pasture land, crop fields, and new structures. Oftentimes, farms are built in floodplains or along rivers and streams, areas typically highest in terms of biodiversity.[66] The implementation of highly-managed monoculture systems or development of pastureland displaces native species and reduces the biodiversity upon which the ecological functioning of an ecosystem depends. Genetically modified organisms can also displace native species or have adverse impacts on native populations. An example is one strain of Bacillus thuringiensis (Bt) corn, Bt 176. This strain is resistant to the European corn borer, a pest which costs US farmers approximately $1 billion in lost crop yields and crop protection costs, led to a severe decline in populations of monarch butterflies.[67] Luckily the effects of the strain were small-scale in that only an estimated 2% of GMO corn was Bt 176 compared to strain MO810 which accounts for almost 95% of planted GMO corn.[68] While this particular strain has since been removed from the marketplace, new GMOs may also have negative, unintended consequences.

Sustainable agricultural processes that foster biodiversity through natural means and low-impact management practices help restore ecosystem functioning and increase biodiversity levels.[69] These practices may also have economic benefits. Practices such as low-till and no-till farming of feed crops, inter-species plantings, grazing-based management, and other practices allow farmers to decrease use of costly external inputs such as fertilizers and insecticides and replace these inputs with natural processes.[70] Use of biodiversity-friendly practices can also eventuate into a marketing opportunity. For example, the Food Alliance (www.thefoodalliance.org) issues program certifications to environmentally-sound producers, allowing those producers the opportunity to differentiate their products in the marketplace.

GLOBAL, NATIONAL AND REGIONAL TRENDS

Biodiversity levels on all three scales are rapidly declining globally due to increased development by humans. The World Wildlife Fund reports that within the next 30 years, as much as 20% of the world's species will go extinct.[71] Within the United States alone, as of 2003, the Fish and Wildlife Service has classified a total of 1,821 species as threatened and endangered.[72] Of these, 749 are plant species and 1,072 are animal species. Other organizations estimate that up to one-third of all plants and animals within the US are at risk.[73]

Vermont is also affected by declining biodiversity levels. Vermont has an estimated 2,274 species.[74] Currently, the State of Vermont's Nongame and Natural Heritage Program has identified 28 fish, 19 amphibians and reptiles, 16 mammals, 59 birds, 83 invertebrates (mostly beetles), 20 moths and 12 mollusks as rare and uncommon.[75] The number comprises almost 10% of all species in Vermont. Moreover, eight of these species are listed as threatened and endangered under the Endangered Species Act.[76] These include six animals (the bald eagle, Indiana bat, eastern puma, puritan tiger beetle, dwarf wedgemussel, and grey wolf) and two plants (Jesup's milk-vetch, and Northeastern bulrush).

FOCUS OF THE FARM FINANCIALS EDUCATIONAL MODULE

While genetic, species and ecosystem measures of biodiversity are necessary for providing a complete understanding the level of biodiversity in a given area, biodiversity at the genetic and species level is complex and difficult to measure. Gene mapping requires scientific expertise, costly lab tests, and time-intensive analysis. Species diversity assessments require time-intensive fieldwork and knowledgeable biologists and zoologists to classify and record species richness and abundance, prior to creating biodiversity indices. Given the complexity of and expertise needed for collecting this information, the Team has worked to identify proxy measures for assessing genetic and species biodiversity on a farm. These measures are 'ecosystem' level measures of biodiversity, which provide more general indications of a farmer's conservation and biodiversity protection practices.

PARAMETERS SELECTED

The following parameters were selected by means of two screening processes, as outlined in the Methodology section. For a listing of parameters that were not used, please see Appendix D.

Genetic Diversity of Crops: Cultivars are seeds cultivated from refinements of wild species through selective breeding and hybridization. Each cultivar is developed to provide certain characteristics (i.e., ability to grow in wet areas, resistance to drought, etc.).[77] Farmers choose different cultivars based upon the particular growing conditions in their region. In general, the more cultivars grown on a farm in a given year, the more resistant the crop is to insects, disease, and varying weather patterns. Increasing the number and types of crops in a field also provides habitat for species, increasing biodiversity as well as sustaining beneficial species such as spiders and birds.

Natural Area Conservation: Biodiversity increases when a multitude of habitats (in terms of structure and function) are available to wildlife. For example, a landscape with a variety of structural components such as a farm that has pasture, cropland, woodland, and riparian areas is more diverse than an ecosystem with only one structural component such as cropland.[78] As of 1992, Vermont has a fairly diverse farmland structure. Of Vermont's 1.28 million acres of farmland, 52% is cropland, 37% is woodland, 7% is pastureland, and 4% is for other uses.[79] While this number indicates a varied landscape, not all farms may be equally diverse in terms of structure and function.

A number of organizations and researchers have proposed questions to evaluate natural area conservation. A parameter for defining structural diversity could be the percentage of area managed to provide the following structural components: pasture, cropland, woodland, and riparian area.[80] The Food Alliance evaluates the availability and quality of wildlife habitat using a four level scale. The lowest rating is if "few wild areas exist around fencerows or wooded areas" whereas the highest rating indicates that a farmer has planned or taken specific actions to improve and enhance wildlife habitat.[81] It also requires that "pastures are managed for multiple (domestic and wild) species" and that "nesting sites or other habitat for beneficial birds is provided." This measure was determined to be best given that it provides a number of practices from "poor" to "best."

Management of Riparian Areas: According to ATTRA, riparian areas are "the edges of streams, wet weather creeks, ditches, or any other area where water flows at various times of the year."[82] Riparian areas on farms provide unique habitats for a diverse set of plants and organisms and are often the most diverse areas, such as Vermont.[83] To date an estimated 35% of Vermont wetlands have been lost.[84] Protection of these areas aids in conserving both species and ecosystem diversity. ATTRA evaluates riparian area health through a number of qualitative questions about riparian area management.[85] The Food Alliance evaluates a farmer's management of riparian zones using a four level scale.[86] The scales is based on such factors as distance from animal confinement areas to on-farm water sources, cow access to surface water, and use of buffer areas

Pasture Management: Sustainable pasture management helps to minimize environmental impact to the ecosystem and maximize economic and social benefits to the farmer. For example, cultivation of native pasture species and trees throughout pastured areas as well as the development of buffer strips around riparian areas in pastures increases habitat for native and beneficial species, allowing for better functioning ecosystem processes. While several frameworks recommend development and implementation of a farm management plan, only the Food Alliance explicitly evaluates a farmer's environmental planning efforts for pastures and plantings.[87] Because the circumstances for managing pastures and plantings differ, the Food Alliance's question was adopted to better fit pasture conditions alone. There are also a number of best practices that facilitate sustainable pasture management. These best practices are combined into the Food Alliance question described above to create a comprehensive question on pasture planning and management.

Crop Field Management: The same benefits achieved through pasture management can be achieved in crop land management. The Food Alliance measure described above was adopted to fit cropping conditions. In addition, best practices for healthy crop field management are included to create a comprehensive question on crop field planning and management.

Adjacent Area Management: Because ecosystems cross political and ownership boundaries, farmers should look beyond their farmed areas to improve ecosystem health. This includes potential pollutants coming onto the farm as well as leaving the farm. While some assessment tools looked at hedgerow plantings, the Food Alliance evaluates a farmer's environmental adjacent area management using a comprehensive, four level scale.[88] The lowest rating is for when "adjacent areas of cropland or pasture are not managed" whereas the highest rating indicates that a farmer manages adjacent areas under his control to curb pest problems, to prevent pesticide and fertilizer movement off-site, and to include "hedgerows, windbreaks, or other low-maintenance plantings to encourage specific beneficial organisms and/or native wildlife."

Use of GMOs: Genetically modified organisms (GMOs) and genetically modified micro-organisms (GMMs) are defined as "organisms (and micro-organisms) in which the genetic material (DNA) has been altered in a way that does not occur naturally by mating or natural recombination."[89] According to the Genomes Project of the US Department of Energy Office of Science (DOE), genetic modification is a "special set of technologies that alter the genetic makeup of such living organisms as animals, plants, or bacteria….Combining genes from different organisms is known as recombinant DNA technology, and the resulting

organism is said to be 'genetically modified,' 'genetically engineered,' or 'transgenic'."[90] Today genetically modified crops are widely used in over 40 countries and on 6 continents, but 99% of genetically modified crops are grown in four countries, the United States (68%), Argentina (23%), Canada (7%), and China (1%).

DOE also describes the potential benefits of and controversies surrounding the use of GMOs. Benefits listed by DOE include:

- Crops: Enhanced taste and quality; reduced maturation time; increased nutrients, yields, and stress tolerance; improved resistance to disease, pests, and herbicides; and new products and growing techniques.
- Animals: Increased disease resistance, productivity, hardiness, and feed efficiency; better yields of meat, eggs, and milk; and improved animal health and diagnostic methods.
- Environment: "Friendly" bioherbicides and bioinsecticides; conservation of soil, water, and energy; bioprocessing for forestry products; better natural waste management; and more efficient processing.
- Society: Increased food security for growing populations.

Potential problems with use of GMOs listed by DOE include:

- Safety Risk: Potential human health impact including allergens, transfer of antibiotic resistance markers, and other unknown effects as well as potential environmental impacts including unintended transfer of transgenes through cross-pollination, unknown effects on other organisms (e.g., soil microbes), and loss of flora and fauna biodiversity.
- Access and Intellectual Property: Domination of world food production by a few companies; increasing dependence on Industrialized nations by developing countries; and bio-piracy—foreign exploitation of natural resources.
- Ethics: Violation of natural organisms' intrinsic values; tampering with nature by mixing genes among species; objections to consuming animal genes in plants and vice versa; and stress for animals.
- Labeling: Not mandatory in some countries (e.g., United States) and mixing GM crops with non-GM confounds labeling attempts.
- Society: New advances may be skewed to interests of rich countries.

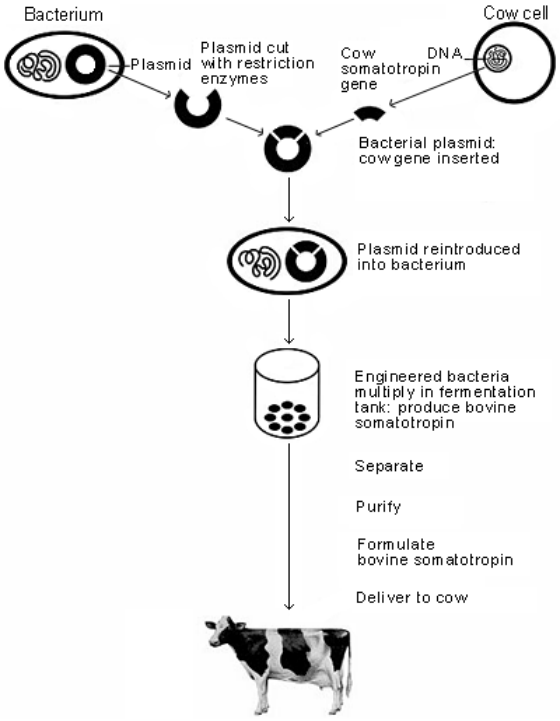
Controversies over the use of GMOs have been especially strong in Europe where strict regulations have been instituted for approval of GMOs.[91] The newest directive, Directive 2001/18/EC, requires in-depth environmental assessments and public comment on the approval and release of any new GMOs. Sixteen GMOs were approved for use under the 1990 regulations, but GMOs have been approved under the new 2001 regulations.

In the US, three federal agencies, the Food and Drug Administration (FDA), the Environmental Protection Agency (EPA), and the U.S. Department of Agriculture (USDA), have regulatory responsibilities over GMO crops. According to the Department of State, the "FDA provides voluntary pre-market consultations with food companies, seed companies, and plant developers to ensure that biotechnology derived foods meet regulatory standards for safety; the USDA's Animal and Plant Health Inspection Service (APHIS) licenses field testing of crops prior to commercial release of newly developed plant strains; and the EPA registers pesticides in U.S. commerce (including plants engineered to produce pesticides) and establishes levels at which pesticides in foods are permitted."[92]

A number of GMOs have been approved for use in the US.[93] However, public backlash against GMOs has caused concern over their use both in the US and Europe. As early as 1999, Archer-Daniels-Midland asked US producers to separate GMO and non-GMO produce due to increasing demands for non-GMO products in Europe and Asia.[94] GMOs are used in the dairy industry primarily in processed foods, cattle feed and to produce recombinant Bovine Growth Hormone (rBGH).

Bovine growth hormone, or bovine somatotropin (BST), is produced by the pituitary gland in cows and affects milk production. Genetically engineered microorganisms have been developed to produce an almost identical hormone (recombinant bovine growth hormone (rBGH)) that when injected into dairy cattle, can increase milk production by 10% to 15%.[95] The process for making BST is shown below (see Figure 2).

Figure 2: Bovine Somatotropin Production[96]



BST, when injected into cows can also be passed into offspring and create genetic modifications in the strains.[97] Negative effects of BST include excess milk production and probable udder pain for cows, increased udder infections, bacteria, pus, and antibiotic resistance.[98] These impacts in cows can be passed on to humans with links to increased risk of cancer and antibiotic resistance.[99]

The Biotechnology Industry Organization estimates that over 30% of U.S. dairy cows are injected with recombinant BST to increase milk yield.[100] Monsanto is currently the only company producing rBGH under the brand name Posilac® Bovine Somatotropin (BST).

EDUCATIONAL MODULE

Combining research on the specific indicator, global, national, and regional trends and the most appropriate parameters, the Team developed the following Educational Module.

BIODIVERSITY EDUCATIONAL MODULE

Description

Biodiversity refers to all plants, animals, and microorganisms existing and interacting within an ecosystem.[101] In an agricultural setting, biodiversity can be viewed in layers: microorganisms and worms living in the soil; native plants, crops, and trees growing on top of the soil; and insects, birds, and animals inhabiting the plants, crops, and trees. The greater the number of microorganisms, plants, and animals in an ecosystem, the higher the level of biodiversity is. Humans also live within and alter natural ecosystems.

Biodiversity levels are rapidly declining globally due to increased development by humans. The World Wildlife Fund reports that within the next 30 years, as much as 20% of the world's species will go extinct.[102] Within the United States alone, as of 2003, the Fish and Wildlife Service has classified a total of 1,821 species as threatened or endangered.[103] Other organizations estimate that up to one-third of all plants and animals within the US are at risk.[104] Vermont is also affected by declining biodiversity levels. Vermont has an estimated 2,274 species.[105] Currently, the State of Vermont's Nongame and Natural Heritage Program has identified 28 fish, 19 amphibians and reptiles, 16 mammals, 59 birds, 83 invertebrates (mostly beetles), 20 moths and 12 mollusks as rare and uncommon.[106] The number comprises almost 10% of all species in Vermont. Moreover, eight of these species are listed as threatened or endangered under the Endangered Species Act.[107]

Plant and animal species fulfill a number of important roles in regulating the natural and agricultural environment. Microorganisms and worms in soil convert nitrogen and other nutrients into a usable form for plants and trees. Plants help to manage water runoff, filter impurities and toxins from water sources, cycle oxygen and provide habit for animals. Animals, such as bats, spiders, birds and other insects help regulate insect and rodent pests. Insects such as bees help to pollinate crops and wild plant species. Many of these species interact and depend upon one another, making high levels of biodiversity important for the functioning of the entire system.

Agriculture, no matter how small the farm, alters the biodiversity in a landscape through the development of pastureland, crop fields and new structures. Oftentimes, farms are built in floodplains or along rivers and streams, areas typically highest in terms of biodiversity.[108] The implementation of highly managed monoculture systems or development of pastureland displaces native species and reduces the biodiversity upon which the ecological functioning of an ecosystem depends. Genetically modified organisms can also displace native species or have adverse impacts on native populations. An example is one strain of *Bacillus thuringiensis* (Bt) corn, Bt 176. This strain, which is resistant to the European corn borer (a pest which costs US farmers approximately $1 billion in lost crop yields and crop protection costs), led to a severe decline in populations of monarch butterflies.[109] Luckily the effects of the strain were small-scale in that only an estimated 2% of GMO corn was Bt 176 compared to strain MO810, which accounts for almost 95% of planted GMO corn.[110] While this particular strain has since been removed from the marketplace, new GMOs may also have negative, unintended consequences.

Sustainable agricultural processes that foster biodiversity through natural means and low-impact management practices provide an alternative. These processes help restore ecosystem functioning and increase biodiversity levels.[111] Practices such as low-till and no-till farming of feed crops, inter-species plantings, grazing-based management, integrated pest management techniques and other practices allow farmers to decrease use of costly external inputs such as fertilizers, pesticides, and GMO seed and replace these inputs with natural processes.[112]

Incentives for Change

- **Decrease in expensive external inputs.** The benefits of increasing biodiversity are most readily seen when the farm is viewed as part of an ecosystem. The key is to "identify and exploit combinations of crops, plants, animals, and practices that increase above- and below-ground diversity and foster proper ecosystem functioning."[113] For example, the use of no or low-till cropping practices maintains soil structure in the top layers of the soil surface, which provides habitat for species which recycle nutrients for plants. One square meter may contain 10,000 species with high population densities.[114] These species assist plants in nutrient uptake and protect plants from disease.[115] If destroyed by tillage practices and the application of certain pesticides, these species must be replaced by costly fertilizers as a means of maintaining production levels.

- **Marketing opportunity.** Certifications for environmentally and socially responsible agricultural production, awarded by groups such as the Food Alliance program (www.thefoodalliance.org), require that farmers work to enhance biodiversity. This sustainable farming certificate may allow farmers to receive a premium for their practices. Genetic biodiversity is also marketable. Most dairy farmers focus on the genetic lineage of their cows or utilize different cultivars when growing crops. Registering cows to certify genetic lineage may allow a farmer to receive higher prices for heifers sold in the marketplace.

Assessment Questions

For all questions, please choose the categories that best identify your current management practices. Use the Summary sheet on the last page of this module to evaluate overall performance.

➢ **GENETIC DIVERSITY OF CROPS**

1. I only use one variety of seed per crop per season.
2. I use more than one variety of seed per crop and track use of the different seed varieties in my fields.
3. I inter-mix different seed varieties to increase genetic diversity throughout my fields.
4. I inter-mix different seed varieties, crops, and utilize cover crops as a means of increasing biodiversity in my fields.

Chromosomes, genes, and DNA "determine the uniqueness" of each individual within a species. Having an array of unique individuals or a genetically diverse number of seed types is important to protect crops from disease and other natural events such as drought that may wipe them out.[116] Increasing the number and types of crops in a field also provides habitat for species, which increases biodiversity as well as encourages inhabitation by beneficial species such as spiders and birds.

- **NATURAL AREA CONSERVATION**[117]
  1. Few, if any, wild areas exist around fencerows or wooded areas to provide habitat for birds, mammals, or other wildlife.
  2. Fencerows and other areas are managed to provide limited wildlife habitat. Any pastures on the farm are in good health and provide limited wildlife habitat.
  3. Fencerows and other areas are managed to provide wildlife habitat. A percentage of pastures, rest pads, ditches and other wild areas are not grazed or mowed until grassland bird nesting is complete. Pastures are managed for multiple (domestic and wild) species.
  4. Fencerows and other areas are managed to provide wildlife habitat. Specific actions are planned and have been taken to improve and enhance wildlife habitat on the farm (Habitat Plan). Pastures are managed for multiple (domestic and wild) species. Native wildlife species are considered in the habitat plan and/or in action (e.g. raptors). Natural habitat areas are connected to provide corridors for wildlife.

Management for natural areas provides habitat for beneficial organisms and other forms of wildlife. While many farmers in the Champlain Valley may already utilize hedgerows and the natural features of the land to provide habitat for biodiversity, farmers in Northern and Southern Vermont may not. Well-structured habitat management plans help ensure higher levels of biodiversity.

- **MANAGEMENT OF RIPARIAN AREAS**[118]

Riparian areas are "the edges of streams, wet weather creeks, ditches, or any other area where water flows at various times of the year."[119] If you have a riparian area on your property, please indicate how you manage your cows:

1. Pastures and confinement areas are less than 50 feet from surface waters. Cow access to surface water sites is not restricted or monitored.
2. Pastures and confinement areas are at least 50 feet from surface waters. Cow access to water sites is restricted by fencing or vegetation.
3. Pastures and confinement areas are at least 50 feet from surface waters. Cow access to water sites is restricted to ensure healthy stream bank vegetation, adequate bank angles, and natural water habitat conditions without visible signs of erosion, sedimentation, and manure deposition in water.
4. Watering sites are developed and located away from stream courses, and cows are not allowed direct access to streams.

Riparian areas on farms provide unique habitats for a diverse set of plants and organisms and are often the most diverse in a given ecosystem.[120] They are therefore a priority for managing biodiversity on a farm. Cows around water bodies can cause erosion, trample diverse populations of aquatic vegetation, and cause high nutrient levels in streams due to uncontained manure. Management of cows to prevent water body damage increases ecosystem health and biodiversity levels.

- **PASTURE MANAGEMENT**[121]
  1. Pastures are managed without regard to environmental impact.

2. Natural plant varieties are established. Any planted varieties selected are compatible with current Integrated Pest Management methods.
3. Site and varieties are carefully selected and designed for optimum production with minimal agrochemical inputs.

- **CROP FIELD MANAGEMENT**[122]
  1. New plantings are established without regard to environmental impact.
  2. Varieties and planting systems are selected that are compatible with current Integrated Pest Management methods.
  3. Varieties and planting systems are selected and designed as per # 2, with at least some of the acreage in (non-GMO) pest-resistant varieties and/or designed to maximize habitat for beneficial organisms. Chemical pre-plant fumigants or other pesticides, if used, are applied by a certified custom applicator.
  4. Site, varieties and planting systems are carefully selected and designed for optimum production with minimal agrochemical inputs. Chemical pre-plant fumigants are avoided whenever possible. Sites are selected or otherwise prepared to avoid nematodes or pre-existing disease conditions. Cover crops are planted and incorporated before planting crops.

Depending upon land management practices, species may be displaced or even lost. Managing pasture and crop field lands in ways that enhance habitat increases production while only minimally impacting biodiversity. Herbicides and fungicides can kill not only pests, but also beneficial plants and fungi that may enhance nutrient uptake and provide disease resistance.

- **ADJACENT AREA MANAGEMENT (LANDS SURROUNDING YOUR PROPERTY)**[123]
  1. Areas adjacent to cropland or pasture are not managed.
  2. Areas adjacent to cropland or pasture under the control of the farmer are managed in response to known pest problems.
  3. In addition to #2, adjacent areas are managed to reduce potential for pest immigration as well as pesticide and fertilizer movement off-site and to encourage wildlife.
  4. In addition to # 3, adjacent areas are planted with hedgerows, windbreaks, or other low-maintenance plantings to encourage specific beneficial organisms and/or native wildlife.

While land ownership stops at property lines, ecosystems function across ownership boundaries. Managing what comes into and flows off your property can adversely or beneficially impact biodiversity.

- **GMOs** (Please check all that apply)
  - ❑ I do not use rBST.
  - ❑ I do not use GMO crops.

Genetically modified organisms (GMOs) are defined as "organisms in which the genetic material (DNA) has been altered in a way that does not occur naturally by mating or natural recombination."[124] The Genomes Project of the US Department of Energy Office of Science cites that some potential benefits associated with GMOs include: improved

quality and taste, increased yields due to decreased loss from pests and disease, increased disease resistance (which decreases the need for costly herbicides and insecticides), and new products. While this may be true, the risks associated with GMO use are also large. Some potential risks include production of new allergens, loss of flora and fauna biodiversity, unintended cross-pollination with natural crops, and problems associated with access to intellectual property.

Controversies over the use of GMOs have been especially strong in Europe where strict regulations have been instituted for approval of GMOs.[125,126] The newest directive, Directive 2001/18/EC, requires in-depth environmental assessments and public comment on the approval and release of any new GMOs. Public backlash against GMOs has caused concern both in the US and Europe. As early as 1999, Archer-Daniels-Midland asked US producers to separate GMO and non-GMO stock due to increasing demands for non-GMO products in Europe and Asia.[127] This trend against the use of GMO-altered crops and animal products may indicate a growing social backlash and financial risk to farmers using GMOs. Vermont itself has a number of active pieces of legislation trying to limit the use of GMO seed.[128] Given these developments and potential negative consequences, a better alternative may be the implementation of an integrated pest management plan which utilizes natural pest management methods and limited pesticide use instead of GMOs.

rBGH is one controversial GMO. Bovine growth hormone, or bovine somatotropin (BST), is produced by the pituitary gland in cows and affects milk production. Genetically engineered microorganisms have been developed to produce an almost identical hormone [recombinant bovine growth hormone (rBGH)] that when injected into dairy cattle, can increase milk production by 10% to 15%.[129] While the increase in production is large, rBGH when injected into cows, can also be passed into offspring and create genetic modifications in the strains.[130] Other potential negative effects of rBGH include excess milk production and probable udder pain for cows, increased udder infections, bacteria, pus, and antibiotic resistance.[131] These impacts in cows can be passed on to humans with links to increased risk of cancer and antibiotic resistance.[132] Due to controversy surrounding the hormone, rBGH has been banned in Europe and rejected by a number of companies including Ben & Jerry's.

Linkages to Other Modules

Water quality issues are tied to Soil, Animal Welfare, and Pest Management. The table below identifies where you can find more information on some of the topics mentioned in this module.

BIODIVERSITY TOPIC	OTHER MODULE(S)
Cover Crops	Soil Health
Pasturing	Animal Welfare
Crop/Pasture Insect Pests	Pest Management
Weeds	Animal Welfare

Further Information

Additional details and information on the above can be obtained through the following programs or sources.

- **Altieri, Miguel.** "The ecological role of biodiversity in agroecosystems." Agriculture, Ecosystems and Environment 74 (1999) 19-31. This article details how biodiversity is essential to a healthy and naturally-functioning agricultural system. It also describes management practices for enhancing biodiversity and restoring ecosystem function to farm lands.

- **Appropriate Technology Transfer for Rural Areas** (ATTRA) "Sustainable Agriculture: An Introduction." http://attra.ncat.org. ATTRA specializes in developing sustainable agricultural information and tools. For a summary of the practices they advocate regarding biodiversity, see "Sustainable Agriculture: An Introduction" at http://attra.ncat.org/attra-pub/PDF/sustagintro.pdf.

- **The Food Alliance.** http://www.thefoodalliance.org/. This organization certifies producers, which use socially and environmentally responsible farming practices. The certification process includes sections on natural area management, watershed management, crop management, pest management, pastureland management, and animal welfare. Details on biodiversity are included under wildlife habitat.

Summary Results for Biodiversity

Instructions: In the table below, please record the score for the answer you selected for each question. For multiple-choice questions, the response number serves as your score for that category (i.e. choice # 2 is worth 2 points). For "check all that apply questions," please see scoring criteria for each question in the chart below. Once all responses have been completed, add up the answers and record the total.

QUESTION	ANSWER/SCORE
1. Genetic Diversity of Crops	
2. Natural Area Conservation	
3. Management of Riparian Areas (If you don't have any riparian areas on your property, give yourself 4 points)	
4. Pasture Management	
5. Crop Field Management	
6. Adjacent Area Management	
7. GMOs	
Total Score	
Total Possible Points	25

Interpretation: The next step in understanding your farm's performance in the category of Biodiversity is to compare your results to best practices. Below is a table that ranks your performance from best practice (green) to practices that require improvement (red). Compare the number of points you received for your practices compared to optimal practices.

	Point Range	Interpretation
Green	21 – 25	Best practices regarding Biodiversity are currently being employed on this farm.
Yellow	16 – 20	Farm is using some good practices regarding Biodiversity; however there are some key areas that should be improved upon.
Red	6 – 15	Biodiversity management practices should be carefully evaluated and a strong effort should be made to adopt improved practices in several areas.

VII. COMMUNITY HEALTH

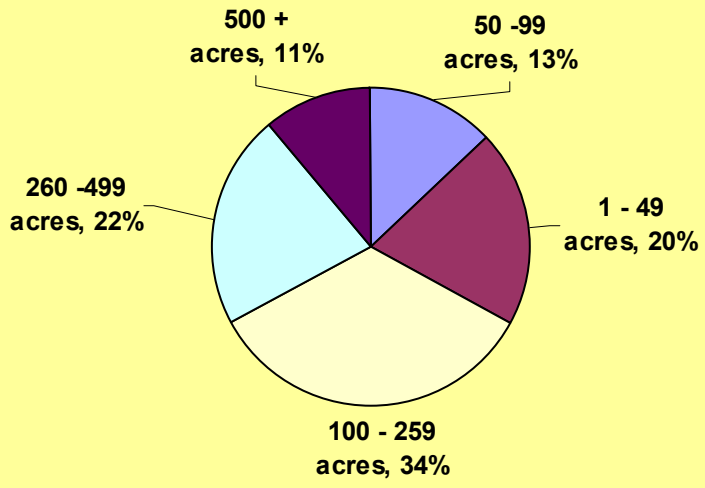
INTRODUCTION

According to Unilever, the challenge of using natural resources sustainably is fundamentally a social one.[133] Decisions made on the farm have effects on the local community. Similarly, the support received from the community can significantly impact a farmer's job satisfaction.[134] The interests of community groups and local inhabitants must be considered during the planning and development stages of agricultural activities when these developments directly affect their living situation. For example, when a farmer wants to expand his or her farm, it may require the acquisition of a neighbor's property. Community health is a concept measuring a unified and cohesive community in which the connection to agriculture and land is strong.

Vermont Agriculture: Community Health Snapshot[135]

- In 1959, Vermont had almost 3 million acres in farmland. This acreage has steadily declined to about 1.3 million acres in 1992. [136]
- Two-thirds of Vermont farmers in 1992 consider farming to be their principal occupation.
- Eight of every ten farms were owned by individuals or families in 1992.
- In 1992, one in five Vermont farms had fewer than 50 acres (see Figure 3). These farms most likely represent fruit and vegetable businesses, poultry producers, and other farms requiring less crop and pasture land for production. Another 11% of farms operate on 500 acres or more.[137]

Figure 3: Vermont Agricultural Land by Farm Size (acres), 1992[138]



Agriculture plays a key role in shaping the quality of the local landscape. One of the principle distinguishing characteristics of the modern agricultural landscape is the large size

and homogeneity of crop monocultures which fragment natural landscapes. In a community where agricultural operations are appreciated, open space will also be a desirable attribute of many communities.[139] Unfortunately, it is difficult to measure the value that society places on landscapes.

Agricultural employment also plays an important role in the maintenance of a healthy community. In most dairy operations, labor accounts for 15 to 20 % of total costs.[140] By hiring and training a long term labor supply, the farmers benefit by saving training costs with new workers. Once hired and trained, replacing labor will be costly and inefficient to the farmer. A permanent or constant labor force will also have more loyalty to the community, contributing to its economic and social viability. Similarly, owner operated farms will have stronger ties to the community because they depend on individuals of the community for their income. Recent market conditions have resulted in the total number of people working in agriculture declining. Simultaneous, the number of part time, migrant labor has been increasing, subsequently resulting in issues relating to the origins and documentation of the migrant labor are of increasing concern to the stability of the farming industry and its communities.[141] Finally, ensuring the health and safety of the employees is an important social concern leading to the advent of worker safety programs and standards.[142]

GLOBAL, NATIONAL, REGIONAL SCOPE

A farmer's current mode of operations, financially or socially, must be considered in light of global agricultural trends. Current agriculture practices in the US are largely driven by historical trends in practice and technology, government policy and farmer resource constraints. Some of the trends are highlighted below. Figure 4 shows the steady decrease in the number of farms and a significant decrease in the available farm pool. Figure 5 demonstrates the increasing gap in the prices received and the prices paid for farmers' products.

Figure 4: Number of Farms and Farm Labor[143]

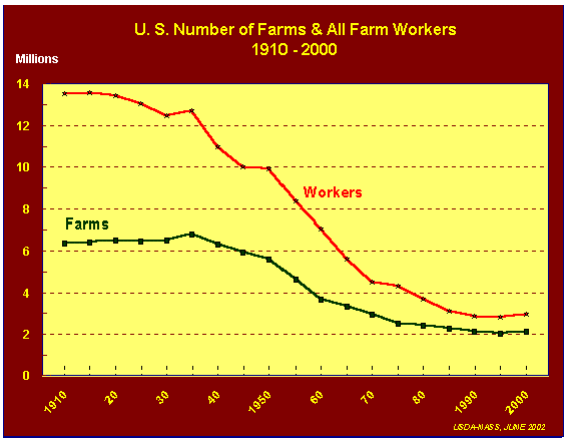
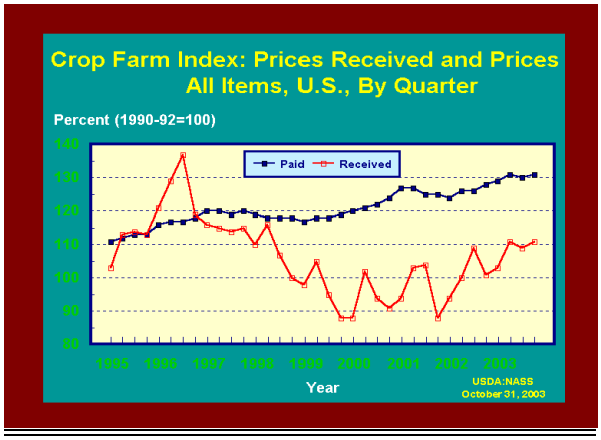


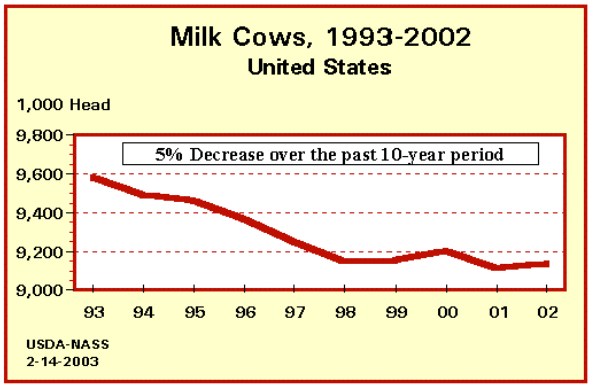
Figure 5: Crop Farm Index Prices[144]

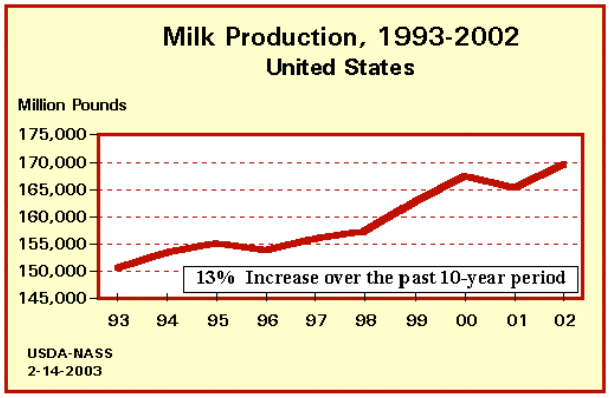


However, while the average number of milk cows on a farm has declined by over 49%, the production of milk has increased by 45%, as seen in Figure 6 below.[145] The Vermont dairy industry has a major impact on the state's economy, representing 80% of the states farming revenues.[146] Moreover, dairy farmers hired nearly 6,500 workers in 1992, resulting in a payroll exceeding $30 million. The industry also has an economic rippling effect through

payments made for the products and services of milk haulers; equipment dealers; grain, feed, seed, and fertilizer companies; livestock dealers; veterinarians; food processors; and other farm-related businesses. Reported figures indicate that well over 200 manufacturing, wholesale, and retail firms are associated with the dairy industry, employing more than 4,250 workers in 1995.[147] These same firms reported sales of approximately $2 billion.

Figure 6: Milk Cows and Milk Production, 1993 - 2002[148]





In addition to impacting farmers and their families, agriculture production significantly affects hired agricultural workers. Unfortunately, the remoteness of farm locations as well as lax international standards, may lead to the mishandling of human (and/or child) labor. Farms rely heavily on seasonal laborers and these migratory laborers should have the same rights and benefits as full time workers. In the US, migrant and part time farm laborers may be subject to abuse, including low base wages, excessive physical demands on the job, or poor living conditions. Consequently, efforts by International Labor Organization, United Nations, Food Alliance, as well as individual corporate standards, are increasingly defining and monitoring labor rights.

FOCUS OF THE COMMUNITY HEALTH MODULE

Adopting best practices for community health management is important to protecting farmers and the communities in which they live. The increase in a farmers community involvement, will improve a community's outlook on farming, increasing a farmer's job satisfaction. Therefore, two critical components contributing to the stability of farming are: 1) community relations and 2) farm labor.

PARAMETERS SELECTED

The following parameters were selected by means of two screening processes, as outlined in the Methodology section. For a listing of parameters that were not used, please see Appendix D.

Community Relations: Stronger community relations and respect for agriculture lead to a better quality of life for farmers. By examining a farmer's relationship to his or her community through community involvement and the subsequent involvement of the community on the individual farms, one can determine the level of acceptance or understanding the community has towards agricultural production. Interviews conducted

with farmers indicated the utmost importance of community involvement to help diversity both the types of interactions in a community as well as types of activities the farmer is involved in, both suggesting an increase in work/life balance for a farmer, an important contributor to farm financial stability as well.

Farm Labor. The agricultural labor pool within the United States is declining, due to arduous working conditions.[149] When it comes to Community Health, the quality of labor supply is directly impacted by availability of supply, treatment by the employers, and the migrant versus permanent status of the workers. Agricultural trends point towards a declining supply of domestic farm labor, leading to the increase of a foreign labor supply. Not only is the quality of the labor in question, but also whether this supply is documented or undocumented. A rise of undocumented labor in the United States can put unnecessary financial constraints on local regions as well as reduce a community's stability in terms of population. Moreover, working conditions in the agricultural section are a concern. Farming has one of the highest work related fatality rates of all occupations, according to the Department of Labor.[150] The Department goes on to report that while the percentage of fatal injuries suffered by hired farm workers (as opposed to farm operators and their families) appears to be proportional in the farm workforce, hired farm workers receive a disproportionately high number of non-fatal injuries (68%).

EDUCATIONAL MODULE

Combining research on the specific indicator, global, national, and local trends and the most appropriate parameters, the team developed the following Educational Module.

COMMUNITY HEALTH EDUCATIONAL MODULE

Description

Community health is defined as the strength of the community in which a farmer operates. Strong community relations and respect for agriculture can lead to a better quality of life for farmers. Research shows that the support received from a community can significantly impact a farmer's job satisfaction.[151] Similarly, the interests of community groups and local inhabitants must be considered by the farmer during the planning and development stages of agricultural activities, including the hiring of migrant labor, when these developments directly affect the community.

Agricultural employment plays an important role in the maintenance of viable farming populations and communities. Ensuring the health and safety of the employees is an important social concern leading to an increasing number of worker safety programs and standards.[152] Recent market conditions have resulted in the decrease of a permanent agricultural labor, from 9.9 million in 1950 to only 2.8 million in 1998.[153] The results include sourcing of undocumented labor, impacting the stability of farming and its nearby communities.

Consequently, this module evaluates a farmer's working environment through two main criteria: 1) community relations and 2) protection of labor supply.

Incentives for Change

- **Benefits to farmers.** In most dairy operations, labor accounts for 15% to 20% of total costs.[154] Identifying and hiring only documented labor will help the farmers and the community in the long term. Once undocumented labor are hired and trained, replacing them will be costly and inefficient to the farmer. Additionally, hiring undocumented labor is illegal across the United States and can result in significant fines. One of the most extreme cases was a farmer in Florida who was fined $150,000 for hiring undocumented workers, and then an additional $120,000 for firing forty workers who presented what appeared to be adequate paperwork.[155]

- **Benefits to community.** Strong community relations and a dependable labor supply help the success of a farmer. Since Vermont dairy farmers contribute 80% of all farming revenues in the state, the stability of these farmers is important to the community and state economy.[156] The hiring of documented or even permanent labor force will have positive repercussions on the community. These laborers are likely to have greater loyalty to the community, contributing to its economic and social viability.

Assessment Questions

For all questions, please choose the answers that best identify your current management practices. Use the summary sheet on the last page of this module to evaluate overall performance.

Community Relations

Community Involvement. What community groups are **you** and/or your family involved in? (Please check all that apply)

	Self	Spouse	Children	Parent
4H	❑	❑	❑	❑
School board	❑	❑	❑	❑
Fire Department	❑	❑	❑	❑
Young Cooperators	❑	❑	❑	❑
[Other]	❑	❑	❑	❑
[Other]	❑	❑	❑	❑

- **The following describes my involvement in the community:**
  1. Unfortunately, I do not have any time for community activities.
  2. Either my spouse or I am involved in one local community organization.
  3. Either my spouse or I are involved in more than one community organization.
  4. In addition to #3, my children and/or my parents are involved in either one or more community activity.

- **When it comes to the community's involvement on my farm:** (Check all that apply)
  - ❑ I host visitors/tourists on the farm at least once a year.
  - ❑ I host educational trips for children from local schools.
  - ❑ Members of the community visit our farm through corporate outreach programs.

Research trends show that a farmer's job satisfaction is strongly tied to his relationship to the community as well as his own personal life. Advocating community building has several benefits including offering variety to a farmer's day, exposing farmers to different professions and other farmers, and increasing the success of local farmer's markets (indirectly improving business relations).[157] Corporations, such as Stonyfield Farms, have established community outreach programs entitled, "Have a Cow." For a price of $6, consumers can adopt a cow, receive regular updates, and visit their cows on the farm.[158] This is an additional method of community outreach from the farmer.

PROTECTION OF LABOR SUPPLY

- **When it comes verifying documentation for new labor:**
  1. I do not check whether they have authorized paperwork.
  2. I am satisfied when they tell me they have authorized paperwork.
  3. I am satisfied after I have examined and verified the paperwork is legal.

It is against the law to hire undocumented labor in the United States. Unfortunately, labor trends have resulted in a growth of this type of labor in the agricultural arena. With the reduction of the American labor supply, U.S. farmers requested the Department of Labor to issue H2A guest - worker visas that allow foreigners to enter the United States to perform seasonal agricultural labor.[159] However, tedious and complicated paperwork often leads workers to enter illegally. The U.S. Department of Labor estimated that in 1998, 52% of the agricultural labor force lacked documentation to work. Hispanic

workers comprise 36% of the hired wage and salary farm workers in the U.S. Of these, approximately 75% of Hispanic farm workers were not U.S. citizens, compared to 28% of all hired farm workers and 7% of all wage and salary workers in the United States.[160]

- **My hiring policies regarding child labor are:**
  1. I do employ legal minors, but only during non-school hours.
  2. In addition to #1, I offer special training for minors.
  3. In addition to #2, I train supervisors on the special management needs of minors.
  4. In addition to #3, I communicate with the parents of minors regarding their work.

According to the US Child Labor Law,[161] the minimum age for general employment in non-agricultural sectors is 14 years old and 18 years old for hazardous work. In agriculture specifically, the minimum age of employment is 11 for non hazardous work and 16 for hazardous work. During school hours, a child must be 16 years old to work during school hours and at least 14 to work outside school hours. However, a child at the age of 12 or 13 may also be employed with written consent of the minor's parent or guardian. A child under the age of 12 may be employed by a parent or guardian on a farm owned or operated by that person.[162]

- **BASE WAGE. How much do you pay your farm workers?**
  1. I pay my workers the legal, minimum wage according to Vermont State Law.
  2. I pay my workers the legal, minimum wage plus provide them with housing.
  3. In addition to #2, I assist them with one of the following: a pasture for the employee's livestock, personal use of the equipment, garden space, or daily meals.
  4. In addition to #2, I assist them with buying health insurance.

The consensus among farmers these days is "a good worker is hard to find." In 1999, an average wage paid on dairy farms was $17,000,[163] compared to the poverty line of $15,000. Vermont's current minimum wage rate is $6.25 per hour, but will increase to $6.75 on January 1, 2004 and to $7.00 on January 1, 2005.[164] Providing additional benefits, such as partial health care costs, housing, and food, to farm workers is a common trend, which helps to ensure the consistency and dependability of a good laborer.

- **What precautions do you take regarding worker sanitation?** (Check all that apply)
  - ❑ I provide all employees with clean drinking water, clean latrines, and hand washing stations.
  - ❑ All hand washing stations have soap and water.
  - ❑ Upon inspection, all facilities are clean.
  - ❑ I provide a shower facility with warm water for employees to wash and change after the workday.

- **What precautions do you take regarding general safety?** (Check all that apply)
  - ❑ I provide general safety training to all employees when they are hired.
  - ❑ I provide general safety training conducted by professional firms to provide safety training.
  - ❑ I have developed training checklists for each job to ensure each employee receives appropriate training.
  - ❑ I have set goals for safety and track success.
  - ❑ I reward my employees with bonuses when safety goals are met.

According to the Cooperative Extension Service at the University of Nebraska, poor employee management causes more safety problems than any other factor. Proper monitoring of worker sanitation and general safety can prevent unnecessary sicknesses and injuries, both of which can result in expensive costs to the farmer.[165]

Linkages to Other Modules

While the questions above cover some of the basics regarding financial and quality of life management, other practices also impact farm financials. Please review your practices regarding the following topics in the Educational Modules listed below.

COMMUNITY HEALTH TOPIC	OTHER MODULE(S)
Community Relations	Farm Financials
Protection of Labor Supply	Farm Financials

Further Information

Additional details and information on the above can be obtained through the following sources:

- **US Department of Labor.** The Department of Labor promotes the welfare of the labor pool of the United States by improving working conditions, advancing opportunities for profitable employment, protecting retirement and health care benefits, helping employers find workers, strengthening free collective bargaining, and tracking changes in employment, prices, and other national economic measurements.
  - Address: Frances Perkins Building, 200 Constitution Avenue, NW Washington DC, 20210
  - 1-877-889-5627
  - www.dol.gov

- **Department of Labor at Vermont.** The Department of Labor & Industry provides for the safety, protection and welfare of people where they work, live and play, in a manner that is fair, consistent, supportive and professional. It also provides historical and current wage information to employees in Vermont.
  - Address: National Life Building, Drawer 20, Montpelier, Vermont 05620-3401
  - Phone: (802) 828-2288
  - http://www.state.vt.us/labind/

Summary Results for Community Health

Instructions: In the table below, please record the score for the answer you selected for each question. For multiple-choice questions, the response number serves as your score for that category (i.e. choice # 2 is worth 2 points). For "check all that apply questions," please see scoring criteria for each question in the chart below. Once all responses have been completed, add up the answers and record the total.

QUESTION	ANSWER/SCORE
1. Community Relations	
2. Documented Labor	
3. Child Labor	
4. Base Wage	
5. Worker Sanitation (add up the total number of boxes checked)	
6. General Safety (add up the total number of boxes checked)	
Total Score	
Total Possible Points	27

Interpretation: The next step in understanding your farm's performance in the category of Community Health is to compare your results to best practices. Below is a table that ranks your performance from best practices (green) to practices that require improvement (red). Compare the number of points you received for your practices compared to optimal practices.

	Point Range	Interpretation
Green	23 - 27	Best practices regarding Community Health are currently being employed on this farm.
Yellow	19 - 22	Farm is using some good practices regarding Community Health; however there are some key areas that should be improved on.
Red	12 - 19	Community Health practices should be carefully evaluated and a strong effort should be made to adopt improved practices in several areas.

VIII. ENERGY

INTRODUCTION

Agricultural production of food accounts for 20% of all the energy spent on the U.S. food system (which includes processing, delivery and consumption).[166] While this is a small percentage, agricultural processes are a significant contributor of greenhouse gases in the atmosphere. And energy use on dairy farms is estimated to contribute up to 15% of a dairy farm's total greenhouse gas emissions.[167] This section explores the uses of energy on a dairy farm and its linkages to greenhouse gas emissions.

Energy

There are two main types of energy: 1) renewable and 2) non-renewable. As the name implies, a non renewable energy source is an energy resource that is not replaced or is replaced only very slowly by natural processes. Primary examples of non-renewable energy resources are the *fossil fuels*--oil, natural gas, and coal. Fossil fuels are continually produced by the decay of plant and animal matter, but the rate of their production is extremely slow, very much slower than the rate at which we use them. Any non-renewable energy resources that we use are not replaced in a reasonable amount of time (a lifetime or that of the next generation) and are thus considered "used up", not available to us again.[168]

Non renewable energy can be further divided into direct and indirect sources. Direct energy consumption occurs with the use of either fuel or electricity. Fuel is used in the transportation of goods and comprises 25% of the total energy used in agricultural production;[169] electricity, on the other hand, is used in a variety of operations including milkings, dairy shed lighting, ventilation, etc. Indirect energy consumption is related to the manufacturing of chemical fertilizers and pesticides, the seeds and feed that are brought onto the farm, and accounts for almost 40% of the energy allocated to dairy production.[170]

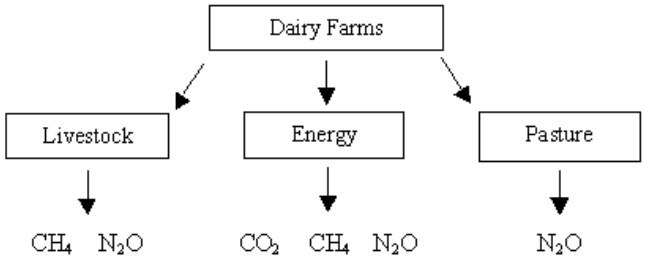
Renewable energy is "any energy resource that is naturally regenerated over a short time scale and derived directly from the sun (such as thermal, photochemical, and photoelectric), indirectly from the sun (such as wind, hydropower, and photosynthetic energy stored in biomass), or from other natural movements and mechanisms of the environment (such as geothermal and tidal energy)."[171] One of the most tangible forms of renewable energy for dairy farmers is methane (biogas) recovery through anaerobic digesters. This process, if affordable to a farmer, reduces energy costs in the long run, improves manure handling, reduces ground and surface water contamination by methane, and controls harmful pathogens.[172]

Greenhouse Gas Emissions

There are three main greenhouse gas emissions from agricultural processes: 1) methane (CH_4) emitted from livestock, 2) nitrous oxide (N_2O) emitted from pasture improvement activities and 3) carbon dioxide (CO_2) emitted from energy generated by the combustion of fossil fuels to produce electricity (see Figure 7).[173] These gases, once emitted into the atmosphere, trap heat in the atmosphere, potentially causing global warming. Global Warming Potentials (GWP) is a metric used to compare the abilities of different greenhouse

gases to trap heat in the atmosphere and are based on the heat absorbing capability of each gas relative to carbon dioxide.[174]

Figure 7: Greenhouse Gas Emissions by Dairy Farms[175]



Methane (CH_4) is produced as a by-product of the digestion of feed in the rumen of cattle (enteric fermentation) under anaerobic conditions and manure. [176] Methane has a global warming potential (GWP) 23 times that of carbon dioxide and is formed any time manure is stored and begins to decompose.[177] Three times more methane is generated by dairy cows than by any other farm animal type and totals 70 kg/year per dairy cattle.[178] Enteric fermentation is the source of 93% of all methane emissions from dairy cattle, while the remaining seven percent of methane emissions are emitted from livestock manure.[179]

Nitrous oxide (N_2O) is also produced from manure and has a global warming potential 296 times that of carbon dioxide.[180] Dairy pastures are likely to have higher nitrous oxide emissions than most other pastures as a result of higher levels of nitrogen applied as animal waste due to high stocking rates and concentrate feeding.[181] Feed supplements can contribute up to 50 kg of Nitrogen per ha applied as animal manure. High rates of Nitrogen fertilizer application are also an important factor in nitrous oxide emissions from pasture and crops. Nitrous oxide emissions are most likely to peak around the autumn break and in spring, when soils are moist and warm.[182]

GLOBAL, NATIONAL AND REGIONAL SCOPE

The emissions of greenhouse gases have been a major international policy topic since signs of global warming or greenhouse effect were first introduced.[183] According to the National Academy of Sciences, the Earth's surface temperature has risen by about 1 degree Fahrenheit in the past century, with accelerated warming during the past two decades. There is strong evidence that most of the warming over the last 50 years is attributable to human activities.[184] While there are many significant sources of these emissions, according to the OECD's annual report a seen in Table 12 below, agriculture is responsible for 40% of the methane emissions, 60% of the nitrous oxide emissions, and 10% of the carbon dioxide emissions globally.[185] Of this total, data indicates that dairy cattle typically contribute about 12% of livestock emissions in the atmosphere.[186]

Table 12: Share of Greenhouse Gases from Global Agricultural Processes

GREENHOUSE GAS	OCED TOTAL EMISSIONS – MILLION METRIC TONS	SHARE OF EACH GAS	EMISSIONS FROM AGRICULTURE	SHARE OF EACH GAS IN AGRICULTURE	SHARE OF AG IN TOTAL OF EACH GAS
Carbon Dioxide	11,552	82%	59	5%	1%
Methane	1,437	10%	557	47%	39%
Nitrous Oxide	929	7%	560	48%	60%
Others: HFCs, PFCs, SF_6	224	2%	0	0%	0%
Total	**14,142**	**100%**	**1,176**	**100%**	**8%**

Some of the expected results of global warming include rising sea levels, a change in precipitation, and other local climate conditions.[187] Changing regional climate could alter forests, crop yields, and water supplies. It could also affect human health, animals, and many types of ecosystems. Consequently, in 1992, leaders from around the world met at an Earth Summit in Rio de Janeiro to create the UN Framework Convention on Climate Change. At a 1997 UN Conference in Japan, the Kyoto Protocol was signed by a 120 countries to voluntarily decrease greenhouse emissions to levels of 5.2% below 1990 emissions by 2008 to 2012.[188] Results are yet to be determined.

Renewable energy sources are one way to reduce greenhouse gas emissions into the atmosphere. Eighty five percent of the energy used on an average dairy farm in Australia is said to be non-renewable, with the remaining 15% being a combination of hydro and geothermal electricity.[189] The U.S. government is currently contemplating tax credits for the use of renewable energy sources in the home or at the office.[190]

FOCUS OF THE ENERGY MODULE

Adopting best practices for energy management is important to protecting the atmosphere by reducing greenhouse gas emissions and promoting renewable energy sources to mitigate demands on unsustainable fuel supplies. Adaptation may also reduce a farmer's operating costs. This module evaluates energy usage on the dairy farm via two main parameters: 1) energy conservation measures and 2) renewable energy technologies.

PARAMETERS SELECTED

The following Parameters were selected by means of two screening processes, as outlined in the Methodology section. For a listing of parameters that were not used, please see Appendix D.

Energy Conservation Measures. On dairy farms, the four most energy intensive operations are ventilation, lighting, cooling of milk, and milking. The management of such direct energy usage offers the greatest tangible benefits for a farmer. Energy reducing technologies, such as variable speed pumps and energy efficient lighting, can save electricity costs to the farmer. Considering Vermont's electricity rates are higher than the national average by approximately 150%, this could result in significant savings.[191] According to Efficiency Vermont, the state's energy efficiency utility, a farmer can reduce milk cooling

costs by 50% with plate-type milk pre-cooler; reduce vacuum pump energy costs by up to 66% with a variable speed drive pump; and save as much as 65% on lighting costs by switching to energy saving lighting.[192]

Renewable Energy. While fossil fuels are the source of over 86% of U.S. energy supply, this source of energy will not always be available.[193] Whether supply will diminish or political reasons require increased use of renewable resources, the United States will eventually be forced to seek out new sources of fuel. Farmers who are aware of these alternatives will benefit by acting early. Methane recovery and biodiesel are two renewable energy sources on the farms. As a substitute to standard petroleum, biodiesel is a clean burning fuel produced from renewable resources. Biodegradable, nontoxic, and essentially free of sulfur and aromatic, over the course of its production and use, biodiesel produces approximately 80% less carbon dioxide emissions and almost 100% less sulfur dioxide.

Wind Energy is another form of renewable energy that can be used on the farm or in homes. It uses energy in the wind to generate electricity, charging batteries, pumping water, or grinding grain. Small wind turbines can be used by homeowners and remote villages to help meet energy needs. Economically, the cost of energy from the wind has dropped by 85% over the last 20 years through federal tax credits and net metering provisions in some areas.[194] Homeowners can generate their own electricity or charge batteries using the wind, and in some cases, sell excess electricity to the utility, a practice called net metering.

EDUCATIONAL MODULE

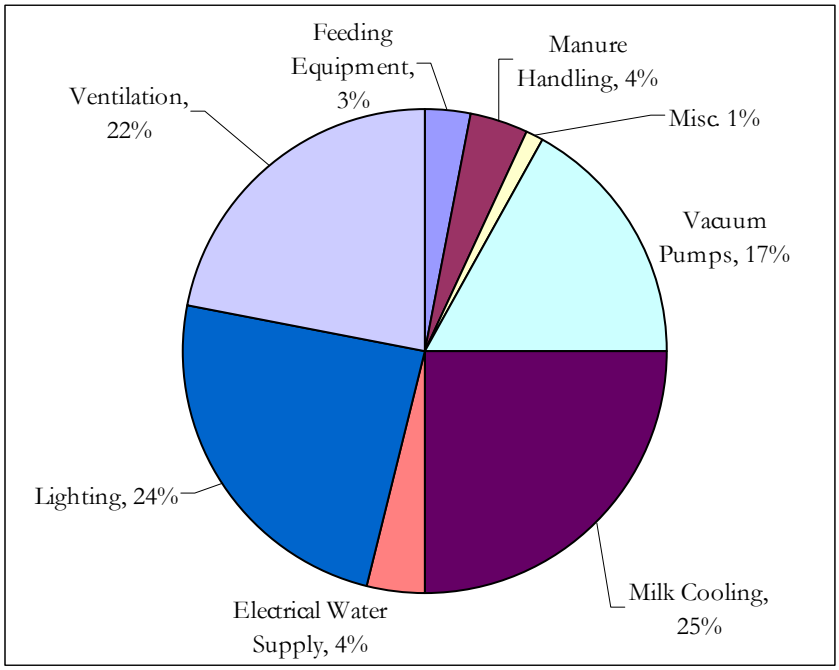
Combining research on the specific indicator, global, national, and local trends and the most appropriate parameters, the team developed the following Educational Module.

ENERGY EDUCATIONAL MODULE

Description

There are two main types of energy: renewable and non-renewable. As the name implies, a non renewable energy source is an energy resource that is not replaced or is replaced only very slowly by natural processes. Primary examples of non-renewable energy resources are the *fossil fuels*--oil, natural gas, and coal. Fossil fuels are continually produced by the decay of plant and animal matter, but the rate of their production is extremely slow, very much slower than the rate at which we use them. Any non-renewable energy resources that we use are not replaced in a reasonable amount of time (a lifetime or that of the next generation) and are thus considered "used up", not available to us again.[195] This category can be further broken down into direct and indirect energy. Electricity is a major use of direct energy farms. Milk cooling, lighting, ventilation and vacuum pumps account for 88% of all direct energy used on dairy farms.[196] Typically, total annual energy used by dairy farms is equal to 3.4 million kWh/year divided into energy intensive components as described in Figure 8.

Figure 8: Typical Energy Use by Equipment on a Dairy Farm[197]



Indirect energy use is comprised of the following sources: fertilizer type or nutrient quantity; chemical pesticides, seeds, feed that was bought-in from outside or sold, and grazing-off recorded by number of animals and time away from the property.[198] The manufacturing of chemical fertilizers and pesticides makes up almost 40% of the energy allocated to agricultural production.

Renewable energy on the other hand, is “any energy resource that is naturally regenerated over a short time scale and derived directly from the sun (such as thermal, photochemical, and photoelectric), indirectly from the sun (such as wind, hydropower,

and photosynthetic energy stored in biomass), or from other natural movements and mechanisms of the environment (such as geothermal and tidal energy)."[199] The most relevant form of renewable energy for dairy farmers is methane recovery. Methane is found in manure can be converted to renewable energy through specific technologies, such as anaerobic digesters, resulting in cost savings to those farmers and a reduction in emissions of greenhouses gases to the environment. Biodiesel is another renewable energy source on the farm. It is a clean burning alternative fuel produced from domestic, renewable resources, contains no petroleum, but can be blended at any level with petroleum diesel to create a biodiesel blend. Biodegradable, nontoxic, and essentially free of sulfur and aromatic, over the course of its production and use, biodiesel produces 78% less carbon dioxide emissions and almost 100% less sulfur dioxide, according to joint study commissioned by the US Department of Energy and the US Department of Agriculture,[200] biodiesel already meets the new EPA standards for low-sulfur diesel fuel mandated for introduction in 2006. [201]

Current agricultural practices, including those on dairy farms, emit a large amount of greenhouse gases globally. Generated through the combustion of fossil fuels, electricity contributes to the emissions of greenhouse gases such as methane, nitrous oxide, and carbon monoxide. These gases, once emitted into the atmosphere, trap heat in the atmosphere, potentially causing global warming.[202]

Incentives for Change

In order to gain maximum farmer participation in adopting best management practices, it is necessary to outline how the dairy farmer benefits from managing their energy use.

- **Cost Savings.** Vermont's electricity rates are among the highest in the country.[203] Energy efficient lighting and equipment can make a substantial difference in reducing monthly energy bills. According to Efficiency Vermont, and as seen below, a farmer can reduce milk cooling costs by 50% with plate-type milk pre-cooler; reduce vacuum pump energy costs by up to 66% with a variable speed drive pump; and save as much as 65% on lighting costs by switching to energy saving lighting.[204]

Assessment Questions

For all questions, please choose the answer(s) that best identify your current management practices. Use the Summary sheet on the last page of this module to evaluate overall performance.

- **Calculate the amount you spend on energy and machinery as a percentage of gross income:**
  - PART 1: From your Schedule F Income Tax Filing add items in the table below.
  - PART 2: Divide Part 1 by gross income.

Items	Dollar Amount ($)
Chemicals	
Custom hire (machine work)	
Depreciation on buildings and equipment	
Fertilizers and lime	
Fuel	
Rent or lease of vehicles, machinery and equipment	
Repairs and maintenance	
Utilities	
Total Dollars Spent:	
Total Gross Income:	
Total Dollars Spent/Total Gross Income x 100 =	**%**

- **Percentage of Total Income**
  1. My total dollars spent per total gross income is greater than 50%.
  2. My total dollars spent per total gross income is between 25% and 50%.
  3. My total dollars spent per total gross income is between 10% and 25%.
  4. My total dollars spent per total gross income is less than 10%.

Recording the amount of money spent on electricity and other energy sources can help homeowners and business managers understand just how much they spend on energy-related services, often prompting a move towards increasing energy efficiency to reduce costs.[205]

- **When it comes to lighting:**[206]
  1. I use only standard lighting in my barns and outbuildings (i.e. mercury vapor yard lights).
  2. I have converted a portion of my lights to more energy efficient alternatives, such as high-pressure sodium yard lights.

  I have already converted all of my lights to energy efficient models (such as high pressure sodium yard lights).

- **When it comes to milking cows:**
  1. I use a traditional vacuum pump.
  2. I am saving money to buy a variable speed drive controller.
  3. I already use a variable speed drive controller.

According to one farmer member in the St. Albans Coop, the use of a variable speed pump has reduced somatic cell count in his milk, upgraded the quality of milk and increased the dollar value he receives for the milk.[207]

- **When it comes to ventilation in the barn:**
  1. I use the standard, mechanical equipment.
  2. I am saving money to be able to convert to more energy efficient equipment.
  3. I have converted a portion of my barn to be ventilated by more energy efficient equipment.
  4. I have already converted my barn(s) to be ventilated by more energy efficient equipment.

In recent years, mechanical ventilation in large freestall barns has become one of the largest peak energy users on dairy farms. Switching to efficient fans can produce savings of 12% to 15% in both smaller barns and large freestall barns.[208]

- **When it comes to milk cooling equipment:**
  1. I use the standard, milk cooling equipment.
  2. I am saving money to use a 'plate milk pre-cooler'.
  3. I have already converted to using a plate milk pre-cooler to reduce my energy usage during milk cooling.

Energy conservation measures on farms include variable speed pumps, plate milk pre-coolers and energy efficient lighting technology. According to farm surveys conducted by EnSave, a Vermont based electric company, the two main areas of resistance to adopting these technologies include labor shortages and high upfront costs.[209] However, as indicated in the table below, the upfront costs of installing new technology can be offset over on the average of five years. For example, a variable speed pump drive will cost a farmer approximately $3401 to install. However, by installing this technology, the farmer will save almost 10,000 kWh, or $1061/year in energy bills. At this savings rate, the cost of installing the pump will be returned to the farmer within five years on average. Data detailing these savings is listed in Table 13.

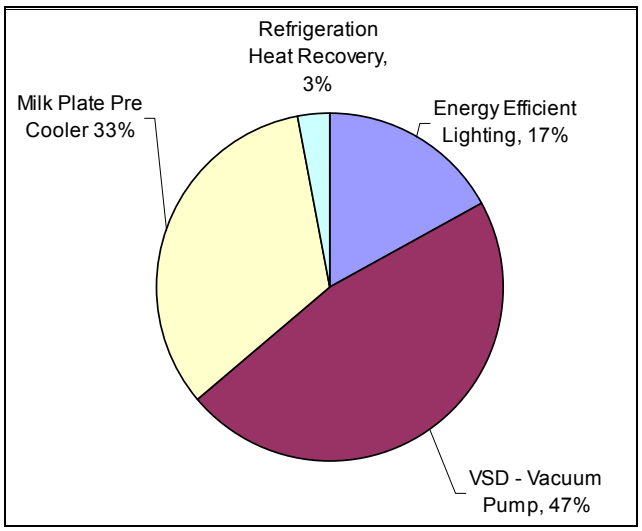
Table 13: Summary of Energy Savings for Energy Conservation Measures[210]

	Annual kWh	**Estimated Annual Savings**	**Estimated Installed Cost**	**Average Payback Years (range)**
Install VSD on Vacuum Pump	9,988	$1,061	$3,401	4.73 years
Add Refrigeration Heat Recovery	5,781	$579	$2,861	5.00 years
Install Plate Milk Pre-cooler	9,414	$948	$2472	4.22 years
Install Energy Efficient Lighting	3,491	$344	$1,473	4.50 years
Total Savings	**28,674**	**$2,931**	**$10,207**	**4.6 years**

*These numbers are based on the average costs in the northeast region in 2002.

These energy conservation measures result in the savings by percentage as shown in Figure 9.

Figure 9: Energy Savings per Area[211]



- **When it comes to renewable energy:**
  1. I do not use any renewable energy measures on my farm.
  2. I plan to implement one of the following renewable technology measures on my farm as soon as I save enough money or I have received funding.
     a. Biodiesel
     b. Methane Recovery
  3. I have already started to use one of the following renewable energy technologies because it makes sense for my size farm.
     a. Biodiesel
     b. Methane Recovery

The use of methane recovery technology, such as anaerobic digesters, has significant improvements in cost efficiency, manure management efficiency, and a reduction in the need of direct energy. However, the practicality of it must be determined on an individual farm basis. The costs of an anaerobic digester to break methane down into energy depend on specific farm conditions. Moreover, the average pay back can range from a few years to more than ten years. According to the Wisconsin Public Service Commission, a minimum herd size of 300 dairy cows needed to make such a system feasible,[212] while other estimates are in the range of 5000 cows. However, money isn't the only consideration. It takes approximately 45 minutes of daily maintenance, including inspection, mixing and pumping manure into a digester twice a day, and checking and recording gauges to measure biogas and electricity output, in order to keep an anaerobic digester working smoothly. Generator engines also require monthly maintenance including oil changes, valve adjustments and spark plug cleaning.[213] Currently, the Vermont Department of Public Service and the Vermont Department of Agriculture have received a total of $695,000 from the federal government to promote the use of methane recovery technology on Vermont dairy farms.[214] The project has been designed to consider methane recovery in a broad context, taking into account its potential benefits as a component of a comprehensive nutrient management system, as a renewable energy source and as a strategy for greenhouse gas reduction.

Biodiesel is a clean air, renewable energy source that is more expensive than petroleum diesel, however it is the least cost strategy when compared with other alternative fuel systems. Consumer benefits include the following: 1) because it is more lubricating than petroleum diesel fuel, biodiesel can extend the life of diesel engines; 2) it does not require any major engine modifications or special storage/handling procedures; 3) it can be made from domestically produced, renewable oilseed crops such as soybeans, as well as from recycled vegetable oil that has already used for frying; and 4) when burned in a diesel engine, biodiesel replaces the exhaust odor of petroleum diesel with the pleasant smell of popcorn, French fries, or donuts.[215]

Linkages to Other Modules

While the questions above cover some of the basics regarding energy management, other practices also impact energy use. Please review your practices regarding the following topics in the Educational Modules listed below.

ENERGY TOPIC	OTHER MODULE(S)
Energy	Farm Financials
Product Quality	Animal Welfare
Manure Management	Nutrient Management

Further Information

Additional details and information on the above can be obtained through the following sources:

- **EnSave Energy Performance Inc.** This energy calculator shows farmers all the aspects that can lead to energy savings on the farm.
  - Address: 65 Millet Street, Suite 105, Richmond, VT 05477
  - Tel: 800-732-1399; Fax: 802-434-7011
  - http://www.ensave.com/EnergyCalculators.htm/

- **Efficiency Vermont.** This is a source of quick information about lowering costs with energy efficiency in new equipment or in existing or new building designs. It recently began to provide 0% financing to supplement financial incentives and technical assistance for dairy farms.
  - Address**:** 255 S. Champlain Street, Suite 7, Burlington VT 05401
  - 1-888-921-5990
  - http://www.efficiencyvermont.com/

- **Consumer's Guide to Small Wind Electric Systems in Vermont**
  - http://www.eere.energy.gov/windpoweringamerica/pdfs/small_wind/small_wind_vt.pdf/

- **Renewable Energy Vermont.**
  - P.O. Box 1036; Montpelier, VT 05601;
  - Phone/Fax (802) 229-0099
  - Andrew Perchlik: E-Mail perchlik@REVermont.org
  - http://www.REVermont.org

- **Vermont Alternative Energy Council.**
  - 147 Allen Brook Lane, Suite 104, Williston, VT 05495

- (P) 802.879.4896/ (F) 802.879.5486
- http://www.vaec2000.com/

SUMMARY RESULTS FOR ENERGY

Instructions: In the table below, please record the score for the answer you selected for each question. For multiple-choice questions, the response number serves as your score for that category (i.e. choice # 2 is worth 2 points). For "check all that apply questions," please see scoring criteria for each question in the chart below. Once all responses have been completed, add up the answers and record the total.

QUESTION	ANSWER/SCORE
1. Percentage of Income	
2. Lighting	
3. Variable Speed Driver	
4. Ventilation	
5. Milk Cooling	
6. Renewable Energy	
Total Score	
Total Possible Points	**20**

Interpretation: The next step in understanding your farm's performance in the category of Energy Module is to compare your results to best practices. Below is a table that ranks your performance from best practice (green) to practices that require improvement (red). Compare the number of points you received for your practices compared to optimal practices.

	Point Range	Interpretation
Green	16 - 20	Best practices regarding Energy are currently being employed on this farm.
Yellow	14 – 15	Farm is using some good practices regarding Energy; however there are some key areas that should be improved on.
Red	6 – 13	Energy practices should be carefully evaluated and a strong effort should be made to adopt improved practices in several areas.

IX. FARM FINANCIALS

INTRODUCTION

Farm Financials refers to a farmer's financial performance as well as his or her quality of life. Financial performance is measured in terms of profitability, efficiency, debt load, and other factors. By monitoring performance using financial measures, farmers are better able to control costs and maximize profits in order to increase profitability over the long-term. In addition, farmers can use their financial data to evaluate their performance across farms to better understand how their performance compares to the industry standard in a given region or even countrywide. Once farmers understand their financial position, they can create appropriate business plans for managing or growing their operations. Using financial data to develop financial plans, farmers are better able to plan for and manage market changes. A farmer can assess his or her financial performance in two ways: using the cash method or the accrual accounting method. Using the cash method, a farmer calculates his or her financial position based upon his or her bank account balance. For example, if a farmer buys a tractor for $80,000 today, he pays $80,000 out of his or her bank account. While this is a dependable method for everyday households, when it comes to businesses, the benefits of this tractor can be extended over 10 years, reducing the financial burden to only $8,000 in any single year. The technique to apply expenditures over time is known as the accrual method.

Appropriate business management that allows for a healthy work-life balance is integral to a farmer's well being and overall quality of life, the second factor important in assessing farm financials. Quality of life is not only influenced by personal wealth, but also by a farmer's ability to spend time with family, friends or helping the community. This includes managing the farm in a way that enables the farmer to spend time with others.

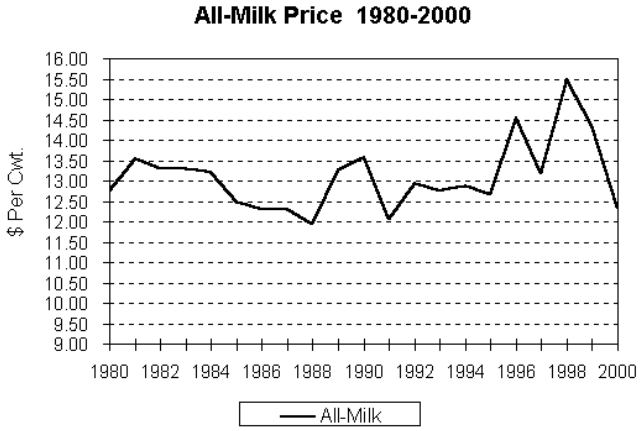
GLOBAL, NATIONAL AND REGIONAL TRENDS

The dairy industry supports hundreds of thousands of families globally. Milk, however, is a primarily local product with 93% of milk consumed in its country of origin, so changes in the milk market in a given country primarily impact domestic producers.[216] Financially stable enterprises can help strengthen the domestic dairy industry as well as support dairy related-industries and government services.

Within the United States, the dairy farm industry comprises a $27 billion dollar business, which grows to $70 billion if the entire dairy foods industry is included.[217] This network includes over 115,000 farms with milk cows.[218] Of these, 71% identified milk sales as the primary source of farm income.[219] A majority of these farms are family run, making farmers and their families susceptible to market swings. In 1997, "sole proprietorships and family corporations accounted for 84% of specialized dairy farms" and "an additional 15% were partnerships, many of which probably involved family members."[220]

Over the last 20 years, milk prices have been volatile, resulting in undependable earnings from milk sales (see
Figure 10).

Figure 10: US Milk Prices, 1980-2000

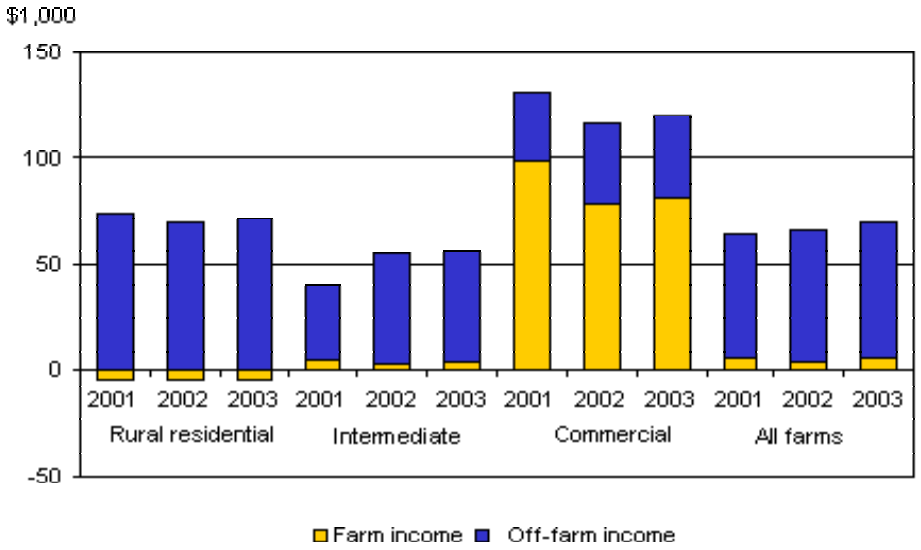


Source: USDA

These impacts greatly affect the number of farming families. In Vermont alone, there are over 1,700 farms dependent upon milk sales for dairy income.[221] This number has decreased from 2,000 farms since 1995[222] in large part due to drops in milk prices. Price fluctuations have also led to a rise in dual income farming families.

The dominant source of earnings for farm households is earned from off-farm sources. This additional income provides several benefits such as: 1) offsetting low farm returns, 2) providing for basic necessities such as health insurance and maintenance of the farm; 3) possibly raising living standards; and 4) protecting against fluctuations in farm income. In recent years, almost 60% of United States farm households had either the farmer, spouse, or both employed in off-farm work.[223] When including wages, salaries, Social Security and other public programs, off-farm sources of income account for about 92% of the total incomes of operator households.[224] Trends across all types of farming can be seen in Figure 11.[225]

Figure 11: Sources of Operator Household Income[226]



Changes in the Vermont dairy industry also have ripple effects throughout the industry, impacting employees, related businesses, and the Vermont state government. In 1992, Vermont dairy farmers alone employed some 6,500 workers with salaries totaling over $30 million.[227] In addition, the industry helped support other dairy-related businesses including grain, feed, fertilizer and equipment companies; veterinarians; livestock dealers; and other businesses.[228] As of 1995, these related industries accounted for over 200 manufacturing, wholesale, and retail firms which employed more than 4,250 workers.[229] The dairy industry also impacts state revenues. In 1996, state cash receipts comprised 70% of total farm gate receipts garnered by the state, making the government extremely dependent upon the industry's existence.[230] Given these linkages, changes in the milk market in Vermont have repercussions across the state.

FOCUS OF THE FARM FINANCIALS EDUCATIONAL MODULE

This module focuses on two aspects of farm financials: financial performance and quality of life.

Financial Performance. In 1989, the Farm Financial Standards Council (FFSC) concluded that agricultural enterprises did not have a uniform method of reporting their economic performance and created a standard set of 16 indicators with explicit methods for calculating each indicator.[231] The measures were to be "common" to all areas of the country to provide a means for comparison across any given commodity group. The FFSC grouped these indicators into five categories: liquidity, solvency, profitability, repayment capacity, and financial efficiency. Interviews with experts confirm that the FFSC indicators are the most widely accepted standard in agriculture and are most often used by many economists and non-profits to measure financial performance of farming enterprises. Therefore, this module focuses on the FFSC's categories for all parameters related to the financial viability of an enterprise.

Quality of Life. This module focuses on the decisions farmers make to affect the everyday quality of their lives, often determined by the amount of financial planning done on a farm. Here, quality of life is not only determined the educational levels, material well being, income or personal wealth, but also by personal, family and life goals, such as free time and labor flexibility.[232] For the purpose of this module, quality of life focuses on personal lifestyle, income stability (provided either by a single or dual income household), and the long term financial/business planning done on the farm. Measures for quality of life, however, vary geographically and by commodity. Nevertheless, research by leading rural agricultural experts indicates that asking farmers to stop and consider these aspects is often enough to motivate change or adjustments if such is desired.[233]

PARAMETERS SELECTED

Financial Stability. As described in the preceding section, there are sixteen different financial ratios areas that are used to assess the financial health and stability of a farm. Dr. David Kohl of Virginia Tech affirmed that these sixteen ratios are the most widely accepted measures by industry with five measures (Term Debt & Lease Coverage Ratio; Current Ratio; Equity to Asset or Debt to Equity; Return on Assets; and Operating Expense/Revenue Ratio), being the most widely used across the industry.[234] These five measures are therefore the parameters selected for this module. These ratios are described in detail in Farm Financials Education Module.

Quality of Life. While farm financials calculate the stability of a farm's enterprise technically, interviews with farmers indicate that quality of life and success of a farm are inextricably linked.[235] Additionally, Quality of Life parameters can be justifications to adopt sustainable agricultural practices such as crop diversification or long term- cost saving initiative. The metrics included in this parameter include work/life balance, the existence and depth of a savings plan, and the mentality towards innovation. According to Dr. Cornelia Flora, Dr. of Rural Sociology at Iowa State, "farmers link quality of life directly to their ability to carve out individual and family leisure time from the necessary demands of production." Spending time with his family was motivation enough to adopt crop diversification on the farm, "allowing for a reduction in both labor and time."[236]

The ratio of on-farm income to off-farm income has underlying social motivations. According to the Department of Agricultural Economics and Business in Canada, two reasons that spouses of dairy farmers pursue off farm jobs are to maintain the farm business or the household income.[237] Additionally, studies by the same organization show that "higher satisfaction with farm life reduces the probability of a spouse working off-farm."[238] Dr. Cornelia Flora states that the choice of sustainable agricultural practices is "directly linked to the management systems that can secure financial viability as their agricultural systems become vulnerable to market forces."[239] Dual incomes can help increase financial stability on the farm increasing the adoption of sustainable production practices.

EDUCATIONAL MODULE

Combining research on the specific indicator, global, national, and local trends and the most appropriate parameters, the team developed the following Educational Module.

FARM FINANCIALS EDUCATIONAL MODULE

Description

Farm Financials is a module designed to assess the financial stability of a farming enterprise. This section describes the merits of monitoring financial performance of the farms, through key ratios, and the subsequent quality of life the farmer leads and is able to provide for his or her family. By monitoring financial performance, farmers can better control costs by creating business plans for managing and perhaps even growing their businesses. Appropriate business management that allows for a healthy work-life balance is also integral to a farmer's well-being and overall quality of life. Quality of life is not only influenced by personal wealth, but also by a farmer's ability to spend time with family, friends or helping the community.

According to the Farm Financial Standards Council (FFSC), there are five main areas that are used to assess the financial health and stability of a farm. These five areas can be determined by sixteen different financial ratios. For the purposes of this module, we will focus on the five most commonly used by farmers and lending institutions when applying for loans.[240]

Term	Definition	Financial Ratio
1. Liquidity	Does a farmer have the ability to pay his or her bills and interest payments on time without affecting business?	Current Ratio
2. Solvency	Does a farmer have the ability to repay all his or her debt if all his or her assets were sold? In weak economic times, usually leading to an increase in debt, can a farmer continue to conduct business?	Equity to Asset Ratio
3. Profitability	Does a farmer have the ability to make a profit from his or her goods?	Rate of Return on Farm Assets
4. Repayment Capacity	Can a farmer repay his or her term farm debt?	Term and Debt Capital Lease Coverage
5. Financial Efficiency	Does a farmer generate the maximum amount of revenues and profits possible on his or her farm?	Financial Efficiency

A farmer can assess his or her financial performance in two ways: using the cash method or an accrual accounting method. Using the cash method, a farmer calculates his or her financial position based upon his or her bank account balance. For example, if a farmer buys a tractor for $80,000 today, he or she pays $80,000 out of his or her bank account. While this is a dependable method for everyday households, when it comes to businesses, the benefits of this tractor can be extended over ten years, reducing the financial burden to only $8,000 in any single year. This ability to account for expenditures over time is known as the accrual method. Most lending institutions utilize

the accrual method and provide farmers accrual-based financial statements, which include balance sheets, income statements, and cash flow or earnings statements.

A balance sheet lists a farm's assets (the value of a farm's financial resources), liabilities (the financial claims of lenders, input suppliers, etc.), and equity (the owner's financial stake in the business) at a specific date in time. An income statement lists a farm's revenue and expenses over a period of time. And finally, a cash flow statement lists a farm's cash supply over a period of time, and an earnings statement provides a summary of net worth.

Incentives for Change

- **Long Term Cost Reductions.** Strategic money management can allow for new capital expenditures on the farm, leading to an increase in efficiency and a long-term decrease in costs. This type of investment can span a number of areas including new tractors, tilling equipment, milk cleaning and production equipment, and energy saving lighting.

- **Quality of Life Improvements.** Financial planning, dual incomes, and health insurance can all mitigate the pressures and stress on the average U.S. farmer. Moreover, a balanced work schedule provides the farmer and his or her family necessary time to spend on non-farming activities, which include community involvement, time with family, vacations, and personal hobbies.

Assessment Questions

For all questions, please choose the categories that best identify your current management practices. Use the Summary sheet on the last page of this module to evaluate overall performance.

FINANCIAL STABILITY

The following ratios are used to assess financial stability and are calculated based on FFSC definitions. Sources of the financial information come from one of three places: (1) the balance sheet, (2) the income statement, or 3) the cash flow or earnings statement.

- **CURRENT RATIO**[241] (Please fill in the following information)

	Amount ($)	Source
(1) Total current farm assets?		Balance Sheet
(2) Total current farm liabilities?		Balance Sheet
Divide (1)/(2) =		

PLEASE SELECT THE APPROPRIATE ANSWER BASED UPON YOUR RESULTS:

1. My current ratio is less than 1.
2. My current ratio is between 1 and 1.50.
3. My current ratio is greater than 1.50.

As a measurement of liquidity, the current ratio measures whether or not a farmer has the ability to pay the bills and interest payments on time without affecting business. This metric is calculated using the following equation:

Total current farm assets / Total current farm liabilities.

Farms enjoying a competitive position generally have a current ratio of greater than 1.50 whereas farms with a current ratio of less than 1 should seek financial guidance to improve performance.[242]

- **EQUITY TO ASSET RATIO**[243] (Please fill in the following information)

	Amount ($)	Source
(1) Total farm equity?		Balance Sheet
(2) Total farm assets?		Balance Sheet
Divide (1)/(2) x 100 =		

PLEASE SELECT THE APPROPRIATE ANSWER BASED UPON YOUR RESULTS:

1. My equity to asset ratio is less than 30%.
2. My equity to asset ratio is between 30% and 70%.
3. My equity to asset ratio is greater than 70%.

As a measure of solvency, the equity to asset ratio measures the proportion of total farm assets financed by the farmer's own equity (as opposed to financed by debt). This metric is calculated using the following equation:

Total farm equity / Total farm assets.

Farms enjoying a competitive position generally have an equity to asset ratio of greater than 70% whereas farms with an equity to asset ratio of less than 30% should seek financial guidance to improve performance.[244]

- **RATE OF RETURN ON FARM ASSETS**[245] (Please fill in the following information)

	Amount ($)	Source
(1) Net income (excluding gains/losses from sale of assets)		Income Statement
(2) Farm interest expense		Income Statement
(3) Owner withdrawals for unpaid labor and management		Income Statement
(4) Average total farm assets		Balance Sheet
(5) Calculate: (1) +(2) – (3)		
Divide (5)/(4) x 100 =		

PLEASE SELECT THE APPROPRIATE ANSWER TO ONE OF THE FOLLOWING QUESTIONS BASED UPON YOUR RESULTS.

I own most of my assets and:

1. My rate of return on farm assets is less than 1%.
2. My rate of return on farm assets is between 1% and 5%.
3. My rate of return on farm assets is greater than 5%.

I lease or rent most of my assets and:

1. My rate of return on farm assets is less than 3%.
2. My rate of return on farm assets is between 3% and 12%.
3. My rate of return on farm assets is greater than 12%.

Rate of Return on Farm Assets measures whether or not a farmer has the ability to make a profit from goods sold. This metric is calculated using the following equation:

> (Net farm income from operation + Farm interest expense – Owner withdrawals for unpaid labor and management)/Average total farm assets.

The "average rate of return on farm assets for farms in the US is between 3-6%".[246] Farms (with mostly owned assets) enjoying a competitive position generally have a rate of return on farm assets ratio of greater than 5% whereas farms with a rate of return on farm assets of less than 1% should seek financial guidance to improve performance.[247] Farms (with mostly leased or rented assets) enjoying a competitive position generally have a rate of return on farm assets ratio of greater than 12% whereas farms with a rate of return on farm assets of less than 3% should seek financial guidance to improve performance.[248]

- **TERM DEBT & CAPITAL LEASE COVERAGE RATIO**[249] (Please fill in the following information)

	Amount ($)	Source
(1) Net income from operations (excluding gains/losses from sale of assets)		Cash Flow or Earnings Statement
(2) Total miscellaneous revenue (if not		Cash Flow or Earnings

included in net income from operations)		Statement
(3) Total miscellaneous expense (if not included in net income from operations)		Cash Flow or Earnings Statement
(4) Total non farm income		Cash Flow or Earnings Statement
(5) Depreciation/amortization expense		Cash Flow or Earnings Statement
(6) Interest on term debt		Cash Flow or Earnings Statement
(7) Interest on capital leases		Cash Flow or Earnings Statement
(8) Total income tax expense		Cash Flow or Earnings Statement
(9) Total owner withdrawals		Cash Flow or Earnings Statement
(10) Annual scheduled principal and interest payments on term debt		Cash Flow or Earnings Statement
(11) Annual scheduled principal and interest payments on capital leases		Cash Flow or Earnings Statement
(12) Calculate: (1) +(2) – (3) +(4) +(5) +(6) +(7) –(8) –(9)		
(13) Calculate: (10) + (11)		
Divide: (12)/(13)		

PLEASE SELECT THE APPROPRIATE ANSWER BASED UPON YOUR RESULTS:

1. My term debt & capital lease ratio is less than 110%.
2. My term debt & capital lease ratio is between 110% and 150%.
3. My term debt & capital lease ratio is greater than 150%.

Better known as repayment capacity, this ratio measures whether or not a farmer can repay term farm debt. This metric is calculated using the following equation:

> (Net farm income from operations +/- total miscellaneous revenue/expense + total non-farm income + depreciation/amortization expense + interest on term debt + interest on capital leases – total income tax expense – owner withdrawals (total))/ (Annual scheduled principal and interest payments on term debt + annual scheduled principal and interest payments on capital leases).

Farms enjoying a competitive position generally have a term debt and capital lease ratio of less than 110% whereas farms with a term debt and capital lease ratio of greater than 150% should seek financial guidance to improve performance.[250]

- **OPERATING EXPENSE RATIO**[251] (Please fill in the following information)

	Amount ($)	Source
(1) Total Operating Expenses		Income Statement
(2)Depreciation and Amortization Expense		Income Statement
(3) Revenues		Income Statement
(4) Calculate: (1) – (2)		Income Statement
Divide: (4)/(3)		

PLEASE SELECT THE APPROPRIATE ANSWER TO ONE OF THE FOLLOWING QUESTIONS BASED UPON YOUR RESULTS.

I own most of my assets and:

1. My operating expense ratio is greater than 80%.
2. My operating expense ratio is greater than 65% but less than 80%.
3. My operating expense ratio is less than 65%.

I lease or rent most of my assets and:

1. My operating expense ratio is greater than 85%.
2. My operating expense ratio is greater than 75% but less than 85%.
3. My operating expense ratio is less than 75%.

This ratio measures whether a farmer generates the maximum amount of revenues and profits possible from the farm. This metric is calculated using the following equation:

(Total operating expenses – depreciation and amortization expense)/ Revenues.

"A benchmark for the operating expense ratio is between 65-80%--a ratio over 80% often indicates profitability problems, while less than 65% indicates great efficiency."[252] Farms (with mostly owned assets) enjoying a competitive position generally have an operating expense ratio of less than 65% whereas farms with an operating expense ratio of greater than 80% should seek financial guidance to improve performance.[253] Farms (with mostly leased or rented assets) enjoying a competitive position generally have an operating expense ratio of less than 75% whereas farms with a ratio of greater than 85% should seek financial guidance to improve performance.[254]

- **FARM INCOME** (Fill in the chart below and answer the following question)

	Income ($)
My Income	
Spouse's Income	
Child's Income	
Total Income	
My Income/ Total Income	
Spouse's Income/Total Income	

- **OUR FAMILY'S INCOME IS SUFFICIENT FOR PAYING FOR** (Please check all that apply):
  - ❑ Food
  - ❑ Clothing
  - ❑ Mortgage and monthly bills
  - ❑ Health insurance
  - ❑ A savings account

Milk price fluctuations have contributed greatly to the rise in off-the-farm family income. Additional income can provide several benefits such as: 1) offsetting low farm returns; 2) providing for basic necessities such as health insurance and maintenance of the farm; and 3) possibly raising living standards and protecting against fluctuations in farm income. In recent years, almost 60% of US Farm households had either the farmer, spouse, or both employed in off-farm work.[255] Moreover, approximately 80% had higher cash incomes from off-farm earnings (including wages, rent, interest) than from farming operations.[256]

WORK/LIFE BALANCE (Please fill in the following information and answer the following question)

	MON	TUES	WED	THURS	FRI	SAT	SUN	Total
# hrs working on farm								
# of hours spent with family								
# of hours of spent on leisure activities								
Total								
% on Farm								

PLEASE CHECK ALL THAT APPLY:

- ❑ I work more than 70 hours/week on the farm.
- ❑ I spend more than 10 hours/week with my family each week.
- ❑ I spend more than 5 hours/week on leisure activities such as hunting, volunteering, etc.
- ❑ I have taken a vacation in the past year with my family.

A farmer must consider his or her financial stability in relation to his or her work/life balance. While the appropriate amount of time to spend with family is based upon individual preference, the general consensus is that the more "family time" a person can accumulate, the happier he or she will be. The response from farmers is overwhelmingly that spending time with children is an esteemed goal and influences a farmer's participation in farming practices that lead to a reduction of labor time required on the farm.[257]

- **ATTITUDE TOWARDS ADOPTING NEW PRACTICES**
  1. New farming practices are costly and risky. Therefore I have not considered them in a while.
  2. I would like to implement new farming techniques and have done a lot of reading on different options; however, money is a constraint.
  3. I am very open to new farming technology and seek out new information. When a new technology makes sense for my farm, I implement it.

- **PLANNING FOR THE FUTURE** (Please check all that apply)[258]
  - ❑ I am not involved with the future planning of the farm; decisions are made by my family.
  - ❑ I am in the process of improving the current conditions of the barn for the cows.
  - ❑ I want to increase the number of cows on the farm.
  - ❑ I am considering additional crops on the farm to diversify sources of income.
  - ❑ I have a plan for when milk prices fluctuate greatly.
  - ❑ I am constantly looking for ways to save money on the farm.

To increase the stability of his or her enterprise, a farmer should investigate new practices and complete business plans, similar to any other business. According to ATTRA, farm planning and production goals are on-going processes that require farm families to define a goal as well as a path to achieve those goals.[259] Research indicates that simply by taking the time to consider long term business planning can be motivation enough to affect change.[260] These actions are increasingly important given current low milk prices. Since 1960, Vermont has lost over 80% of its dairy farms primarily due to changing prices of milk and competing uses for land and labor.[261] While production per cow has risen steadily, farmers' profits have been squeezed, since the costs of producing milk have increased at a substantially faster rate than the price of milk.[262] Therefore business planning must account for rapid changes in order to ensure a farmer's success.

Linkages to Other Modules

While the questions above cover some of the basics regarding financial and quality of life management, other practices also impact farm financials. Please review your practices regarding the following topics in the Educational Modules listed below.

FARM FINANCIAL TOPIC	OTHER MODULE(S)
Farm Financials	Energy
Quality of Life	Community Health

Further Information

Additional details and information on the above can be obtained through the following programs or sources.

- Center for Farm Financial Management, University of Minnesota. http://www.cffm.umn.edu/. This website provides information on financial and business planning.

- Doehring, Todd A. "Analyzing the Efficiency of Your Operation," AEC, 2001 http://www.centrec.com/resources/Articles/FinAnalysisFarmRanches/Efficiency.pdf. This document walks through how to calculate and measure each FFSC metric for efficiency.

- Doehring, Todd A. "Analyzing the Profitability of Your Operation," AEC, 2001 http://www.centrec.com/resources/Articles/FinAnalysisFarmRanches/Profitability.pdf. This document walks through how to calculate and measure each FFSC metric for profitability.

- Pennsylvania State University. "Green Milk Successfully Test-Marketed at Mid-Atlantic Stores." http://aginfo.psu.edu/news/may00/greenmilk.html. This article describes a program which pays farmers a premium if they produce milk using environmentally friendly management practices. The program, called the Environmental Quality Initiative Inc., is a joint venture of the Chesapeake Bay Foundation, Pennsylvania State University, the Rodale Institute, the Pennsylvania Association for Sustainable Agriculture and the US EPA. The program pays farmers a five-cent premium per half gallon to encourage participation and offset any costs incurred due to changes in management practices. .

- Purdue University Cooperative Extension Service. "Farm Business Management for the 21st Century. Measuring and Analyzing Farm Financial Performance." http://www.agecon.purdue.edu/extension/programs/fbm21/EC712entry.htm This site provides additional measures for farm financial performance including cash flow analysis, debt service analysis, and information on how to respond to financial difficulty.

- Virginia Cooperative Extension Service. http://www.ext.vt.edu/resources/. This page includes information on a variety of topics related to farm financials. Sections of interest include Financial Management and Farm Business Management and Marketing. These sections cover specific financial topics such as estate planning, equipment leasing economics, and much more.

- Kohl, David. *Summary of Key Ratios and Benchmarks*. Not dated. This table developed by David Kohl and shown on the following page summarizes additional key financial ratios, their calculations, and corresponding benchmarks for the agriculture industry. It includes fifteen of the sixteen farm financial ratios advocated by the FFSC plus one additional ratio. This additional ratio, the California Working Capital Rate, is used to calculate liquidity.

Summary of Key Ratio Calculations and Benchmarks

Repayment Analysis	Calculation	Green	Yellow	Red
Term Debt and Lease Coverage Ratio	[(NFIFO* + Gross Non-Farm Revenue + Depreciation Expense + Interest on Term Debts and Capital Leases) - Income Tax Expense - Family Living Withdrawals] / Scheduled Annual Principal and Interest Payments on Term Debt and Capital Leases	>150%	110% to 150%	<110%
Debt Payment / Income Ratio**	Scheduled Annual Principal and Interest Payments on Term Debt and Capital Leases / (NFIFO* + Gross Non-Farm Revenue + Depreciation Expense + Interest on Term Debts and Capital Leases)	<25%	25% to 50%	>50%
Liquidity Analysis				
Current Ratio	Total Current Farm Assets / Total Current Farm Liabilities	> 1.50	1.00 to 1.50	< 1.00
Working Capital	Total Current Farm Assets - Total Current Farm Liabilities	compare to business expenses, absolute amount depends on scope of operation		
California Working Capital Rule**	Working Capital / Total Expenses	> 50%	20% to 50%	<20%
Solvency Analysis				
Debt / Asset Ratio	Total Farm Liabilities / Total Farm Assets	<30%	30% to 70%	>70%
Equity / Asset Ratio	Total Farm Equity / Total Farm Assets	>70%	30% to 70%	<30%
Debt / Equity Ratio	Total Farm Liabilities / Total Farm Equity	<42%	42% to 230%	>230%
Profitability Analysis				
Rate of Return on Farm Assets (ROA) (mostly owned)	(NFIFO* + Farm Interest Expense - Operator Management Fee) / Average Total Farm Assets	>5%	1% to 5%	<1%
Rate of Return on Farm Assets (ROA) (mostly rented / leased)	(NFIFO* + Farm Interest Expense - Operator Management Fee) / Average Total Farm Assets	>12%	3% to 12%	<3%
Rate of Return on Farm Equity (ROE)	(NFIFO* - Operator Management Fee) / Average Total Farm Equity	look at trends and compare to other farm and non-farm investments		
Operating Profit Margin Ratio	(NFIFO* + Farm Interest Expense - Operator Management Fee) / Gross Revenue	>25%	10% to 25%	<10%
Financial Efficiency				
Asset Turnover Ratio	Gross Revenue / Average Total Farm Assets	depends heavily on type of operation and whether it is owned / leased		
Operating Expense / Revenue Ratio (mostly owned)	Operating Expenses [excluding interest and depreciation] / Gross Revenue	<65%	65% to 80%	>80%
Operating Expense / Revenue Ratio (mostly rented / leased)	Operating Expenses [excluding interest and depreciation] / Gross Revenue	<75%	75% to 85%	>85%
Depreciation Expense Ratio	Depreciation Expense / Gross Revenue	compare to capital replacement and term debt repayment margin		
Interest Expense Ratio	Interest Expense / Gross Revenue	<12%	12% to 20%	>20%
Net Farm Income From Operations Ratio	NFIFO* / Gross Revenue	look at trends, varies due to cyclical nature of agricultural prices and incomes		

* NFIFO = Net Farm Income From Operations excluding gains or losses from the disposal of farm capital assets
** Not a ratio recommended by the Farm Financial Standards Taskforce and Council, but widely used

Summary Results for Farm Financials and Quality of Life

Instructions: In the table below, please record the score for the answer you selected for each question. For multiple-choice questions, the response number serves as your score for that category (i.e. choice # 2 is worth 2 points). For "check all that apply questions," please see scoring criteria for each question in the chart below. Once all responses have been completed, add up the answers and record the total.

QUESTION	ANSWER/SCORE
1. Current Ratio	
2. Equity to Asset Ratio	
3. Rate of Return on Farm Assets	
4. Term Debt & Capital Lease Coverage Ratio	
5. Operating Expense Ratio	
6. Work/Life Balance	
7. Attitude Towards Adopting New Practices	
8. Farm Income	
9. Planning for the Future	
Total Score	
Total Possible Points	33

Interpretation: The next step in understanding your farm's performance in the category of Farm Financials and Quality of Life Module is to compare the results to best practices. Below is a table that ranks your performance from best practice (green) to practices that require improvement (red). Compare the number of points you received for your farm to optimal practices.

	Point Range	Interpretation
Green	28 – 33	Best practices regarding Farm Financials are currently being employed on this farm.
Yellow	20 – 27	Farm is using some good practices regarding Farm Financials; however there are some key areas that should be improved on.
Red	6 – 19	Farm Financials should be carefully evaluated and a strong effort should be made to adopt improved practices in several areas.

X. NUTRIENT MANAGEMENT

INTRODUCTION

Nutrients, such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg) and sulfur (S) are necessary for plant and animal growth and are therefore an integral part of any agricultural or dairy system. At the same time, excess levels of nitrogen and phosphorus can be detrimental to environmental health, particularly water quality. While levels of other nutrients (K, Ca, Mg, S and other micronutrients) are also increasing, on-going soil tests show that these increases are less dramatic and are not causing any known environmental damage to the farm ecosystem.[263] This nutrient management section, therefore, will focus exclusively on controlling the use and flows of nitrogen and phosphorus on dairy farms.

When the amount of nitrogen and phosphorus coming onto a farm exceeds the level leaving the farm, an excess, or surplus, of nutrients builds up (see box for an explanation of nutrient flows on dairy farms). As a result of increasingly intensive crop systems, the soil's ability to sustain high-production crops has diminished, resulting in an over-reliance on concentrated inorganic fertilizers as well as renewable nutrient sources such as manures. Low plant uptake efficiency combined with over-application of nutrients can result in a build-up of nutrients in the soil. This surplus, in and of itself, is not an environmental problem. The problem stems, instead, from the fact that increased nitrogen and phosphorus levels increase the chance that these excess nutrients are transported off of the farm into water sources via leaching or runoff or into the atmosphere via wind erosion of soil. (For a further discussion of soil erosion, please see the Soil Health Educational Module.)

Nutrient Flows on a Dairy Farm

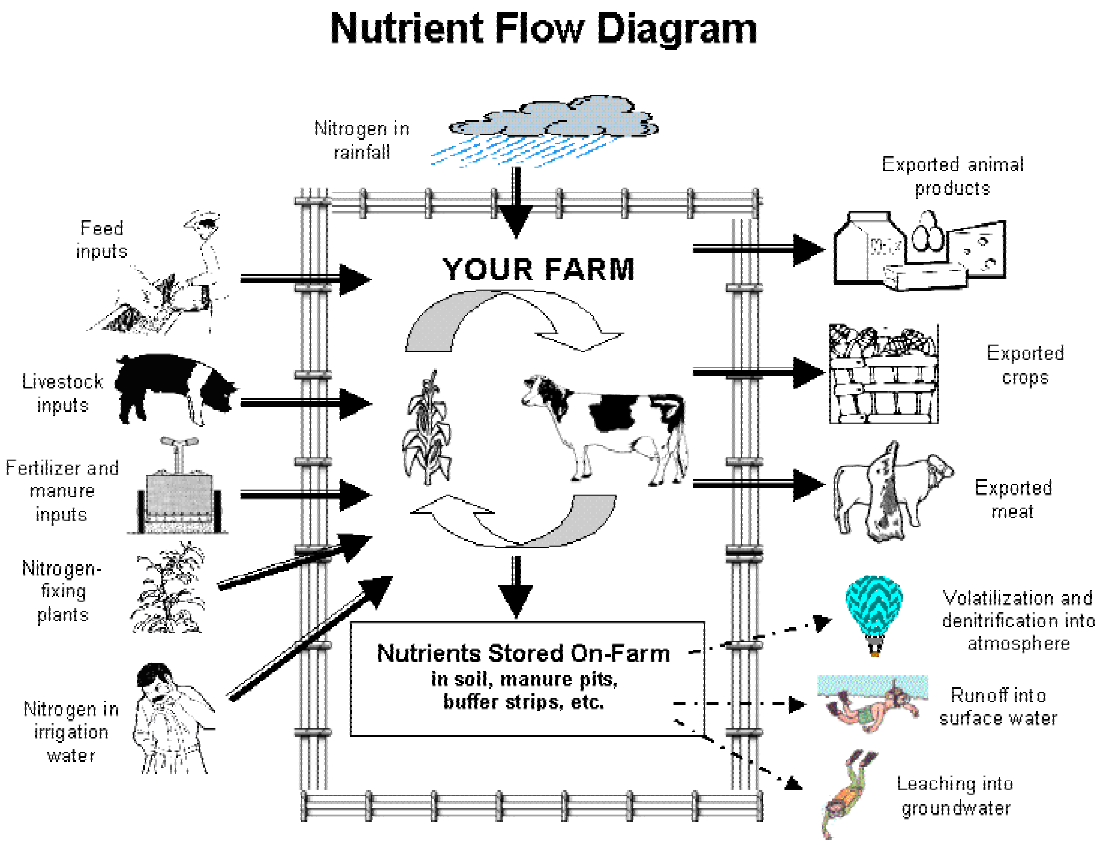
A variety of nutrient cycles occur on a dairy farm as nutrients interact with animal, crop, and soil systems, both on- and off-farm (see
Figure 12). Nutrients become available for use on the farm via mineralization of organic matter in soil, nutrient release from decomposition of plant residue, precipitation and irrigation water that contain nutrients, legume crops that fix nitrogen into the soil, and fertilizers and manure that are spread on fields to improve crop yield or growth of pasture forage materials. Nutrients that are contained in feed are processed through cows and released to the system via manure. A 1000-pound dairy cow produces, on average, 82 pounds (9.9 gallons) of manure per day.[264]

Once in the soil, these nutrients are 1) absorbed by plants, 2) stored in the soil or 3) transported off the farm via leaching, runoff or soil sediment erosion to air. Although plants or crops take up some of the nutrients as they grow, the majority of nutrients is not utilized and instead remains in the soil.[1] In fact, research shows that 59-81% of imported nitrogen and phosphorus remains on a dairy farm over one year.[265] The nutrients that remain in the soil will then either be available for the next season of plants or crops, or can be transported

[1] The exception to this is certain types of legume crops, which fix nitrogen into the soil, rather than extracting it.)

off of the farm via leaching, runoff or wind erosion. When plants or crops are used as feed for cows, the cows process the nutrients into cow tissue (growth), milk and manure. When manure is recycled and spread on the fields, the on-farm nutrient cycle continues. Alternatively, nutrients in manure can be transported off the farm in other ways, including runoff or sale of excess manure.

Figure 12: Nutrient Flows on Dairy Farms[266]



Surplus levels of nitrogen and phosphorus can be damaging to ground and surface water. Nitrate nitrogen is particularly problematic to ground water, since excess can leach through the soil and contaminate ground water. Nitrate-nitrogen contamination of drinking water (beyond Federal and State drinking water standards of 10 mg/l of nitrate-nitrogen) can pose a risk to some infants, causing a condition known as 'blue baby syndrome, a respiratory illness."[267] High nitrate-nitrogen levels can also be a health hazard for young livestock, who are particularly susceptible to such health problems, especially in combination with high levels of nitrate-nitrogen in feed sources.[268]

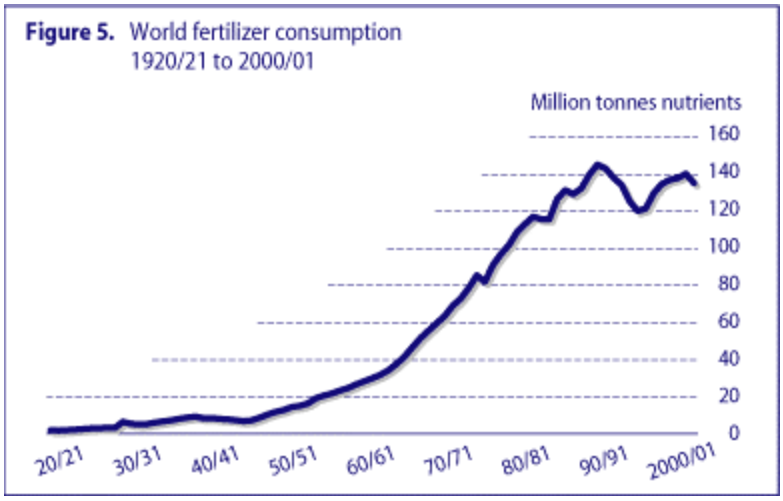
Both phosphorus and nitrogen (in the form of ammonium-nitrogen) can leave the farm via runoff or sediment removal, polluting surface waters. High nutrient levels in surface waters can lead to eutrophication, or nutrient enrichment of water, which results in oxygen depletion that kills fish and other aquatic organisms. An extreme result of excess nutrients

in surface waters is hypoxia, where dissolved oxygen levels are too low to support marine life, thus creating 'dead zones' in bodies of water.[269] High nutrient levels in surface waters can also sustain microorganisms from human or animal wastes or cause blooms of aquatic organisms that produce toxins.[270] Such changes to surface water characteristics are harmful to the biological balance and health of the aquatic ecosystems and the life that it supports and can also impair the use of the water for recreational activities such as swimming or commercial activities such as fisheries, and for industrial, municipal or agricultural purposes.

GLOBAL, NATIONAL AND REGIONAL TRENDS

At a global level, fertilizer use has increased significantly since the 1950's and 1960's (see Figure 13). Prior to the introduction of chemical fertilizers, nutrient cycles were kept in balance through the recycling of nutrients through crop production, intake of crop nutrients by animals, subsequent excretion of nutrients in manure and use of on-farm nutrient sources (plant residues and manure) for crop production. Since its introduction, however, world consumption of nitrogen fertilizer has increased almost 700% in the last forty years, growing from 10.83 million tons in 1960/61 to 80.80 million tons in 2000-01.[271] Use of phosphate fertilizer is increased 300%, growing from 10.73 million tons in 1960-61 to 32.44 million tons in 2000-01.[272]

Figure 13: World Fertilizer Consumption 1920/21 to 2000/01[273]



Chemical fertilizer and the increased reliance on purchased feed, versus grown feed or forage, has resulted in increasing build-up of nutrients in soils. Additionally, economics are driving farming decisions to increase herd size, purchase more feed, and shift feed productions from perennial forage crops to annual row crops, all of which can lead to an accumulation of nutrients on a farm.[274] Nationally, agriculture is the greatest nonpoint source of pollution to groundwater and surface water in the U.S.[275] and dairy farming trends are leading to increased potential for surplus nutrient build up and corresponding emissions to air and water. Illustrating the problem in the U.S., the Gulf of Mexico has a hypoxia zone (oxygen depleted 'dead' zone) that reached a record 8,500 square miles in 2002, largely the result of commercial fertilizer and animal manure (which account for about 50% and 15%, respectively, of the nutrient flows to the Gulf) nutrient flows from agricultural lands into the Mississippi River Basin.[276] This 'dead zone' has negative environmental implications for

species health and biodiversity. There are also economic implications due to the potential negative impact of hypoxia on commercial fisheries in the region.

In the Northeast, dairy farms typically have surplus levels of nitrogen and phosphorus.[277] Vermont's Lake Champlain, a critical water resource, is experiencing a serious decline in water quality, in part due to sediment and nutrients from agricultural runoff from barnyards, manured and fertilized fields and cropland erosion. Also, many drinking water wells have been found to have nitrate-nitrogen levels exceeding the Vermont public health standard.[278] While Vermont dairy farms are certainly not the only source of this pollution, contributions from dairies can be significant and participation from the dairy farmer community is therefore essential to improving this water quality problem.

FOCUS OF THE NUTRIENT MANAGEMENT EDUCATIONAL MODULE

Adopting best practices for nutrient management is important for maintaining ground and surface waters that are safe for drinking, support healthy aquatic ecosystems, function as industrial and commercial water supplies, and provide recreational enjoyment. Because healthy farm systems normally recycle nutrients via soil, crops, cows and manure, the focus is on nutrient imports, which serve as additions to these natural processes and often are the cause of nutrient buildup on a farm. The Vermont Dairy Farm Sustainability Project found that feed and fertilizer are largest sources of nutrient imports, accounting for 89.5% of imported nitrogen and 96% of imported phosphorus.[279] As a result, the Nutrient Management Educational Module is devoted to controlling both imports and direct nutrient use on farms by means of overall nutrient management plans, fertilizer and manure use and use of phosphorus supplements (which translates to phosphorus levels in manure).[2]

It should be noted that other factors contribute to nutrient pollution of water. As mentioned in the introduction, nutrient contamination of water is the result of both excess levels of nutrients in the soil and the actual transport (via water and soil runoff) of the soil from fields to the water. Controlling nutrient levels applied to fields, as per the current module, will minimize excess nutrients in the soil in the first place. To build on this improvement, steps must be taken to manage soil in such a way as to minimize or eliminate runoff or leaching to ground water. These steps can be found in the Soil Health Educational Module. Additionally, nutrient water pollution resulting from other aspects of farm management, such as manure and silage storage and livestock yards, are addressed in the Water Management Educational Module.

PARAMETERS SELECTED

The following Parameters were selected by means of two screening processes, as outlined in the Methodology section. For a listing of parameters that were not used, please see Appendix D.

Nutrient management and planning: The existence of a nutrient management plan is a strong indicator of the attention a farmer pays to nutrient use and cycles on a farm, which can significantly impact the potential for excess use and build-up. As a result of this attention,

[2] Much of this section refers to nutrient application to crops. This is relevant to dairy, and dairy farmers in Vermont in particular, since the majority of Vermont dairy farmers grow crops as cash crops or food for their cows.

nutrient application to fields or pastures can be matched specifically to crop and soil need, reducing the potential for excess nutrients and build-up. Many states require farmers to develop and utilize nutrient management plans. Additionally, new regulations passed by the EPA require that certain concentrated animal feeding operations (CAFO's) develop and implement nutrient management plans as a condition of operations (i.e. permits for operation are contingent on these plans). The University of Vermont (UVM), the Michigan Department of Agriculture, and the USDA Natural Resources Conservation Service Farm*A*Syst are some of the programs that recommend the use of comprehensive nutrient management systems. This body of work highlights the importance of this consideration to and makes available sufficient resources for delineating clear best management practices around it.

Soil Testing: While nutrient management plans can vary in terms of comprehensiveness and specificity, one of the best bases for nutrient management is regular soil testing. Soil testing is beneficial in multiple ways. First, the practice of conducting soil tests on a regular basis (at least once every 3 years) demonstrates a farmer's commitment to comprehensive understanding and management of their farm (in terms of nutrient application levels and maintaining high soil quality, which can also benefit farms and the environment). Second, soil tests allow farmers to know, rather than estimate, exact nutrient levels and other soil characteristics on their farms. Other soil characteristics, such as pH, can affect crop uptake of nutrients, therefore a soil test provides a comprehensive, multi-faceted understanding of nutrient management. Finally, soil tests are processed by experts in soil and nutrient management and results are accompanied by actual nutrient recommendations that are specific to the characteristics of the farm (such as which crop to be grown, soil type, etc.) to ensure application levels that are precisely matched to need. As a result, numerous studies and programs point to soil testing as a key part of an overall nutrient management system.

Fertilizer and Manure Application Amount: Above and beyond soil testing and the existence of nutrient management plans, it is important to assess the specific drivers of manure and fertilizer application levels as a more direct means of evaluating the potential for overuse of nutrients. Addressing a farmer's use of these nutrient sources is also important for educating the farmer on specific best practices regarding nutrient use. Fertilizer and manure application rates are specifically important for two reasons. First, overuse of these nutrient sources is the main driver increasing a farm's potential for nutrient runoff or leaching to water sources. Second, the use of fertilizer and manure nutrients is controllable by the farmer and will not adversely affect his or her operations. In fact, modeling studies from Illinois show that a 10-15% reduction in fertilizer or manure use would not affect yield but could reduce nitrate (nitrogen) output from row crops by 30%.[280]

Historical and present trends emphasize the importance of focusing on monitoring and managing fertilizer and manure application rates. Farmers' tendency to follow historical practice and utilize excess fertilizer as insurance for crop yields results in overuse of fertilizers for cropland on dairy farms. Since the availability of fertilizers has increased since the 1960's, farmers have increasingly come to rely on it instead of more traditional methods of nitrogen-fixing crops or manure or other organic matter as a source of nutrients. Many agricultural systems have a fertilizer use efficiency of less than 50%, resulting in over-use of inorganic fertilizers, resulting in an increase in runoff and pollution to water.[281] Today, commercially manufactured chemical fertilizers are the major source of applied plant

nutrients in U.S. and commercial fertilizer accounted for 6.4% of total farm production expenses in 1997.[282] Finally, fertilizer is produced largely from nonrenewable nutrient resources and fossil fuels.[283]

Manure application to fields should be viewed as a means for supplying needed nutrients, versus a means for disposing of stored manure. If there is no other way to dispose of manure, farmers may apply more than is needed, given the amount of land they have, and increase the potential for runoff. A U.S. study showed that 35 counties (up from 6 in 1954) had manure nutrients in excess of total potential plant uptake across farmland, including pastureland. The same study found that 112 counties had excess levels of phosphorus (up from 38 in 1954).[284]

Manure and Fertilizer Application Equipment, Timing & Techniques: In addition to applying the proper quantity, utilization of appropriate timing and techniques, with appropriately calibrated equipment, will minimize the amount of nutrients applied, maximize the efficiency of use by the crops, and minimize the potential for runoff. Appropriate timing of fertilizer application can increase utilization by crops, which minimizes the amount needed, and will ensure that freshly applied nutrients will not be carried off of the farm (before they can do their job) to water sources. Additionally, in order to work effectively, manures and phosphorus fertilizers must be incorporated into the soil. This provides the double benefit of increasing availability for crop use and decreasing potential for runoff, since the manure is not sitting on the surface of the soil. Finally, the efforts around nutrient planning and management will be wasted if application equipment is not properly maintained to avoid spillage and calibrated to ensure accurate application rates.

Purchased Minerals and Supplements: It has been found that many dairy farmers over-use phosphorus supplements to ensure dairy production levels. The USDA Agricultural Research Center, in cooperation with several universities and other research institutions, found that, by replacing dietary phosphorus supplements with low-phosphorus protein supplements, phosphorus excretion in manure was dramatically reduced. This resulted in less cropland required for the recycling of manure nutrients and in manure nitrogen and phosphorus levels that more closely matched crop requirements.[285] The same group also found that feeding diets containing .57% phosphorus had no reproductive benefits over diets with .37% phosphorus (the recommended amount). Controlling the level of phosphorus fed to the cows can have a large impact on the phosphorus levels in manure. This is key to Vermont dairies, where phosphorus is the problem nutrient in Lake Champlain.

In addition to the study listed above, a booklet outlining best management practices for phosphorus use in feed ("Feeding Strategies to Reduce Phosphorus Inputs from Dairy Sources") was developed through a cooperation of numerous organizations, including the U.S. EPA, the USDA Natural Resources Conservation Service, the University of Vermont, the Vermont Department of Agriculture, Food and Markets and the Miner Institute. Together these studies provide adequate scientific verification of the issue and the efficacy and importance of related best practices. The issues and practices are straightforward and easy to understand, contributing to the potential success with which the farmer can utilize the best management practices.

EDUCATIONAL MODULE

Combining research on the specific indicator, global, national, and regional trends and the most appropriate parameters, the Team developed the following Educational Module.

NUTRIENT MANAGEMENT EDUCATIONAL MODULE

Description

Nutrients are needed to sustain healthy animals and crops but overuse or mismanagement of nutrients, in particular nitrogen and phosphorus, can lead to nutrient pollution of ground or surface waters. Purchased feed and fertilizer are by far the largest sources of nutrient imports onto a farm, accounting for 89.5% of imported nitrogen and 96% of imported phosphorus.[286] Reliance on these external nutrient sources is becoming problematic in that 59-81% of imported nitrogen and phosphorus remain on a dairy farm over one year.[287] This results in a build-up of nutrients in the soil and an increased chance that nutrients will be transported to water sources, resulting in environmental harm to surface and ground water.

While Vermont dairy farms are certainly not the only source of this pollution, contributions from farmland can be significant and participation from the dairy farmer community is therefore essential to improving overall water quality. In Vermont, Lake Champlain, a critical water resource, is experiencing a serious decline in water quality, in part due to sediment and nutrients from agricultural runoff from barnyards, manured and fertilized fields and cropland erosion. Also, many drinking water wells have been found to have nitrate-nitrogen levels exceeding the Vermont public health standard.[288]

Adopting best practices for nutrient management is important to maintaining ground water that is safe for drinking and surface waters that can support healthy aquatic ecosystems, function as industrial and commercial water supplies, and provide recreational enjoyment. This module is devoted to controlling direct nutrient use on farms, specifically with respect to nutrient applications to fields. Recommendations regarding nutrient management plans, use of fertilizer and manure, and use of dietary phosphorus supplements are intended as an introduction to best management practices to improve farm performance and environmental health. Actual changes to nutrient management should be made in cooperation with experts, such as UVM extension representatives, feed or fertilizer specialists, or other consultants. Controlling water pollution from other nutrient sources, such as manure or silage storage, is addressed in the Water Management module.

Incentives for Change

- **Cost savings.** Appropriate nutrient management can reduce unnecessary feed and fertilizer purchases, improving crop production efficiency and farm profitability. The Vermont Dairy Farm Sustainability Project found that, by reducing phosphate fertilizer application by 40% (average reduction over a 3 year period), farms could reduce total fertilizer expenditures by an average of $2800/farm or $27/acre, while maintaining farm yields.[289] One farm decreased phosphate fertilizer use by 8.3 tons/year for savings of $4200/year.[290]

- **Improved on-farm water quality.** Minimizing impact on surface and ground water is beneficial to the extent that these water resources become inputs on the farm. Maintaining healthy drinking water can reduce the chance for illness, and associated costs, from contaminated water.

- **Regulatory environment and funding.** The EPA recently passed water quality legislation requiring that farms with large 'concentrated animal feeding operations' (CAFO) obtain a permit for operation. However, in order to get a permit, a farmer must first develop and implement a comprehensive nutrient management plan. While Vermont's current limit of "large" CAFO operations is 675 milking cows, there is discussion of reducing this number to 200. Additionally, regulation of phosphorus in Vermont requires that farmers take action to reduce the amount of phosphorus coming onto the farm.[291] As this and other water quality legislation becomes more stringent, dairy farms will increasingly need to demonstrate nutrient management best practices.

Assessment Questions

For all questions, please choose the categories that best identify your current management practices. Use the Summary sheet on the last page of this module to evaluate overall performance.

➢ **NUTRIENT MANAGEMENT & RECORD KEEPING**:

1. No nutrient management plan exists for the farm. Nutrient use is driven by compliance with applicable state or local regulations governing nutrient use.
2. Nutrient management plan is based on some soil testing and recommendations of the University of Vermont or another credible source. Recommended nutrient application rates are exceeded by 5-25% as 'insurance' for a good yield level.
3. In addition to #2, the plan is based on soil tests ever 1-3 years and recommended application rates not exceeded by more than 10%. Detailed nutrient records are kept (soil test results, crop yields, nutrient application rates and timing, etc.).
4. In addition to #3, recommended application rates are never exceeded. Additionally, detailed records are used to guide and improve the nutrient management plan on an annual basis.

Record keeping can help farmers further understand, monitor, and therefore improve, farm performance. It also demonstrates good management and can provide valuable data if management practices are ever challenged. While a bit of effort needs to be invested up front, implementation and maintenance of a nutrient management and record-keeping plan will ultimately save both time (e.g. records are readily available when needed for taxes or other purposes) and money in the long term. A nutrient management plan, developed in conjunction with the UVM Extension service, consultant or other expert resource, covers multiple nutrient flows on farms, including use of manure, fertilizer, and feed and supplements. Some best practices associated with nutrient management plans are captured in the questions in this module.

➢ **MANURE APPLICATION RATE:**

1. Application rates are unknown or manure is applied until all manure is used up (without regard to nutrient requirements of field or crop).
2. Application rates are determined by crop-specific phosphorus needs (per UVM or other published standards) and realistic yield goals (goals are within 10% of 5-year average yield). To prevent over-application, some excess manure may be applied to neighboring fields or otherwise properly disposed of.

3. In addition to #2, application rates are loosely determined by soil nutrient need according to soil tests performed every 3-5 years. To prevent over-application, most excess manure is applied to neighboring fields or otherwise properly disposed of.
4. In addition to #3, rates are determined by strictly following application recommendations from soil tests conducted every 1-3 years and application reflects manure nutrient content, as determined by laboratory analysis. To prevent over-application, all excess manure is applied to neighboring fields or otherwise properly disposed of.

Manure is a valuable source of nitrogen, phosphorus and potassium for crop production but it is important that the use of manure on fields focuses on crop utilization of manure nutrients rather than manure waste disposal. Over-application of manure can result in build up of nutrients in the soil and increased potential that nutrients will be leached through the soil to groundwater or transported to surface waters via runoff. The amount of manure applied should therefore be closely matched to the needs of each field.

Any excess manure remaining after application should be applied to neighboring fields or otherwise properly disposed of. As a benchmark for the amount of land that will be needed for your farm, best practice requires .5 to 1.0 animal units (AU) per acre of cropland that is environmentally, economically, and agronomically suitable for the application of manure.[292] One AU is equivalent to 1,000 pounds so a 1,400-pound dairy cow would be 1.4 AU's.[293]

To more closely match manure application rates to soil and crop needs, the farmer should base application rates on the following:

- Soil Testing*:* Soil testing, conducted at least every 3 years, is the best way to determine soil nutrient content and other characteristics that affect crop uptake of nutrients. UVM offers soil test kits that provide information on soil pH, available phosphorus, aluminum (which affects plant uptake of phosphorus) and other nutrients, and soil fertility recommendations. At $9/sample, soil testing is a non-time-intensive, non-costly way to better understand and manage on-farm nutrients.
- Manure Nutrient Content: The percentage of nutrients in manure will vary, depending on such factors as type of cow, composition of feed, additions of other substances to manure, and collection and storage methods. Because of the wide potential variation in nutrient content, a manure nutrient analysis, which can be done for $30 at UVM, is highly recommended as the best means of determining exact nutrient content for precision crop nutrient applications. If such an analysis is not possible, using published averages for manure nutrient levels is the next best alternative.
- Type of Crop and Crop Yield: Different crops and yield levels will result in varying crop nutrient needs. Manure use should be based on nutrient need of the crop being grown, together with realistic yield goals (within 10% of average yields from the last 5 years). Ideally, nutrient content should be matched with crop need and soil nutrient content per the results of soil testing. However, using general published standards is the next best alternative.

- **COMMERCIAL FERTILIZER APPLICATION RATE:**
  1. Application is based on historical practice; specific application rate is unknown.
  2. Rates are determined by crop-specific nutrient needs (per UVM or other published standards) and realistic yield goals (goals are within 10% of 5-year average yield).
  3. In addition to #2, application rates are loosely determined by soil nutrient need according to soil tests performed every 3-5 years and manure nutrient credits and legume nitrogen credits (per UVM guidelines published standards) are reflected in application rates.
  4. In addition to #2 (not #3), rates are determined by strictly following application recommendations from soil tests (conducted every 1-3 years) and by annual Pre-Sidedress Nitrate Tests. Every effort is made to use only on-farm nutrient sources (manure, compost, cover crops, etc.).

Given that manure is an excellent and abundant source of crop nutrients, every effort should be made to effectively utilize manure (or other on-farm, organic nutrient sources) to satisfy crop nutrient need. However, and when inorganic commercial fertilizer is needed to supplement manure nutrients, precisely matching it to crop need will minimize fertilizer costs and nutrient build-up in soils.

As discussed in the "Manure Application Rate" section, soil testing and closely following corresponding nutrient recommendations is a best management practice. These nutrient recommendations should take into account crop type and yield (as discussed above) as well as the following:

- Manure and Legume Nutrient Credits: Fertilizer rates should be adjusted for nutrients provided by manure, both present and past applications, and by legume crops such as alfalfa, clover or soybeans. A percentage of nitrogen from manure applications remains in the soil in the years following application and legume crops also add nitrogen to the soil. This amount of nitrogen must be taken into account and fertilizer application rates need to be adjusted accordingly so as not to provide more nutrients than necessary for the soil. A soil test is the preferred and most accurate means of assessing soil nutrient content and corresponding need. In the absence of that, UVM published standards for manure and legume nitrogen credits are the next better alternative.
- Pre-Sidedress Nitrate Test (PSNT): The PSNT, a soil sample taken when corn plants are 8-12 inches tall, is a way to accurately understand precise nitrogen needs of the crops and to adjust nitrogen fertilizer levels for specific field conditions. The PSNT should be done on an annual basis and, at a cost of $6/sample, is not a costly investment toward proper fertilizer application levels.

- **MANURE & PHOSPHORUS FERTILIZER APPLICATION TIMING & TECHNIQUES:**
  1. Application is performed without regard to weather or proximity to on-farm water sources. Manure and phosphorus fertilizer is not incorporated into soil.
  2. Some effort is made to avoid application near water sources or prior to heavy rains (that could result in manure runoff); manure and phosphorus fertilizer is incorporated after 7 days.

3. Nutrients are never applied if heavy rain is expected and are not applied to frozen soils; buffer strips separate fields and nearby water sources. Manure and phosphorus fertilizer is incorporated within 4 to 7 days.
4. Nutrients are never applied if heavy rain is expected and are not applied to frozen soils; buffer strips separate fields and nearby water sources and manure not applied to edge of field. Manure and phosphorus fertilizer is incorporated within 1 to 3 days.

Every effort should be made to prevent manure ponding and runoff to surface water, adjacent property, or drainage ditches. It is therefore very important to incorporate manure soon after application to prevent runoff, particularly on sloped land, and to avoid applying manure if heavy rain is expected, since the rain may simply wash the manure off the field if it is sitting on the surface of the soil. Furthermore, avoiding application close to water sources and using buffer strips between fields and water sources can prevent manure and runoff from reaching the water.

Quickly incorporating manure is also valuable to making sure that it can 'do its job,' since ammonium nitrogen can evaporate out of manure if it is left on the surface. It has been found that 70% of nitrogen is retained if manure is incorporated within one day. Only 40% remains if incorporated in 2 to 3 days and only 20% of nitrogen is left in manure if it is incorporated in 4 to 7 days.[294] Manure should never be applied to frozen soils because it cannot be easily incorporated, leading to higher runoff potential and nutrient loss. An effort should be made to spread manure earlier in the season (i.e. well before the December 15 manure spreading ban) to ensure that application to frozen soils is avoided.

- **NITROGEN FERTILIZER APPLICATION TIMING & TECHNIQUES:**
  1. Broadcast applications are made without consideration to weather. Timing is not planned to optimize crop utilization of nutrients.
  2. Application is based in part on some precision application techniques (sidedress or band applications) and/or proper timing to optimize crop utilization of nutrients (multiple delayed or split applications with starter fertilizer, if appropriate). An effort is made to not apply fertilizer prior to heavy rain.
  3. Per #2, application strategy relies almost exclusively on precision application techniques and proper timing to optimize crop utilization of nutrients. Fertilizer is never applied prior to heavy rain.

Timing fertilizer applications to maximize crop uptake and utilizing precision application methods are other ways of ensuring the most efficient use of commercial inorganic fertilizer. The use of starter fertilizer and split applications of fertilizer should be matched to soil and climate characteristics as well as to PSNT results to maximize their benefits.

- **FERTILIZER & MANURE APPLICATION EQUIPMENT:**
  1. Application equipment has never been calibrated and application rates unmonitored. No effort is made to prevent spillage.

2. Application equipment is calibrated periodically and application rates are monitored somewhat. Spillage is controlled and minimized. Spills, if any, are cleaned up promptly.
3. Application equipment is adjusted and calibrated at least once a year and application rates monitored closely. Spillage is minimized and spills, if any, are cleaned up promptly.

Efforts to match nutrient application amounts to soil and crop need would be wasted if the nutrient application equipment is not calibrated or otherwise cannot be relied on to provide accurate information on nutrient application rates (e.g. due to spills or leaks). As such, best management practice calls for regular calibration of the equipment, close monitoring of application rates, and avoidance of any spillage or leaks.

- **USE OF PHOSPHORUS SUPPLEMENTS:**
  1. Dietary phosphorus is not closely monitored, or is maximized to guarantee production levels.
  2. Dietary phosphorus levels are monitored but exceed National Research Council (NRC) 2001 guideline levels.
  3. Diets are strictly regulated and monitored to ensure that cows are receiving no more than the NRC recommended amount of dietary phosphorus.

Numerous studies have found that closely following National Research Council 2001[295] recommendations for dietary phosphorus can reduce current phosphorus levels for dairy cows (which frequently exceed required amounts) without affecting production levels. The result is dramatically reduced phosphorus levels in manure, which can allow for better matching of manure nutrients to soil and crop need. **Important:** Any phosphorus reduction strategy must result from a collaborative effort between farmers, feed and fertilizer consultants, veterinarians and manure haulers.

Linkages to Other Modules

Nutrient issues are very closely tied to Water Management, Soil Health and, to a lesser extent, Animal Welfare. The table below identifies where you can find more information on some of the topics mentioned in this module.

NUTRIENT MANAGEMENT TOPIC	OTHER MODULE(S)
Manure Storage	Water Management
Fertilizer Storage	Water Management
Dietary Phosphorus	Animal Welfare
Soil Testing	Soil Health

Further Information

Additional details and information on the above can be obtained through the following programs.

- **University of Vermont Extension Program** provides laboratory testing, nutrient recommendations for field crops in Vermont and other services. Information can be accessed on the web at http://pss.uvm.edu/vtcrops/?Page=nutrientmanure.html. Soil test information is available at http://pss.uvm.edu/ag_testing/?Page=soils.html.

- **Miner Institute** (http://whminer.serverbox.net/) does research and education on dairy farm and environmental conservation best practices. They published "Feeding Strategies to Reduce Phosphorus Inputs from Dairy Sources," which provides information on better utilizing dietary phosphorus. More information is available on the internet or by calling Kurt Cotanch at the Miner Institute at 518-846-7121, extension #123.

- **Livestock and Poultry Environmental Stewardship (LPES) Curriculum** provides environmental best management practice recommendations for dairy farms (http://www.lpes.org/les_plans.html). They also provide information on the new Concentrated Animal Feeding Operations (CAFO) regulations and links to funding and additional technical resources (http://www.lpes.org/CAFO.html). You can also call 1-800-562-3618 for more information.

- The **USDA Natural Resource Conservation Service (NRCS)** offers nutrient management information and tools at http://www.nrcs.usda.gov/technical/ECS/nutrient/. The program also provides funding and technical assistance for conservation efforts through Farm Bill 2002 (http://www.nrcs.usda.gov/programs/farmbill/2002/) and its affiliate programs, such as EQIP (http://www.nrcs.usda.gov/programs/eqip/). The **Vermont NRCS** also manages Farm*A*Syst, a program devoted to national and state-level improvements to ground water that provides comprehensive evaluation and best management sheets specifically for dairy farmers in Vermont. More information can be found at http://www.vt.nrcs.usda.gov/technical/FarmASyst/. Vermont NRCS has twelve regional field offices that can provide more assistance and information on the above. Contact the District Conservationist at the office nearest you at:
    - Bennington: (802) 442-2275
    - Berlin: (802) 828-4493
    - Brattleboro: (802) 254-9766
    - Middlebury: (802) 388-6748
    - Morrisville: (802) 888-4935
    - Newport: (802) 334-6090
    - Rutland: (802) 775-8034
    - St. Albans: (802) 527-1296
    - St. Johnsbury: (802) 748-2641
    - White River Junction: (802) 295-7942
    - Williston: (802) 879-4785
    - Vermont NRCS State Office: Dave Hoyt, Assistant State Conservationist, 802-951-6796, extension 227

- The **Vermont Agency of Agriculture, Food and Markets** provides a clearinghouse of information on controlling non-point source pollution from dairy farms, including accepted agricultural practices (AAPs), best management practices (BMPs) and technical and financial assistance for projects.
  See http://www.vermontagriculture.com/pidnonpointsource.htm for more information.
  You can also call the Vermont Natural Resources Conservation Districts
    - Windham, Bennington, Rutland, Windsor, Counties: 802-257-5621
    - Orleans, Essex, Caledonia, Orange, Washington Counties: 802-229-2720
    - Addison, Chittenden, Lamoille, Franklin, & Grand Isle Counties: 802-388-6746

Summary of Results for Nutrient Management

Instructions: In the table below, please record the score for the answer you selected for each question. For multiple-choice questions, the response number serves as your score for that category (i.e. choice # 2 is worth 2 points). For "check all that apply questions," please see scoring criteria for each question in the chart below. Once all responses have been completed, add up the answers and record the total.

Once all responses have been completed, add up the answers and record the total.

QUESTION	ANSWER/SCORE
1. Nutrient Management & Record Keeping	
2. Manure Application Rate	
3. Commercial Fertilizer Application Rate	
4. Manure & Phosphorus Fertilizer Application Timing & Techniques	
5. Nitrogen Fertilizer Application Timing & Techniques	
6. Fertilizer & Manure Application Equipment	
7. Use of Phosphorus Supplements	
Total Score	
Total Possible Points	25

Interpretation: The next step in understanding your farm's performance in the category of Nutrient Management is to compare your results to best practices. Below is a table that ranks your performance from overall best practice (green) to general need for improvement (red). Compare the number of points you received for your practices compared to optimal practices.

	Point Range	**Interpretation**
Green	21 - 25	Nutrient Management best practices are currently being employed on this farm.
Yellow	16 - 20	Farm is using some good practices regarding Nutrient Management. However there are some key areas that should be improved upon.
Red	7 - 15	Nutrient Management should be carefully evaluated and a strong effort should be made to adopt improved practices in several areas.

XI. ORGANIC

INTRODUCTION

Organic farms are certified under the USDA National Organic Program. The USDA National Organic Program is defined in the United States Federal code and is the only legally recognized standard for organic products in the United States (although programs from other countries may be granted USDA status). The regulations were approved in October 2002 as a means of providing consistent, uniform standards to the industry and consumers. The National Organic Program requires that farmers meet certain criteria with regard to planning, producing, handling, labeling, and record keeping for plant and animal products. In general, these standards require a 'natural' approach to farming in which ecosystem processes drive growth as opposed to 'man-made' inputs such as synthetic fertilizers, pesticides, and other chemicals.

The regulations require a combination of metrics and best practices. Some requirements of the regulations are absolute in nature, such as the prohibition of non-organic seed stock. Others are more qualitative such as the requirement to minimize soil erosion. In this case, certifying agents are expected to evaluate a farmer's performance regarding its environmental impacts. Therefore, some parts of the program rely upon absolute criteria whereas others rely upon subjective criteria evaluated by the certifying official. The use of non-absolute criteria is necessary because many factors vary based on the location of the farm within the US. This makes the definition of universal metrics almost impossible, so certain measures were determined to be more appropriately evaluated by certifying officials.

Nonetheless, the system of organic farming provides a fairly consistent means of ensuring that most major environmental concerns are mitigated. Key environmental benefits include a stable nutrient balance, sound water quality, generally lower energy use (due to low amounts of energy-intensive fertilizers/pesticides), and stringent animal welfare practices. Many of these environmental benefits are gained due to the absolute requirement of using organic feed, given that feed production is responsible for many of the negative environmental impacts incurred during milk production.[296]

Social and economic benefits of organic production are more difficult to estimate due to a lack of concrete data. Adoption of organic production does provide benefits such as market differentiation. This market differentiation allows for organic milk to be sold at a premium. Current organic milk prices are almost $20 per one hundred pounds compared to $11 to $14 for conventional milk.[1] This price premium is maintained despite the fact that organic yields are similar to conventional yields. Research shows that organic harvests are dependent upon the type of feed given to cows, rather than upon the type of farming system used.[1] Despite these factors, organic production may not be more profitable than non-organic production since inputs such as feed and seed are also more expensive.

GLOBAL, NATIONAL AND REGIONAL TRENDS

Globally, organic production has increased 20% annually over the past 10 years, with the biggest producers being Australia, the European Union, and the United States.[297] In 2001, global organic sales were estimated at around $20 billion.[298] Rapid continued growth is expected. Analysts predict "that demand in many markets will continue to grow at 10% to 30% per year, with the international organic market expected to grow to a volume of $100 billion in the next 10 years."[299] Because milk is primarily consumed in the country of origin,[300] increased global demand may not greatly impact United States markets.

The United States organic market is still on the rise. Currently, only 2% of the United States food supply is grown using organic methods.[301] The market, however, is growing approximately 20% per year,[302] and is expected to continue to grow at a high rate in the future. In 2000, the US organic market accounted for $7.8 billion in sales, with nearly half of those purchases occurring in conventional retail outlets.[303] According to the Natural Foods Merchandiser, this is up from 7% in 1991, indicating a broader acceptance and demand for organic products by the general public.[304] During the 1990's, organic dairy sales were "the most rapidly growing segment, with sales up over 500% between 1994 and 1999" and accounted for over $588 million in sales in 2000.[305] This trend may be fueling increases in the number of certified organic milk cows, which "tripled between 1992 and 1994 and more than doubled between 1994 and 1997."[306] As of 1997, there were almost 13,000 certified organic dairy cows located mostly in New York, Wisconsin, Minnesota, Pennsylvania, California, and Maine.[307] Limited public information exists about the size of the organic dairy market in Vermont. However, it appears that demand currently outweighs supply. This is supported by Ben & Jerry's need to seek organic milk sources outside of the Northeast because the organic milk supply in the Northeast was already accounted for by other buyers.[308]

Despite the huge increases in organic sales, there are mixed reports on the profitability of organic production as business management is a function of more than just the farming techniques employed. Several studies for mainly fruits and vegetables show that organic farming systems can be more profitable than conventional systems, but little concrete research has been conducted for organic dairy farming in the US.[309]

FOCUS OF THE FARM FINANCIALS EDUCATIONAL MODULE

In order to sell products as organic, a producer must meet ALL of the requirements laid out in the USDA National Organic Program guidelines. Therefore, all portions of the regulations are equally important. Given the length of the guidelines and the number of criteria (some of which require an independent certification), the development of assessment questions was impractical. Therefore, this module differs from the other modules in that it provides a summary of the regulations rather than assessment questions.

PARAMETERS SELECTED

The following metrics are taken from the USDA National Organic Program regulations and are divided into three categories: management, livestock, and cropping.

- **MANAGEMENT**[310]
  - **Organic production and handling system plan.** A farmer must provide a management plan that includes a description of the practices and procedures to be used in raising organic crops and livestock; a list of chemicals and other inputs to be used; a description of monitoring practices; and a description of a recordkeeping system.
  - **Separate organic and non-organic handling systems.** The farmer must implement measures necessary to prevent commingling of organic and non-organic products and protect products from prohibited substances. He or she must not package goods in containers that have a synthetic fungicide preservative or fumigant or use or reuse any container that could contaminate the integrity of an organic product.
  - **Product labeling.** Only products with a certain amount of organic content may be marketed as 'organic.' Products sold as '100% organic' must contain by weight or fluid volume 100% organically produced ingredients (excluding water and salt). Products sold as 'organic' must contain at least 95% organically produced products (excluding water and salt). Both 100% and 95% organic products may be labeled with the USDA organic seal. Products sold as 'made with organic ingredients or food group(s)' must contain at least 70% organically produced products (excluding water and salt). These products may not use the USDA seal. Products with less than 70% organically produced ingredients may identify each ingredient that is organic with the word 'organic' if the percentage of organic contents is shown on the information panel. These products may also not use the USDA seal.
  - **Organic handling requirements.** Mechanical or biological methods may be used to process organic products for the purpose of retarding spoilage or preparing goods for market.
  - **Pest management in buildings and facilities.** The farmer must use practices to prevent pests, including, but not limited to: removal of pest habitat, food sources, and breeding areas; preventing pest from accessing facilities; and management of temperature, light, humidity, and other factors. Pests may be controlled through: mechanical or physical controls, lures and repellents allowed under the rule, or methods not allowed under the rule if the handler and certifying agent agree on the method and the handler updates the management plan accordingly.

- **LIVESTOCK**[311]
  - **Origin of livestock.** Organic milk or milk products must be from animals that have been under organic management for at least one year. If a grower wants to convert an entire herd, he or she must provide a minimum of 80% organic feed for nine months, followed by three months of 100% organic feed. In addition, all other requirements must be met. Moreover, cows must be managed under organic requirements for at least the last third of gestation in order for newborn calves to be considered organic. The heifer that gave birth however will not be considered organic and must be removed from the farm or converted separately. Cows removed from an organic operation may not be sold as organic. All management must be continuous. Records must be maintained to identify organically managed animals.
  - **Livestock feed.** Farmers must provide cows organic feed, including pasture and forage, and may provide non-synthetic or synthetic feed additives and supplements

allowed under the rule. The farmer must not use animal drugs (including hormones) to promote growth or provide feed supplements and additives above amounts needed for nutrition and health maintenance. A farmer can not use plastic pellets for roughage; must not feed cows formulas containing urea, manure, or mammalian or poultry slaughter by-products; or use additives or supplements in violation of the Federal Food, Drug, and Cosmetic Act.

- **Use of drugs, vaccinations, hormones.** Milk or milk products may not be sold as organic if biologics have been administered within 30 days. Farmers may not administer any drugs other than vaccinations in the absence of illness, use growth hormones or recombinant bovine growth hormone, administer synthetic parasiticides on a routine basis, administer parasiticides to slaughter stock, administer drugs in violation of the Federal Food, Drug, and Cosmetic Act, or withhold medical treatment from a sick animal in an effort to preserve its organic status. All appropriate medications must be used to restore a sick animal to health. Cows treated with prohibited substances may not be represented as organic.
- **Livestock health care practice standard.** The farmer must provide and maintain health care practices. He or she must: select species and types of livestock with regard to suitability for site-specific conditions; provide a feed ration sufficient to meet nutritional requirements; establish appropriate housing, pasture conditions, and sanitation practices; provide conditions which allow for exercise, freedom of movement, and reduction of stress; perform physical alterations to minimize pain and stress; and administer vaccines and biologics if necessary.
- **Livestock living conditions.** The farmer will provide living conditions that accommodate the health and natural behavior of animals including access to outdoors, shade, shelter, exercise areas, fresh air, and direct sunlight, access to pasture for ruminants, and clean dry bedding. The farmer must provide shelter designed for natural maintenance, comfort behaviors, and the opportunity to exercise. Any shelter must also be designed for the appropriate temperature level, air circulation, and low potential for injury. The farmer may provide temporary confinement due to inclement weather, animals' stage of production, conditions where health and safety may be jeopardized, or to avoid risk to soil or water quality. The farmer must manage manure in a way that optimizes recycling of nutrients and does not contribute to contamination of crops, soil or water.

- **CROPPING**[312]
  - **Land requirements.** Any parcel of land must have been managed according to the soil fertility and crop nutrient practice standard (see below) and have had no prohibited substances applied to it for at least three years preceding harvest of any organic crops.
  - **Soil fertility and crop nutrient management practice standard.** The farmer must implement tillage and cultivation practices that maintain or improve the physical, chemical, and biological condition of soil and minimize soil erosion; manage crop nutrients and soil fertility through crop rotations, cover crops, and the application of plant and animal materials; and manage plant and animal material to maintain or improve soil organic matter content. Specific direction is included for use of raw animal matter, composted plant and animal materials, and uncomposted plant

materials. In addition, methods for managing crop nutrients through other means are provided.

- **Crop pest, weed, and disease management practices standard.** The farmer must use management practices to prevent crop pests, weeds, and diseases through crop rotation, sanitation measures, and cultural practices such as selecting plant varieties that are resistant to pests, weeds, and diseases. When natural methods cannot control pests, weeds, and diseases, an allowed synthetic substance may be used as long as it is documented in the organic plan.
- **Crop rotation practice standard.** The farmer must implement a crop rotation including, but not limited to sod, cover crops, green manure crops, and catch crops to maintain or improve soil organic matter content, provide for pest management, manage nutrients, and provide erosion control.

EDUCATIONAL MODULE

Combining research on the specific indicator, global, national, and regional trends and the most appropriate parameters, the Team developed the following Educational Module.

ORGANIC EDUCATIONAL MODULE

Description

Organic farms are those certified under the USDA National Organic Program. The USDA National Organic Program is defined in the United States Federal code and is the only legally recognized standard for organic products in the United States (although programs from other countries may be granted USDA status). The National Organic Program requires that farmers meet certain criteria with regard to planning, producing, handling, labeling, and record keeping for plant and animal products. In general, these standards require a 'natural' approach to farming in which ecosystem processes drive growth as opposed to 'man-made' inputs such as synthetic fertilizers, pesticides, and other chemicals. Conversion of a herd from traditional to organic takes at least one year. Conversion of a field takes at least 3 years.

Because only an accredited organization can certify a farm as organic under the requirements of the USDA National Organic Program, this module provides a summary of the regulations rather than certification questions. To obtain an application form or further information on certification, contact the Northeast Organic Farming Association of Vermont (NOFA) (see www.nofavt.org).

Incentives for Change

- **Benefits to the farmer.** Currently, less than 2% of the U.S. food supply is grown using organic methods.[313] However, the market is growing approximately 20% per year,[314] and is expected to continue growing at a high rate into the future. Therefore, the organic milk market provides a unique opportunity for farmers to differentiate their products within the milk market and sell them at a premium. Current organic milk prices are almost $20 per hundred pounds compared to $11 to $14 for conventional milk.[315] Moreover, there is little difference between traditional and organic yields. Research shows that organic harvests are dependent upon the type of feed given to cows, rather than upon the type of farming system used.[316] Yields may also vary depending upon the amount of grazed forage compared to high-concentrate feed.[317]

  While the price paid to farmers per hundredweight is higher than conventional milk prices, inputs such as feed and seed are also more expensive, so this method may not necessarily be more profitable than non-organic production. Given this, and the fact that demand for organic milk may vary by season or location, it is recommended that farmers ensure adequate demand before undertaking conversion to organic. With current trends in fluctuating milk prices, however, this method does guarantee a higher price per hundredweight.

- **Environmental benefits.** To be certified, the USDA National Organic Program requires that farms take action to produce their goods in an environmentally sustainable way. This Program addresses the following issues: water quality, soil health, nutrient balances, erosion, biodiversity, and animal welfare practices. Many of the requirements are specific to cropping practices, but also affect livestock production in that only organic feed may be fed to an organic herd.

Summary of USDA National Organic Program Regulations

The following metrics are taken from the USDA National Organic Program regulations and are divided into three categories: management, livestock, and cropping. It is important to note that some of the criteria laid out under the regulations are absolute, leaving no room for interpretation by the certifying official (such as no use of hormones). Other criteria lack strict definitions for compliance (such as whether or not tillage practices minimize soil erosion), leaving the certifying official to evaluate performance in each category.

- **MANAGEMENT**[318]

Organic production and handling system plan. A farmer must provide a management plan that includes a description of the practices and procedures to be used in raising organic crops and livestock; a list of chemicals and other inputs to be used; a description of monitoring practices; and a description of a recordkeeping system.

Separate organic and non-organic handling systems. The farmer must implement measures necessary to prevent commingling of organic and non-organic products and protect products from prohibited substances. He or she must not package goods in containers that have a synthetic fungicide preservative or fumigant or use or reuse any container that could contaminate the integrity of an organic product.

Product labeling. Only products with a certain amount of organic content may be marketed as 'organic.' Products sold as '100% organic' must contain by weight or fluid volume 100% organically produced ingredients (excluding water and salt). Products sold as 'organic' must contain at least 95% organically produced products (excluding water and salt). Both 100% and 95% organic products may be labeled with the USDA organic seal. Products sold as 'made with organic ingredients or food group(s)' must contain at least 70% organically produced products (excluding water and salt). These products may not use the USDA seal. Products with less than 70% organically produced ingredients may identify each ingredient that is organic with the word 'organic' if the percentage of organic contents is shown on the information panel. These products may also not use the USDA seal.

Organic handling requirements. Mechanical or biological methods may be used to process organic products for the purpose of retarding spoilage or preparing goods for market.

Pest management in buildings and facilities. The farmer must use practices to prevent pests, including, but not limited to: removal of pest habitat, food sources, and breeding areas; preventing pest from accessing facilities; and management of temperature, light, humidity, and other factors. Pests may be controlled through: mechanical or physical controls, lures and repellents allowed under the rule, or methods not allowed under the rule if the handler and certifying agent agree on the method and the handler updates the management plan accordingly.

- **LIVESTOCK**[319]

- **Origin of livestock.** Organic milk or milk products must be from animals that have been under organic management for at least one year. If a grower wants to convert an entire herd, he or she must provide a minimum of 80% organic feed for 9 months, followed by three months of 100% organic feed. In addition, all

other requirements must be met. Moreover, cows must be managed under organic requirements for at least the last third of gestation in order for newborn calves to be considered organic. The heifer that gave birth however will not be considered organic and must be removed from the farm or converted separately. Cows removed from an organic operation may not be sold as organic. All management must be continuous. Records must be maintained to identify organically managed animals.

- **Livestock feed.** Farmers must provide cows organic feed, including pasture and forage, and may provide non-synthetic or synthetic feed additives and supplements allowed under the rule. The farmer must not use animal drugs (including hormones) to promote growth or provide feed supplements and additives above amounts needed for nutrition and health maintenance. A farmer can not use plastic pellets for roughage; must not feed cows formulas containing urea, manure, or mammalian or poultry slaughter by-products; or use additives or supplements in violation of the Federal Food, Drug, and Cosmetic Act.
- **Use of drugs, vaccinations, hormones.** Milk or milk products may not be sold as organic if biologics have been administered within 30 days. Farmers may not administer any drugs other than vaccinations in the absence of illness, use growth hormones or recombinant bovine growth hormone, administer synthetic parasiticides on a routine basis, administer parasiticides to slaughter stock, administer drugs in violation of the Federal Food, Drug, and Cosmetic Act, or withhold medical treatment from a sick animal in an effort to preserve its organic status. All appropriate medications must be used to restore a sick animal to health. Cows treated with prohibited substances may not be represented as organic.
- **Livestock health care practice standard.** The farmer must provide and maintain health care practices. He or she must: select species and types of livestock with regard to suitability for site-specific conditions; provide a feed ration sufficient to meet nutritional requirements; establish appropriate housing, pasture conditions, and sanitation practices; provide conditions which allow for exercise, freedom of movement, and reduction of stress; perform physical alterations to minimize pain and stress; and administer vaccines and biologics if necessary.
- **Livestock living conditions.** The farmer will provide living conditions that accommodate the health and natural behavior of animals including access to outdoors, shade, shelter, exercise areas, fresh air, and direct sunlight, access to pasture for ruminants, and clean dry bedding. The farmer must provide shelter designed for natural maintenance, comfort behaviors, and the opportunity to exercise. Any shelter must also be designed for the appropriate temperature level, air circulation, and low potential for injury. The farmer may provide temporary confinement due to inclement weather, animals' stage of production, conditions where health and safety may be jeopardized, or to avoid risk to soil or water quality. The farmer must manage manure in a way that optimizes recycling of nutrients and does not contribute to contamination of crops, soil or water.

➢ **CROPPING**[320]

- **Land requirements.** Any parcel of land must have been managed according to the soil fertility and crop nutrient practice standard (see below) and have had no prohibited substances applied to it for at least three years preceding harvest of any organic crops.

- **Soil fertility and crop nutrient management practice standard.** The farmer must implement tillage and cultivation practices that maintain or improve the physical, chemical, and biological condition of soil and minimize soil erosion; manage crop nutrients and soil fertility through crop rotations, cover crops, and the application of plant and animal materials; and manage plant and animal material to maintain or improve soil organic matter content. Specific direction is included for use of raw animal matter, composted plant and animal materials, and uncomposted plant materials. In addition, methods for managing crop nutrients through other means are provided.
- **Crop pest, weed, and disease management practices standard.** The farmer must use management practices to prevent crop pests, weeds, and diseases through crop rotation, sanitation measures, and cultural practices such as selecting plant varieties that are resistant to pests, weeds, and diseases. When natural methods cannot control pests, weeds, and diseases, an allowed synthetic substance may be used as long as it is documented in the organic plan.
- **Crop rotation practice standard.** The farmer must implement a crop rotation including, but not limited to sod, cover crops, green manure crops, and catch crops to maintain or improve soil organic matter content, provide for pest management, manage nutrients, and provide erosion control.

Linkages to Other Modules

While this is the only module that focuses directly on organic production, it should be noted that organic practices can positively impact other sustainable agriculture indicators such as Animal Welfare, Soil Health, Water Management, Nutrient Management, and Pest Management as described below.

ORGANIC TOPIC	OTHER MODULE(S)
Livestock Feed	Nutrient Management
Livestock Health Care Practice Standard	Animal Welfare
Livestock Living Conditions	Animal Welfare
Soil Fertility and Crop Nutrient Management Practice Standard	Soil Health
Soil Fertility and Crop Nutrient Management Practice Standard	Water Management
Soil Fertility and Crop Nutrient Management Practice Standard	Nutrient Management
Crop Pest, Weed, and Disease Management Practices Standard	Pest Management
Crop Rotation Practice Standard	Nutrient Management

Further Information

Additional details and information on the above can be obtained through the following programs or sources.

- **Northeast Organic Farming Association of Vermont.** http://www.nofavt.org/index.cfm. This non-profit association of farmers, gardeners, and consumers works to organic farming in Vermont. It is also the only accredited certifying organization in Vermont.

- **Appropriate Technology Transfer for Rural Areas (ATTRA).** "Organic Farming Source List." http://attra.ncat.org/organic.html#list. ATTRA specializes in developing sustainable agricultural information and tools. This page provides a number of documents focused on organic farming including: organic fruits, vegetables, flowers, herbs, field crops and livestock. It also has documents focusing on organic practices for pests, soil and fertilizer health, and marketing.

- **Appropriate Technology Transfer for Rural Areas (ATTRA).** "An Organic and Sustainable Practices Workbook and Resource Guide for Livestock Systems, April 2002." http://attra.ncat.org/attra-pub/PDF/livestockworkbook.pdf. ATTRA specializes in developing sustainable agricultural information and tools. This workbook explains the range of practices and materials allowed under the USDA National Organic Program regulations. It is a great tool for helping farmers contemplating conversion to organic production.

- **USDA.** "The National Organic Program" homepage. http://www.ams.usda.gov/nop/indexIE.htm. This USDA site provides the full regulation text, questions and answers, a list of certifying agents, and other information on the National Organic Program.

XII. PEST MANAGEMENT

INTRODUCTION

Since its introduction to agriculture in the 1940's,[321] chemical pesticides have been the dominant approach to controlling and eliminating pests, resulting in more consistent crop yields as well as a reduction in labor needed to manage the crops. Pesticides include herbicides, insecticides, fungicides, rodenticides, and plant growth regulators. While pesticide use has increased, traditional pest management methods, such as crop rotation and growing a variety of crops, have been phased out. In fact, pesticide use in the US increased ten times from 1945 to 1989.[322] However, with the increased use (and additional cost to the farmer), there is increasing evidence that the effectiveness of pesticides is decreasing, thereby constantly requiring more chemicals to get the same effect. Over the same time period that pesticide use increased ten times, crop loss from pests almost doubled from 7 to 13%.[323] The decrease in effectiveness occurs because the target pest builds up resistance and/or because the pesticide also eliminates competitors or predators of the target pest.[324]

In addition to the decrease in pesticide effectiveness, there is growing concern regarding the use of pesticides as they "…can cause harm to humans, animals, or the environment because they are designed to kill or otherwise adversely affect living organisms."[325] Consumers and community members are becoming increasingly aware and concerned regarding the harmful chemicals entering their food, water, and air. From a health perspective, there are diseases related to a significant one-time exposure to pesticides as well as afflictions related to minimal exposure to pesticides over longer periods of time. A number of studies are calling into question the health impacts chemicals have on humans and other organisms. In 2000, California adopted a voluntary Healthy Schools Act. The focus of this program is to promote IPM practices and decrease the amount of pesticide used on school grounds. This program focuses on children's exposure, as chemical exposure has more significant effects on children than adults. There are "increasing amounts of data that suggest links between pesticide exposure and cancers in children"[326] and to Parkinson's disease.[327] In addition to cancers, other suspected affects of chronic exposure, even at low levels, include damage to immune systems and the nervous system. Those working and living in close proximity to treated fields may be at significant risk, depending on factors such as the pesticide type, weather conditions during application, and frequency of application.

In addition to concerns regarding the elimination of the natural predators of the pests, environmental concerns include possible contamination of ground and surface water. Contamination of water sources can affect human health, marine life and many other species that rely upon these water sources.

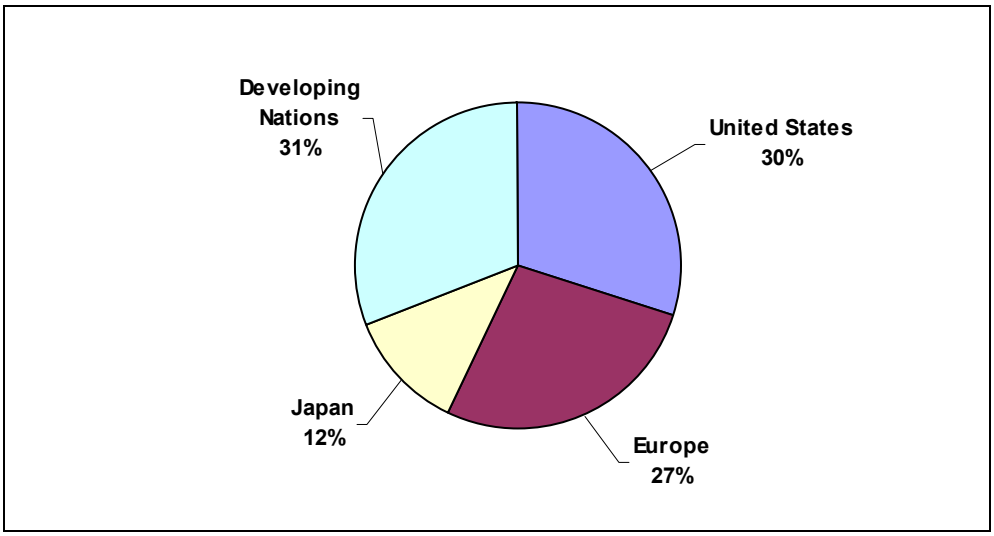
All of these concerns have led to an alternative approach, called Integrated Pest Management (IPM). IPM addresses both the concern of the farmer regarding having to purchase ever-increasing amounts of pesticide to maintain the same effectiveness and the concern for human and ecosystem health.

What is Integrated Pest Management?
The California Healthy Schools Act of 2000 defines IPM as "…a pest management strategy that focuses on long-term prevention or suppression of pest problems through a combination of techniques such as monitoring for pest presence and establishing treatment threshold levels, using non-chemical practices to make the habitat less conducive to pest development, improving sanitation, and employing mechanical and physical controls. Pesticides that pose the least possible hazard and are effective…are used only after careful monitoring indicates they are needed according to pre-established guidelines and treatment thresholds."[328] Basically, IPM takes advantage of nature's own system, versus purchasing chemicals.

GLOBAL, NATIONAL AND REGIONAL TRENDS

The top three areas of pesticide usage are the United States, Europe and Japan. The developing countries, particularly China, make up the remaining portion. Pesticide use in developing countries has increased recently, due to increased production of fruits and vegetables that are sold to more developed countries. The need for pesticides, in part, resulted from switching from native plants to high yielding crops. Native plants were better able to resist pests than the newer varieties.

Figure 14: Global Distribution of Pesticide Use[329]



According to the Worldwatch Institute, overall use of pesticides has increased in the US by ten times from 1940's to the 1990's, while losses in agricultural products due to pests have increased seven percent from 30% to 37%.[330] Figure 14 shows global pesticide use by different regions of the world. In 1995, more than 540,000 tonnes of pesticides were used in the US.[331] Currently, sixty-two percent of planted acreage and ninety-three percent of row crops in the United States is treated at least annually with pesticides. In 1986, herbicide use

accounted for 70% of the pesticides used. Over the years, farmers have become increasingly dependent on pesticides and have stopped using alternative practices.

Vermont dairy farmers use more than 720,000 acres for agriculture and primarily grow hay and corn.[332] They tend to rely heavily on pesticide companies and their expertise. Nonetheless, it is important for the farmer to understand and track the use of pesticides, especially since they can have profound impacts on farming families. In addition to using pesticides to encourage high crop yields, barns and cows may also be sprayed with pesticides to keep flies away. When growing field corn, Vermont dairy farmers are concerned about the Western corn rootworm (WCRW) as 95% percent of Vermont's 95,000 acres of field corn is fed to lactating dairy cows.[333] The traditional approach is to apply pesticide at the time of planting or to use *Bacillus thuringiensis* (Bt) corn, which may have negative impacts on biodiversity (see Biodiversity). The University of Vermont Extension Service is researching alternative IPM approaches for the WCRW and plans to provide educational sessions and coordinate trips to fields managed under this alternative system.[334]

FOCUS OF THE PEST MANAGEMENT EDUCATIONAL MODULE

Pest management is an area with potential cost savings for the dairy farmer. The Pest Management Module is designed to determine how pests are currently being managed as well as to identify alternative methods that rely more heavily on natural devices, versus man-made devices to control pests. Advantages of using Mother Nature's own defense are decreased amounts of pesticides, which translate into cost savings as well as improved environmental and community benefits.

PARAMETERS SELECTED

The following Parameters were selected by means of two screening processes, as outlined in the Methodology section. For a listing of parameters that were not used, please see Appendix D.

Pesticide Application: In order to monitor and manage pests, it is critical to understand what methods are used. Understanding which pests are of concern, pesticides used, and the frequency and intensity of application are all important dimensions with significant impact on costs – financially, environmentally and socially. By recording and analyzing pesticide practices, opportunities to decrease pesticide usage should appear, and the farmer can start to consider moving towards IPM.

Integrated Pest Management: Farmers around the world are switching from applying large amounts of chemicals to healthier practices of controlling pests by applying the IPM process. As defined previously, "IPM involves a systematic approach that incorporates cultural, biological and chemical methods of pest control."[335] As mentioned throughout the Educational Module, there are specific management practices that can decrease the amounts of pests.

EDUCATIONAL MODULE

Combining research on the specific indicator, global, national, and regional trends and the most appropriate parameters, the Team developed the following Educational Module.

PEST MANAGEMENT EDUCATIONAL MODULE

Description

Since its introduction to agriculture in the 1940's,[336] chemical pesticides have been the dominant approach to controlling and eliminating pests, resulting in more consistent crop yields as well as a reduction in labor needed to manage the crops. Pesticides include herbicides, insecticides, fungicides, rodenticides, and plant growth regulators. While pesticide use has increased, traditional pest management methods, such as crop rotation and growing a variety of crops, have been phased out. However, there is growing concern regarding the use of pesticides as they "…can cause harm to humans, animals, or the environment because they are designed to kill or otherwise adversely affect living organisms."[337]

These concerns lead to an alternative approach, called Integrated Pest Management (IPM). The California Healthy Schools Act of 2000 defines IPM as "…a pest management strategy that focuses on long-term prevention or suppression of pest problems through a combination of techniques such as monitoring for pest presence and establishing treatment threshold levels, using non-chemical practices to make the habitat less conducive to pest development, improving sanitation, and employing mechanical and physical controls. Pesticides that pose the least possible hazard and are effective…are used only after careful monitoring indicates they are needed according to pre-established guidelines and treatment thresholds.[338] Elements of IPM are integrated into the Assessment Questions below.

Field corn is susceptible to the Western corn rootworm (WCRW) and of specific interest to Vermont dairy farmers, as 95% of Vermont's 95,000 acres of field corn is fed to lactating dairy cows.[339] The traditional approach is to apply pesticide at the time of planting or use *Bacillus thuringiensis* (Bt) corn instead, which has negative impacts on biodiversity (see Biodiversity Module). The University of Vermont Extension Service is researching alternative IPM approaches for the WCRW and plans to provide educational sessions and coordinate trips to fields managed under this alternative system.[340]

Incentives for Change

- **Human benefits.** From a health perspective, there are diseases related to significant exposure of pesticides as well as afflictions related to minimal exposure of pesticides, but over longer periods of time. Children are especially at risk. There are "increasing amounts of data that suggest links between pesticide exposure and cancers in children"[341] as well as Parkinson's disease.[342] In addition to cancers, other suspected affects of chronic exposure, even at low levels, include damage to immune systems and the nervous system. Those working and living in close proximity to treated fields may be at significant risk, depending on factors such as the pesticide type, weather conditions during application, and frequency of application.

- **Environmental benefits.** In addition to concerns regarding the elimination of the natural predators of the pests, environmental concerns include possible contamination of ground and surface water. This could then affect human health, marine life and many other species that rely upon these water sources.

- **Cost savings.** With repeated pesticide use, the effectiveness on pests decreases. From 1945 to 1989, pesticide use in the US increased 10 times, but total crop loss from pests almost doubled from 7 to 13%.[343] The decrease in effectiveness occurs because the target pest builds up resistance and/or because competitors or predators of the target pest are also eliminated by the pesticide.[344] Moving towards IPM provides cost benefits by taking advantage of nature's own system, versus purchasing chemicals.

Assessment Questions

For all questions, please choose the categories that best identify your current management practices. Use the Summary sheet on the last page of this module to evaluate overall performance.

➢ **PEST IDENTIFICATION[345]**

1. Farmer has not been trained to identify pests OR does not seek advice from a professional consultant when managing pests.
2. Farmer knows key pest species of crops and has been trained in pest identification, but does not routinely use scouting information to manage pests.
3. Farmer knows key pest species of crops, has been trained in pest identification, OR employs certified consultant.
4. Farmer and consultant (if hired) understand key pest life cycle factors and exploit "weak links" for effective management. Pest identification and scouting information are always used to manage pests and beneficial organisms.

To maximize pesticide efficiency, it is best to determine what the target pest is. Once correctly identified by the farmer or a specialist, it is better to apply the pesticide specific to that pest, but only when there is evidence (through scouting) that the pest is causing problems. The best practice in terms of *when* to apply the pesticide includes an understanding of when the pest is most susceptible based on the optimal timeframe (day/night, weather conditions, etc.). By combining all these practices, the farmer will require less pesticide, incur lower costs, and create fewer human and environmental impacts.

➢ **PESTICIDE SELECTION[346]**

1. Only pesticides registered in the state as 'approved' for the target pests and affected crop are used. Pesticide mixtures prohibited by the label are not used.
2. In addition to #1, all pesticides at risk of pest resistance development are rotated with other pesticides of a different chemical class, starting with the first year of use. Pesticides at high risk of resistance development are used sparingly.
3. In addition to #2, pesticides labeled "Danger" are avoided. The timing of applications and selection of pesticide materials correspond to scouting records.
4. When a control measure is needed, every effort is made to use beneficial organisms or cultural controls, using reduced toxicity pesticides (labeled "Caution") as a last resort.

When determining which pesticide to use, consideration should be given to the effectiveness of the pesticide. Factors that can decrease the effectiveness of the pesticide include: (1) built-up resistance by pests and (2) accidental elimination of benign, natural competitors or predators of the pest. To minimize the development of resistance by pest to pesticides, farmers should rotate the type of pesticide that is used and understand which types of pesticides the pest is able to more readily resist. Another concern addressed here, is the level of toxicity with regard to human health. Using pesticides labeled "Danger" and "Caution" should be avoided whenever possible.

- **TIMING OF PESTICIDE APPLICATION**[347]
  1. Pesticide application is based only on calendar date or stage of crop development.
  2. Pesticide application is made at first sign of pests.
  3. Pesticide application is based on pest population levels determined by scouting, but treatment threshold is not used.
  4. Pesticide applications are made only when pests reach a predetermined treatment threshold. "Weak link" of pest's life cycle is targeted for pesticide applications.

Another way to decrease the amount of pesticides used while reducing costs and achieving the same outcome is to understand how to determine when pesticides should be applied. The easiest and least efficient method is to apply pesticide annually at certain time periods. In contrast a best practice is to plan ahead of time what level of pest presence will prompt you into action. When this level is achieved, the timing of the application is aligned with when the pest is most susceptible. This practice allows for optimal pesticide efficiency, which translates into cost savings and minimal threat to humans and the environment.

- **WEATHER CONDITIONS**[348]
  1. Weather forecasts are not considered when planning to spray. Spraying occurs in weather conditions contrary to the pesticide bottle label, such as windy days or imminent rain.
  2. Weather forecasts are considered when planning to spray. Pesticide application is made during rain-free periods and at low wind speeds.
  3. Weather forecasts are used to plan pesticide applications. No spraying is done when wind would move it off target. Applications are made during label-required rain-free periods.

What happens to pesticides post-application is of great importance. There is significant concern regarding the entry of these chemicals into the water system, which can happen if there is no or minimal consideration given to the rain forecast. Wind can also carry the pesticide to non-target areas, such as the barn area or farmer's house. Inadvertent exposure to these chemicals should be avoided whenever possible. By considering the weather, pesticide application can be more concise and efficient.

- **RECORD KEEPING**[349]
  1. All legal requirements for pesticide record keeping are met, including date, field identification, target pest, pesticide name and EPA number, formulation, rate and number of acres treated.
  2. Pesticide record keeping includes regular weekly pest scouting records.
  3. The timing of applications and the selection of pesticide materials correspond to scouting records.
  4. Application records include reference to decisions about the materials selected based on pesticide toxicity rankings. Pesticide records are tabulated annually to indicate progress in reducing overall use of high toxicity pesticides.

Keeping accurate and up to date records is important for regulations but also can aid in better understanding of your current pesticide management practices. Once a baseline is established, opportunities to decrease pesticide usage or increase its efficiency can be identified.

SPECIFIC MANAGEMENT PRACTICES TO CONTROL FLIES (Please check all that apply)

- ❑ Powder cows
- ❑ Capture flies by using fly strips
- ❑ Eliminate wet seepage areas
- ❑ Handle and store manure properly
- ❑ Maximize sanitation in and around structures
- ❑ Use biological controls (such as fly parasites)

SPECIFIC MANAGEMENT PRACTICES TO CONTROL WEEDS (Please check all that apply)

- ❑ Conduct weed scouting
- ❑ Prepare and update weed maps twice per season
- ❑ Rank weeds in order of abundance or importance
- ❑ Plan and manage ground cover or soil quality to prevent weeds and weed seed immigration
- ❑ Plant crops using a precision system, which allows for precise mechanical weed removal

One aspect of IPM is to modify the habitat so it is less conducive to pest development, improves sanitation, and employs mechanical and physical controls.[350] Such management practices for controlling flies and weeds are identified in the above questions. Some practices are less time and/or resource intensive than others and are more applicable and/or easier to implement, but they all work to minimize use of pesticides. As a farmer who switched to IPM as part of a research project commented, "You have to change with the times. That's why I got involved with the IPM project," explains Iverson. "You have to be able to adapt to survive in farming these days, whether it's portable computers or the new soft chemicals. They're here to stay."[351]

Linkages to Other Modules

Pest management issues are tied to nutrients, biodiversity and water management. The table below identifies where you can find more information on some of the topics mentioned in this module.

PEST MANAGEMENT TOPIC	OTHER MODULE(S)
Crop Rotation	Soil Health
GMOs Competitors or Predators of Target Pest	Biodiversity

Further Information

Additional details and information on the above can be obtained through the following programs.

- **University of Vermont Extension Program** is conducting research on Integrated Pest Management. Information on the program's current efforts can be accessed on the web at http://pss.uvm.edu/ipm/.

- **Farm*A*Syst**, managed through the Vermont Natural Resources Conservation Council, is devoted to national and state-level improvements to pest management and provides comprehensive evaluation and best management sheets specifically for dairy farmers in Vermont. More information can be found at their web-site, http://www.vt.nrcs.usda.gov/technical/FarmASyst/**.**

- **The Food Alliance.** http://www.thefoodalliance.org/. This organization certifies producers, which use socially and environmentally responsible farming practices. The certification process includes sections on natural area management, watershed management, crop management, pest management, pastureland management, and animal welfare. Details on pest management are included under pesticide applications and record keeping.

- **Appropriate Technology Transfer for Rural Areas** (ATTRA) "Sustainable Agriculture: An Introduction." http://attra.ncat.org. ATTRA specializes in developing sustainable agricultural information and tools. For a summary of the practices they advocate regarding pest management, see "Sustainable Agriculture: An Introduction" at http://attra.ncat.org/attra-pub/PDF/sustagintro.pdf. Phone: 1-800-346-9140.

Summary Results for Pest Management

Instructions: In the table below, please record the score for the answer you selected for each question. For multiple-choice questions, the response number serves as your score for that category (i.e. choice # 2 is worth 2 points). For "check all that apply questions," please see scoring criteria for each question in the chart below. Once all responses have been completed, add up the answers and record the total.

QUESTION	ANSWER/SCORE
1. Pest Identification	
2. Pesticide Selection	
3. Timing of Pesticide Application	
4. Weather Conditions	
5. Record Keeping	
6. Specific Management Practices: Flies (Add 1 for each box checked)	
7. Specific Management Practices: Weeds (Add 1 for each box checked)	
Total Score	
Total Possible Points	30

Interpretation: The next step in understanding your farm's performance in the category of Pest Management is to compare your results to best practices. Below is a table that ranks your performance from best practice (green) to practices that require improvement (red). Compare the number of points you received for your practices to optimal practices.

	Point Range	Interpretation
Green	26 – 30	Best practices regarding Pest Management are currently being employed on this farm.
Yellow	18 - 25	Farm is using some good practices regarding Pest Management, however there are some key areas that should be improved upon.
Red	5 - 17	Pest Management practices should be carefully evaluated and a strong effort should be made to adopt improved practices in several areas.

XIII. Soil Health Management

INTRODUCTION

Many dairy farms grow crops and forage for feed, grazing or cash crop, making healthy soils integral to the economic and environmental performance of dairy farms. The USDA Natural Resources Conservation Service defines soil quality as "the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation."[352] The essence of soil health is its ability to perform these functions simultaneously. Proper functioning is based on physical, chemical and biological characteristics:

- Physical characteristics include soil structure, depth, infiltration (capacity to filter water through soil), bulk density (number of soil particles per unit area) and ability to hold water. Maintenance of these characteristics improves soil's capacity to filter water (thereby improving water quality), retain and transport water and nutrients, provide an adequate habitat for soil organisms and support plant growth.

- Chemical characteristics include pH, electrical conductivity and extractable (i.e. plant-available) nutrients such as nitrogen, phosphorus and potassium. Adequate levels of extractable nutrients are essential to plant growth; pH influences both the solubility of nutrients and the activity of microorganisms that break down organic matter into nutrients.

- Biological characteristics include soil organic matter (anything in soil that was formerly alive) and the amount and activity of living organisms in soil, such as microbes and arthropods. Soil biological activity is important for transforming organic matter into nutrients for plants and maintaining proper soil structure.

Under current production methods, soil health and its corresponding contribution to farm production is under threat. Enhancing soil quality is therefore essential to maintaining agricultural productivity and minimizing environmental degradation. In fact, a 1993 National Research Council report indicates that "protecting soil quality, like protecting air and water quality should be a fundamental goal of national policy."[353]

Perhaps the most pressing problem associated with soil is that of soil erosion, which is the physical removal of surface soil material by wind or runoff by water. Wind erosion results in soil sediment being transported to the atmosphere, where the sediment itself can contribute to particulate matter (PM) pollution,[3] which can be damaging to human health when inhaled into the lungs. Soil erosion by water runoff contributes to the pollution of water sources through the sediment itself and as well as through any heavy metals, nutrients or chemicals (e.g. pesticides) that are attached to the sediment. Sedimentation can also cloud water, reducing the amount of sunlight that reaches aquatic plants; covers fish spawning areas and food supplies; and clogs the gills of fish.[354]

[3] Particulate matter (PM) is an EPA-designated 'criteria pollutant' that is regulated on a national level.

Soil compaction also has negative environmental consequences. When soil is compacted, for example, when it is run over by a tractor, it cannot absorb as much water. This is problematic in two ways. First, the soil acts as a natural water filter and, through absorption, can cleanse the water as it passes through the soil. When compacted soil does not allow for absorption, this valuable service is lost. Second, less absorption of the water means more runoff from the land, and more potential for water quality degradation.

Finally, overall degradation of soil quality can lead to other practices that can further degrade the environment. Agricultural practices that deplete soil nutrients can be harmful to yields, resulting in over-reliance on inorganic chemical fertilizers to replace these nutrients, potentially leading to nutrient build up and its consequences on local water conditions (see Nutrient Management). Unstable or unhealthy soils can also lead to increased potential for pest problems and increased use of agrochemicals such as pesticides and herbicides, which can be damaging to human and environmental health. These problems also tend to build on themselves, as these chemicals can destroy beneficial organisms in the soil, resulting in further instability and degradation of soil quality and health.

Maintaining optimally healthy soils can benefit the farmer in several ways. First, healthy soils can assure maximum yields with fewer inputs of commercial fertilizers and pesticides, thereby reducing costs for purchased feed and fertilizers. In addition, the most recent 2002 Farm Bill requires that conservation systems to protect land from excessive soil erosion be implemented for agricultural operations on federally-designated "highly erodible land" (HEL). Non-compliance can result in a producer becoming ineligible for numerous USDA benefits. Conservation efforts can also serve as a means to access federal funding for farm improvement projects. The 2002 Farm Bill re-authorized funding to help farmers adopt conservation strategies directed at improving soil quality, water quality, air quality and wildlife habitat. Through this program, farmers can be paid to implement new practices that will benefit their operations as well as the environment. For example, soil quality improvement practices can reduce impact to the environment and improve farmers' yields, thus improving revenues and lowering costs overall.

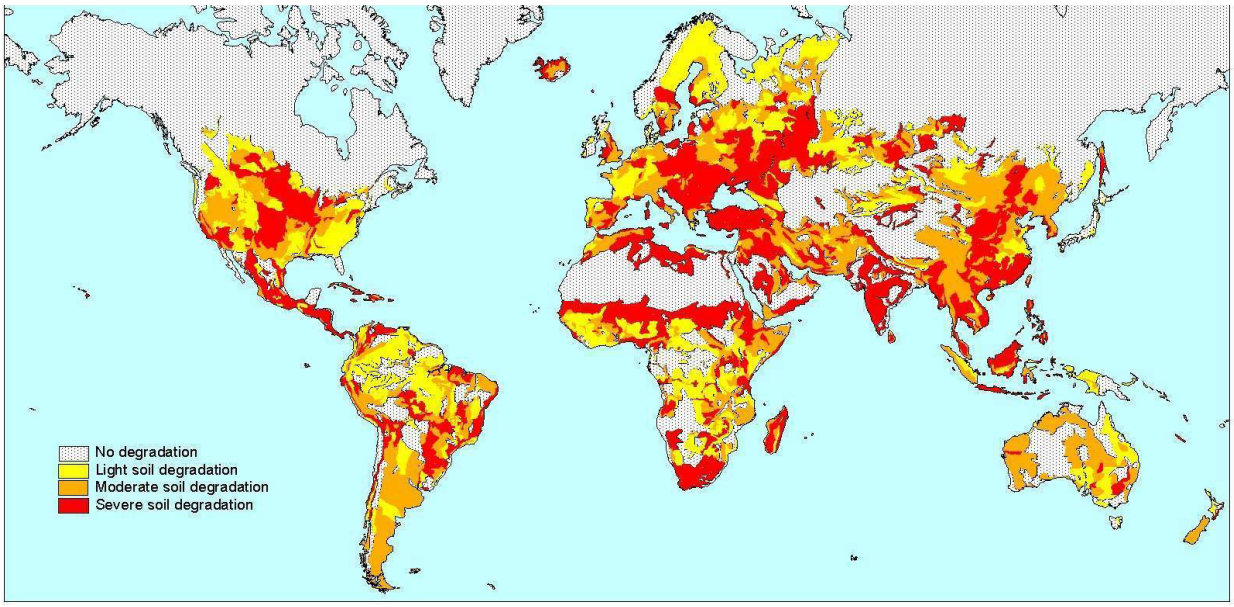
GLOBAL, NATIONAL AND REGIONAL TRENDS

By volume, sediment is the largest contaminant of water on earth.[355] Soil is also considered a threatened natural resource. According to the International Soil Reference and Information Centre, 17% of the world's land surface has been degraded due to such factors as overgrazing, inappropriate land clearing and general overexploitation.[356] It has been estimated that as of 1990, 562 million hectares, about 38% of cropland worldwide, was degraded due to poor agricultural practices.[357] The 1990 Global Assessment of Human-Induced Soil Degradation (GLASOD) found that a large portion of the world's soils had been degraded.

Figure 15 shows global areas of light (yellow), moderate (orange) and severe (red) soil degradation. Soil degradation has continued since these assessments, and it is estimated that 5 to 6 million hectares are lost annually as a result of severe soil degradation.[358] It should be noted, however, that progress is being made to reverse these trends. The Organization for Economic Co-Operation and Development (OECD) found that some OECD countries

were experiencing a shift in some land areas from high/moderate erosion classes to low/tolerable erosion classifications.[359]

Figure 15: Global Assessment of Human Induced Soil Degradation[360]



Nationally, the National Resources Inventory of the USDA (1999b) reports that 1,700 megatonnes (million metric tonnes) of soil eroded from U.S. land in 1997, of which 760 megatonnes was caused by wind and 960 was caused by water.[361] To put this amount into perspective, 1,700 megatonnes of soil would fill a freight car train loaded to capacity that would encircle the planet seven times.[362] Also, in North America, soil organic matter (an important component of healthy soil) in some areas has declined 30-60% since the start of cultivation.[363]

Vermont dairy farms occupy approximately 720,000 acres of land.[364] Much of this land is used to grow corn, hay and grass, which serve as food for dairy cows. Use of this land for agriculture can contribute to erosion. Cropland erosion is cited as one of the significant contributors to severely eutrophic (oxygen depletion) conditions in the Missisquoi Bay of Lake Champlain.[365]

FOCUS OF THE SOIL EDUCATIONAL MODULE

Adopting best practices for soil management is important to protecting water and air quality and to maintaining adequate crop and forage production levels for dairy farmers. This module will focus on best management practices to maximize soil quality and health. Areas of management will include overall quality, erosion minimization, maximizing organic matter and decreasing soil compaction.

It should be noted, however, that soil health can also affect other aspects of farm productivity and health. As mentioned in the introduction, healthy soils can maintain higher natural nutrient levels, reducing requirements for commercial fertilizer. Maintaining high soil quality can also reduce the incidence or potential of pest infestations, reducing the need for chemical pesticides. Finally, soil and water are inextricably linked as a natural part of

geological and hydrological cycles, both on and off the farm. To gain further understanding of the areas and the interaction with soils, see the Educational Modules on Nutrient Management, Pest Management and Water Management.

PARAMETERS SELECTED

The following Parameters were selected by means of two screening processes, as outlined in the Methodology section. For a listing of parameters that were not used, please see Appendix D.

Soil Compaction: Soil compaction occurs when soil particles are pressed together as a result of pressure applied to the soil surface, for example by animals or farm machinery. Soil is particularly susceptible to compaction when wet. Soil compaction has an effect on both environmental and economic considerations for the farmer. Crop yields can be affected by compaction in that plants' roots cannot grow as deep into the soil and thus cannot take up nutrients and water as efficiently. Compaction also reduces soil moisture levels and can increase soil temperatures, which has a negative impact on the rate of decomposition of soil organic matter and corresponding release of nutrients for use by plants.[366] Compacted soil also does not allow for adequate water infiltration, which exacerbates erosion via runoff and potential pollution of water sources.

Soil Compaction is assessed via questions around management practices aimed at reducing compaction. Practices include avoiding running equipment or machinery over wet soils, minimizing the area that farm equipment travels over fields, and increasing organic matter in the soil, which can reduce soil compaction levels and increase soil permeability.

Soil Organic Matter: Soil organic matter affects biological, physical and chemical characteristics of soil. The University of Minnesota Extension's Soil Management Service states "Building soil organic matter may be the most important thing you can do to enhance long-term soil performance."[367] Soil organic matter provides the following services:

- Organic matter regulates, stores and supplies nutrients for plant use and serves as a carbon and energy source for soil organisms that process organic matter into plant available nutrients.

- Organic matter stabilizes soil structure by a) holding soil particles together (reducing erosion) and b) minimizing compaction, which has the dual effect of allowing for greater water infiltration and improving soil's capacity to hold water and air for use by plants.

- Chemically, appropriate levels of soil organic matter can impact pH in that it reduces the need for inorganic fertilizers, which can alter soil pH levels.

Tillage practices, use of cover crops, crop rotation, and use of inorganic fertilizers can all affect soil organic matter in soils.

Erosion: Soil erosion can significantly affect agricultural yields because the eroded portion of the soil, the topsoil, contains a large percentage of organic matter and biological activity, which is permanently lost when soil erodes. Loss of topsoil also leads to lower capacity of

the soil to provide water air and nutrients to plants.[368] Environmentally, erosion is a primary factor in non-point source pollution of water sources due to runoff.

Of particular concern is the fact that erosion leads to an irreversible alteration of the landscape. While soil is technically considered a renewable resource, it takes 500-1000 years to develop one inch of topsoil, and most farms have erosion three to ten times that amount.[369] The effects of erosion can be extensive and severe. The loss of just 1/32 of an inch of topsoil, a seemingly minimal amount can equal a loss totaling 5 tons per acre.[370]

Erosion is exacerbated by both site characteristics and management practices, including slope of the land, plant coverage of the soil at various points during the year (e.g. when there are higher chances of strong winds or rain), and tillage of cropland, which loosens topsoil. Because soil erosion levels cannot be assessed directly by the farmer, this Parameter is measured according to management practices related to erosion prevention, the existence of which indicates a decreased potential for erosion. Management practices to reduce soil erosion include both monitoring activities and other management strategies, such as tillage practices and use of cover crops.

Soil Testing: Soil testing can serve as a further means of ensuring soil quality.

EDUCATIONAL MODULE

Combining research on the specific indicator, global, national, and regional trends and the most appropriate parameters, the Team developed the following Educational Module.

SOIL HEALTH EDUCATIONAL MODULE

Description

Soil health is based on a variety of characteristics, including organic matter, salinity, structure and compaction, available nutrients, pH, water holding capacity and erosion levels. Together, these characteristics allow soil to serve a variety of functions: supporting the growth of crops (and therefore animals), regulating the distribution of rain and irrigation water and providing filtration to improve water as it infiltrates through soils.

Under current production methods, soil health and its corresponding contribution to farm production is under threat by increasing levels of soil degradation and erosion. The 1999 National Resources Inventory of the USDA reports that 1,700 megatonnes (million metric tonnes) of soil eroded from U.S. land in 1997.[371] This is enough to fill a fully loaded freight car train that would encircle the planet seven times.[372] Also, soil organic matter in some areas of North America, has declined 30-60% since the start of cultivation.[373] These effects make farmers' jobs increasingly difficult, as it becomes necessary to improve degraded soil quality with cost and time intensive inputs. Soil erosion is particularly problematic since its effects are irreversible.

Healthy soils are not only important to farm production, but also to overall environmental health. When soil is eroded via runoff, sediments, in addition to being a water pollution source, can carry nutrients or pesticide residues that further pollute surface waters. Soil that is impacted worsens this problem in that impacted soils cannot absorb as much water, increasing the amount of runoff. Unhealthy soil also contributes to particulate matter air pollution when loose topsoil is transported off of the farm via wind.

This module focuses on best management practices to maximize soil quality and health in order to maximize production and minimize erosion and pollution to water or air. Recommended areas of management include monitoring overall quality, minimizing erosion, maximizing organic content and preventing soil compaction.

Incentives for Change

- **Regulations:** The most recent 2002 Farm Bill includes an amendment to the Food Security Act of 1985 requiring that conservation systems must be implemented for agricultural operations on federally-designated "highly erodible land" (HEL). Conservation systems must protect land from excessive soil erosion and non-compliance can result in a producer becoming ineligible for numerous USDA benefits. In 1997, Vermont had approximately 125,000 acres of HEL. Conservation efforts undertaken now can mean assured compliance with this regulation and can safeguard a farmer's operations in the future. Technical and financial assistance is often available for farmers to implement both voluntary and compliance-driven conservation initiatives. See the "Further Information" section for details.

- **Cost Savings:** Maintaining healthy soils encourages maximum yields, meaning that farmers can maximize the amount of feed that they grow on the farm and correspondingly reduce costs of purchased feed. Healthy soils can also support crop growth with fewer inputs of commercial fertilizers and pesticides, thereby decreasing costs for these inputs, saving farmers time on their application and providing more

efficiently produced crop yields. Benefits received now will be compounded in the future as soil health becomes increasingly better and increasingly self-sustaining.

- **Governmental Cost Sharing:** The 2002 Farm Bill re-authorized funding to help farmers adopt conservation strategies directed at improving soil quality, water quality, air quality and wildlife habitat. Through this program, farmers can be paid to implement new practices that will benefit their operations as well as the environment. For example, soil quality improvement practices can reduce impact to the environment and improve farmers' yields, thus improving revenues and lowering costs overall. Cost sharing is generally up to 75%, though certain farmers may be eligible for 90%, and incentive payments can last up to three years to promote continued use and long-term adoption of management strategies. In 1993, the USDA Natural Resources Conservation Services allotted $5,692,454 for technical assistance and $4,134,600 for financial assistance in Vermont.

Assessment Questions

For all questions, please choose the categories that best identify your current management practices. Use the Summary sheet on the last page of this module to evaluate overall performance.

➢ **SOIL ORGANIC MATTER**

1. Soil organic matter is not monitored and inorganic fertilizers are used to provide a large portion of crop nutrients.
2. Some effort is made to increase soil organic matter through a) restricted tillage practices, b) cover crops, c) use of least oxidizing inorganic fertilizers or precision fertilizer applications, d) crop rotations, or e) use of manures or composts on fields.
3. A strong effort is made to maximize and maintain soil organic matter. Soil is tested for organic content and two practices from #2 are used as appropriate to soil need.
4. As per #3, and use of inorganic fertilizer is completely or almost completely eliminated.

The elements of soil that were once alive are termed as 'soil organic matter.' Organic matter is essential to soil health and productivity due to the myriad of services and benefits it provides. Examples include stabilizing and holding the soil together; improving the soil's ability to store and transmit air, water and nutrients to crops; and helping to prevent soil compaction. The net benefits are more productive crop harvests with fewer inputs, reduced runoff, and minimized soil erosion.

Cover crops contribute to soil organic content by increasing the plant material that is left on the soil and by preventing erosion of topsoil that is rich in organic material. Tillage and overuse of inorganic fertilizers, particularly nitrogen, accelerates the rate of decomposition of organic material in the soil, thereby causing loss of this material at a faster rate. These practices should therefore be minimized. Manures, which increase organic matter in the soil, should be used to supply soil with needed nutrients.

- **USE OF COVER CROPS AND VEGETATIVE AREAS**
  1. No effort is made to vegetate areas of bare soil on the farm; cover crops are never used.
  2. Some effort is made to vegetate areas of bare soil on the farm. Soil is covered some of the time/in some areas by vegetative plantings, buffer strips, pasture, other perennial crops and seasonal crops. Cover crops are sometimes used.
  3. Bare soil on the farm is kept to a minimum via vegetative plantings, buffer strips, pasture, other perennial crops and seasonal crops. Cover crops are used every year to maximize soil coverage and soil benefits.
  4. As per #3, and cover crop type and timing are strategically chosen, based on farm characteristics such as soil type and traditional crop grown, to maximize benefits to soil.

Plantings such as cover or perennial crops, grass, and hay hold soil in place, prevent compaction of soil, improve tilth,[4] and curb nutrient loss. Plant cover is also beneficial in that it increases organic matter and biological activity in the soil, which is beneficial to soil quality and plant growth. When cover crops are legumes such as alfalfa, clover or soybeans, they provide an added benefit of fixing nitrogen into the soil for use by future crops. Cover crops provide the additional benefit that yields can be sold or used as feed for cows. It is important to manage any plantings well by maintaining appropriate practices with respect to nutrient application and pesticide use.

- **CROP ROTATION**
  1. Crops are not rotated and most fields have corn or other high intensity row crops.
  2. Crops are rotated every four or more years and rotation tends to include high intensity row crops and with small grain (oats, wheat, etc.) crops.
  3. Crops are rotated at least once every three years and rotation includes row crops and grass or legume forage crops. Some effort is made to utilize crop rotation to optimize nutrient and pest management.
  4. Crops are rotated at least once every three years and grass or legume forage crops are grown more often than row crops. Crop rotations are specifically planned to optimize nutrient and pest control.

Crop rotation leads to greater quantity and diversity of soil organic material, improves nutrient availability, and can help control pests. Including legume crops in the rotation will provide the needed diversity while also fixing nitrogen in the soil. Other crops can also help prevent nutrient leaching. The Michigan State University Agriculture Experiment Station found that, with regard to nutrient leaching, wheat never loses more than 20 pounds of nitrogen per acre per year, as compared to continuous corn, which leaches up to 100 pounds.[374] Various rotations may reduce nitrogen leaching 30-50% as compared to growing continuous corn.[375] Crop rotation is beneficial economically, in that it can improve amount and diversity of yields and reduces the need for costly commercial fertilizers and pest-control chemicals.

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[4] Tilth is defined as soil's suitability to support plant or root growth by means of proper pore spaces for air and water filtration and movement and ability to hold adequate amounts of water and nutrients

- **TILLAGE PRACTICES**
  1. Tillage practices are undertaken without consideration of impacts to soil.
  2. An effort is made to minimize/alter tillage use to benefit soil quality. Conservation tillage is used to maintain crop residue on soil; tillage is never done on wet soil; tillage is restricted to specific portion of fields (strip tillage); or tillage is avoided completely.
  3. Tillage is strictly restricted as per one or more methods in #2, and resulting soil quality is monitored.
  4. Perennial crops or crop rotation system is used, allowing for a no-till farming operation.

Adjusting tillage practices is beneficial for reducing soil compaction, minimizing erosion and improving organic matter content, all of which are environmentally and economically beneficial to the farmer. Soil compaction can restrict plant roots (reducing uptake of water and nutrients), affect moisture and soil temperatures (affecting organic matter and nutrient release), and decrease infiltration of water, which increases the levels of runoff and erosion.

Tillage should never be done on wet soil, as it is particularly susceptible to compaction versus dry soil. Conservation tillage leaves at least 30% of the soil surface covered by crop residues after planting, thereby protecting it from erosion and contributing to the organic matter and beneficial biological activity in the soil. Additionally, no-till or strip-tillage[5] practices minimize the area being tilled, thus minimizing soil compaction and removal of plant residues. Restrictive tillage practices can also result in cost savings by reducing the amount of fuel needed to run the equipment or eliminating the need to own and maintain the equipment.

- **SOIL CONSERVATION/EROSION PREVENTION**
  1. No consideration is given to the problem or prevention of soil erosion. Erosion rates are unknown.
  2. An effort has been made to evaluate soil erosion, per the following evidence: presence of channels/gullies on fields, soil deposits at field margins or base of sloping areas, surface-crusted areas, exposure of lighter colored subsoil, and/or bare soil and loss of soil around plant roots.
  3. In addition to #2, at least one step has been taken to minimize erosion, such as utilizing diversion ditches, maintaining vegetated buffer strips around bodies of water, using conservation tillage or creating windbreaks.
  4. In addition to at least two actions from #3, at least one other action is taken: no-till or strip-till methods, mulches are used, manure or composts incorporated into fields, perennial crops are used on farm.

Soil erosion is the physical removal of surface soil material. Erosion can negatively impact crop production by contributing to the breakdown of soil structure and resulting in the loss of the uppermost soil layer. This top layer of soil has the highest levels of organic matter and biological activity, both of which are important for plant growth and overall soil health. It is very important to minimize erosion on the farm even if signs are

[5] Strip-tillage is defined as less than full-width tillage of varying intensity that is conducted parallel to the row direction. Generally no more than one-fourth of the plow layer is disturbed by this practice.

not obvious that erosion is occurring. The loss of just 1/32 of an inch of topsoil, very difficult to notice on a farm, can equal a loss of 5 tons of soil per acre.[376]

Soil loss can be mitigated in several ways:

- Diversion ditches or windbreaks reduce soil loss by diverting excess water or wind from reaching vulnerable soils.
- Vegetated buffer strips can 'catch' runoff from fields, including soil, sediments, and nutrients, to help prevent water pollution and soil loss from farms.
- Adjusting tillage practices can help by leaving more crop residues on the soil, contributing to soil organic matter content and decreasing soil compaction and removal of plant residues, all of which minimize soil erosion.
- Mulches and manure or composts cover the soil and increase organic matter content, protecting soil from erosion and improving its quality. Perennial crops provide compound benefits by covering the soil and holding it in place with their roots.

➢ **SOIL QUALITY MONITORING**

1. Soil quality on farm is not monitored.
2. Soil quality (including nutrient levels, salinity, and pH) is measured via soil tests every 5+ years but test results don't necessarily guide farm practices.
3. Soil quality is measured via soil tests every 3 years and test results and corresponding UVM recommendations guide farm practices.
4. Soil quality is measured via soil tests every 1-3 years and farm practices strictly follow corresponding UVM recommendations.

Regular soil testing (done at least once every 3 years) is the best way to ensure that soil remains healthy and productive, maximizing benefits to your farm. UVM and other experts offers soil test kits, analysis services and corresponding management recommendations that provide information such as soil pH, organic matter, available phosphorus and other nutrient levels, and fertility recommendations. At UVM, a basic soil test costs $9/sample and additional tests can be run for nominal fees (e.g. tests for organic matter cost an additional $3).

It is important to not only do the tests, but also to follow recommendations associated with the results. Results of these tests may include recommendations for nutrient application rates or improve soil characteristics such as pH or organic matter content. Maintaining high soil quality is increasingly beneficial over time as the soil is able to do the job that it is intended with fewer inputs (including time and money) from the farmer. If done every 1 to 3 years, soil testing is a non-time-intensive, inexpensive way to better understand and manage soil quality.

Linkages to Other Modules

Soil Health issues are closely tied to Biodiversity and Nutrient Management. The table below identifies where you can find more information on some of the topics mentioned in this module.

SOIL HEALTH TOPIC	OTHER MODULE(S)
Use of Inorganic Fertilizers	Nutrient Management
Soil Testing	Nutrient Management
Manure Use on Fields	Nutrient Management
Cover Crops	Biodiversity
Buffer Strips	Biodiversity

Further Information

Additional details and information on the above can be obtained through the following programs.

- The **USDA Natural Resources Conservation Service** provides information on soil quality, offers tools for assessing soil quality and recommends best practices for improving soil quality. Information can be found at http://soils.usda.gov/sqi/soil_quality/what_is/index.html.

- NRCS also operates a **Conservation Reserve Program (CRP)**, which provides technical and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. See http://www.vt.nrcs.usda.gov/programs/CRP/ and http://www.fsa.usda.gov/dafp/cepd/crp.htm for more information.

- The **Environmental Quality Incentives Program** (EQIP), also run by the NRCS, was re-authorized by the 2002 Farm Bill to provide cost sharing up to 75% for farmers to implement conservation practices that address soil, water, air, wildlife and other natural resource concerns. Incentive payments may last up to 3 years to encourage farmers to continue utilizing new management practices. See http://www.nrcs.usda.gov/programs/eqip/ for more information.

- **Vermont NRCS** has twelve regional field offices that can provide more assistance and information on all of the above. Contact the District Conservationist at the office nearest you:
    - Bennington: (802) 442-2275
    - Berlin: (802) 828-4493
    - Brattleboro: (802) 254-9766
    - Middlebury: (802) 388-6748
    - Morrisville: (802) 888-4935
    - Newport: (802) 334-6090
    - Rutland: (802) 775-8034
    - St. Albans: (802) 527-1296
    - St. Johnsbury: (802) 748-2641
    - White River Junction: (802) 295-7942
    - Williston: (802) 879-4785

- Vermont NRCS State Office: Dave Hoyt, Assistant State Conservationist, 802-951-6796, extension 227

- The **Vermont Agency of Agriculture, Food and Markets** provides a clearinghouse of information on controlling non-point source pollution and runoff from dairy farms, including accepted agricultural practices (AAPs), best management practices (BMPs) and technical and financial assistance for projects. See http://www.vermontagriculture.com/pidnonpointsource.htm for more information. You can also call the Vermont Natural Resources Conservation Districts
    - Windham, Bennington, Rutland, Windsor, Counties: 802-257-5621
    - Orleans, Essex, Caledonia, Orange, Washington Counties: 802-229-2720
    - Addison, Chittenden, Lamoille, Franklin, & Grand Isle Counties: 802-388-6746

SUMMARY OF RESULTS FOR SOIL HEALTH

Instructions: In the table below, please record the score for the answer you selected for each question. For multiple-choice questions, the response number serves as your score for that category (i.e. choice # 2 is worth 2 points). For "check all that apply questions," please see scoring criteria for each question in the chart below. Once all responses have been completed, add up the answers and record the total.

QUESTION	ANSWER/SCORE
1. Soil Organic Matter	
2. Use of Cover Crops and Vegetative Areas	
3. Crop Rotation	
4. Tillage Practices	
5. Soil Conservation/Erosion Prevention	
6. Soil Quality Monitoring	
Total Score	
Total Possible Points	24

Interpretation: The next step in understanding your farm's performance in the category of Soil Health is to compare your results to best practices. Below is a table that ranks your performance from best practice (green) to practices that require improvement (red). Compare the number of points you received for your practices compared to optimal practices.

	Point Range	**Interpretation**
Green	21 - 24	Soil Health best practices are currently being employed on this farm.
Yellow	15 - 20	Farm is using some good practices regarding Soil Health. However there are some key areas that should be improved upon.
Red	6 - 14	Soil Health practices should be carefully evaluated and a strong effort should be made to adopt improved practices in several areas.

XIV. WATER MANAGEMENT

INTRODUCTION

The availability of clean, high quality water is essential to sustaining plant, animal and human life. Surface and ground waters must be protected to ensure their continued use for municipal and industrial water supplies, to support a healthy aquatic ecosystem, and to enjoy recreationally. Prevention of water pollution is also critical to maintain surface and ground water that is safe for drinking. In addition to water quality, there is increasing concern regarding the availability of freshwater. "Less than three percent of the water on Earth is fresh, and most of it is in polar ice or too deep underground to reach. The amount of fresh water that is accessible, in lakes, rivers and reservoirs is less than a quarter of one percent of the total."[377] Because water is essential to life, proper care must be given to ensure an adequate fresh water supply for future generations.

The most recent National Water Quality Inventory indicates that agricultural nonpoint source (NPS) pollution is the leading source of water quality impacts to surveyed rivers and lakes, the third largest source of impairments to surveyed estuaries, and a major contributor to ground water contamination and wetlands degradation.[378] Management practices on dairy farms can lead to increased water pollution from a variety of sources. These include pesticides, fertilizers and manure applied to fields; soil sediment runoff; runoff or leaching from storage of nutrient-rich materials or livestock areas; and disposal of contaminated water used to clean milking equipment. Pollution can enter water sources via runoff directly to surface waters, runoff to drainage ditches or other areas that lead to surface waters, "leaching" of contaminants through soil into ground water, and disposal of contaminated water into drains that lead directly to water sources.

The effects of water pollution vary. In surface water, high levels of the nutrients nitrogen and phosphorus can lead to eutrophication, or nutrient enrichment of water, which results in oxygen depletion that kills fish and other aquatic organisms. A risk to ground and surface water is fecal bacteria in livestock waste. Ingestion of polluted water can lead to such infectious diseases as dysentery, typhoid and hepatitis.[379] Other organic materials may not cause health problems, but can lead to an unpleasant taste and odor in drinking water and can serve as an indication of the presence of other more serious contaminants. Nutrient pollution of water can exacerbate the effects of microorganism pollution in that nutrients serve as a food source for the organisms, sustaining them and allowing them to thrive.

Taking steps to improve water quality can benefit farmers in helping them achieve compliance with regulations and making them eligible to participate in governmental cost-sharing programs. As water pollution becomes an ever-larger issue throughout the U.S., legislation supporting the Clean Water Act is becoming increasingly broad reaching and stringent. In 2002, the EPA approved a new regulation requiring that certain "concentrated animal feeding operations" implement best management practices for impact to water in order to gain a permit to operate. USDA and state-level programs provide support in the form of cost sharing, technical assistance and economic incentives to implement non-point source pollution management practices. The National Environmental Quality Incentives Program (EQIP) authorizes the Secretary of Agriculture to provide cost-sharing incentives

up to $450,000 per farmer to implement management practices that will protect water quality.[380]

Water quality is closely linked to Nutrient Management and Soil Health. Please see these chapters for additional details on water quality issues.

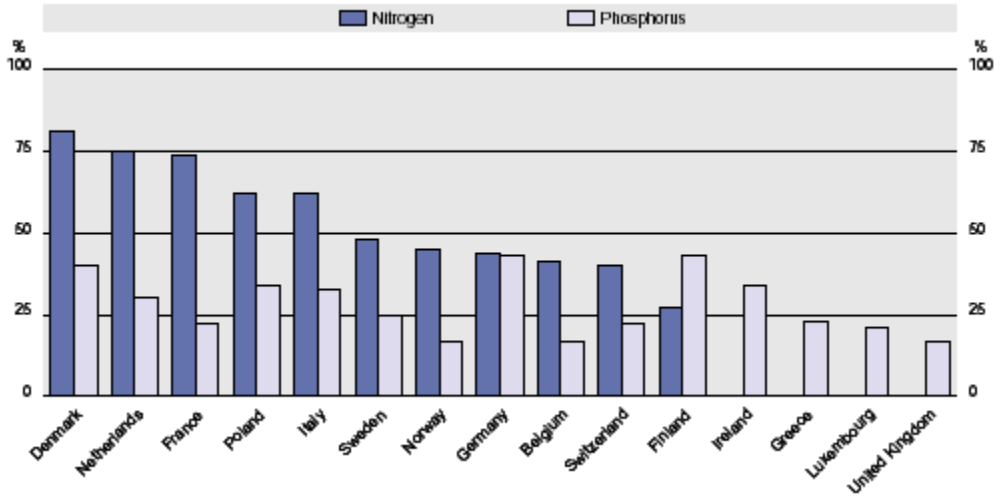
In addition to water quality, the concern regarding rapidly diminishing aquifers and freshwater sources must also be addressed. In the US, agriculture is responsible for using 65 – 70% of freshwater resources in the US and the world.[381] Of this amount, it is estimated that 39% of the freshwater that is withdrawn is for irrigation purposes.[382] This is approximately twenty times as much water as is needed for livestock.[383] Dairy farmers in Vermont do not commonly irrigate crops and have much smaller usage amounts for the cows. One exception to this general rule is during the hot, dry season. Therefore, while water scarcity is a top environmental concern, critical to consider when reviewing sustainable agriculture, due to the geographical location of Vermont and the limited amount of irrigation conducted, water use in Vermont is not as significant of a concern.

GLOBAL, NATIONAL AND REGIONAL TRENDS

Water Quality:

Agriculture contributes sizable amounts of pollutants to waters and is the major contributor of nitrogen and phosphorus in many OECD countries.[384] It is estimated that agriculture accounts for over 40% of nitrogen and over 30% of phosphorus emissions to surface waters in many OECD countries (see Figure 16).[385] Burdens to water from soil sediment and pesticides are more difficult to assess, although recent trends in global soil loss and pesticide use may indicate that the situation is improving.[386] However, this does not mean that action is not needed, since there are still many areas for which this is a concern.

Figure 16: Share of Agriculture in Total Emissions of Nitrogen[387]



The National Summary of Water Quality Conditions reported that agriculture is the leading source of pollution in the nation's rivers, lakes and wetlands.[388] This is becoming increasingly problematic as populations and standards of living increase, placing additional

demand on our water resources and agricultural systems. According to the US EPA, agriculture is the source of excess nutrients in 50% of the lakes and 60% of the river miles suffering from degraded water quality.[389] The Gulf of Mexico has an oxygen-depleted 'dead' zone that reached a record 8,500 square miles in 2002, largely the result of commercial fertilizer and animal manure flows from agricultural lands into the Mississippi River Basin.[390] Given that riparian zone degradation is increasingly contributing to this pollution, the Office of Science and Technology Policy Committee on Environment and Natural Resources Hypoxia Work Group has recommended the recreation or restoration of 24 million acres of riparian zones to reduce nitrogen in the Mississippi River Basin.[391]

In Vermont, pollution from agricultural runoff and other sources has led to a serious decline in water quality in Lake Champlain, a critical water resource for the region. Phosphorus is a particular concern for the lake and the Missisquoi Bay, which receives about 150 metric tons of phosphorus each year via the Rock, Pike, and Missisquoi Rivers.[392] Approximately 70% of this phosphorus is derived from agricultural sources that make up only 26% of the land area in the Missisquoi basin.[393] For water conditions to improve, Vermont Department of Environmental Conservation Water Quality Division estimates that these phosphorus loads must be reduced by 40% so that no more than 92.7 metric tons enter each year.[394] In addition to surface water issues, many drinking water wells have been found to have nitrate-nitrogen levels exceeding the Vermont public health standard, making the water unsafe for consumption by babies and young livestock.[395]

Water Availability:

The executive director of the United Nations Environment Programme, projected 12 million deaths, related to water pollution, poor sanitation and water shortages in 2002.[396] While already a concern, freshwater shortages are expected to get significantly worse in the next 20 years. One-third of the people in the world, in more than 62 countries, lack an adequate fresh-water supply.[397] With rapidly increasing population figures and increasing water consumption, the shortage of freshwater is expected to sharply increase. This shortage will have significant impact on farmers, but the impact will vary based on specific geographical region. A report focused on the global outlook in 2025, produced by The International Food Policy Research Institute (IFPRI), found that "the main factors limiting future food production will be water. This scarce resource is facing heavy and unsustainable demand from users of all kinds, and farmers increasingly have to compete for water with urban residents and industries."[398]

Water scarcity within the US is also becoming more of a concern. If current practices continue, in 20 years, Southeast Florida, Southern California, and Atlanta are all likely to run out of fresh water.[399] The aquifers around the country are also being used up at a faster rate than nature can refill them. "The High Plains Ogallala aquifer, which runs 1,300 miles from Texas to South Dakota, is drawn down eight times faster than nature refills it."[400] At a recent congressional hearing, the President of the American Farm Bureau Federation, Bob Stallman, spoke of the economic importance of water supply to the nation's agriculture industry and the impacts of water supply problems facing all parts of the United States, from the Rio Grande to the Great Lakes, and the New England area to the West Coast.[401]

Though Vermont does not have a shortage of water, the availability of potable water is increasingly becoming a concern. Like Vermont, Maryland is also considered to have plenty

of water. However, central Maryland experienced a draught with imposed water use restrictions from April 2002 until February 2003.[402] This drought illustrates that "while water may be abundant in many areas, it is not limitless, and even our nation's most water-rich regions can run dry."[403] While irrigation is a significant user of water, it is important to note that livestock are as well. Even in Vermont, sources say the "demand for ground water from the bedrock aquifer is continuously increasing as new sources of surface water decrease and the cost of surface-water treatment increases."[404]

FOCUS OF THE WATER MANAGEMENT EDUCATIONAL MODULE

As explained in the introduction, water quality is affected by a variety of on-farm activities. The current module will focus on minimizing the potential for water pollution from silage, manure and fertilizer storage; livestock yards; and disposal of milkhouse wastewater. It should be noted that one of the most significant contributors to degraded water quality is overuse of nutrients, in the form of commercial fertilizer and manure that are applied to fields. The magnitude of this issue is such that it warranted complete and separate coverage in a separate section on Nutrient Management. Water quality implications of soil management practices are addressed in the Soil Health module and pesticide runoff is addressed in the Pest Management module. Please see these sections for additional information on protecting water quality.

Because research showed that water scarcity is currently not a large concern for Vermont, water quality is the primary focus of this Educational Module. However, because water use may be a concern in the future and have financial implications, water use planning and conservation management plans are evaluated.

PARAMETERS SELECTED

The following Parameters were selected by means of two screening processes, as outlined in the Methodology section. For a listing of parameters that were not used, please see Appendix D.

Runoff and Leaching Prevention: Livestock areas as well as manure, silage and fertilizer storage areas are potential sources of water pollution on the farm and must be properly managed to reduce potential impact on water quality. Poor management may result in contaminated water running off these areas into surface waters or leaching into groundwater. The Minnesota Pollution Control Agency found that oxygen depleting properties of these contaminants can be measured by oxygen demand, which indicates potential for these materials to reduce oxygen levels in water, thereby reducing the amount of oxygen available for plants and animals in the aquatic ecosystem.[405] As shown in Table 14, milkhouse wastes, silage leachate and cow manure have 6, 140 and 200 times the oxygen depleting potential of *untreated* municipal sewage.

Table 14: Typical Oxygen Depleting Properties of Various Materials[406]

Type of Material	Oxygen Demand (mg/l)
Municipal Sewage, treated	25
Municipal sewage, untreated	250
Cattle feedlot runoff	1,000
Milkhouse wastes	1,500
Silage stack leachate	35,000
Cattle or hog manure	50,000

Livestock areas, such as barnyards, holding areas and feedlots, are areas of concentrated livestock wastes and other materials, such as feed or bedding. Runoff or leachate from these areas can contain fecal bacteria, nutrients, or other organic materials that contribute to pollution of ground and surface water. Manure storage facilities similarly have high concentrations of pathogens, nutrients and other organic material. Care must be taken to prevent contaminated water or manure from leaving the storage facility and running off into surface water or leaching into ground water. Building and maintaining adequate storage facilities and carefully locating the facilities will minimize the chance of leaching or runoff.

Water contact with stored silage can result in silage juice (leachate) running off or leaching from storage areas. Leachate can be highly acidic and corrosive to concrete or steel. This acidity (low pH) is an even greater threat in that it can free up and release naturally occurring metals in soils and groundwater. It also has a high nutrient and organic material content, which can cause eutrophication (oxygen deprivation) in surface waters, as well as ammonia, nitrates and iron. Silage leachate pollution is so severe that leachate from 300 tons of high-moisture silage has been compared to the daily sewage generated by a city of 80,000 people.[407]

Fertilizer storage areas pose a threat because the inorganic chemicals stored contain a high level of nutrients that, if improperly managed, can leach into ground water or run off to surface water.

Milkhouse Waste Management: Water used to clean the milkhouse and milkhouse equipment contains high levels of milk, detergents, sanitizers, manure, urine, dirt, feed and bedding, which can contaminate water with ammonia, nitrate, phosphorus, detergents and disease-causing organisms if not disposed of properly.[408] Small to medium dairy farms may generate 200 to 400 gallons of milkhouse wastewater daily while larger operations can generate 1,000 gallons or more.[409] It is therefore important to control how milkhouse waste is discarded to prevent either intentional or accidental discharge of untreated waste into the water supply.

Protection of On-Farm Water Sources: Management practices to control runoff are intended to eliminate or largely reduce contamination of surface waters from on-farm pollution sources. To the extent that runoff still occurs, contamination of surface water can be mitigated by physically protecting the water sources. The Vermont Department of Environmental Conservation Water Quality Division indicates that farms can reduce their phosphorus loads by leaving buffer strips between fields and water and fencing animals out of waterways.[410] Buffer strips are natural (untreated with nutrients or pesticides) areas near

water sources that will inhibit runoff from reaching surface water, either through absorption into the soil or physically stopping water and sediment with vegetation. Buffer strips and other physical barriers, such as fences, can also keep cows from walking in water sources. This is important in that cows can track contaminants from their bodies into water.

Water Use: Agriculture is a primary user of water. On a dairy farm, water is used for: drinking by cows, cleaning dairy equipment, sprinkling cows to cool, flushing manure, and irrigating crops (if applicable). Livestock are significant water users as one dairy cow typically consumes 35 gallons per day.[411] Given the increasing shortage of fresh water, along with the large volumes consumed, it is critical that dairy farmers examine and improve the efficiency with which they use water.

EDUCATIONAL MODULE

Combining research on the specific indicator, global, national, and regional trends and the most appropriate parameters, the Team developed the following Educational Module.

WATER MANAGEMENT EDUCATIONAL MODULE

Description

The availability of clean, high quality water is essential to life. Prevention of water pollution is critical to maintain ground water that is safe for drinking. Surface waters must also be protected to maintain healthy aquatic ecosystems, provide industrial and municipal water supplies, and support recreational enjoyment. In Vermont, Lake Champlain, a critical water resource, is experiencing a serious decline in water quality, in part due to sediment and nutrients from agricultural runoff. Many drinking water wells have been found to have nitrate-nitrogen levels exceeding the Vermont public health standard (caused by nitrogen leaching through soil).[412] Nitrate contamination can make drinking water unsafe for babies or young livestock and fecal bacteria in drinking water (from manure) can cause infectious diseases such as dysentery, typhoid and hepatitis.[413] While Vermont dairy farms are certainly not the only source of this pollution, contributions from these sources can be significant and participation from the dairy farmer community is therefore essential to correcting this water quality problem.

Though Vermont does not have a shortage of water, the availability of potable water is increasingly becoming a concern. A drought in Frederick County, MD, last summer illustrates that "while water may be abundant in many areas, it is not limitless, and even our nation's most water-rich regions can run dry."[414] While irrigation is a significant user of water, it is important to note that livestock are as well. Even in Vermont, sources say the "Demand for ground water from the bedrock aquifer is continuously increasing as new sources of surface water decrease and the cost of surface-water treatment increases."[415]

This module will focus on best management practices dairy farmers can use to minimize and prevent water pollution and, to a lesser extent, to promote appropriate water use. General areas to be covered include preventing pollution from livestock yards, storage areas and milkhouse waste, general land management strategies and management of water use.

Incentives for Change

- **Regulations.** As water pollution becomes an ever-larger issue throughout the U.S., legislation supporting the Clean Water Act is becoming increasingly broad reaching and stringent. In 2002, the EPA approved a new regulation requiring that certain "concentrated animal feeding operations" implement best management practices to improve water quality in order to gain a permit to operate. In Vermont, there are many programs to address the water quality issues of Lake Champlain, and dairy farmers may find themselves subject to increasing pressure and/or regulations to take steps to improve water quality.

- **Governmental cost sharing.** USDA and state-level programs provide support in the form of cost sharing, technical assistance and economic incentives to implement NPS pollution management practices. Recently, 40% percent of section 319 Clean Water Act grants were used to control agricultural NPS pollution.[416] The National Environmental Quality Incentives Program (EQIP) authorizes the Secretary of Agriculture to provide cost-sharing incentives up to $450,000 per farmer to implement management practices that will protect water quality.[417]

- **Cost Savings:** Conserving and reusing water can have economical benefits. While current prices for water are reasonable, as water shortages become more common, frequent occurrences, water costs will increase. Therefore, the more water that can be collected, conserved, and reused, the more flexibility the farmer has regarding water demand.

- **Improved On-farm Water Quality:** Minimizing impact on surface and ground water is beneficial to the extent that these water resources become inputs on the farm. Maintaining healthy drinking water can reduce the chance for illness, and associated costs, from contaminated water.

Assessment Questions

For all questions, please choose the categories that best identify your current management practices. Use the Summary sheet on the last page of this module to evaluate overall performance.

➢ **LIVESTOCK YARD MANAGEMENT**

1. Livestock yard is unroofed and on course-textured (sands, sandy loam) soil less than 100 feet from on-farm water sources. Yard is rarely cleaned and runoff water is uncontrolled.
2. Livestock yard is open or partially roofed on medium- or fine-textured soils (loam, silt loam, clay loams, clay) greater than 100 feet from on-farm water sources. Yard is cleaned once a month and some effort is made to collect runoff water or divert to manure storage area.
3. Livestock yard is open or partially roofed on concrete or medium- or fine-textured soils greater than 100 feet from on-farm water sources. Yard is cleaned once per week and has protective barriers to prevent runoff. An effort is made to prevent water from entering/flooding yard and any runoff is collected or diverted to manure storage area.
4. Livestock yard is open or partially roofed on concrete greater than 100 feet from on-farm water sources. Yard is cleaned at least once per day and water is diverted so that flooding or runoff from yard never occurs.

Livestock yards (barnyards, holding areas and feedlots) are concentrated areas of livestock wastes and are therefore vital to protection of water quality. These yards, especially when on permeable soils or near on-farm water sources, can cause nitrate and bacteria contamination in ground or surface water. To minimize the possibility of contaminants leaching to groundwater or running off to surface water, such yards should be located on concrete or fine- to medium textured soils over 100 feet from water sources such as wells, surface water, adjacent property, drainage ditches, or other areas that could result in the runoff reaching water sources. The best means to achieve this is to prevent flooding in livestock yards by diverting rain and/or floodwaters from the area. Having a roof over the yard or otherwise diverting water from yard is the best way to prevent runoff. This is especially important if yards are on a slope. If it is impossible to prevent runoff completely, other practices, such as keeping the yard clean, diverting runoff to manure storage areas or collecting and re-using runoff (e.g. as nutrients on fields), can minimize potential pollution to water sources.

- **MANURE STORAGE SYSTEM**
  1. Storage structures allow for contact of stored material with porous/non-clay soils (because of leakage/cracks or overflow) and are subject to flooding. Storage structures are located without regard to proximity to on-farm water sources.
  2. Storage structures are lined with clay or cement, though some leakage may occur due to cracks or overflow. Some effort is made to divert water from site and proximity of storage structures to bodies of water is considered in their placement.
  3. Storage structures are lined with clay or cement, are of sufficient capacity to hold all materials, and cracks/leaking are minimized. Some effort is made to divert water from site and proximity of storage structures to bodies of water is considered in their placement.
  4. Storage structures are lined with clay or cement, are of sufficient capacity to hold all materials, and are maintained to allow for no leakage. Water is prevented from entering/flooding storage area. Storage structures are all located downslope and at a maximum distance from bodies of water.

- **FERTILIZER STORAGE SYSTEM**
  1. Storage structures allow for contact of stored material with porous/non-clay soils (because of leakage/cracks or overflow) and are subject to flooding. Storage structures are located without regard to proximity to on-farm water sources.
  2. Storage structures are lined with clay or cement, though some leakage may occur due to cracks or overflow. Some effort is made to divert water from site and proximity of storage structures to bodies of water is considered in their placement.
  3. Storage structures are lined with clay or cement, are of sufficient capacity to hold all materials, and cracks/leaking are minimized. Some effort is made to divert water from site and proximity of storage structures to bodies of water is considered in their placement.
  4. Storage structures are lined with clay or cement, are of sufficient capacity to hold all materials, and are maintained to allow for no leakage. Water is prevented from entering/flooding storage area. Storage structures are all located downslope and at a maximum distance from bodies of water.

- **SILAGE STORAGE SYSTEM**
  1. Storage structures allow for contact of stored material with porous/non-clay soils (because of leakage/cracks or overflow) and are subject to flooding. Storage structures are located without regard to proximity to on-farm water sources.
  2. Storage structures are lined with clay or cement, though some leakage may occur due to cracks or overflow. Some effort is made to divert water from site and proximity of storage structures to bodies of water is considered in their placement.
  3. Storage structures are lined with clay or cement, are of sufficient capacity to hold all materials, and cracks/leaking are minimized. Some effort is made to divert water from site and proximity of storage structures to bodies of water is considered in their placement.
  4. Storage structures are lined with clay or cement, are of sufficient capacity to hold all materials, and are maintained to allow for no leakage. Water is prevented from entering/flooding storage area. Storage structures are all located downslope and at a maximum distance from bodies of water.

Storage areas for manure, fertilizer and silage can be potential sources of water pollution if not managed properly. It has been found that silage leachate and cow manure have 140 and 200 times the oxygen depleting potential of *untreated* municipal sewage, which can lead to eutrophication in water bodies.[418] Silage leachate is also highly acidic and leachate from 300 tons of high-moisture silage has been compared to the daily sewage generated by a city of 80,000 people.[419] The best way to prevent such pollution is to ensure that storage systems are well-maintained (allowing for no leakage of stored material), are of adequate size (to avoid spillage due to overflows), are not subject to water infiltration or runoff, and do not allow for contact of stored material with porous or course-textured soils. Runoff prevention can be achieved by using closed or covered storage and by ensuring that diversion ditches or other techniques are used to prevent moving water from coming into contact with the stored material. If it is impossible to prevent runoff completely, other practices, such as collecting and re-using runoff as fertilizer, can minimize potential pollution to water sources. Finally, locating these storage systems an adequate distance (preferably at least 100 feet) from wells, surface water, adjacent property, drainage ditches, or other areas that could result in runoff reaching water sources, can prevent or minimize water pollution.

Protection of farm inputs such as silage and fertilizer can also improve efficiency and cost-effectiveness on farms. For example, preventing water from coming into contact with silage can help to maintain the freshness and quality of the silage, thereby minimizing additional feed costs. Preventing impact to fertilizers can also ensure that these materials remain useful for their intended life.

- **MILKHOUSE WASTE**
  1. All waste is poured down a drain that leads to the municipal drainage system or is sent to a leach field, usually also washing down feed and manure.
  2. Most waste is diverted to the manure storage area, though some goes to the municipal drainage system or is sent to a leach field. No effort is made to remove excess feed and manure from the parlor prior to wash down.
  3. All waste is diverted to the manure storage area, though the first rinse is sometimes used as fertilizer. Some effort is made to remove excess feed and manure from the parlor prior to wash down.
  4. All waste is diverted to the manure storage area. Any field application of first rinse is matched to field nutrient needs. Most manure and excess feed is removed from the parlor prior to wash down.

Water used to clean the milkhouse and milkhouse equipment contains high levels of organic matter, nutrients, chemicals and microorganisms, which can contaminate water with ammonia, nitrate, phosphorus, detergents and disease-causing organisms if not disposed of properly.[420] Milkhouse wastewater is made nutrient-rich by virtue of having high amounts of milk residues or being washed down the drain with manure and feed. This nutrient-rich water can lead to pollution if it is untreated before it reaches water supplies. To minimize this potential impact to water, wastewater should be diverted to manure storage areas. Nutrient-rich first rinse water can also be re-used by applying it directly to fields as fertilizer. When applying first rinse to fields, care should be taken to match field nutrient needs with nutrient content of first rinse. Cleaning the parlor of feed and excess manure prior to wash down will minimize the amount of this material that enters water and can minimize the volume of water needed for cleaning.

- **PROTECTING ON-FARM WATER SOURCES**
  1. There is no effort made to protect on-farm bodies of water (lakes, ponds, streams, creeks).
  2. Some 'buffer areas' (uncultivated land with some natural vegetation) are utilized to absorb farm runoff water and protect some water sources.
  3. Buffer areas are utilized along edges of all water sources and an effort is made to maximize vegetation in these areas in order to maximize absorption of runoff water. Cows are generally prevented from entering the water.
  4. Buffer areas with maximum vegetation are utilized along edges of all water sources and the width of buffer strips is increased if water is at the bottom of a downslope. Cows are prevented from entering the water at any time.

Buffer areas are natural, uncultivated areas on the farm that are covered with vegetation (either planted or naturally occurring). Maintenance of these areas around water sources on the farm serves to further protect these water sources from pollution due to runoff. The protection comes from the fact that the buffer areas can potentially halt the flow of runoff water or absorb it before it reaches surface waters. Buffer areas should be as large as possible in order to maximize the benefits they provide. When they are at the bottom of a slope (i.e. protecting water at the base of a slope), it is especially important that they be as wide and densely vegetated as possible.

It is important to note that buffer areas should be **untreated** by chemicals or nutrients and instead developed and managed in a way that they do not need additional inputs to flourish. In this way buffer areas can benefit from the addition of nutrients to their soils via the absorption of runoff waters. Buffer areas also have the additional benefit of adding to the biodiversity (variance of flora and fauna) on a farm.

In addition to buffer strips, preventing cows from entering water is vital to maintaining water quality. Cows can be harmful to water quality to the extent that they urinate or excrete manure into the water or track these and other substances, such as bedding or feed, into water via their legs or hooves. Cows should not come into contact with water sources at any time.

- **WATER USE PLAN**[421]
  1. Water use on the farm is not monitored or planned.
  2. Water use on the farm is monitored and reported to users with suggestions for decreasing use.
  3. In addition to #2, water use on the farm is budgeted and includes action steps to improve water use efficiency by minimizing runoff, water loss, and erosion and pest problems. Areas monitored include wash down and milking equipment clean up, drinking, cooling and irrigation.
  4. In addition to #3, imported water use on the farm is minimized by recycling, conserving, and/or collecting water and/or using low demand systems. Water use is further minimized by planting water-conserving varieties and/or ground covers.

While there appears to be plenty of water available for a reasonable to cheap price, it is important to start thinking about a water use plan. As more and more water shortages are realized, water costs are expected to increase. If the market is used to dictate price,

this competition, especially in Western states, is expected to have significant impacts on agriculture.[422] Once a baseline is established, then proactive steps can be taken in a methodical manner. Also, while water appears to be a plentiful resource, it is important to determine if this is actually true by investigating the health of a farm's specific watershed.

- **WATER USE MANAGEMENT STRATEGIES** (Please check all that apply)
  - ❑ I recycle water on the farm, such as using wastewater to flush feeding areas and free-stall barns (ensuring that resulting water flow is directed to the manure storage area).
  - ❑ I use grass-based and/or seasonal dairying to eliminate the need to wash off manure from high use areas.
  - ❑ I use a housing system that keeps cows clean which eliminates the need to wash cows before milking.
  - ❑ I use water to cool milk by passing it through the cooler plate, while simultaneously heating water that the cows will drink.

Using certain management strategies can decrease water use. There are strategies regarding irrigation as well as reuse and recycling water from different activities. While recognizing that irrigation is not a top concern in Vermont, it is worth noting that corn is one of the top six crops in the US that requires 70% of the irrigation.[423] More applicable to Vermont are the management strategies that focus on either reducing the need for water (via type of dairying or housing system) or by reusing wastewater.

Linkages to Other Modules

Water quality issues are tied to Nutrient Management, Soil Health, Biodiversity and Animal Welfare. The table below identifies where you can find more information on some of the topics mentioned in this module.

WATER MANAGEMENT TOPIC	OTHER MODULE(S)
Buffer Areas	Soil Health & Biodiversity
Field Nutrient Applications	Nutrient Management

Further Information

Additional details and information on the above can be obtained through the following programs.

- **Livestock and Poultry Environmental Stewardship (LPES) Curriculum** provides environmental best management practice recommendations for dairy farms (http://www.lpes.org/les_plans.html). They also provide information on the new Concentrated Animal Feeding Operations (CAFO) regulations and links to funding and additional technical resources (http://www.lpes.org/CAFO.html). Call 1-800-562-3618 for more information.

- The **USDA Natural Resource Conservation Service (NRCS)** offers nutrient management information and tools at http://www.nrcs.usda.gov/technical/ECS/nutrient/. The program also provides funding and technical assistance for conservation efforts through Farm Bill 2002 (http://www.nrcs.usda.gov/programs/farmbill/2002/) and its affiliate programs, such as EQIP (http://www.nrcs.usda.gov/programs/eqip/). The **Vermont NRCS** also

manages Farm*A*Syst, a program devoted to national and state-level improvements to ground water that provides comprehensive evaluation and best management sheets specifically for dairy farmers in Vermont. More information can be found at http://www.vt.nrcs.usda.gov/technical/FarmASyst/. Vermont NRCS has twelve regional field offices that can provide more assistance and information on the above. Contact the District Conservationist at the office nearest you at:

- Bennington: (802) 442-2275
- Berlin: (802) 828-4493
- Brattleboro: (802) 254-9766
- Middlebury: (802) 388-6748
- Morrisville: (802) 888-4935
- Newport: (802) 334-6090
- Rutland: (802) 775-8034
- St. Albans: (802) 527-1296
- St. Johnsbury: (802) 748-2641
- White River Junction: (802) 295-7942
- Williston: (802) 879-4785
- Vermont NRCS State Office: Dave Hoyt, Assistant State Conservationist, 802-951-6796, extension 227

- The **Vermont Department of Environmental Conservation Water Quality Division** provides a newsletter pertaining to water quality as well as information on best management practices, grants and educational opportunities. See http://www.vtwaterquality.org/ for more information or contact the Water Quality Division at 802-241-3770 or 802-241-3777.

- The **Vermont Agency of Agriculture, Food and Markets** provides a clearinghouse of information on controlling non-point source pollution from dairy farms, including accepted agricultural practices (AAPs), best management practices (BMPs) and technical and financial assistance for projects. See http://www.vermontagriculture.com/pidnonpointsource.htm for more information. You can also call the Vermont Natural Resources Conservation Districts
    - Windham, Bennington, Rutland, Windsor, Counties: 802-257-5621
    - Orleans, Essex, Caledonia, Orange, Washington Counties: 802-229-2720
    - Addison, Chittenden, Lamoille, Franklin, & Grand Isle Counties: 802-388-6746

Summary of Results For Water Management

Instructions: In the table below, please record the score for the answer you selected for each question. For multiple-choice questions, the response number serves as your score for that category (i.e. choice # 2 is worth 2 points). For "check all that apply questions," please see scoring criteria for each question in the chart below. Once all responses have been completed, add up the answers and record the total.

QUESTION	ANSWER/SCORE
1. Livestock Yard Management	
2. Manure Storage System	
3. Fertilizer Storage System (If no fertilizer is stored on property, give yourself 4 points)	
4. Silage Storage System	
5. Milkhouse Waste	
6. Protecting On-Farm Water Sources	
7. Water Use Plan	
8. Water Use Management Strategies (1 point for each box checked)	
Total Score	
Total Possible Points	32

Interpretation: The next step in understanding your farm's performance in the category of Water Management is to compare your results to best practices. Below is a table that ranks your performance from best practice (green) to practices that require improvement (red). Compare the number of points you received for your practices compared to optimal practices.

	Point Range	**Interpretation**
Green	27 - 32	Best practices regarding Water Management are currently being employed on this farm.
Yellow	20 - 26	Farm is using some good practices regarding Water Management, however there are some key areas that should be improved upon.
Red	7 - 20	Water Management should be carefully evaluated and a strong effort should be made to adopt improved practices in several areas.

XV. IMPLEMENTATION

BACKGROUND

Per the scope of the master's project, the Team has developed recommendations for implementing an overall program that utilizes the Educational Modules to improve awareness and adoption of best management practices for Vermont dairy farms. Implementation will include outreach to farmers, assisting farmers in use of the modules and adoption of best management practices, monitoring and reporting results, and revising and maintaining the Educational Modules over time. Ben & Jerry's goal is to transition the ownership of the Educational Modules and overall program execution to another organization in Vermont. While the implementing organization and actual mechanisms and logistics around implementation are to be determined, this section will provide guidance based on the Team's research and interactions with various stakeholders. Recommendations will cover characteristics of the implementing organization, goal setting and some key elements of the program.

IMPLEMENTING ORGANIZATION

The number and variety of stakeholders associated with this project require that the implementing organization have wide-ranging areas of expertise and the capacity to work effectively with a variety of stakeholder groups. Expertise in general Vermont dairy farming practices is essential to understanding baseline practices, appreciating farmers' perspectives, and achieving strong credibility with the farmers. Knowledge of best practices across environmental, economic and social criteria is important to providing adequate tools and resources for dairy farmers to carry out management changes. It is also essential to helping farmers further understand why these changes are important, both for their operations as well as benefits to society and the environment overall. Finally, such knowledge will facilitate on-going maintenance and revision of the Educational Modules.

The implementing organization should also have access to and rapport with a number of representative stakeholder groups. Channels of communication to farmers will be required for initial outreach and overall implementation and maintenance of the program. It is also important that the organization have access to regulatory agencies to serve as a conduit of information flow in several ways. Primarily, it will assist in linking farmers to state and federal financial and technical assistance. It can also be useful in keeping the Educational Modules up-to-date as regulatory priorities and state and federal laws change. Also, the implementing agencies can keep state agencies informed of program progress, if appropriate, with the goal of securing additional assistance and resources for farmers in the program. Despite this connection to regulatory agencies, it is essential that the farmers see the organization as an impartial intermediary that is "on their side." This is important to maintaining credibility with farmers in an environment in which regulatory agencies and their actions are sometimes viewed in a negative light.

GOAL SETTING

Prior to actual implementation, goals of the program must be established to ensure that implementation strategies are appropriate to achieving goal targets. The first step is to determine the program's ultimate aim, which could include general awareness-raising and farmer education, actual changes in management practices, assessment and reporting of farm

performance, or a combination thereof. While the Team expects that many farmers will be performing at a best practice level in some areas, there will likely be room for improvement. When changes need to be made, the Team recommends that goals be set around farmer improvements as well as assessment and reporting of those improvements in the context of the overall program. The reasoning is that these goals are measurable, which is important to evaluating success of the program. Also, achievement of these goals translates to concrete benefits to farmers, the environment, local communities and society in general. Assessing and communicating these results to other stakeholders can have the additional benefits of recognizing farmers for their efforts, improving community relations and the image of dairy farmers, attracting positive rewards such as additional state and federal funding and resources, and serving as positive advertising and public relations to encourage other farmers to participate in the program.

Farm Performance Goals

Goals around improving farmer performance should consider such factors as the degree of change expected, the number of farms achieving improvements, and timing of execution and measurement of expected changes.

- Degree of change: Given that the Educational Modules present levels of performance, goals should be organized around degree of improvement in performance. This improvement can be measured in absolute or relative terms both within Educational Modules and across modules. Absolute goals would specify farmers achieving a certain level (e.g. level "3") of performance across a number of questions within a module and/or across a number of different modules. Relative goals would measure discrete improvements, such as improving performance by one level for all questions within a module.

- Number of farms achieving change: Goals should also include the number of farms that can reasonably be expected to achieve desired changes. Again these goals can be set in absolute or relative terms. Absolute terms may be set according to a reasonable number that can be expected given the resources (both financial and human resources) of the program. Relative goals can also be set as a percentage of a larger farmer population that has been identified. Such populations can include members of the St. Albans Cooperative Young Cooperators group, all of St. Albans member farmers, or all dairy farmers within the state of Vermont. Population determination will likely depend on resources and connections of the implementing organization and corresponding accessibility of farmers.

- Overall timing: Both of the above goals must be set in the context of overall timing. Reasonable timing within which to achieve goals and measure success will be a function of the degree of expected change, timing to implement and maintain change, and number of farmers expected to improve practices. Timing goals should also be a function of expected resources of the implementing organization, in order to ensure that goals are appropriately 'stretch,' while also being achievable. It is expected that an initial measurement of program progress could take place three years from the start date.

Program Reporting Goals

At present, it is undetermined if individual farmer assessment results or overall program results will be communicated to outside stakeholders. If it is decided that this information will be shared, milestones for evaluation of 'success' can be set and used to drive assessment and communication planning. Given that changes to management practices will take time and may require a whole year or season, assessment and reporting should occur every few years, in order to be able to achieve and report large-scale, impactful changes.

Target audiences of this information could include the larger dairy farming community, government agencies and other programs (such as NGO's or universities) organized around sustainable dairy farming, and the larger Vermont community that can benefit from the improvements that are being made. To reach this large number of stakeholders, communication channels should vary from targeted to general. Targeted communications could come through specific farmer or community organizations, such as special interest groups or the St. Albans Cooperative, that already have on-going communication mechanisms, such as general meetings, newsletters or e-mail updates. This communication could take the form of articles or updates on achievements within these existing communication channels. General communications could be channeled through a program website and articles in local or statewide newspapers.

Timing of this communication should balance the goals of conveying significant updates and keeping stakeholders interested and engaged on a regular basis while not inundating them with information. Smaller program updates, in the form of a short article in one of the channels mentioned above, should be released perhaps every six months to keep interested parties updated on program highlights. Complete assessments of milestone goals should be released every two to three years, to allow adequate time for changes to farm practices. These larger assessments can encompass reporting on overall progress toward pre-set goals, specific examples on changes that took place along the way, and anticipated impact to the environment or community. Farmers may or may not want to be identified and it should be mutually agreed upon upfront as to whether farmer names are released in these communications.

IMPLEMENTATION RECOMMENDATIONS

Specific implementation logistics will depend in large part on the resources of the implementing organization and the goals that are set for the program. However, based on research and stakeholder input, the Team recommends some key elements that are believed to be integral to the success of the program.

Outreach and Farmer Selection

Overall, it appeared that farmers in our sample were aware of environmental and social issues and were open to the idea of making changes for the better, as long as their business did not suffer. However, the nature of their business is extremely time intensive, leaving them with little spare time for 'extra' activities. Also, dairy farming is a highly traditional business and farms and farming practices have been handed down for generations. As such, there is generally speaking a resistance to actual change among the dairy farmer population, despite good intentions. Because of these factors, the program should include a farmer

outreach component and provide adequate 'hands on' support for farmers to participate in the program and to evaluate and potentially change their management practices.

The first step in farmer engagement will be identifying potential participants from the target farmer population that is determined during goal setting. Depending on the target population, the mechanism for engagement will vary. For example, if the initial target farmer population is the St. Albans Young Cooperators group, participation could be solicited via the regular communications with the group, such as at a group meeting or through one of the weekly e-mails. On the other hand, if the target population is all dairy farmers in Vermont, farmers could be invited to participate via a mass mailing that describes the program. Given geographic considerations, potentially limited resources, and the potential need to 'work the bugs out' of the program in the first couple of years, our recommendation is to start with the Young Cooperators group. Because they have been involved in the development of the Educational Modules and are more familiar with the program, they may be more likely to agree to participate, thereby giving the program a strong start.

Once participants are secured, the program should be implemented with individualized attention. Farmers, with little free time, are generally inundated with programs offering similar information and training on improved practices and performance. According to representatives from St. Albans Coop and University of Vermont Extension, voluntary participation in these programs tends to be low, and it is therefore recommended that the implementing organization take a more individualized, "hands on" approach. Calling on farmers individually will minimize additional time and effort on their part, thereby increasing the chance that they will participate. These individual calls should occur upfront to introduce farmers to the program and Educational Modules and to set goals for their participation. Though the modules are designed to be 'stand alone' documents, on-going follow-up and maintenance, in the form of additional calls and visits to the farmers, will be required. This will ensure that farmers are making changes on an on-going basis, rather than finding out "too late" that they weren't able to implement the changes. Despite best intentions, farmers' intense schedules are such that continual follow up will be necessary to ensure that changes actually take place.

Financial Incentives

As mentioned above, farmers are generally open to the idea of improving their performance. However, these farmers are also under tremendous financial pressure to maintain a profitable business. This pressure is exacerbated by the fact that, to a certain extent, their success is dependent on factors somewhat beyond their control, such as inclement weather, pest infestations and milk prices. The farmers and other stakeholders who interact with farmers on a daily basis generally agreed that, in addition to outreach, financial incentives are also necessary for widespread adoption of the program.

The reasoning for financial incentives is several-fold. First, though farmers may ultimately benefit economically from changing their practices, it is often still the case that they will be unwilling to spend the time and effort to change without some sort of incentive upfront. Second, some practices require additional upfront costs that farmers may not have in their budgets. An example of this is cover crops, the seeds for which may cost in excess of $1000. Finally, some practices, such as reducing fertilizer levels, come with some measure of risk

(either real or simply as perceived by the farmer) that production levels or crop yields will suffer. As such, farmers will want guarantees that farm financials will not suffer as a consequence of altering management practices. This incentive can take the form of an upfront payment that the farmer receives regardless of outcome or an agreement to a sort of "insurance" payment that is paid only if production levels or crop yields do suffer. For any financial agreements, care should be taken to agree on terms, in writing, up front in order to set expectations and avoid communication gaps.

Unfortunately, funding for such programs can be hard to secure. As mentioned above, communication of the program results to government agencies or other stakeholders can raise awareness of the program, possibly resulting in some additional funding being channeled to these efforts. Also, members of the implementing organization may be able to help farmers secure existing government funding available for dairy farmers who take steps to improve environmental performance. Innovative ways to obtain funding through multi-stakeholder collaboration can also be designed. An example of this is the Environmental Quality Initiative Inc., a joint venture of the Chesapeake Bay Foundation, Pennsylvania State University, the Rodale Institute, the Pennsylvania Association for Sustainable Agriculture and the US EPA. This program used premium pricing for milk produced by farmers implementing environmentally friendly management practices. The five-cent premium per half gallon was paid by the consumer and went directly to participating farmers in order to encourage participation and offset any costs of adjusting their management practices. Out-of-the-box thinking and multi-stakeholder engagement may result in funding becoming available for the Vermont dairy farmer program.

Program Size

Because of the recommended 'hands on' nature of the program, geographic issues, and likely resource constraints of the implementing organization, the reach of the program, in terms of number of farms participating at any one time, may be limited at first. However, using a smaller sample group of farmers upfront will facilitate accomplishing sustainable change for those farmers as well as fine-tuning the Educational Modules and program overall. A smaller, more manageable group will allow for program adjustments to better suit farmer understanding and needs. Adjustments will also lead to efficiencies and best practices within the program so that in the future, a larger group of farmers can be served with the same or fewer resources. Starting with a smaller group may also increase the chances that the program is well-run and successful, thus encouraging other farmers to participate in the future.

UPDATING AND MAINTAINING THE MODULES

Over time, the modules will need to be updated to reflect best practices and more current information. Updates would be managed by the implementing agency and should occur annually. The following outlines methods for identifying appropriate modifications for each module.

Farmer Voice

Farmers should not only be utilizing the modules but also be part of the dynamic on-going refinement and improvement of the modules. Understanding and responding to farmer feedback on the modules and the program overall will allow for continual improvement and

increased user-friendliness of the modules. Also, as farmers are going through the process, they may learn of or devise new farming techniques or solutions for addressing the issues in the modules. It is important to capture this feedback and convey it to other participants. Making changes according to farmer feedback will increase their ownership of the program and facilitate commitment and buy-in.

To achieve these goals and to keep farmers engaged in and excited about the program, regular meetings should be arranged to bring participants together to discuss their experiences and share successes, suggestions and frustrations. These meetings should perhaps bi-annually, with one meeting each year serving as a more official feedback session.

It could also be useful to identify one or two farmers as 'champions' of the program, who would be willing to speak to other farmers about there participation and encourage other farmers to participate. This could assist with overall program management, adding to the program's credibility and encouraging word-of-mouth marketing and promotion.

Advisory Board

Participation of other stakeholders (in addition to the farmers), will be useful to on-going maintenance and promotion of the program. Advisory board members could include representatives of government, Vermont Natural Resources Conservation Service State and District Conservationists, university personnel, person's from industry (perhaps a Ben & Jerry's or Stonyfield representative) and representatives of feed and fertilizer companies.

Module Revision

As mentioned above, farmer feedback should be incorporated into the program, both informally and in more structured feedback sessions. Periodic assessments of the modules (every year or every other year) could take into account new university research findings (both within and outside of Vermont), new policies and regulations, or additional funding or technical assistance from government agencies. In addition to research and monitoring, more official feedback sessions can be held with the advisory board to benefit from their input and knowledge in this area.

XVI. APPLICATION TO OTHER PRODUCTS

INTRODUCTION

While this project focuses specifically on Vermont dairy, Ben & Jerry's requested the delineation of a generic process that could be used to develop indicators and modules for other agricultural inputs. This chapter describes the process for developing indicators for these other inputs.

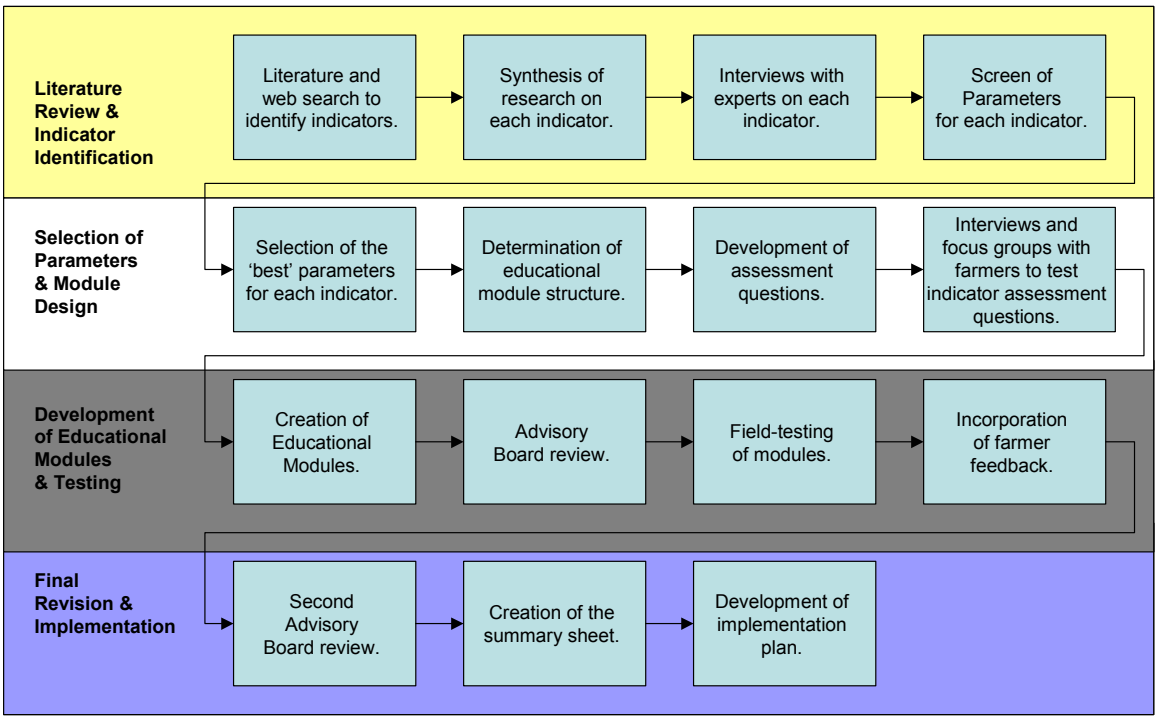
FOCUS ON VERMONT DAIRY

When considering expanding this project to additional agricultural inputs or geographical areas, the focus of this project needs to be recalled. While the initial list of indicators was created based on what constitutes "sustainable agriculture," the final indicators and Educational Modules were specifically developed for dairy farmers within Vermont. Areas of importance were determined based on practices specific to the product and region. There are different considerations when analyzing dairy farming in another region. For example, water scarcity and biodiversity are other issues that need to be addressed in different ways for Vermont, compared to either the Southwest or Great Plains of the US. Or when considering another agricultural input, Animal Welfare may not be a concern at all. Given the specificity of the indicators, Educational Modules developed here, and the learnings achieved during the process, the Team has outlined below a suggested methodology for developing similar indicators and modules for additional inputs and/or geographical areas.

REVIEW OF EXISTING METHODOLOGY

Figure 17 below is a flowchart of the methodology used for this project. While the results of this project are not directly transferable to other situations, the overall methodology is transferable. A modified version of this methodology is recommended for development of indicators and Educational Modules for other products based upon key learnings.

Figure 17: Methodology Process Map



KEY LEARNINGS

Throughout the project, the Team has identified key learnings that will improve future indicator and module development. Some learnings focus around additional steps to help with the process while others encourage earlier involvement of specific groups.

- **Identify program goals and scope early in process.** When developing the tool that will be used, it is helpful to understand the scenario in which it will be used and the specific goals of this program. Answers to these questions are critical when developing the structure of the module, as they will influence the format and type of questions that can be asked. For example, a program that is administered by a third party would use a very different tool than one that is expected to be completed by the farmer. Likewise, a program that is targeting 15 farms would be designed with different implementation considerations than a wide-scale program of all dairy farmers in the St. Albans Coop. The sooner goals and scope are identified, the better the tool can be targeted to the specific intent.

- **Engage stakeholders early in process.** By stakeholders, the Team refers to individuals or groups that are interested parties that may be affected by this project. For this project, key stakeholders include Ben & Jerry's, St. Albans Cooperative, the farmers, the implementation group, an academic group and potentially, a government-sponsored group, such as an Extension Service or a specific group within the USDA or EPA. Because these groups will either be impacted or impact others through the Educational Modules, it is critical to involve them early in this process. The earlier they are involved, the higher the chance of success for the project.

In addition to building the groundwork for the implementation phase, conversations with stakeholders can identify specific areas of concern. For example, the Western corn rootworm is of particular concern to dairy farmers in New England. In addition to learning about problem areas, early stakeholder engagement will help project coordinators to identify perceptions and attitudes that need to be addressed in the modules to be truly effective. Biodiversity was one area that was modified based on conversations with farmers and their disbelief that this is an issue in Vermont. While it is very important to hear the concerns of the stakeholder groups, especially the farmers, their feedback should be carefully considered and compared against academic research and expert opinions, as they may have biased interests. Such areas of controversy should have additional support within the module to provide compelling evidence to overcome farmers' hesitation. By becoming a part of the process and having their feedback incorporated and addressed, the farmers are more involved and more likely to be committed and willing to participate. As part of this process, conversations with stakeholders will also aid in developing a format for the tool in the most appropriate format given the users, their preferences, and the preferences of the implementing organization.

- **Identify implementing organization early in process.** Ideally, the organization that developments the tool is the same as the implementing organization. Unfortunately, this will not always be possible. In this case, it is critical to involve the implementing organization as soon as possible in the project. Again, having them be part of the process ensures their agreement and invested interest in the success of the program as well. Their involvement will also assist in the research of important issues surrounding the product and/or geographical region.

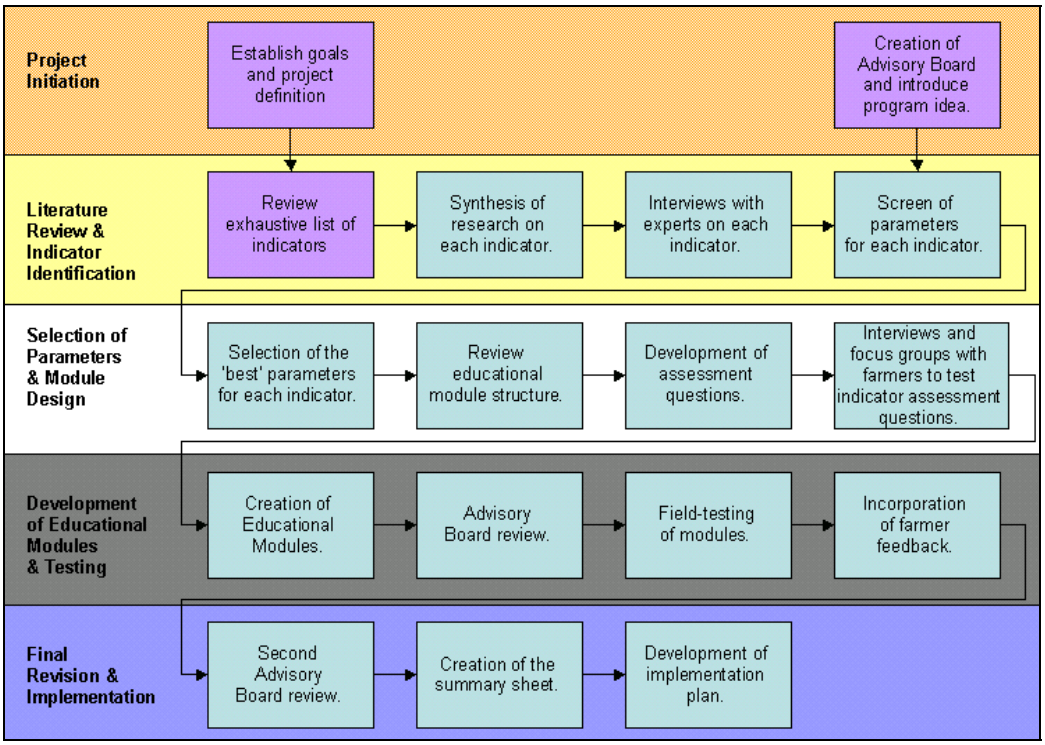
- **Discuss project with numerous experts throughout process.** Experts have the unique advantage of providing sources of information as well as specific areas of concern. Also, they may have a slightly different take on some of the areas of concern identified by the stakeholders. Conversations with stakeholders and multiple experts will lead to a well-rounded perspective of the topic area. Experts familiar with growing the product within the specific geographic area are a plus. Different programs, such as university extension programs or national organizations, which provide educational materials on relevant material, will frequently list experts, or experts may be authors of related articles. Experts are also often excited by the prospect of additional research and viewpoints on their respective areas of specialization.

- **Review existing programs/frameworks.** There is a tremendous amount of literature and guidance available. Governmental programs and extension programs through universities proved to be very helpful. Regulations and certification programs are also important sources of information as they convey baseline practices, while certifications highlight preferred practices that some farmers are already moving towards. Additionally, international standards can provide helpful information, as the government of other countries may require more stringent practices that can serve as helpful models. NGOs can also provide helpful information.

METHODOLOGY FOR OTHER PRODUCTS/GEOGRAPHICAL AREAS

Given these key lessons, a variation on this original methodology process map is proposed (Figure 18) to develop indicators and Educational Modules for other inputs.

Figure 18: Revised Methodology Process Map



The process map above contains minor changes that are highlighted above in yellow. All other steps should be followed as described in the original Methodology section. Additional details for each modified step are provided below:

Establish goals and objectives of program. As previously discussed in Key Learnings, the importance of establishing upfront goals and objectives of the end program was a key learning. By identifying and articulating the purpose of the program, the Team would be forced to communicate exactly what the end-goal is envisioned to be. It is often not until dialogue ensues those discrepancies, albeit, minor, may be discovered. Also, discussing end goals at the start of the project allows a better comparison of progress and results against expectations throughout the project. This would better enable the Team to ensure that the work matches expectations of the end deliverable. This criterion has been added as the first step when developing Educational Modules for other agricultural inputs or geographical regions.

Review extensive list of indicators. When identifying what indicators were most relevant for this project, the Team started with an extensive list and then focused on the most relevant for dairy farming in Vermont. This extensive list can be found in Appendix A and should be used as a starting place for additional module development. Later, the specific product and region can be used to prioritize and decide which identified indicators are most

relevant. While the Team feels that the majority of the ten indicators identified in this project will be relevant for most extensions of this project, reviewing indicator categories is beneficial as well. One indicator, Animal Welfare, may be irrelevant to produce and gain production, but the remaining indicators apply to all other products. Also, a few additional indicators that need to be added may be identified through research specific to the product/region in question. Specific research related to the importance of each indicator with respect to the new product or region will need to be conducted. Such research will enable the modules to highlight areas of major concern for the specific product or region.

Creation of Advisory Board and introduce program ideas. In order to begin building momentum around the program, the Team feels it would be instrumental to form the Advisory Board earlier in the process. While the primary role of the Advisory Board would still be to review questions and the modules, this initial conference should introduce the members to the project goals and allow for some immediate feedback from parties that will be more involved in the program itself. This up-front conversation could highlight key challenge areas, thereby providing additional time to address them as opposed to discovering them late in the process. In order for this group to be as effective as possible, it should include members from various stakeholder groups, especially farmers. Such stakeholder groups should include a variety of government, non-profit, academic, and corporate organizations in order to achieve a well-rounded vantage.

How to approach developing indicators and Educational Modules specific to strawberries.

The following provides an example of how this revised methodology would be applied to another product, strawberries. The steps outlined below illustrate some ways that the revised methodology varies from the original methodology in terms of key learnings and modified steps for application to another product or geographical region.

1. Goals and objectives of the project for sustainable strawberry production need to be addressed at the start of the project. How many strawberry farmers will be included in the study? What is the time frame? What will be the geographical area focus?

2. Once the goals and objectives have been identified, research should commence with the extensive list of indicators and parameters identified in Appendix A. Review these indicators and parameters, and research strawberry specific information for each. This research may yield different content or focus of modules. For example, water management, specifically water use, is a more important consideration for this specific product, as growing strawberries are water-intensive.[424] Also, the Pest Management module might include a discussion on the benefits of switching from using methyl bromide[425] to chloropicrin as a fumigant.[426]

3. Stakeholders of the strawberry growing industry should be identified and engaged early in the process. The Team would expect strawberry farmers in California to be a key group, as

California farmers grow 75% of the fresh strawberries and 80% of the processed strawberries for the US.[427] If Ben & Jerry's purchases strawberries from a more local source, research should shift to concerns and practices within that specific area. Once the appropriate farming group is identified, discussions regarding practices, concerns, and areas of change should be discussed. This will help the Team understand topics that should be addressed as well as ways for implementing change once best practices have been identified. In addition to the farmers, strawberry processors that purchase strawberries from the growers and then sell strawberry product to Ben & Jerry's, would also be included. The strawberry producers are equivalent to the St. Albans Cooperative Creamery in the dairy example.

4. Locate and interview multiple experts. Searching for programs focused around the production of strawberries on the web, a number of different organizations and related research are quickly identified. By investigating potential sources, potential experts are identified. Dr. Marvin Pritts, Horticulturist of Cornell University, David Handley, Extension Horticulturist from the University of Maine, and Holly Bourne and Martin Guerena of ATTRA[428] are all potential experts that should be consulted. Again, these experts can provide valuable information in terms of concerns associated with growing strawberries as well as initiatives currently underway. While the farmers provide the "on-the ground" expertise, these experts can provide more of the scientific or academic background.

5. Lastly, there are a number of programs that should be researched. These programs can be the programs that the experts are affiliated with, or additional programs. The North American Strawberry Growers Association[429] could be a good starting place as well as The University of California Cooperative Extension, Santa Barbara County.[430] The Food Alliance has a certification program that is applicable to strawberry growing and ATTRA also has a Horticulture Production Guide specific to strawberries.[431]

6. Once the above steps have been taken to complete targeted research, the further efforts to refine indicators and parameters and develop Educational Modules can be done using the same methodology as the present project.

XVII. CONCLUSION

This project has identified a large universe of indicators for sustainable agriculture and developed a methodology by which these indicators were pared down to those most appropriate to both measure and improve dairy farm performance in Vermont. The results of this work include the following:

- Identification of ten indicators for evaluating environmental, social and economic performance of dairy farmers;
- Identification of parameters within the ten indicators, to measure indicator performance specifically relating to dairy farming practices and economic, environmental and social conditions within Vermont;
- Creation of expert-reviewed and farm-tested Educational Modules for Vermont dairy farmers to use to 1) better understand the key indicators for and measures of sustainable dairy farming, 2) assess their performance against benchmarks of "best practice," and 3) improve, if needed, existing management practices to enhance on-farm performance;
- Development of a methodology to evaluate the "sustainability" of agricultural inputs that Ben & Jerry's can apply to other ingredients in the future; and
- Recommendations for an implementation program that would focus on farmer use of the ten modules, direct revision of the modules on a periodic basis, and report outcomes with respect to overall program goals.

Key learnings that will facilitate the success of future projects largely center on goal setting and stakeholder engagement. In developing similar projects, specific goal setting at the outset is critical to ensure that the final product is an appropriate tool for achieving the desired goals. Developing specific goals can also help in early identification of all relevant stakeholders, facilitating early engagement, and increasing the likelihood of their commitment to the project. Multi-stakeholder engagement is critical and should include the target audience (end-users of Educational Modules), representatives of the organization that will be implementing the final program, and representatives of governmental, academic or NGO organizations devoted to similar goals and objectives. This can maximize collaboration and minimize duplicate work or "reinventing the wheel."

While the design of a useful program is a first important step, it does not solve the ever-present issue of sufficient resources and funding to ensure successful execution by the farmer or the implementing organization. As a result, the Team recommends two additional areas for future research:

1. The first is the investigation of grants or other funding available for a program such as this one. The source of this funding could include federal aid, foundation grants, or charitable donations and could be applied to the implementing organization or to assisting farmers with any costs of making changes on the farm.
2. Second, future research efforts should focus on quantifying potential economic benefits that farmers can reap by altering specific management practices. While the Team found occasional examples of such quantification, they were relatively few in occurrence and often not of significant magnitude or credibility to convince farmers of the benefits. The development of case studies that profile significant environmental and/or social gains combined with economic savings are one way to

demonstrate to farmers that implementing sustainable dairy projects is beneficial. In this way, increasing research, documentation, and communication of such quantifiable benefits can increase interest in and adoption of corresponding farm practices.

Moving forward, the Team anticipates that the Educational Modules will serve as the basis for a successful, dynamic program that inspires farmers to improve their on-farm processes environmentally, socially and economically. Moreover, it is hoped that the benefits achieved through this program may be applied to other products in different geographic regions over time, resulting in an overall improvement on farms, in communities, and for the environment.

APPENDICES

APPENDIX A: LITERATURE SEARCH SPREADSHEET

The Appendix includes the results of the team's initial literature review. The search included a review of web-based academic, governmental, and non-profit agriculture programs (focusing on both traditional and 'sustainable' dairy and agriculture management), best practices, and publication reference lists. The findings from this search are organized using the following structure:

- Column 1: Category. Each entry was first classified under a sustainable development category: economic, environmental, or social;
- Column 2: Indicator. Each entry was then assigned to an indicator category for sustainable dairy farming (per the chart above);
- Column 3: Sub-Indicator. Each entry was next organized into a sub-indicator category (in order to sort the parameters into major topics under each indicator); and
- Column 4: Parameter. Finally, each parameter was listed and defined the specific metrics that could be used to assess farm performance for a given indicator category.

It is important to note that this search was not limited to a particular region of the world; therefore the identified indicators and parameters portray a wide array of measures used at the global, national, and regional level to assess sustainable dairy farming. The list also includes measures for practices related to cropping, since many dairy farms also raise their own feed or cash crops. Therefore, this list may be used to create Educational Modules for other products.

Article Reference List

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A1	Introduction	www.nhg.nres.usda.gov/BCS/agecol/agecol.html		govn't	lists criteria for selecting indicators. Provides indicator selection model - think may be good visual to explain process.	general ag		looks at them based on their affect on the ecosystem: 1. System processes (precipitation caught, stored, used; chemicals used; CF & incentives timely); 2. Recovery process (recovery time allowed for system from stress; …; human and animal health concerns)	1994			B	USDA
A2	A Conceptual Model and Indicators for Assessing the Ecological Condition of Ag Lands			journal	determining how to reach sust at the agroecosystem scale	havested herbaceous crops		yes - Productivity (crop yeild, soil quality) Mgmt at agroecosystem scale - crop rotation and use of integrated pest mgmt practices Ant diversity Mgmt for landscape scale (crop diversity, nitrogen subsidy index, pesticide leaching, wildlife habitat quali	2000			B	J. Environ. Qual.
A3	A framework for integrated biophysical and economic land use analysis at different scales			journal	pg 62 lists some potential indicators at theoretical level	general ag		theoretical level: Biophysical - crop, forest and pasture characteristics (yield potential, nutrient concentrations); management characteristeristics of crops, forests, and pastures, weather data, land characteristics, soil properties, attribute data GIS	1999			B-	Elsevier Science
A4	A generalized enviromental sustainability index for ag systems			journal	design and development of Enviro sust index (ESI)	case study on corn and wheat	US	no - gives framework	1999			B	Elsevier Science

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A5	A Life Cycle Approach to Sustainable Ag Indicators			private individuals?	provide numbers regarding their dairy farming in Wisconsin, and break out by overall, and 3 legs - good to see #'s to begin to get a feel for a real dairy farm	dairy	Wisconsin - but think can be generalized	no	b/f 1999			A-	Wayne & Kay Craig, Wisconsin
A6	A Life Cycle Approach to Sustainable Agriculture Indicators.	http://css.snre.umich.edu/css_doc/Proceedings.PDF		Css	identifies trends and potential indicators - id'd thru brainstorming session	general ag w/ dairy	case study in Wisc & MI	yes - for dairy (pg 57); Econ - ROI, exit/entry ration, flexibility of the prdctn system, & by-prdt utilization Social - consumer's willingness to pay for sust prdts, social equity/community inclusion of ag, quality of life for farming families, share of disposible income of consumers spent on food Enviro - use of renewable resources compared to total resource use, tons of soil erosion per unit of production, earthworm and microbial activity per acre, share of open-pollinated plants relative to hybrid and genetically modified varieties, balance btwn # of animals on the land & ability of land to use nutrients	February 26-27, 1999			A	CSS
A7	A total system approach to sustainable pesticides management			govn't & University	change reliance on pesticides	general ag	no	no	1997			C+	Proc. Natl. Acad. Sci.

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A8	American Farms	www.usda.gov:80/news/pubs/fbook00/factbook2000.pdf		govn't	Farms - breaks out small scale farms. what makes them successful, what are their demographics,	general ag	US	no	2000			B-	USDA
A9	An input/output methodology to evaluate farms as sustainable agroecosystems: an application of indicators to farms in central italy	www.elsevier.com/locate/agee		journal	systems approach to evaluating sust farm	general ag	central italy	yes - but very much systems approach - not very applicable	Jul-99			B+	Elsevier Science
A11	Assessing the sustainability of the US food system: a life cycle perspective	ScienceDirect	Heller	journal		general ag	US	Yes - long list				A	UM research
A10	Assessment of the Condition of Ag Lands in Six Mid-Atlantic states			journal	evaluate ag of 6 states; used indicators - more theoretical though	general ag	US - Mid-Atlantic	yes - based off of "A Conceptual Model and Indicators for Assessing the Ecological Condition of Ag Lands", as listed above	2000			B-	J. Environ. Qual.
A12	Changes in soil chemical properties resulting from organic and low-input farming practices			journal	comparing conventional with organic farming	general ag		no	1998			B-	Agronomy Journal

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A13	Chemical and Pesticides Results measures			group	indepth info on pesticides - type, etc. Also provides figures for organic farms,	general ag		no	2001			C	EPA, Office of Prevention, Pesticides and Toxic sutstances (OPPTS), and Prgm for Enviro Policy and Planning systems (PEPPS), …
A14	Conservation Reserve Program			govn't	prgm to encourage farmers to plant LT resource conserving covers to improve soil, water and wildlife resources	general ag	US	no	1997			B	USDA, Farm Service Agency (FSA)
A15	Consortium for Sustainable Agriculture Research and Education (pamphlet)	www.csare.org			helpful in id'ing other organizations/schools					U of IL Sustainable Ag Prgm, WSU Center for Sustaining Ag & Natural Resources, Umass Extension, Uof ME Extension, U of NH Extension, Michael Fields Ag Institute, New England Small Farms Institute		B-	CSARE
A16	Dairy farm thrives with manure composting			journal	composting of manure	dairy		no	1998			B+	BioCycle

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A17	Denitrification from soils of a year-round forage production system fertilized with liquid dairy manure			journal	manure handling for diary production	dairy productio n		no	1998			B+	Journal of Environmental Quality
A18	Do GM Crops Mean less Pesticide Use?			journal	thoughts on GM vs pesticides	general ag - uses Bt corn and cotton and soybeans as examples	US	no	2001			C	The Royal Society of Chemistry ; Charles Benbrook
A19	Ecological Indicators for the Nation (book summary)	www.nap.edu		govn't, NGO, academic	framework for indicator selection - with more policy oriented slant	general ag	US	w/in book, but not in summary	?			B	National Research Council
A20	Environmental and Economic Cost of Siol Erosion and Conservation Benefits			journal	Erosion backgrnd, factors influencing it, and control technologies	general ag	US	no	1995			C+	Science
A21	Environmental benefits and economic costs of manure incorporation on dairy waste application fields	Osei, Gassman, Hauck											

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A22	Environmental Indicators for Agriculture; Methods and Results; Executive Summary	www.oecd.org/agr/env/indicators.htm		NGO	objectives: 1. Review and see progress in developing indicators across OECD countries; 2. Build on earlier work…4. Highlight linkages btwn indicators, 5. Outline limitations an challenges for FUTURE indicator development	general ag	OECD countries - europe?	yes; I. Ag in broader econ,social and enviro context - contextual info and indicators and famr financial resources II. Farm Mgmt and Enviro - Farm mgmt (whole farm, nutrient, pest, soil and land mgmt, and irrigatn and H20 mgmt) III. Use of farm inputs and	2000			A	Organisation for Economic Co-operation and Development (OECD)
A23	Environmental Life Cycle assessment (LCA) of Swedish Semi-hard cheese	ScienceDirect	Berlin	Govt./Academic	LCA of cheese in Sweden	diary/cheese	Sweden/EU	sort of (can be extrapolated from data)	2002	Food Chain 21 research project to investigate env. Consequences of Swedish dairy projects		B	Chalmers U. of Technology, Swedish Institute for Food and Biotech.
A24	Estimated Use of Water in the US in 1995	http://water.usgs.gov/watuse/pdf1995/html		govn't	how much water is used by farming	general ag	US	no	1995				USGS
A25	Farm Resources, income, and expenses				# of workers on farm, and labor rates for different areas w/in US	labor		no	1998			C+	? Random pages w/o reference
A26	Farm Sustainability evaluation: methodology and practice			journal	provides guidance on overall ranking, and also how to "score" on quantitative items	general ag		no	1999			A-	Elsevier Science

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A27	Findings from the National Agricultural Workers Survey (NAWS) 1997-1998			govn't	demographic and employment profile of US farmworkers	labor		no	2000			B	USDOL
A28	Frontiers of Sustainability: Environmentally Sound agriculture, forestry, transportation, and power production			NGO	general overview, includes factors of sustainability and recommendations for action	general ag		? Think book at the grad library				C	WRI
A29	Growing Carbon: A new crop that helps agricultural producers and the climate too	www.swcs.org		govn't, NGO	How Ag producers can reduce GHG emissions and increase carbon storage	general ag	US	no				B	USDA's NRCS, EDF, Soil and Water Conservation Society
A30	High-cost Fertilizer May Result in Better Use of Animal Wastes			academic	discusses benefits/costs of using manure vs. commercial fertilizer on crops	general ag	Michigan	no	2001			C	MSU
A31	Highlights from Current Agricultural issues: risk, organic crops, and biotechnology crops	www.usda.gov:80/news/pubs/fbook00/factbook2000.pdf		govn't	Farms - organic	general ag	US	no, but discusses use of pesticides (w/ gmo's) and organic	2000	Economic Research Service, USDA		B-	USDA
A32	how much would increasing the minimum wage affect food prices	www.ers.usda.gov		govn't	affects of changing using min wage on food prices	labor		no	May-00			B	USDA, ERS - Current Issues in Economics of Food Markets

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A60	Indicators of resource use and environemntal impact for use in a decision aid for Danish livestock farmers	scienceDirect	Halberg	Govt.	Danish Institute of Ag. Sciences, Department of Agricultural Systems	livestock	Denmark	Paper covers indicators, data collection strategies, environmental impact information, farmers decisions and effects of decisions/ability to influence results	1998	OECD Environemental Indicators for Ag, 1997; Ethical Accounting: Jensen & Sorensen, 1998	GREAT	A	Danish Institute of Ag. Sciences, Department of Agricultural Systems
A33	Indicators of Sustainability in Whole-Farm Planning : Literature Review			academic	cites current literature relating to indicators of sust and whole farm planning	general ag		no	1990 - 1996 review	good list of potential references - but a bit old		B-	KA Sustainable Ag Series, Paper #2
A34	Is Agricultural Sustainability a Useful Concept?	peak.umdl.umich.edu (?)		journal	general view of sustainability. Good contrast btwn conventional and sust ag (table 2), briefly mentions indicators suggested by others	general ag			1995			B	Elsevier Science
A35	Is milk responsible for male reproductive disorders?	Ganmaa, Wang, Qin			Effects of estrogen from dairy on male reproductive problems								
A36	Land Degradation: Effects on Food and Energy Resources			journal	background on state of soil erosion; how much soil lost assoc w/ crops in different regions	general ag - breaks out #'s by corn, cotton, wheat, grass and forest	US	no	1976			B-	Science

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A37	Life Cycle Based Indicators for Sustainable Agriculture	css website (is listed as prjt, unsure how we find write-up)			This report presents a broad set of indicators covering the life cycle stages of the food system. Indicators address economic, social, and environmental aspects of each life cycle stage: origin of (genetic) resource, agricultural growing and production, food processing, packaging and distribution, preparation and consumption, and end of life.				1997 - 1999				National Pollution Prevention Center, United States Environmental Protection Agency
A38	Life Cycle-Based Sustainability Indicators for Assessment of the U.S. Food System	http://css.snre.umich.edu/css_doc/CSS00-04.pdf		Css	evaluating total life cycle for US food system	general ag		yes - matrix that Greg showed us during a mtg	2000		limited section on topic. Rest outside of scope	B+	Martin C. Heller, Gregory A. Keoleian

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A39	Measuring Community Success and Sustainability; An Interactive Workbook			group	Offers practical way (thru id'd indicators) to measure progress towards sustainability for rural community.	rural communit y		TONS listed, but not helpful in indicator selection. However, could provide good pratical ways to measure some things.	1999			B-	North Central Regional Center for Rural Development, along with USDA Forest Service, Social Sciences Institute of the Natural Resources Conservation Service
A40	Multicriteria analysis applied to the sustainable ag problem			journal	high level overview of 3 leg approach with ag. Leverage main cat's and references?	general ag	Brazil	main cat's that they fit into	2001			B	Int. J. Sustain. Dev. World Ecol
A41	National Summary of Water Quality Conditions	http://www.epa.gov/OW/resources/9698/sec_one.pdf		govn't	highlights what causes pollution w/in water (lakes, streams, etc.) - farming is #1 pollutor!	general ag	US	no	1996			C+	EPA
A42	Organic Farming, Seeking the Mainstream			newspaper		general ag	international, primarily focused on US	no	2000			B-	NY Times, April 9, 2000
A43	Performance Indicators for Sustainable Agriculture			NGO	has case study with indicators and metrics/rankings	general ag	SE Asia Case study	yes	Oct-98			B+	The World Bank

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A44	Principles of Agricultural Sustainability	www.umass.edu/umext/directory/jgerber/principl.htm		? Industry leader?	5 points of sust ag: 1. Renewable/reycle resources, 2. Protect natural systems, 3. Improve QOL of individuals/communities, 4. Profitable, 5. Interested in LT good of all members of land community (biodiversity)	general ag		no	1990			C	John Gerber
A45	Prioritizing greenhouse gas emission mitigation measures for agriculture	www.elsevier.com/locate/asgy		academic	discusses sources of GHG from ag	general ag	no	no	2000			C	Elsevier Science & Agricultural Systems
A46	Profile of Hired Farmworkers			govn't	demographics of farm workers	labor		no	1996			B-	USDA, Economic Research Service (ERS)
A47	Soil Fertility and Biodiversity in Organic Farming	www.sciencemag.org		academic	looks at organic vs conventional farming. Very science-based.	winter wheat grain, potato tuber, and grass-clover	Central Europe	no	2002			C	Science magazine

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A48	Standards, technology, institutions and economics of organic farming in the USA			academic	organic farming compared to conventional; soil, pesticides, marketing & brief certification history	general ag	US	no	1998				George Bird & John Fisk, MSU
A49	Sustainable agriculture and conservation tillage: managing the contradictions			journal	examining conservation tillage and is it sustainable?	general ag		no	1998			C+	The Canadian Review of Sociology and Anthropology
A50	Sustainable Agriculture: Defininitions and Terms	www.nal.usda.gov/afsic/AFSIC_pubs/srb9902.htr		govn't	ecological, economic and social concerns, impact on heath and indicators (as listed in TOC, but not printed out - ck web-site)	general ag		potentially - on web-site (which doesn't work anymore)	Sep-99			B+	USDA, National Ag Library (NAL)
A51	Sustainable Crop Production: Definition and Methodological approach for assessing and implmenting sustainability			journal	sets stage and framework for developing indicators	crop productio n		no - gives framework	1999			B+	Crop Science
A52	Sustainable Development in Ag Indicators, Agri-Environmental Programme and Demonstrations			nonprofit	exam sust development in ag. Provide framework for developing indicators	general ag	Finland as example	Developed idicators, looking at 1. Material flows, 2. Nutrient balances, 3. Life cycle analysis, 4. Landscape diversity, and 5. Socio - eco, and 6. Socio cultural.	2000			B	MTT, Ag Research Centre of Finland, Resource Mgmt Research

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A53	The Indicator explosion: local needs and international challenges	www.elsevier.com/locate/agee		academic	discusses difficulty of creating indicators that apply to local but can be used internationally (folder only contains preface to article, w/ note that this issue has a number of ag indicator articles)	general ag	no	no	2001	look up issue as supposedly has number of ag indicator articles		B	Elsevier Science & Ag Ecosystems & Environment
A54	The Multiple Functions and Benefits of Small Farm Ag			nonprofit	examines small vs large farms	general ag	no	no	1999			C+	Food First; Institute for Food and Development Policy
A55	The rapid emergence of genetic modification in world agriculture: contested risks and benefits			journal	id risks and benefits of GMO's	general ag	no	no	2001			B-	Environmental Conservation
A56	Trends in the Potential for Nutrient Loading from Confined Livestock Operations			group	analyzes dairy livestock affects and then questions how to reintegrate nutrients from manure	dairy ag/ livestock	North america	no	1999			B+	NRCS/USDA

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A57	Troubled Times Amid Commercial Success for Roundup Ready Soybeans			academic	herbicide use on soy beans - the affects	soy bean	US	no	2001			C-	Dr Charles M. Benbrook, Northwest Science and Environmental Policy Center, Sandpoint, Idaho
A58	Welfare of Farm Animals a Growing concern	www.cast-science.org/anwb_nr.htn			defining humane treatment of animals	livestock		no	1997			B	Council for Agricultural Science (CAST) & Technology News Release
A59	Wisconsin Dairy Grazing Profitability Analysis			nonprofit	analyzes what affects profitability of dairy farmer	dairy	Wisconsin - but think can be generalized	no	1999			B	U.W. Center for Dairy Profitability, by Tom Kriegel
A60	Carey to fill in												
A61	Response-Inducing Sustainability Evaluation at the Farm Level			academic	easy instrument for the assessment of the sustainability of farms and a tools for the comparative evaluation and planning of farms or farming sectors!!!!	dairy	no	yes	?			A+++	Fritz Hani, Thomas Keller, Harald Menzi
A62	Colworth Farm Project: Experimental Design and Strategy 2002-03			corporate	Measure impact of farm practices, assess biodiversity, economic consequences	general ag	England	yes	2002			B	

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A63	Sustainable Farming Systems: Demonstrating Environmental and Economic Performance	http://www.misa.umn.edu/publications/SFSreport.pdf	MISA (Minnesota Institute for Sustainable Agriculture)	group	environmentally sound farming alternatives that improve profitability	general ag	Minnesota	yes	2001			A	Mullan, Caitrin. Ed. Minnesota Institute for Sustainable Ag
A64	The Changing Landscape of US Milk Production	www.ers.usda.gov		government	History of milk production	dairy history						A	
A65	Land stewardship practices on the Krusenbaum organic dairy farm	www.wisc.edu/cias/pubs/brief/017.html		academic				no				B	
A66	Expected economic effects of BST in the Netherlands			academic	Dairy and BST	dairy		no	2002			?	Gisen, G.W.J.
A67	Sustainability of different dairy farming systems			academic	PhD student looking at trade-offs between economic, social, and ecological sustainability	dairy			2000-2004	Research Institute for Animal Husbandry			Klaas Jan van Calker
A68	Dairy Farm Sustainability Checksheet	www.attra.ncat.org		group	Appropriate Technology Transfer for Rural Areas	dairy	USA					A+++	
A69	A Life Cycle Approach to Sustainable Ag Indicators	http://css.snre.umich.edu/css_doc/Proceedings.PDF		academic		dairy, fruit, grain, pork	USA	yes					

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A70	Life cycle assessment of milk production - a comparison of conventional and organic farming	ScienceDirect	Cederberg	Govt./Academic	LCA of conventional v. organic milk production in Sweden	dairy	Sweden/EU	sort of (can be extrapolated from data)	1999	- EU Common Ag policy: provides financial support for sust. Ag - KRAV: Sweden;s env. Labelling system for organic milk	- VERY good coverage of issues/trade-offs with organic v. conventional - STANK: computer program from National Board of Agriculture for contents of plant nutrients in products (feed, fertilizers, milk, etc.)	A	Goteborg University, Swedish Institute for Food & Biotechnology
A71	Life cycle assessment of cleaning-in-place processes in diaries	ScienceDirect	Eide	Govt.	LCA of different ways to clean dairy processing equipment	diary	Sweden/EU	sort of (can be extrapolated from data)	2001	TINE Norweigian Diaries	Good coverage of different issue than I've seen	A	TINE Norweigian Diaries, Swedish Institute for Food & Biotechnology

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A72	Sustainable agriculture: how to sustain a production system in a changing environment	ScienceDirect	Wagner	govt.	Random assortment of ag issues	general ag	US	No	1997	Integrated Animal Product Systems program, Sustainable Ag. Research & Ed. Program	Seemingly random assortment of ag issues without deep coverage of any of them	C	USDA
A73	Environmental performance indicators (EPIs) for nitrogen	ScienceDirect	Hanegraaf	govt.	Environmental performance indicators (EPIs) for nitrogen AT THE FARM LEVEL	general ag & dairy	Netherlands	yes, nitrogen only, farm level	1998	Centre for Agriculture and Environment, Netherlands	FARM LEVEL	A	Centre for Agriculture and Environment, Netherlands
A74	Organic Livestock farming: A critical review	ScienceDirect	Sundrum	academic	overview of organic livestock farming	dairy	Germany	sort of (can be extrapolated from data)	1999	EEC-Regulation 1804/1999: standard for organic labeling in EU countries - EEC Council Directives on protection of farm animals	Good info on organic	A	University of Kassel
A75	Energy and Emergy Analysis of Meat & Dairy production in intensive, extensive & biological systems	ScienceDirect	Serrano	academic	Energy accounting: traditional energy and energy from sun	dairy/meat	Portugal	No	??		Weird, irrelevant and confusing	F	Instituto Superior Tecnico

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A76	Alternative rates of structural change in Norwegian dairy farming: impacts on costs of production and rural employment	ScienceDirect	Flaten	NGO/govt.	How farm structure and size affects social costs of milk production (true monetary costs, labor hours, unemployment, etc.)	Dairy	Norway	No	2002		Talks about actual monetary costs of dairy farming, some discussion of impacts of employment losses; very socially/economically oriented	C	Norwegian Agricultural Economics Research Institute
A77	Multiple job holdings among dairy farm families in New York And Ontario	ScienceDirect	Weersink	University	Looks at reasons that farmers/spouses seek employment off farms	Dairy	NY/Ontario	sort of (can be extrapolated from data)	1997		Social and economic information (though not much) - more just ideas for indicators	C	

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A78	Animal health problems in organic farming: subjective and objective assessments and farmers' actions	ScienceDirect	Cabaret	Govt./NGO? ?	Health issues of cattle with organic farming and ability of farmers to control health effects	Animal/livestock		sort of (can be extrapolated from data)	?			C	INRA BASE, Ecology & Genetics of Parasites
A79	Procedures to improve scope definition and inventory analysis in LCAs of farming systems	Keoleian Conference Abstract	*Hayo M. G. van der Werf and Claudine Basset-Mens*		We identify three methodological weaknesses in Life Cycle Assessments of farming systems.	Farming						C	

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A80	A new land use impact assessment method for LCA: theoretical fundaments and field validation	Keoleian Conference Abstract	Bart MUYS and Juan GARCIA QUIJANO		In order to measure the impact, the distance from the site specific maximum ecosystem performance in exergy terms is measured using 17 quantitative indicators and aggregated into five thematic scores: the indicator scores for ecosystem biomass and structure and for biodiversity are quantifying the land use impact on the ecosystem exergy level, while the indicator scores for water and for soil and nutrients are quantifying the land use impact on ecosystem buffering capacity for exergy fluxes. Thematic scores are finally multiplied by the time*space needed for the production of the functional unit.	Farming						B	

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A81	Life Cycle Assessment of Milk production and processing in Galicia (Spain)	Keoleian Conference Abstract	Hospido, A., Moreira, M.T. and Feijoo, G.									A	
A82	Quantitative risk assessment at the farm		E-mail: marc.vissesr@nizo.nl									A	
A83	Operation specific engine load pattern and emission data from vehicles used in typical agricultural operations	Keoleian Conference Abstract	M. Lindgren[1]; O. Pettersson[2]; O. Norén[2]; P.-A. Hansson[1; 1] Department of Agricultural Engineering, Swedish Institute of Agricultural and Environmental Engineering. Uppsala, Sweden;										

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A84	LCA of Animal Products from Different Housing Systems: Relevance of Infrastructure and Energy Use	Keoleian Conference Abstract	\		We compared two housing systems for dairy cows (tied housing / loose housing with litter and exercise yard) and two systems for fattening pigs (slatted floors / systems with straw bedding and exercise yard). Special attention was paid to energy consumption, demand for buildings and installations, and air emissions. In addition to the environmental aspects, animal health, product quality, working conditions, and economic aspects were also investigated. This made a sustainability assessment possible and allowed for the definition of measures that have a high potential for implementation.								

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A85	Comparison of LCA, ecological footprint analysis, and nutrient balance approach	Keoleian Conference Abstract	Imke J.M. de Boer and Daphne Bras		The aim of this article is to determine prospects and constraints of NB, EFP and LCA at commercial agricultural farms. This aim was illustrated by assessing the environmental impact of eight commercial organic dairy farms using NB, EFP, and LCA. Each method yields different environmental indicators.								

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A86	Regional water balance: a new impact category for LCA	Keoleian Conference Abstract	Griet Heuvelmans[(1)(2)], Bart Muys[(1)] and Jan Feyen[(1)], griet.heuvelmans@agr.kuleuven.ac.be		This paper proposes the use of the outputs of the regional water balance as criteria to quantify the impact on water quantity in agricultural and forestry activities. Water quantity aspects are currently handled in two input related impact categories: abiotic resource depletion and land use.								
A87	"The ecological role of biodiversity in agroecosystems." *Agriculture, Ecosystems and Environment 74* (1999) 19-31.	Scient Direct	Altieri, Miguel.		Agroecology		Global						
A88	Monitoring sustainable agriculture with conventional financial data	http://www.landstewardshipproject.org/mtb/monitoring.pdf	Levins, Dick.		Paper on how to use tax data to assess social and environmental performance								
A89	Milk production costs in 2001 on selected Wisconsin dairy farms	http://cdp.wisc.edu/pdf/cop2001.pdf	Frank, Gary.		Paper on milk production cost trends in Wisconsin								

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A90	Growing for the Future II: Unilever and Sustainable Agriculture		Unilever		SD report								
A91	Financial Guidelines for Agricultural Producers. Revised, December 1997.	http://agmarketing.extension.psu.edu/Business/PDFs/FinGuidAgProd.pdf	Farm Financial Standards Council.		Ag industry financial standards								
A92	Sustainable Agriculture: Making Money, Making Sense	http://www.iatp.org/enviroObs/library/uploadedfiles/Sustainable_Agriculture_-_Making_Money_Making_.pdf	Corslius, Kristen	nonprofit	Institute for Agriculture and Trade Policy publication on sustainable ag								
A93	Analyzing the Profitability of Your Operation	http://www.centrec.com/resources.htm	Doehring, Todd	Consulting company	explanation of profitabililty								
A94	Analyzing the Efficiency of Your Operation	http://www.centrec.com/resources.htm	Doehring, Todd	Consulting company	Explanation of efficiency								
A95	Alterantive rate of structural change in Norwegian dairy farming: impacts on costs of production and rural employment	Journal of Rural Studies	Flaten, Ola										

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A96	The Great Agricultural Transition: Crisis, Change, and Social Consequences of Twentieth Century US Farming	Annual Review of Sociology	Lobao, Linda										
A97	On-farm management of crop diversity: an introductory bibliography	ODI	Long, Joanee										
A98	Recent growth patterns in the US Organic Foods Market		Dimitri, Carolyn	government									
A99	Environmental impact assessment of conventional and organic milk production	Livestock Production Science	de Boer, Imke J.M.										
A100	Animal health and welfare in organic livestock production in Europe: current state and future challenges	Livestock Production Science	Hovi, M.										
A101	Heifer International Animal Welfare Guidelines	From Ann Wells, ATTRA	Heifer International	nonprofit									
A102	An Overview of Current Dairy Welfare Concerns from the North American Perspective	http://www.nal.usda.gov/awic/pubs/dairy/overview.htm	Morrow, Julie, PhD	government									

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A103	Effects of Dairy Cattle Breeding and Production Methods on Animal Welfare	http://www.nal.usda.gov/awic/pubs/dairy/effects.htm	Broom, Donald M, PhD	government									
A104	Research on animal health and welfare in organic farming –a literature review	Livestock Production Science	Lund, Vonne										
A105	Report on the Welfare of Dairy Cattle by Farm Animal Welfare Council (UK) (FAWC)	http://www.fawc.org.uk/reports/dairycow/dcowr079.htm	FAWC										
A106	Our Water is Running Out	http://www.healthy-communications.com/waterrunningout.html>.	Rothfeder, Jeffrey	Boston Globe									
A107	Water Predicament haunts global agricultural activities	http://www.planets-voice.org/_interface/news.shtml?x=504	Onyango, Emmanuel	Planet's voice									
A108	Water Resources of New Hampshire and Vermont, New Hampshire Bedrock Aquifer Assessment	http://nh.water.usgs.gov/CurrentProjects/bedrock.htm	USGS Homepage	government									
A109	Guidelines for Manure Application and Water Quality	Provided by Bill Jokela, UVM	Bill Jokela	academic	Guide on phosphorus applications based on VT Phosphorus Index								

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A110	The Phosphorus Index: A Tool for Management of Agricultural Phosphorus in Vermont	Provided by Bill Jokela, UVM	Bill Jokela	academic	In depth tool meant to comprehensively asses phosphorus flows on dairy farms, looking at phosphorus sources and transport potential.								
A111	Integrated cropping systems and Nutrient Management on Dairy Farms	http://www.ars.usda.gov/research/projects/projects.htm?accn_no=402968	US Agricultural Research Service/US Dairy Forage Research Center	Govt.	Reearch on pasturing and forage								
A112	What really needs to be in a Comprehensive Nutrient Management Plan?		Deanne Meyer	academic	Discussion of development of governmental nutrient management guidelines								
A113	The Nuteint Management Yardstick: a tool for promoting on-farm efficiency and environmental protection	http://www.iatp.org/yardstick	IATP	NGO	Comprehensive tools for measuring nutrient flows on farms								
A114	Water Quality Implications of Nitrate Leaching from Intensively Grazed Pasture Swards in the Northeast US		Stout, Fales, Muller, Schnabel, Weaver	Govt.	Discusses negative effects of MIG on water quality								

Ref. Code	Name	Address	Primary Author	Type	Initiative/ Mission	Focus (Type of Ag)	Geographic region	Indicators	Project Status	Other NGO's/ Companies	Notes	Rating A-F	Misc/ Who sponsored
A115	Generally Accepted Agriculture and Management Practices for Nutrient Utilization		Michigan Dept. of Ag	Govt.	GAAMP for Nutrients								
A116	Generally Accepted Agriculture and Management Practices for Manure Management and Utilization		Michigan Dept. of Ag	Govt.	GAAMP for manure management								
A117	Dairy Farm Energy Audit Summary		NY State Energy Research and Development Authority	Govt	Energy Usae and conservation measures on a dairy farm								

APPENDIX B: NOTES FROM INITIAL INDICATOR RESEARCH

TITLE OF INDICATOR: ANIMAL WELFARE

Animal welfare is defined as the "human responsibility that encompasses all aspects of animal well-being, including proper housing, management, nutrition, disease prevention and treatment, responsible care, humane handling, slaughter and, when necessary, humane euthanasia." (N3, from the American Veterinary Medical Association Policy on Animal Welfare and Animal Rights). The FAWC explains that general guidelines for good welfare can be spelled out through five freedoms (N7):

1. freedom from hunger and thirst (and proper diet)
2. freedom from discomfort
3. freedom from pain, injury and disease
4. Freedom to express normal behavior (with enough space, etc.)
5. freedom from fear and distress

For our purposes we'll group these five freedoms into: animal nutrition, herd health, and living conditions. Many overlaps exist between the three characteristics, which are further defined below. The main overarching theme that cuts across the first two subcategories is the constant push for increased milk production at the cost of herd health. This is the result that dairy incomes are determined by their ability to produce milk at the lowest cost per liter. There are two ways to increase income: increase milk production or decrease operating costs. Typically the focus has been on increasing milk production, which causing decreased animal welfare, which then causes increased management demands (and increased cost). (N7) Strategies to maximize income by, instead, decreasing costs, will be discussed. Organic livestock stipulates some requirements for each area and will be referenced under the appropriate metric.

ANIMAL NUTRITION

Definition or description of indicator

- Animal nutrition focuses on the type and quality of feed provided to dairy cows. According to ATTRA, feeding systems and choice of forages are key parts of a dairy nutrition program. However, the most important nutritional component is the quality of forages, regardless of whether forages are grazed or harvested. Dairy cows require a combination of grain and ruminants (like grass). Grain provides nutrients and energy, while ruminants ensure proper digestion process. Milk production is correlated with grain, so sometimes it receives more attention. However, proper nutrition requires the proper balance of both ingredients.

Metric(s)

- Variety of feed stuffs/feed analysis/calculation of diet and feeding patterns
  - Proper balance between fiber and grain.
    - Fiber is essential to keep the rumen working well, which is necessary to keep healthy, productive animal. Neutral detergent fiber (NDF) levels are used to determine intake and acid detergent fiber (ADF) levels are used to

determine the digestibility of a feed. Best indication of fiber level is amount of time a ruminant chews her cud. (A68)
    - How much time do milking animals spend chewing their cud? (A68)
    - NDF and ADF levels? (NDF determines intake and ADF determines digestibility of feed - both related to fiber and working the rumen). (A68)
  - Grain provides the energy component. Larger breeds of cows, like Holsteins, need about one pound of grain for every four lbs of milk, while smaller breeds, like Jerseys, need a 1:3 ratio. Too much grain causes acidosis because of the lower pH of the rumen. Grain intake should not exceed 60% of the ration DM. Also may need to supplement diet with some fat – especially for high producing dairy cows. (A68)
    - There is some concern that organic cows with genetics for producing high levels of milk may be at risk for metabolic disorders and poor fertility due to energy deficiency in early lactation (because of the organic restriction of feed supplements and synthetic vitamins). (N2) A survey regarding organic standards and their impact on animal welfare was conducted with veterinarians, farm advisors and organic certification body inspectors. The restriction on the use of dietary supplements was one such standard that over 35% of respondents indicated as having a "potential, deteriorating effect on animal welfare." (N2)
    - Ratio of grain to milk produced? (indication of grain = energy amount) (A68)
    - Body condition score? (also indicator for health) (A68)
  - Is an animal nutritionist involved to ensure the proper mix of fiber and grain? (W117)
- Check the feeding program for balanced protein content by conducting a milk urea nitrogen (MUN) test, which determines the amount of nitrogen being excreted through the milk, or a blood urea nitrogen (BUN) test (more accurate, but more difficult to measure). Normal results are between 12 and 18, but some variation among individual herds exists. Protein levels significantly lower indicate lower production levels, but higher levels indicate lower reproduction as well as increased feed costs. Low levels are typical if quality of harvested forages is inadequate while high levels may occur with protein-rich pastures that also have a very high percentage of soluble protein. High soluble protein usually lacks an energy component, thereby requiring "supplemental feeding on what is thought to be high quality pasture." (A68)
  - Are crude protein levels of total ration around 18 – 19%?
  - Is the degradable intake protein (DIP) between 60 – 65%?
  - Is the undegradable protein or bypass protein in the 35 – 40% range?
  - Test for MUN (or BUN)? What are the levels?
- Need SAI membership to access W100.

- Equal distribution of animal feed? (N7)
  - Sufficient trough space to allow all animals to feed at once? (N7)
- Availability of clean drinking water? (N7)
- Percent of feed bought versus produced (A68)

        - How many acres of pasture on farm and what is grown (A68)
            - Crops for silage, for grain, alfalfa, cool/warm season annuals, grasses, legumes
        - Limitation to homegrown feedstuffs can cause imbalances in diets with possible negative affects on animal health. (A74)
        - Growing grass or legume pastures instead of hay, grain or cut forage is easier on the land. Therefore it requires less (if any) pesticide and causes less erosion, as grass and legumes keep soil more firmly anchored. (W92)
        - Is there any way to decrease these expenditures? How do you know which ones you really do need? Can you decrease these by alternative management practices, such as: using by-product feeds, harvesting better quality feedstuffs, improving fertility of your pastures, better grazing management to be more efficient in pasture utilization, having better or more diverse forage species to extend the grazing season, change the time of year when nutrition requirements of animals are highest? (A68)
        - Straus dairy grows between 50 – 60% of their own feed. (W117)
    - Quality of forage
        - Straus lists the type of feed and silage that they use, if helpful as reference point. (W117)
    - Use of synthetic fertilizers/pesticides on graze-land
        - For organic livestock, can't use pesticides or synthetic hormones. (W116)
        - Straus does not use any herbicides, pesticides or chemical fertilizers. (W117)
    - Organic livestock must be feed organically grown feed. (W98, W116)

Verifiability
May be a bit difficult to verify some metrics depending on the type of records that the farmer has.

Measurability
Some may be difficult to measure (quality of forage, nutritional content of diet) while others should be easy (# of acres of pasture). For the ones that are difficult to get an exact measurement, ask for range instead of an exact amount.

Data collection
Assume that most farmers have a good handle on the quality of forage that they provide. Some numbers may require some additional research on their end, but still minimal burden.

Relevance to dairy
- Animal nutrition is a top concern for dairy farmers, as production and farm success depends on their livestock. Also is strongly related to herd health, which again has cost implications through veterinarian costs as well as culling.
- In the US today, only 11% of dairy farms allow their cows to graze. (W117)
- Over half of forage crops fed to dairy cattle are perennial legumes and grasses, which save soil and can be grown on land that are unsuitable for row crops like corn or soybeans. They improve water infiltration and are important for managing nutrient problems on dairy farms (W91)

Business case for farmer

- Farmers need to balance and understand the connection between high production and healthy cows. In the short-term, a higher grain diet results in higher milk production, thus increasing profits. However, the risk of poor welfare, as indicated by lameness, mastitis or fertility problems increases as the milk yield increases. (N5) A direct link between the level of milk production and the extent of disease conditions has been demonstrated. Specifically, mastitis and leg and foot problems, milk fever, retained placenta, metritis, fatty liver and ketosis have been seen in modern, high producing, good body-conditioned cows. (N5)
- "Any animals will perform well below potential wherever under nutrition or stress is present." (W95)
- Feeding dairy cows 20% less phosphorus could save US dairy producers $100 million a year and improve water quality without sacrificing milk production or cow health. (W91) (Excess phosphorus in water runoff from fields boosts algae and aquatic plant growth in streams and lakes.) This practice has water quality and financial implications.
- Growing alfalfa fixes nitrogen (W91), which would eliminate the need of farmers to add nitrogen fertilizer. By growing alfalfa, the farmer will save money and decrease environment problems. (Follow-up with Linda McGraw and/or Neal Martin, W91.)

Interaction with other indicators

- Herd health
- Animal welfare
- Farm financial health
- Organic livestock
- Soil nutrients (especially when considering organic vs. conventional livestock, and type of feeding system)
- Manure management (affected by type of feeding system, W92)
- Water quality (affected by the waste mgmt system)

Possible management strategies for improvement

- Typically, US farms use harvested forages, while other parts of the world use grazing with management plans. Managed grazing eliminates the cost of harvesting forages (equipment, labor, fertilizer, fuel, etc.). Farmers should consider a grass-based system instead of confinement operations as it has demonstrated economical benefits through decreased operating costs for farmers.
- "…benefits of the basic standards (organic versus conventional) are primarily related to environmentally friendly production and to the animal welfare issue while the issues of animal health and product quality are more influenced by the specific farm management than by the production method." (A74)
- Farmers can only act only on their existing knowledge. (A78)

Interactions with Farm Characteristics

- Feeding system (confinement, grazing, seasonal grazing, intensive management grazing, etc.)
- Manure management system

- Soil nutrients

HERD HEALTH

Definition or description of indicator

- Diseases, such as mastitis (udder inflammation), lameness and parasites, affect a substantial numbers of cattle. Cows with high metabolic turnover (i.e. high milk producing cows) have a higher potential for getting mastitis, lameness, infertility and other production diseases and require better care to maintain satisfactory level of welfare. (N7) Specifically, the use of rBGH is a significant contributing factor to mastitis and lameness. Twenty-five percent of US producers use BST while EU prohibits the marketing and use of BST due to "its effect on cow health and welfare." (N4) The incidence of mastitis is also affected by the bedding type, sanitation related procedures and the high amount of confinement time. Lameness is often the result of standing long hours on concrete. The overall condition of cattle and the likelihood of disease are related to stress. Stress results from a multitude of practices, such as feeding practice, nutritional intake, housing and weather conditions, animal density, the mixing of cattle, which is disruptive to social order, and the introduction of new heifers. (N4) It is in the farmers' best interest to minimize stress with whatever factors are within their control. Fearfulness can also add to stress. "Fearfulness in cattle affects productivity and can become increasingly severe." (N4)

Metric(s)

- Incidence of disease (Mastitis, acidosis, internal/external parasites, leg and feet problems, milk fever, ketosis, etc.)
  - Disease results from many factors – mistakes by farmer, inadequate handling, inappropriate housing conditions, etc. (A74)
  - Main issues in dairy cows are fluke and other worms, fly strike, footrot, and mastitis. (A78) Parasites were reported as the top disease (farmers usually aware of potential effects but not strongly concerned), mastitis #2 and reproduction without hormonal induction #3. (A78)
    - External and internal parasites. Conventional system relies on routine application of antiparasitic agents. Organic production place restrictions on these agents, resulting in more parasite problems with organic livestock. The restriction of conventional veterinary medicinal inputs was one organic standard that over 35% of respondents to a survey indicated as having a "potential, deteriorating effect on animal welfare." Survey respondents were veterinarians, farm advisors and organic certification body inspectors. (N2)
    - Mastitis is inflammation of the udder (very painful) and is usually caused by bacteria. It can occur in clinical form (changes in milk are obvious) or subclinical form (no visible changes). It can also be acute (seriously ill) or chronic (no outward sign).
      - Mastitis pathogens are either contagious or environmental. (N7, #190)

        - Contagious mastitis can be spread from infected quarters to healthy quarters of the same or other cows. Can also be spread because of the milker, the milking machine or dirty bedding. (N7)
        - Mastitis from environmental bacteria is associated with dirty, wet bedding and poor ventilation. It also can be spread during the milking process. (N7)
    - Incident of clinical and subclinical mastitis has dropped. In the 1960s there were about 135 cases for 100 cows to 1997 35-40 cases (in the UK). (N7) (Another source indicated the UK reported average of 40 out of 100 per year. (N5)) Primarily attribute this decline to the introduction of the National Institute for Research in Dairying (NIRD)/Central Veterinary Laboratory Five Point Plan. (N7)
        - Percent have mastitis? (A68) Set targets for incidence. (N7)
    - Detecting mastitis can be done through somatic cell counts, which indicate a broad indication of the general level of udder health. (N7) They can be used to evaluate each cow individually or to get a reading of at the herd level. (A68) See Interview with Diane Bothfeld for more information.
    - Management strategies through the Five Point Plan.
        - Hygienic teat management
        - Prompt treatment of clinical mastitis
        - Dry cow therapy
        - Culling chronically affected cows
        - Correct maintenance of the milking machine
    - Other management strategies:
        - Litter/bedding increases the hygienic risks, which factor into mastitis. (A74) Do they have dry bedding? (A68)
        - Maintain records as to which cows contract mastitis and frequency. (N7)
        - Mastitis monitoring and control should be part of routine vet visits. (N7)
    - Organic vs conventional livestock. There's differing evidence regarding occurrence of mastitis given the two methods. (A74) Speculate that local or national conditions (like mgmt, medication use, herd size) may explain the differences seen. Another source indicates higher incidence of disease, such as mastitis in organic cows (N2) while another indicates lower incidence of mastitis, abscesses, arthritis and liver diseases (N6).
- Reproduction. Farmers reported failure to conceive as the predominant reason for culling. Mastitis, fee and leg problems, ketosis and other diseases can lead to reproductive problems. Conception rates have declined from 55-66% 20 years ago to 45 – 50% recently, while milk production has increased substantially. A positive correlation between increased milk yield and fertility problems has been shown. (N5) Most problems with reproduction results from poor nutrition. If adopt forage management plans that ensure high quality forage throughout the year, there will be a decreased incidence of health and reproduction problems

in the herd. (A68) It is critical to have them maintaining weight before breeding. (A68) Has overlap as a farmer management strategy (category discussed below).
  - Strive for condition score of 3.5 for heifers and 3.75-4.0 for cows (1-5 scale). (A68) Condition score assess the degree of fatness or thinness of livestock. By monitoring frequently, changes in the body condition can be noticed before there are health and welfare impacts. (N7) See Interview with Diane Bothfeld for more information.
  - Organic livestock have higher reproduction life spans. (A74) However, another source voiced concern that organic cows with genetics for producing high levels of milk may be at risk for metabolic disorders and poor fertility as a result of energy deficiency in early lactation (because of restricted feed supplements and synthetic vitamins). (N2)
- Metabolic disorders (milk fever, ketosis). Organic livestock appear to have a decreased incidence of metabolic disorders than conventional (A74, A78, N2). There is thought (although not proven) that higher yielding cattle cannot react to inadequate conditions as well as animals with average performance. (A74) Probably due to the reduced production levels in organic livestock, i.e. they are healthier, so can fight off disease better as well as genetic performance capacities are not exhausted.
- Lameness. A study at University of Liverpool found 55 new cases out of 100 cows in a year. Over the past 40 years, the incidence has increased. (N7, #134) It the US, a study reports it occurs in dairy cows 35 – 56 cases out of 100/year. (N5)
  - It has significant welfare impact, because it is painful, a cause for culling, and interferes with the cow's ability to interact with her social environment. Also has significant cost to farm, through veterinary costs as well as replacement animals (from culling). (N7, #135)
  - It is difficult to impossible to detect lameness at an early stage, however it may be possible with engineering tools. (N4)
  - Caused by:
    - Standing on concrete for long periods of time increases the chance of lameness; hence lameness is rarer in cows at pasture. (N5) Poor lying conditions (cubicle size and design) or poorly designed buildings also contribute to increased standing times. (N7, #136) In terms of social behaviors, lower ranked cows spend more time standing. And the lower the ranking, the higher the probability that she will become lame. (N4)
    - Poor hygiene, especially the build-up of slurry (N7)
    - Poor quality of walking surfaces (N7, #141) in buildings, yards, paths and tracks
      - Such items as rough concrete, which may puncture the foot, or smooth concrete, which may contribute to sliding, will both encourage lameness. Alternative textures are available

that provide the optimal smooth/roughness for cow usage. (N7)
- Too many cows for the number of cubicles, too frequent changing of group composition, and poor management (which has cows having to stand in slurry) can also contribute to foot problems and lameness. (N7, #137)
- Also, anything that makes foot injury likely during normal movements will increase chance of lameness. (N7)
- Genetic selection based on high productivity and overlooking foot shape and hind leg conformation. (N4, N7) Lesions in the outer claw of the hind foot cause much lameness. (N7, #150)
- Unbalanced or inappropriately formulated feeds – especially too much energy or protein. (N4, N7) High production cows are more susceptible to lameness, probably because of metabolic reasons. (N7, #138)
- Rapid change in diets (N7)
- Not using footbaths. (N7) Footbaths are valuable management tool. The reduce lameness by cleaning feet, kill bacteria and help to harden horn. A footbath should be included in the housing system. Should not be administered everyday, but as required or recommended by advisor. (N7, #155) Should also inspect feet of all cattle (including bulls and non-lame) regularly. (N7, #159)

  - Almost all animals with a limp or reduced walking suffer from some leg or foot pain. (N5)
  - Enough knowledge now exists to enable farmers to significantly reduce the incidence! (N7, #139)

- What do cows do after being milked? (A68)
- Where do animals lie? (A68)
- Much of the research consists of comparisons between organic and conventional farms. However, it must be noted, that "…so few comparative studies makes it impossible to draw general conclusions regarding animal health in organic production systems." (N6)

- Severity of disease (N7)
- Farmer awareness of management strategies (examples: regular checks of milking machine, feed analysis and diet calculations)
  - High importance for animal health. (A74) Farmers can only check for what they are aware of. (A78)
  - Check milking machines to ensure they are working correctly. If test tissue is adversely affecting, can increase the risk of mastitis infection. (N7) There should be an annual assessment of machine milking – measure vacuum stability, cluster removal, milking routine and teat condition. (N172)
  - Believe farmers are more aware on highly specialized farms versus mixed farms. (A74) Livestock concerns may be lower priority and fail to receive the attention they need on mixed farms. Similar discrepancies may also be seen in the social farmer health piece, regarding income variation between selling milk and other products (like corn stands). Can ask in financial section how they decide their priorities for expenditures on the farm, given a certain

amount of money (A68). Also noted that organic is more common on mixed farms. (N2)

- Organic livestock farmer requires higher qualifications in farm management. (A74)
- Reproduction management, see above.
- Breeding, genetics and selection program. A number of bulls are being selected to maximize milk output per cow. (N7) Perhaps a better breeding selection would include selecting against lameness, mastitis and infertility. (N7) When doing breed selection, one must analyze what characteristics are desirable. Traits that may be good for one geographical area may not be desirable for another area. Similarly, "cattle developed in a confinement setting may not perform well on a pasture program." (A68, N3) Gene selection for high productivity in temperate climates may negatively influence the dairy cow's ability to adapt to heat stress. (N4)
  - Specific questions (A68)
    - What traits do you want to improve? (A68)
    - What breeds do you choose? Why? Other breeds that fit marketing and or forage management program better?
    - Do you breed out of season? Do most of your cows calve when your pastures can supply the most forage?
    - Do your animals have good feet and legs? Udders?
    - What percent of heifers become pregnant during breeding? (A68)
    - What is your culling rate? On what basis do you cull? (A68)
    - Is your nutritional level adequate to meet the animal's needs? (A68)
    - What is your calving interval? (A68)
    - What is the body condition scores of your animals? At beginning of dry period? At parturition?
- Medical treatment. More than 40% of antibiotics used in the US are given to farm animals. (W98) Organic livestock does not allow the use of antibiotics. Instead believe healthy, low stress environment will enable cows to heal themselves and ward off attacking organisms. (W116) Concern organic livestock will be treated inhumanely as result of not using medication when is in cows best interest to use.
  - Specific questions:
    - Regularly scheduled herd health check with your veterinarian? (A68)
    - What vaccinations do you give? (A68)
    - When, how often and on what basis do you deworm? (A68)
- Physical manipulations, such as dehorning and tail docking
  - Cattle behavior in response to flies has changed after tail docking. (N4)
- Other specific management related questions:
  - In what order do you milk your cows? (A68)
  - How is the milking equipment cleaned? Poorly cleaned equipment can lead to mastitis through contagious pathogens. (A68, N5)

- Pounds of milk sold per acre and/or per animal (A68) / Daily milk yields recorded at least monthly and monitored. (N7)
  - May give some indication on the amount of stress and/or potential overproduction (or underproduction) per animal.

        - Mastitis, lameness and reproductive failure tend to increase as milk yield increases. (N5) Metabolic disorders, mastitis, lameness and subfertility can occur b/c of inappropriate nutrition. (N7)
    - Animal well being – life expectancy
        - Animals on smaller farms receive personal attention and live longer lives under less stress. (W98)
        - Most modern dairy cows have a lifespan of less than four lactations. Are we forcing higher milk production at the cost of a shorter cow life? (N7, #37)
    - Twice daily inspection of animals? (N7)
        - Overall appearance of animals? Seem to be thrifty, content, and performing to satisfaction? (A68)
    - Records of treatments, diseases, production records and feed inputs (N7)

Verifiability

- It is difficult to know the frequency of parasites, however, given the sensitivity of the udder, mastitis is easily determined. Management practices related to medical treatment should be easy to verify with veterinarian, while breeding practices seem more nebulous.

Measurability

- As mentioned regarding verifiability, measurability may be difficult with some of the diseases, because farmers can't always tell when cattle are inflicted. However, other measurements are straightforward.

Data collection

- Believe that some information will be readily available while others (such as what breeding traits are desirable) may be more difficult to ascertain.

Relevance to dairy

- Without dairy cattle, a dairy farmer's livelihood is non-existent. The health of these animals is absolutely essential to the profitability of the farm. The short-term goal of high milk production may cause increased disease incidence, which will increase operating costs. Again, a balance must be obtained.

Business case for farmer

- As mentioned above, the cost of disease is significant – in terms of medical costs as well as lost milk production. Various management practices can reduce the likelihood of different diseases. For example, farmers who increase the amount of time their cows are outside (to be more than 50% of the time) find a decrease in mastitis incidence. This deals effectively with environmental pathogens that cause mastitis. The other cause of mastitis, contagious pathogens, can be decreased by correctly managing milking procedures. (A68)

Interaction with other indicators

- Animal nutrition
- Living conditions
- Farm financial health
- Organic livestock
- Farm financials (social perspective)

- Pesticides/ag chemicals (because can damage quality of water for cows and used in the cleaning, W95)

Possible management strategies for improvement

- "If you give a cow space and cleanliness, it will have less stress and have better health." (W117)
- Minimize stress by providing clean bedding, room to move, balanced diet, space (inside and outside), cooler climate and individual bedded stall for each cow (W117).
- Others are listed above in the metric section.

Interactions with Farm Characteristics

- Housing conditions (A74)
- Quality of stockmanship and management (A74)
- Feed patterns (A74)
- Climatic factors (A74)
- Hygienic situation (A74)

LIVING CONDITIONS

Definition or description of indicator

- The general comfort of the animal includes the quality, size, and cleanliness of the living and milking space. The amount of time allowed outside the barn is also considered.

Metric(s)

- Quality/condition of housing
  - Locomotion area
    - Increasing locomotion area and providing litter bedding have been found to be of substantial benefit for animal health and welfare of cows and calves. (A74)
    - Minimal standards provided by organic livestock guidelines. Outdoor area must be at least 75% of the indoor area, thus providing enough room for moving about. Also provides higher dimensions of the feeding and locomotion areas in loose housing stables. (A74)
    - EEC Regulation requires 4.5 sq meters for outdoors and 6 sq. meters indoors. (A74)
  - Number of animals/unit of area
    - # of animals barn can hold? how many are currently in barn? (A68)
    - Lower livestock density in organic farms, because of requirement of farm produced fodder. (A70)
    - EEC-Regulation (for European Countries) on organic production stipulates a max of 2 livestock units per hectare for livestock density. (A74)
  - Floor characteristics in pens for cows and calves
    - EEC Regulation specifies "floor characteristics" as lying space with litter/bedding. (A74)
    - Bedding should prevent skin abrasions and pressure sores and should be kept clean of excessive manure and be kept dry. Ventilation also helps to keep the bedding dry. (N3) One source suggested straw bedding, so each

cow can create his or her "preferred environment" from it. (N4) The key is to whatever environment encourages the most lying time. (N7)

- Kerb height can strain hind legs of animals, which are standing half-in, half-out cubicle with hind feet in the slurry channel. Must also not be too low as to allow bed to be contaminated with slurry. (N7, #74, 79)
- Another organic requirement is limited area of slanted floors, which may benefit foot health. (N2)
- Organic livestock stipulates "appropriate clean, dry bedding" and group penning. Must be large enough to allow for natural maintenance, comfort behaviors and opportunity for exercise while also allowing for good ventilation and air circulation. (W116, A74, N3)
  - Straus provides clean, dry bedding. (W117)

- Cubicle should take size, shape and weight of animal into consideration (N7)
  - Should be wide enough for animal to rest, sufficient head room (to go down, lie and get up w/o difficulty), gentle downward slope from front to back to encourage reduced rumen pressure on the diaphragm and drainage at the base. (N7) Areas that are too short (to lay down) or poorly designed can result in lameness. (N5)
  - At least one cubicle per cow. Provision of extra cubicles (recommend 5% extra) allows subordinate cows to find alternative cubicles if only open one is next to dominate cow. (N7)
  - Apply lime on cubicle base to reduce wetness and, in the short term, killing bacteria, which will lower the incidence of mastitis. (N7)
  - Cubicle passageways should be wide enough for cows to pass one another with ease. Suggested minimum of 2.4m. (N7, #82)
  - Should be cleaned twice a day to keep clear of manure (N7). Bedding should be replaced as needed. (N7, #84)
- Straw yards. Check with St. Albans Co-op to see if applies before research further. (N7) Per Interview with Diane Bothfeld, straw yards are not used.
- Loafing area should provide cows space to stand and move about. It is key to allow each cow to express its behavior in as natural a way as possible. (N7, #98-102) Some say that cows should stand after milking, which will allow the teat orifice to close and help control mastitis. (N7)
  - Should be large enough to allow bulling behavior and allow the avoidance of dominate cows. (N7) Recommendation that the dimensions be determined based on the average size of the largest 10% of the group. (N7)
  - Should be clean (scraped twice a day to eliminate slurry), not slippery and at least partially covered. (N7)
- Cowsheds. Check with St. Albans Co-op to see if applies before research further (N7)
- Ventilation. (A68) Air movement allows bedding to dry and lowers ammonia odors. (N3) A lack of ventilation increases incidence of mastitis and spread of respiratory disease, which can decrease production, and in extreme cases, death. (N7, #110) Most ventilation occurs by having heated air escape through the top and pull in cooler air from the bottom. The livestock heat

the air. This system works so long as the building is not wide or lofty or understocked. (N7) May need to improve older buildings by adding inlets and/or outlets. (N7, #115)
    - Respiratory problems? (A68)
  - Appropriate lighting. (N3) Lighting patterns and intensity should encourage cows to feed and act normal. (N7, #126) It has been found that increasing the day-length through artificial light, increases production (but only up to a point). (N7, #126) There should be enough light for proper stock inspection. (N7, #128)
  - Manure should be removed and urine should drain away from bedding areas. (N3)
  - Organic livestock prescribes housing conditions to serve as preventive measures (which then decrease incidence of injuries/sickness). (A74)
  - Need SAI membership to access W100.
- Quality/condition of milking parlor
  - How calm are they while being milked? (A68)
  - How long in milking parlor? (A68) Standing on concrete for long periods of time has negative health affects.
  - Do you feed in the milking parlor? Feeders clean? (A68)
- Percent of time animals are outdoors (A11, A68, A70, W98, W115, W116, W117)
  - Free to move outdoors? (A68)
  - Outside access to shade? Windbreaks? Water? (A68) cooling mechanisms? (N4)
  - Cows in deep mud? (A68)
  - Organic livestock are required to have access to outdoors, including access to pasture for ruminants. (W98, W116)
  - Straus keeps animals outdoors from spring to fall, in winter they are inside due to potential erosion and lameness occurrence. (W117)
- Animal behavior
  - Free to move outside? (A68)
  - Are cows on slick concrete (inside housing or milking parlor)? (A68)
  - % of time use their free stalls properly? (A68)
  - Where do they drink? Are feeders and waterers clean? (A68)
  - Do cows appear stressed during weather extremes? Comfort zone for cattle is between 30 – 75 degrees effective temperature. (A68)
  - Do they lay down and chew their cud? Where do they rest? (A68)
  - Do they stand for more than 4 hours at a time? (A68)
- Calf raising conditions
  - Raise your own replacement heifers? (A68)
  - How do you raise them? (A68)
  - Disease incidence? (A68)
  - What do you feed them? (A68)
- Husbandry practices for calves
  - European countries have standards for the protection of calves. (A74)
  - Also certain standards regarding locomotion area and floor characteristics (for exact area see A74).
- Husbandry practices/tethering

        - Exercise once a day should be provided for tethered animals. (N3)
        - Organic livestock guidelines (and EEC-Regulation) forbids the tethering of farm animals. (A74)
    - Use of stanchion barns
        - By banning stanchion barns, there has been an increase in living conditions of cattle. Stanchion barns are often inappropriate size and have poor technical execution (because so old). (A74)

Verifiability

- One paper indicated concern regarding measures that may lack validation when the cow's responses are not assessed directly in the specific situation. Farm animals vary widely in their requirements in relation to housing condition and, like humans, respond differently based on individual preferences (although general practices applicable to all exist). Therefore, critical to record and track how the animals actually fare in the system (A74).

Measurability

- Some may be difficult to measure (quality of housing) while others should be easy (# of animals/hectare). One expert commented on the wide gap between the "technical" measurements and "humane" subjective measurements with few in between. (ATTRA interview)

Data collection

- Concern that the more subjective measures will vary based on each farmer's individual interpretation and an accurate across farm comparison will be difficult and highly subjective.

Relevance to dairy

- 25% of all dairy cattle in North America are housed in free-stall environment (can enter and leave the stall at will). Predominate housing is the tie-stall, where cows are confined to the stall by a neck tether. They are able to lie down but cannot turn around or leave the stall. And a minority are kept on pasture throughout the year. Europe developed the loose housing systems, which is not utilized very much in North America. Cows tend to lie down for longer periods of time in the free-stall or loose housing systems. The dry lot environment (large dirt paddocks with central milking parlor) has become more popular. Concern exists regarding the time spent standing on the hard surfaces, which results in increased lameness (and culling rates for lameness). (N4)
- Poorly treated animals are under more stress. When stress level is increased, their production level decreases, which then decreases the financial return on the farm.
- Animal welfare is a hot topic for certain activist groups. Heifer International is developing standards and communicating with stakeholders to ensure that they do not become under attack from the activist communities regarding inhumane practices.

Business case for farmer

- "Any animals will perform well below potential wherever under nutrition or stress is present. Good stockmanship and concern for the well-being of the animal help identify stressors in the environment and reduce them or their effects." (W95)
- Difficult to promote animal welfare, because much is related to precautionary steps, which in the short term have higher costs and lower productivity. (A74)

Interaction with other indicators

- Animal nutrition
- Herd health
- Farm financial health
- Manure management (outdoor vs confinement, W92)
- Soil nutrients (outdoor vs confinement, W92)
- Water quality (affected by the waste mgmt system)
- Organic livestock

Possible management strategies for improvement

- "…benefits of the basic standards (organic versus conventional) are primarily related to environmentally friendly production and to the animal welfare issue." (A74)
- "Management is the most important factor in both (organic, conventional) production methods" (A74)
- Farmers can only act only on their existing knowledge (A78)
- Also listed above in the metric section

Interactions with Farm Characteristics

- Quality of stockmanship and management
- Hygienic situation
- Geographic location/Climatic factors

Programs organized around Animal Welfare issue

- Fund of Rural America (A72)
- USDA Cooperative State Research, Education and Extension Service (CSREES) (A72)
    - Managing Change in Agriculture: www.reeusda.gov/resd/ag---econ/mchg-01.htm
    - Sustainable Agriculture Research and Education: www.ces.ncsu.edu/san/
- Sustainable Agriculture Research and Education programme (one project is investigating the use of forage crops in more innovative ways) (A72)
- Network for Animal Health and Welfare in Organic Agriculture (NAHWOA) (conclusions and recommendations from workshops are at: www.veeru.reading.ac.uk/organic) (N2)

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N2: Animal health and welfare in organic livestock production in Europe: current state and future challenges

N3: Heifer International Animal Welfare Guidelines

N4: An Overview of Current Dairy Welfare Concerns from the North American Perspective

N5: Effects of Dairy Cattle Breeding and Production Methods on Animal Welfare

N6: Research on animal health and welfare in organic farming –a literature review

N7: Report on the Welfare of Dairy Cattle by Farm Animal Welfare Council (UK) (FAWC)

TITLE OF INDICATOR: BIODIVERSITY

(Many of the ideas/metrics/best practices in this section are already covered in the Nutrients, Soil, Water, and Pest Management. Therefore, the scientific basis for these recommendations is not repeated here.)

Definition or description of indicator.

Article 2 of the Convention on Biological Diversity (CBD), biological diversity is "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (CBD A, 2003).

- CBD recognizes that interactions between bio-diverse species provide "life sustaining systems" such as oxygen cycling and sustenance as well as "social, economic, scientific, educational, cultural, recreational and aesthetic values." It also recognizes that human activity has the ability to negatively impact biodiversity and that humans should make efforts to conserve biodiversity. For example, modern agriculture in many cases has led to a decline in biodiversity through implementation of highly-managed monoculture systems. This shift reduces biodiversity upon which the ecological functioning of an ecosystem depends, causing farmers to buy costly external inputs to maintain soil fertility and regulate pests (Altieri, 1999).
- Processes which foster biodiversity through specific management practices help restore ecosystem functioning and return ecosystem services to self-sustaining, low-input levels (Ibid).

The three levels of biodiversity identified by the CBD (diversity within species, between species and of ecosystems) provide the primary focal points for most research and conservation efforts surrounding biodiversity today:

- Genetic diversity refers to the genetic variation within species. Chromosomes, genes, and DNA "determine the uniqueness" of each individual within a species. Genetic diversity is important to protect crops and food systems from disease and other natural events such as drought that may wipe them out (Oregon State, 2003). Many natural populations have diverse genetic pools, creating traits that allow the species to survive changing conditions such as disease and drought. Species become susceptible to extinction when genetic homogeneity exists, which is becoming more and more the case as farmers purchase greater quantities of bred cattle or seeds of almost the same genetic make-up from centralized suppliers. Scientists conserve genetic diversity of crops, livestock, and wild species through "ex-situ" conservation [such as through gene banks] or through "in-situ" conservation [by sustainably managing genetic diversity of crop varieties within traditional agricultural, horticultural or agri-silvicultural cultivation systems] (Long et al, 2000).
- Species diversity refers to the variety of species within an ecosystem. Species interactions constantly affect ecosystem processes and shape ecosystem structures. According to the CBD, "1.75 million species have been identified" thus far, but scientists estimate that there are actually about 13 million species, with estimates ranging from 3 to 100 million" (CBD B, 2003). Species diversity can be measured in a number of ways with the two most common being richness (number of species) and evenness (abundance of species

within a given ecosystem), however more detailed indices have also been developed (Ellsworth, 2003). Maintaining species diversity is important to conserving biodiversity since the richness and abundance of species can greatly affect a species susceptibility to extinction.

- The CBD defines 'ecosystem' as a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit" (CBD A, 2003). Ecosystem diversity is the diverse array of functional ecosystem units that shape the world. These units can be at any range or scale, but generally transcend political or socio-economic boundaries, and often include diverse functional and structural components which naturally change over time.

Metric(s) [Genetic diversity]:

All three components of biodiversity are affected by agriculture. The following provides metrics under genetic, species and ecosystem diversity categories. Moreover, because ecosystems often cross political or ownership boundaries, ecosystem diversity indicators are grouped into two categories, on-farm metrics which affect an individual farmer's land and off-farm metrics which cross a farmer's ownership boundaries to other lands.

- ***Number of breeds.*** Farmers breed cattle for specific characteristics. The greater the number of different breeds, the greater the genetic diversity.
- ***Number of cultivars.*** Cultivars are seeds cultivated from refinements of wild species through selective breeding and hybridization. Each cultivar is developed to provide certain characteristics (i.e., ability to grow in wet areas, resistance to drought, etc.) (Ellsworth, 2003). Farmers choose different cultivars based upon the particular growing conditions in their region. The cultivars grown on a farm, the more resistant the crop is to being destroyed by a natural disaster

.

Metric(s) [Species diversity]:

- ***Species richness/Number of species/acre (i.e., ants, earthworms).*** The number of different types of species indicates species richness in a given area. Counting the number of species, however, can be time intensive and require in-depth identification knowledge for plants, wildlife, and insects, depending upon the sample size requested. I need to do further research on whether indices exist regarding expected average numbers of species in given ecosystems.
- ***Abundance of species.*** The abundance of species can be measured by counting the frequency or total number of individuals of the same species in a given area. Counting the number of species, however, can be time intensive and require in-depth identification knowledge for plants, wildlife, and insects, depending upon the sample size requested. I need to do further research on whether indices exist regarding expected average numbers of species in given ecosystems.
- ***Shannon-Weiner biodiversity index rating.*** The Shannon-Weiner biodiversity index uses species abundance and richness data to calculate total species diversity for a given area. This tool is especially helpful in comparing biodiversity between ecosystems. However, this tool is time intensive to implement given that both species richness and abundance data must be collected followed by calculations for each area. Moreover, there is no current regional guide on what appropriate levels of biodiversity are, making it difficult to assess performance (Ellsworth, 2003).

- ***Wildlife habitat (same as Farm landscape/habitat for natural predator systems (e.g., hedgerows, ponds, non-cropped areas and Wildlife conservation/wildlife habitat quality).*** Chances of species diversity are improved if a diverse set of habitats (in terms of structure and function) are available to wildlife. The Food Alliance evaluates the availability and quality of wildlife habitat using a four level scale. The lowest rating is if "few wild areas exist around fencerows or wooded areas" whereas the highest rating indicates that a farmer has planned or taken specific actions to improve and enhance wildlife habitat (Food Alliance, 2002). It also requires that "pastures are managed for multiple (domestic and wild) species" and that "nesting sites or other habitat for beneficial birds is provided."
- ***% of cultivated vs. natural area.*** This metric relies upon the assumption that there will be greater biodiversity in natural areas than cultivated areas. By estimating the percentage of land in natural areas, it is possible to judge the amount of natural habitat available to wildlife and extrapolate biodiversity health. At the same time, this metric does not provide insight into the status or management of natural areas. Additional information may be necessary to make this an effective indicator.
- ***Wetland loss/riparian areas.*** Riparian areas on farms provide unique habitats for a diverse set of plants and organisms. Protection of these areas aids in conservation of both species and ecosystem diversity. The Food Alliance evaluates a farmer's management of riparian zones using a four level scale. The lowest rating is for when "pastures and confinement areas are less than 50 feet from the Ordinary High Water Mark (OHM) of surface waters" and when "cattle access to surface water sites is not restricted or monitored" (Food Alliance, 2002). The highest rating indicates that a pastures and confines areas are less than 50 feet from the OHM, cattle access to surface waters is restricted, buffer zones are vegetated without visible erosion, and in-stream crossings are graveled to prevent erosion (Food Alliance, 2002).

Metric(s) [Ecosystem diversity: On-Farm]:

- ***Structure of landscapes.*** Landscape structures provide a variety of habitats for the species that inhabit them. For example, a landscape with a variety of structural components such as a farm that has pasture, cropland, woodland, and riparian areas is more diverse than an ecosystem with only one structural component such as cropland (Ellsworth, 2003). A metric for defining structural diversity could be the percentage of area managed to provide the following structural components: pasture, cropland, woodland, riparian area.
- ***Pasture and cropland monitoring.*** In addition to environmental planning, monitoring is a key to ecosystem health and conservation of biodiversity. The Food Alliance evaluates a farmer's monitoring efforts of pasture and cropland using a four level scale. The lowest rating is for no monitoring activities whereas the highest rating indicates that a farmer uses monitoring records to "improve management in subsequent seasons" (Food Alliance, 2002).
- ***Environmental planning for new plantings/pastures.*** Farm planning helps to minimize environmental impact to the ecosystem and maximize social and economic benefits to a farmer. The Food Alliance evaluates a farmer's environmental planning efforts for new plantings and pastures using a four level scale. The lowest rating is for expansion "without regard to environmental impact" whereas the highest rating indicates that a farmer does the following: "Site, varieties and planting systems are carefully

selected and designed for optimum production with minimal agrochemical inputs. Chemical pre-plant fumigants are avoided whenever possible. Site area selected or otherwise prepared to avoid nematodes or pre-existing disease conditions. Cover crops are planted and incorporated before planting" (Food Alliance, 2002).

- ***Reproductive ability of plant/ Plant protection/ Grazing-based system.*** Grazing based systems lesson the need for imported feed and can be developed to increase biodiversity and deliver increased nutritional value to cattle. The Food Alliance evaluates a farmer's pasturing techiniques using a four level scale. The lowest rating is for when "pastures are open grazed, undivided, and are inadequate or inaccessible to calves, heifers, lactating and dry cows" (Food Alliance, 2002). The highest rating requires that pastures are accessible to cattle; divided into at least four paddock divisions with scheduled rotations; forage species are managed for maximum vegetative production; and supplemental feed, water, and shelter sites are rotated to prevent erosion and reduce compaction; and sacrifice areas are use in non-growing seasons (Food Alliance, 2002).
- ***Crop rotation plan.*** See Carey's work.
- ***Plant cover of desirable species.*** Cover crops help reduce soil erosion, slow runoff, provide habitat for ground-nesting birds and other wildlife, break insect and disease cycles, suppress weed growth, and improve soil tilth and water-holding capacity (SARE, 2003). The Food Alliance evaluates a farmer's use of cover crops using a four level scale. The lowest rating is when a farmer does not plan or manage use of cover crops whereas the highest rating indicates that a farmer maintains cover crops "to minimize soil erosion, improve water infiltration, suppress weeds, encourage beneficial organisms, and optimize soil temperatures for rapid germination and growth" (Food Alliance, 2002). The farmer also selects mulches which "improve soil microbial activity, organic matter levels, and nutrient cycling" and ensure that "bare soil is maintained by cultivation and is present only during the growing season" (Food Alliance, 2002).
- ***Number of acres of cover crop per unit of production.*** This metric measures how much cover crop is planted per unit of production. The higher the number, the more cover crop that is utilized. Cover crop is effective in promoting biodiversity by creating habitat for insects and birds, regulating soil temperature which benefits soil microorganisms, preventing erosion, and trapping water for a number of species and organisms.
- ***Weed control.*** Farmers need to control weeds as a means of ensuring the maximum growth of capital crops. The Food Alliance evaluates a farmer's weed control efforts using a four level scale. The lowest rating is when a farmer uses herbicides on a routine basis whereas the highest rating indicates that a farmer does the following: conducts weed scouting and mapping; uses cultural, mechanical or biological methods to control weeds; manages soil quality, ground cover, and adjoining areas to manage weeds; pre-irrigates fields and destroys early weed growth; uses a precision system to remove weeds, limits weed seed access to water; and uses only herbicides labeled "caution" or less toxic herbicides, neither of which threaten biological control programs (Food Alliance, 2002).
- ***Plant Disease/Pesticide use (% unsprayed area).*** The Food Alliance evaluates a farmer's management of crop and pasture plant diseases using a four level scale. The lowest rating is for when "fungicides are applied on a regular schedule, transplant treatments are used on a routine basis or no management plan is implemented for the disease" (Food Alliance, 2002). The highest rating requires that "fields are scouted to detect disease and permit early corrective action," "no chemical pesticides are applied for

plant diseases," and that "resistant varieties, sanitation or other appropriate cultural controls and preventative strategies are used" (Food Alliance, 2002). Another method of measuring this indicator to measure what % of an area is sprayed on a regular basis. More environmentally friendly alternatives such as biological controls would result in less chemical sprays and treatments.

Metric(s) [Ecosystem diversity: Off-Farm]:

- ***Conservation of ecosystems around farmed areas (same as level of biodiversity off-site/cross boundary effects).*** Because ecosystems cross political and ownership boundaries, farmers should look beyond their farmed areas to improve ecosystem health. The Food Alliance evaluates a farmer's environmental adjacent area management using a four level scale. The lowest rating is for when "adjacent areas of cropland or pasture are not managed" whereas the highest rating indicates that a farmer manages adjacent areas under his control to curb pest problems, to prevent pesticide and fertilizer movement off-site, and to include "hedgerows, windbreaks, or other low-maintenance plantings to encourage specific beneficial organisms and/or native wildlife" (Food Alliance, 2002).
- ***Planting trees in buffer zones.*** Planting trees in buffer zones is one way to create more complicated landscape structures on farms. These structures help to mimic natural ecosystems and promote biodiversity. Trees also help minimize nutrient leaching and soil erosion as well as restore key nutrients to lower soil layers. While this metric is helpful, some of the others such as 'Landscape Structure' are more comprehensive in their measures of biodiversity.

Benefit to Farmer:

- Enhancing these systems at the genetic, species, and ecosystem level can help restore biodiversity as well as "promote diversity of diet and income, stability of production, minimization of risk, reduced insect and disease incidence, efficient use of labor, intensification of production with limited resources, and maximization of returns under low levels of technology" (Altieri, 1999).

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TITLE OF INDICATOR: COMMUNITY HEALTH

- Community health is reflected in a unified and cohesive community in which the connection to agriculture and to the land itself has not been lost.(CSS, 53) According to the Sustainable Agriculture Network, a community is considered healthy when 1) the interests of community groups and local inhabitants are considered during the planning and developmental stages of agricultural activities, 2) areas of social, cultural, biological, environmental, and religious significance are preserved, 3) communities adjacent to the farm have priority of employment as well as training opportunities to participate in activities of the agricultural company, 4) the legally responsible representatives of the agricultural activity must prove their ownership or long term right to use the land, 5) producers help protect community watersheds and forests, and 6) agricultural companies should contribute to the local economy and accept their fair share of costs of community infrastructure such as in schools, roads, water supplies, etc.(SAN) These general standards can be measured through the following metrics.

Metric(s) [Community Relations: - This indicator measures the farmer's relationship to his/her community.**]**

- **# of Harvest or Agricultural Festivals/Year** in the community
- **Community perception of farming**: Do citizens see farming as a cultural asset or a nuisance because of the smells, dust, etc?
- **Presence of farm organizations/civic organizations** with an overlap in agrarian and civic activities
- **Rural community awareness** of relevance and benefits of sustainable practices/connectivity to society at large (Unilever, 11)
- **Presence of Farmer's Markets vs. Direct Sales of Produce.** When consumers have a choice between supporting local producers and paying a little less for the products of the industrial food system, they will often choose to support their neighbors. Farmers selling locally benefit from differentiating their products and services by qualities other than price. Fresh produce, specialty items, and locally grown and processed foods are competitive in the market place, especially when consumer education and personal contact with the farmer are part of the marketing plan. CSA or Community Supported Agriculture is a targeted marketing strategy that is effective. (ATTRA, 7)
- **Number of educational programs** that incorporate the local and agricultural community. This can be measured by the # of field trips to local farm lands would remind children of where food comes from.
- **Ratio of owner operated farms compared to tenant agriculture.** Owner operated farms will have stronger ties to the community because they will depend on individuals

of the community for their income. Tenant farmers are employed someone outside the area and are generally less concerned if locals buy their products.

Metrics [Sustainability of Local Community - How strong and sustainable is farm's local community?]

- **Population Growth:** What has been the change in population over the last 10 years? (SAN)
- **Ethnic Group Diversity:** Research that indicates greater population diversity leads to greater sustainability. (SAN)
- **Gender distribution:** Male (%); Female (%) (SAN)
- **Social Equity:** (CSS, 11) % of racially oriented crimes in the area, % of ethnically oriented crimes, % of gender oriented crimes, # of social justice organizations in the community. According to Dr. Cornelia Flora, social equity does not mean that al individuals, populations and communities have the same things or are similar. Instead, it refers to having similar opportunities for participation in market activities as producers and consumers. Skills, abilities and knowledge of individual's should be recognized, appreciated and transparent. These aspects are a critical base for rural communities that desire healthy ecosystems and vital economies. (Flora, 11)
- **Access to Facilities**: Does the town have basic facilities such as transportation, potable water, education, electricity, medical services, and sewage systems?
- **% of local children who go away to college but return afterwards**. (The higher the number, the greater the sustainability of the town's social persistence.)
- **Corporate Commitment**: Commitment to economic and social well-being of the communities by local companies
- **Entrepreneurial Spirit of the community:** Number of bank loans granted to non conventional farmers or small business interests. The willingness of local institutions to support progressive methods of income will lead to a more sustainable community.

- **Metrics [Land Resource Planning/Landscape Aesthetics -** Agriculture plays a key role in shaping the quality of landscape and agricultural landscapes are outcomes of several interactions among natural resources, agricultural operations, and cultural/societal values. Landscape are composed of three elements: (OECD, 42) 1) Landscape structures- this includes a) environmental features such as habitats, b) land use types such as crops, and c) man made objects such as hedges, 2) Landscape functions – such as a place to live, work, visit, and provide environmental services; and 3)Landscape values – concerning the costs to farmers of maintaining landscapes and the value society places on agricultural landscape, such as recreational and cultural value**s] -**

- Amount of open space in communities;
- Number of local land resource planning/educational programs for agriculture
- Current state of landscape; Appearance of landscape and how it's changing
- % of agricultural land under public vs private schemes for landscape conservation
- cost of landscape provisions by farmers
- The value society attaches to landscape

- **Metrics [Farmer Worker Stability -** Migration to urban or suburban centers is more commonly seen than the reverse trend, ultimately reducing the sustainability of farming communities. Growers demonstrate to the Department of Labor that American workers are unable, so the US has an H2A guest worker program that allows aliens to enter the US to perform seasonal agricultural labor. However, tedious and complicated paperwork often leads workers to enter illegally. The U.S. Department of Labor estimated that as of 1998, 52% of the agricultural labor force lacked legal authorization to work. Often low prices received for agricultural commodities lead farmers to depend on cheap, illegal migrant labor to harvest crops.**]**
    i. Ratio of Migrant Workers to Local Laborer
    ii. % of farming population that has been there longer than 5 years vs. 10 years. http://css.snre.umich.edu/css_doc/Proceedings.PDF (page 54). This measures farming population persistence:

Metrics(SAN)

i. Average age of agricultural workforce
ii. What nationalities are the farm laborers?
iii. Number of families that permanently reside on the farm
iv. Number of permanent employees
v. Number of families that reside on the farm only during the harvest
vi. Origins of seasonal worker
vii. Type and number of residences for permanent workers
viii. Type and number of services provided
ix. Basic services provided for permanent workers: Transportation, Potable Water, Education, Electricity, Medical Services, Sewage Systems
x. Basic services provided for seasonal workers: Transportation, Potable Water, Education, Electricity, Medical Services, Sewage Systems
xi. Extent of land care and participation
xii. Are they interested in more than just the labor?

Measurability, Data collection, Verifiability, Relevance to dairy, and Business case for farmer:

- The farmer's relationship to his/her community can only be as strong as the community in which he lives. Community focused businesses cannot prosper in declining localities and the problems of crime and drugs affect business. The interests of community groups and local inhabitants must be considered during the planning and development stages of agricultural activities when these developments directly affect their living situation. The support received from the community can significantly impact a farmer's job satisfaction, especially in light of tumultuous economies and weather patterns. It is important that the community be supportive of agriculture in order for it to be sustainable.
- *Development over Farmland* - According to "Assessing the sustainability of US Food systems" by Martin Heller and Greg Keoleian, the trends indicate larger farms. In 1997, 9.5% of the farms and 38% of the farmland account for 75% of the market value of agricultural products sold. The farms that sold over $500,000 in products averaged $373,730 in net cash returns. However, those selling less than $50,000 in products

averaged a net loss in cash return of $850. Agricultural land is under increasing pressure from developers who want to transform the land into new urban housing. Farmers who struggle financially are often tempted by these developers. The reduction of farm income and the increase of dual employment have led to an adjustment of labor out of agriculture, reducing the number of farms.

Table 4: Number and size of farms in the US by year

	1998[a,d]	1988[a,d]	1974[b,d]	1950[b,e]
Number of farms (in 1000)	2192	2201	2314	5388
Land in farms (in 1000 ha)	385,976	402,429	411,578	470,011
Average farm size (ha)	176	183	178	87.4
Farmland per capita[c] (ha/person)	1.4	1.6	1.9	3.1

[a] USDA (1999b).
[b] US Department of Commerce (1977).
[c] population statistics from (FAO 1999).
[d] Since 1974, the definition of a "farm" used by the Census of Agriculture has been "Any place from which $1000 or more of agricultural products were produced or sold, or normally would have been sold, during the census year." (USDA, 1999a).
[e] To qualify as a farm in the 1950 Census, a place of three acres or more had to produce $150 worth of agricultural products for home use or sale. If less than three acres, $150 worth of agricultural products had to be produced for sale only.

- Agricultural employment plays an important role in the maintenance of a viable rural population. Trends indicate that the total number of people working agriculture has been declining for a long time. Additionally, there has been a move form full time to part time working labor. Research indicates that it is not feasible to set a target for numbers of people employed in agriculture as the labor requirements are largely determined by market conditions and available technology.(www.hertz.co)

- According to Heller and Keoleian, approximately 17% of hired farm labor were less than 20 years old and over half were under 35 years old, versus 6 and 43% of all wage and salary workers, respectively. Fifty seven percent had not completed high school, compared with 14% of all wage and salary workers. While 1/10th of all wage and salary workers were Hispanic in 1996, this proportion grows to 36% of hired farm workers. About ¾ of Hispanic farmers were not US citizens. Overall, 28.4% of hired farm workers were not US citizens, compared with all salary and wage earners. (Heller and Keoleian).

    - The number of farm laborers has dropped significantly over the past 50 years, from 9.9 mm in 1950 to 2.8 mm in 1998.
    - Family workers, paid or unpaid, accounted for 69% of farm laboring 1998, the remainder being hired.
    - The average wage rate for hired farm workers was $7.47 per hour in 1998. (Keoliean/Heller). This compared to $16.91 for mining, $16.61 in construction, $13.49 in manufacturing, and $11.80 in food and kindred products. (bureau of labor statistics).

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TITLE OF INDICATOR: ENERGY

- Energy flow is the non-cyclical path of solar energy, or sunlight into and through any biological system. The natural world runs on sunlight. Our management decisions affect how much of it is captured and put to good use on the farm. Energy flow begins when sunlight is converted into plant growth, and continues when animals' consumer plants, when predator animal's consumer prey, and when microorganisms decompose dead plants and animals. Some energy is lost as heat at every transfer point in the food chain. On the farm, energy capture is enhanced by maximizing- both in space and in time, the leaf area available for photosynthesis, and by efficiently cycling the stored solar energy through the food chain. Off season cover crops, perennial vegetation, and intercropping are among the tools for capturing more solar energy. Capturing sunlight and converting it to dollars is the source of all wealth. (ATTRA, 3)
- A goal of the Dutch government is an energy productivity increase of 26% by 2000 compared with 1989. Dairy farms use fossil energy directly as fuel and gas for heating, and they use electricity for milking machines and refrigeration of milk. Dairy farms also apply inputs that contain fossil energy at an earlier stage in the product chain. This energy use is referred to as indirect energy. For instance a lot of energy is used to produce nitrogen fertilizer. Also concentrates contain an implicit amount of fossil energy. We take the direct and indirect use of energy into account, to prevent that intensive dairy farms (which buy concentrates) are more energy efficient than extensive farms (that grow roughage). Total energy use measures the application of energy, and is a proxy for the emission of CO2, that contributes to global warming.
- Energy is consumed primarily in the refrigeration of milk, heating of water and use of vehicles and machinery, including water pumps. It is thought that energy use contributes around 10% to 15% of a dairy farm's greenhouse gas emissions. Over 40% of the food related household energy is consumed by refrigerators.
- An energy efficient system includes heat recovery, an energy-conserving vacuum pump, high-efficiency fans, and fluorescent lighting at 100 percent of recommended levels. Lighting and ventilation were potentially the largest energy users in the simulations,

assuming that recommended levels are achieved. Ventilation is a largest electrical load on 30- and 60-cow farms. In recent years, mechanical ventilation in large freestall barns has become the largest peak energy user on dairy farms. Switching to efficient fans can produce savings of 12 to 15 percent in both smaller barns and large freestall barns. Energy use per cow decreases as herd size increases, so fan energy use per cow on a 30-cow farm will be twice that of a 60-cow farm. In Australia, on a 30-cow farm, changing the water-heating system to heat-recovery without pre-cooling saved 4,900 kilowatt hours per year, cutting cooling costs in half and heating costs by 25 percent. Changing to an efficient lighting system saved 3,000 KwH/year.

Metric (s) [Greenhouse Gases (OECD, 36)- Agricultural processes are a major contributor of greenhouse gases in the atmosphere, but of the impact of climate change on agriculture is a huge concern. There are three main gas emissions from agricultural processes: - methane (CH4) emissions from livestock, nitrous oxide (N2O) emissions from pasture improvement activities and carbon dioxide (CO2) emissions from energy generated by the combustion of fossil fuels. Methane and nitrous oxide are very potent greenhouse gasses. Methane has a global warming potential 21 times that of carbon dioxide and nitrous oxide 310 times the global warming potential of carbon dioxide.

- Carbon Dioxide – 10% of total GHG emissions come from agriculture; Sources include conversion of grassland to other uses and clearing forests. (farmland questions)
- Methane – 40% of total GHG emissions come from agriculture; sources include livestock farming and the use of inorganic fertilizers.
- Nitrous Oxide – 60% of total GHG emissions come from agriculture; sources include livestock farming and the use of inorganic fertilizers. It has been estimated that doubling the concentration of nitrous oxide in the atmosphere would result in a 10% decrease in the ozone layer and this would increase the UV radiation reaching the earth by 20%. (Cederberg, 57).

- $C0_2$ Equivalent- Emissions of Nitrogen Compounds to the Air
    a. Soil
    b. Urine Deposition
    c. Cattle Feed
    d. Synthetic fertilizer
- CO2 Equivalent Emissions of Methane to the Air
    e. Manure
- CO2 Equivalent Emissions of CO2
    f. From burning of fossil fuels for energy
- Mitigation Techniques
    g. Conversion from conventional tillage to no-till
    h. Increase in cover cropping
    i. Improvement of crop residue mgmt practices

Relevance to Vermont Farmer: The Vermont Department of Public Service and the Vermont Department of Agriculture have received a total of $695,000 from the federal government to promote the use of methane recovery technology on Vermont dairy farms. This technology has the potential to help farmers with their nutrient management plans and

at the same time provide additional on-farm income. The project has been designed to consider methane recovery in a broad context, taking into account its potential benefits as a component of a comprehensive nutrient management system, as a renewable energy source and as a strategy for greenhouse gas reduction.

Metric [Direct Energy Use - Agricultural production of food in the U.S. accounts for only 20% of the total energy consumed in the US Food system.

Fuel: Transporting raw and processed foods from manufacturing and distribution sites. When considering energy usage on a farm, transportation is a big component. It includes energy in transporting raw and processed foods form manufacturing and distribution sites to areas of retail distributions, as well as the estimated energy consumed in household shopping trips. Another component is the packaging material which includes feedstock and processing energy for food and beverage packaging. This value is based on food related packaging material.

Electricity- is a significant source of energy due to the greater requirements for pumping water onto sprays irrigated properties (irrigation, dairy shed and other uses). It is generated by the combustion of fossil fuels as well as the consumption of petrol, diesel and gas on farm contribute to the emission of carbon dioxide and other greenhouse gases including methane, nitrous oxide and carbon monoxide.

- Energy used in cleansing milk
  - Energy used on production of containers
  - Energy used on production of detergents
  - Energy used on transport to dairy
  - Energy used on cleaning process
  - Energy used on rinsing
  - Energy used on waste management
  - Energy used on effluent management

- Energy used in transportation of products.
  a. Type of machine,
  b. hours of operation,
  c. areas worked,
  d. Or amount of material carted or spread.

Metric [**Indirect Energy Use**. The manufacturing of chemical fertilizers and pesticides makes up almost 40% of the energy allocated to agricultural production. Indirect energy use is comprised of the following sources: fertilizer type or nutrient quantity; chemical pesticides, seeds, feed that was bought-in from outside or sold, and grazing-off recorded by number of animals and time away from the property.]

- Total energy products purchased by farmer
- Total energy products purchased by farmer
- Amount of chemical fertilizer used
- Use of imported/conventional feed

- Amount of grazing off time/month

Metric: [**Renewable Energy Use** -Electricity use in general and for spray irrigation in particular, emerged as the most significant cause of variability in the calculated energy indicators between different dairy farms. Nitrogen application rate and fertilizer use in general, also had a significant effect. Given the findings of this study the most significant areas for improving overall energy efficiency on dairy farms are: a]Fertilizer management, Use of urea, to reduce indirect energy requirements for fertilizer manufacture; b)Water management on irrigated dairy properties, particularly those with high pressure spray irrigation, to reduce direct use of electricity; c)Tractor and vehicle selection and operation to reduce direct use of diesel and petrol; and d)Insulation of hot water cylinders and milk vats and use of heat exchangers to reduce direct use of electricity in dairy sheds.]

- Wood/Biomass energy usage
- Hydro/wind energy usage
- Ratio of renewable energy/to total energy use
- Ratio of renewable energy to non renewable energy
- Ratio renewable over non-renewable energy inputs

Benefits to a Vermont Dairy Farmer. – Vermont's electricity prices are 150% higher than the national average according to the state department of energy. Consequently, by pursuing alternative energy sources and/or energy conserving technologies, farmers can save a significant amount of money.

TITLE OF INDICATOR: FARM LABOR

- Labor is a large component of agricultural production. Unfortunately, the remoteness of farm locations as well as lax international standards, often lead to the mishandling of human (and/or child) labor. Farms depend highly on seasonal laborers and these migratory laborers should have the same rights/benefits as full time workers. In the United States, migrant and part time farm laborers are subject to the worst forms of abuse, whether they are financial, physical demands of the job, or living conditions. Consequently, efforts by International Labor Organization, United Nations, Food Alliance, as well as individual corporate standards, to name a few, labor rights are a well defined topic. The International Labor Organization's articles state:
    - Article #24: Allows any national or international workers' or employers' organization to make a so called "representation" claiming that a given member state has failed to apply an ILO convention ratified.
    - Article #26: Asserts than complaints that an ILO member state is not satisfactorily securing the effective application of an ILO Convention can be brought by another ILO member State which has ratified the same convention

Metric (s) [Base Wage - 1) Worker salaries must be equal to or greater than the established minimum wage and average regional salary based on their responsibility and experience. (SAN) 2) Pays wages and benefits that are competitive within its industry and that allow workers and their families to have a good standard of living commensurate with

the societies in which workers live and work. Worker salaries greater than average regional salary based on responsibility and experience (http://www.rainforest-alliance.org/programs/cap/socios/generic.pdf)]

- How often do you pay your workers?
- How much do you pay your farm laborers?
- Are wages adjusted according to seniority, performance and changing crop conditions
- Are Bonuses are given to reward productivity of the group
- Are Profits are shared
- Employer distributes work opportunities fairly, not giving the favorite employees the best opportunities
- Employer conducts regular performance evaluations, rewarding good performance with pay raises
- When an employer pays wage advances, they have a system to communicate expectations to prevent confusion on the part of the employee

Metric(s) [Child Labor - The ILO specifies this range from 13 to 18 years of age depending on the country's economic situation and type of work. SAN 3.1.4: The hiring of minors is not permitted. The definition of minor is based on the established law of each country regarding agricultural activities. According to the Convention on the Rights of the Child, International treaty that recognizes the human rights of children, defined as persons up to the age of 18 years. Article 32 refers specifically to child labor. The ILO's Minimum Age Convention, 1973 (No. 138) specifies that 1) The first principle is that the minimum age should not be less than the age for completing compulsory schooling and in no event less than age 15, 2) for countries whose economic and educational facilities are insufficiently developed, the age can be set initially at 14, and 3) the second principle is that a higher minimum age should be set for hazardous work. This age may not be less than 18. And 4) finally, in the case of light work, the minimum age can be set at 13 years, or 12 years where the economy and educational facilities are insufficiently developed.]

- Employer has a written policy designed to keep all employees out of the workplace. This policy exempts family members; however it states that children of the farm family (under the age of 12) must be supervised when around the workplace.
- Employer only employs legal minors during non school hours
- Employer has special training for minors and/or farm family's children.
- Employer communicates with the parents of minors regarding the employment of children
- Employer provides daycare for employee's children
- Train supervisors on the special management needs of minors

Verifiability. - Swiss seed producer Syngenta will ask representatives from Monsanto, Unilever, Proagro and Advanta to meet in Andhra Pradesh, India with the aim of setting up an independent monitoring committee on child labor, according to a local NGO. 6/18/03.

Relevance to Dairy Farmer in Vermont. Additionally, Vermont has very strict local child labor laws. In the agricultural sector, a 16 year minimum is set for employment in agricultural during school hours for the school district in which the employed minor is living. There is a

minimum age requirement of 14 years generally for employment in agriculture outside school hours. However, a child at the age of 12 or 13 may also be employed with written consent of the minor's parent or person standing in the place of a parent, or may work on the farm where such parent or person is employed. A child under the age of 12 may be employed by a parent or guardian on a farm owned or operated by that person. (Vermont Child Labor Rules, 5) According to the US Child Labor Law: The minimum age for employment is 14 years in non-agricultural sectors (with a few exceptions), and 18 years for hazardous work. IN addition, in agriculture, children as young as 11-12 are allowed to work; children under 16 are prohibited from hazardous work in agriculture. The United States has not ratified the UN Convention on the Rights of the Child. (http://www.fieldsofhope.org/world/index.asp?country=United+States+Of+America)

Metric [Freedom of Association. SAN (3.2.1) Workers right to organize and negotiate freely with their superiors must be guaranteed in accordance with conventions 87 and 98 of the ILO. SAN (3.2.2.) The company must inform employees about planned farm management or organizational changes and the possible social, economic and economic impacts of these changes. Employers must respect the freedom of the individual worker to join the union of his or her choice or to refrain from such membership. Employees who have chosen unions in accordance with applicable laws and regulations are entitled to bargain collectively through representatives of their own choosing.]

Verifiability. The Committee on Freedom of Association (CFA) is a tripartite committee of the Governing Body established in 1951. It examines complaints from governments, workers' and employers' organizations that member States of the ILO are not respecting basic principles of freedom of association. It meets three times a year and has examined since its establishment nearly 2000 cases. Complaints may be examined whether or not the country concerned has ratified the ILO's Conventions on the subject, as the procedure is based on constitutional principles; If the Conventions are ratified and there are legislative issues raised, the Committee's conclusions receive follow-up from the Committee of Experts. The "Fact-Finding and Conciliation Commission on Freedom of Association (FFCC)" was created by agreement with ECOSOC in 1950; Examines complaints of infringement of trade union rights referred to it by the ILO's Governing Body in respect of both countries which have ratified the FOA Conventions and those which have not, though in the latter case referral may not be made without the consent of the country concerned; May also examine complaints of violations of freedom of association against non-member States of the ILO when such complaints are forwarded to it by the United Nations and the country consents; Composed of nine independent members appointed by the Governing Body working in panels of three.

Metrics: Non-Discrimination - Eliminate discrimination in access to employment, training and working conditions, on grounds of race, color, sex, religion, political opinion, national extraction or social origin and to promote equality of opportunity and treatment.]

- The Employer has no written policy claiming non discrimination practices consistent with the law
- The Employer has a written policy that considers age, race, third party affiliation, religion, gender, sexual orientation, national origin, and disability (SAN 3.1.1)

- The employer provides training for managers implementing non discrimination
- The employer provides training for employees implementing non discrimination
- **Relevance to Dairy Farmer in Vermont:** The U.S. Dairy Export Council prohibits discrimination on the basis of age, disability, national origin, race, color, religion, creed, gender, sexual orientation, political beliefs, marital status, military status, and arrest or conviction record. (http://www.usdec.org/research/index.cfm). The University of New Hampshire Cooperative Extension programs and policies are consistent with pertinent Federal and State Laws and regulations on non-discrimination regarding race, color, religion, sex, age, national origin, sexual orientation, disability, veteran status, or marital status(http://ceinfo.unh.edu/common/documents/dairycon.htm). Discrimination (Employment and Occupation) Convention, 1958 (No. 111). Equal Remuneration Convention, 1951 (No. 100)

Worker Safety

- The next three indicators fall under a general heading of worker safety. Why should farmer's care about worker safety? The Vermont Agency of Agriculture, Food, & Markets have a "Pesticide Control Program" that works in cooperation with the Environmental Protection Agency. It mandates that any person producing an agricultural product on land who own or rent, who wants to use restricted use pesticides must be certified. Certification is a regulatory program run by the Plant Industry Division and ensures that pesticide applicators are knowledgeable about the proper use of pesticides.

Metric(s) [Worker Safety with Pesticides. http://www.ianr.unl.edu/pubs/dairy/g1064.htm#WAGES; The exposure to pesticides and other agrochemicals constitutes one of the major occupational risks, accounting in some countries, for as much as 14 % of all occupational injuries in the agricultural sector and 10 % of all fatal injuries. According to SAN 3.5, plantations should also provide environmental education to workers and their families.]

- Are workers closely supervised by a licensed pesticide applicator?
- All workers have taken a pesticide application course
- Emergency eye washing facilities are provided near the storage, mixing/loading and/or application sites
- Showers and changing rooms are provided near storage, mixing/loading and/or application sites
- Spare clean clothing
- Protective clothing is used and cared for properly
- Respirators are kept in protective packaging
- Respirator pads are changed regularly
- Pesticide applicators applying highly toxic chemicals are equipped with powered filtered-air respirator and positive/ pressure cabs
- When applicable, workers handling solvents, fertilizers , etc, with potential to cause injury, provided appropriate safety equipment

Metric(s) [Worker Safety: Hazardous materials emergency management]

- All spills in storage, mixing/loading or application sites are cleaned up promptly.
- Spill response kits are readily available where hazardous materials are stored. Materials used to clean up are disposed of properly.
- Emergency washing facilities such as showers, eyewash and spare clean clothing provided near storage, mixing/loading and application sites.
- Emergency management plan includes:
    - Identification and phone numbers for person who should be contacted,
    - Procedures and equipment to be used,
    - Copies of complete labels of hazardous materials used,
    - Location of fixed storage sites,
    - Policies requiring training for those who work with or around hazardous materials

Metric(s) [Worker Safety: Sanitation and General Safety]

- Employers provide clean drinking water and clean latrines with hand washing stations
- All hand washing stations have soap and water
- Upon inspection, all facilities are clean
- Employers provide safety training
- Employer provides a shower facility with warm water for employees to wash and change after the work day
- Employer contracts with professional firms to provide safety training
- Employer has developed training checklists specific to jobs to ensure each employee gets training
- Employer sets goals for safety and tracks success
- Employer gives bonuses when safety goals are met.

- **Data Collection and Verifiability.** There is limited reliable data on the extent of pesticide-related illness both in developed and developing countries due to difficulties in the accurate reporting of cases which leads to under-estimation.

- **Relevance to Dairy Farmer in Vermont**. Workers in Dole farms are trained in safe application of crop protection products and are required to use personal protective clothing appropriate to their activities. According to the EPA, there are anywhere between 20,000 and 300,000 the annual number of acute pesticide poisoning cases among agricultural workers and the WHO places the total cases of pesticide poisoning at between 2 and 5 million each year of which 40,000 are fatal.

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TITLE OF INDICATOR: FINANCIAL HEALTH

- While traditional financial measures have focused in large part on the profitability of an enterprise, the Global Reporting Initiative defines economic indicators for sustainability as those focused on "how the economic status of [an enterprise's] stakeholders changes as a consequence of the organization's activities, rather than on changes in the financial condition of the organization itself" (GRI, 2002).
- The stakeholders of a farm are many-fold including employees and communities, buyers and suppliers, investors, government officials, and the natural environment. At the same time, in the farming community, it is also the individuals farmers that make up much of the fabric of the community.

ECONOMIC INDICATORS FOR FARMERS AND THEIR FAMILIES

- In 1989, the Farm Financial Standards Council (FFSC) concluded that the agricultural enterprises did not have a uniform method of reporting their economic performance and created a standard set of 16 indicators with explicit methods for calculating each indicator. The measures were to be "common" to all areas of the country to provide a means for comparison to help analyze performance for any given commodity group. The FFSC grouped these indicators into five categories: liquidity, solvency, profitability, repayment capacity, and financial efficiency (FFSC 1997).
- Through its literature review, the team found that these standards were most often used by economists and non-profits to measure financial performance of farming enterprises. Moreover, interviews with experts confirm that the FFSC indicators are the most widely accepted standard in agriculture—in practice, farmers are not required to keep records asides from reporting taxable income to the IRS each year (and the IRS accepts many different practices).
- We have maintained the FFSC's categories and many of its definitions as a baseline by which to classify all indicators related to the financial viability of an enterprise.
- Dr. David Kohl of Virginia Tech affirmed that these are the most widely accepted measures by industry with 5 measures (Term Debt & Lease Coverage Ratio; Current Ratio; Equity to Asset or Debt to Equity; Return on Assets; and Operating Expense/Revenue Ratio), being the most widely used across the industry. Dr. Kohl has focused much of his research on indicators used by lending institutions to judge whether or not to issue a farming enterprise a loan.
- The FFSC Guidelines were most recently revised in 1997.
- Currently, no international standard exists, but many of the FFSC measures are universally used an understood across borders (Kriegl, 2003).
- Dr. Kriegl of the Center for Dairy Profitability at the University of Wisconsin asserted that a number of different measures should be used to accurately evaluate financial performance, but that use of many indicators will require some investment by B&J to educate farmers on their purpose/helpfulness in assessing financial health.

- In addition to the FFSC indicators, there exist additional indicators. They are lumped under the FFSC categories (below) as a means of capturing and evaluating the universe of indicators that fall under each category.

Measurability, Data collection, Verifiability, Relevance to dairy, and Business case for farmer:

- While these measures are widely used, there is still much variability in how some items are measured. Differences caused by use of historical or real market values, methods of depreciation and amortization, and other factors may cause similar enterprises to return unsimilar financial performance results.
- Given these differences, there is no easy way to ensure comparability of measures across enterprises unless an explicit accounting system is mandated through a computer program, farm management association, or other university research project. Dr. Dick Levins at the University of Minnesota argues that the use of a conventional system would allow farmers to compare their performance across the industry and allow farmers to improve their performance where needed.
- Hal Hamilton of the Sustainability Initiative acknowledged that farmers may be amenable to participating in such a program if they were in return given data that allowed them to evaluate their performance against others (Hamilton, 2003).
- Diane Bothfeld of St. Alban's Cooperative Creamery agreed, citing that farmers would be interested in participating if they received helpful information in return (Bothfeld, 2003).
- Dr. Levins suggested that Ben & Jerry's could require that all of its suppliers belong to a Farm Management Association, an organization that tracks financial performance and provides financial and tax assistance to farmers as a means of helping them measure and track performance over time (Levins, 2003). This would allow for 3rd party verification of results as well as allow a 3rd party to maintain and update the system over time. He mentioned that the same could be done for the environmental and social indicators as well under a program such as the Midwest Food Alliance.
- Dr. Levins was concerned that Ben & Jerry's use of its own system could make the company liable if a 'bad actor' made it through the screening process, leaving Ben & Jerry's (or Unilever) open to public criticism.

<u>Title of Indicator: Liquidity (same as indicator 'bank loans')</u>

Definition or description of indicator: Liquidity "measures the ability of a firm to meet financial obligations as they come due in the ordinary course of business, without disrupting the normal operations of the business" (FFSC 1997). The FFSC recommends two measures of liquidity: current ratios and working capital.

Metric(s):

- ***Current ratio.*** This ratio indicates the "current farm assets, if sold, would cover current farm liabilities"—the higher the value for this ratio, the more liquid the operation. This metric is calculated [based on FFSC definitions] using the following equation: Total current farm assets/Total current farm liabilities. Using David Kohl's "Stoplight" performance rating system, a farm receives a 'green light' for a ratio greater than 1.50, a 'yellow light' for 1.00 to 1.50, and a 'red light' for a ratio of less than 1.00 (Kohl, x).

- ***Working capital.*** This figure measures the theoretical "amount of funds available to purchase inputs and inventory items after the sale of current farm assets and the payment of all current farm liabilities." The more money available in this category, the more money the firm has to use to reinvest in the business. This metric is calculated [based on FFSC definitions] using the following equation: Total current farm assets – Total current farm liabilities. The absolute amount depends upon the scope of the operation. This measure can be converted into a ratio by dividing working capital by total expenses. This ratio is known as the California Working Capital Rule. Using this definition and David Kohl's "Stoplight" performance rating system, a farm receives a 'green light' for a ratio greater than 50%, a 'yellow light' for 20% to 50%, and a 'red light' for a ratio of less than 20% (Kohl, x).

Title of Indicator: Solvency

Definition or description of indicator: According to the FFSC, solvency "measures the amount of borrowed capital (or debt), leasing commitments, and other expense obligations used by a business relative to the amount of equity invested in the business…Solvency measures provide (a) an indication of the firm's ability to repay all financial obligations if all assets were sold, and (b) the ability to continue operations as a viable business after a financial adversity, which usually results in increased debt or decreased equity" (1997). The FFSC recommends three measures of solvency: debt/asset ratio; equity/asset ratio; and debt/equity ratio.

Metric(s):

- ***Debt/Asset Ratio.*** This ratio "compares total farm debt obligations owed against the value of total farm assets" or the proportion of total farm assets owed to creditors. This metric is calculated [based on FFSC definitions] using the following equation: Total farm liabilities/Total farm assets. Using David Kohl's "Stoplight" performance rating system, a farm receives a 'green light' for a ratio less than 30%, a 'yellow light' for 30% to 70%, and a 'red light' for a ratio of greater than 70% (Kohl, x).
- ***Equity/Asset Ratio.*** This ratio measures "the proportion of total farm assets financed by the owner's equity capital." This metric is calculated [based on FFSC definitions] using the following equation: Total farm equity/Total farm assets. Using David Kohl's "Stoplight" performance rating system, a farm receives a 'green light' for a ratio greater than 70%, a 'yellow light' for 30% to 70%, and a 'red light' for a ratio of less than 30% (Kohl, x).
- ***Debt/equity ratio.*** This ratio measures "the extent to which farm debt capital is being combined with farm equity capital"—the higher the value of the ratio, the more total capital has been supplied by the creditors and less by the owners. This metric is calculated [based on FFSC definitions] using the following equation: Total farm liabilities/Total farm equity. Using David Kohl's "Stoplight" performance rating system, a farm receives a 'green light' for a ratio less than 42%, a 'yellow light' for 42% to 230%, and a 'red light' for a ratio of greater than 230% (Kohl, x).
- ***Flexibility of production system/ Livestock/crop production diversity.*** No definition was provided for flexibility of the production system (A69). Livestock or crop production diversity was defined as the degree of innovation applied on farm by taking into consideration multiple levels of system interaction and levels in the food chain (A69). Both of the indicators seem to get at the idea that financial sustainability will be

increased if a farmer produces multiple goods, thereby preventing financial loss due to a decline in that market. No further information is provided.

Title of Indicator: Profitability

Definition or description of indicator: The profitability of the operation is often a primary indicator as to the economic sustainability of the enterprise and a key indicator of the economic impact of the business on the farmer's and his family's standard of living. According to the FFSC, profitability "measures the extent to which a business generates a profit from the use of land, labor, management, and capital" (1997). The FFSC recommends four measures of profitability: rate of return on farm assets; rate of return on farm equity; operating profit margin ratio; and net farm income.

Metric(s):

- ***Rate of return on farm assets.*** This ratio measures how profitable a farmer is in making a return on his or her asset base—the higher the value for this ratio, the more profitable the operation. This metric is calculated [based on FFSC definitions] using the following equation: (Net farm income from operation + Farm interest expense – Owner withdrawals for unpaid labor and management)/Average total farm assets. The "average ROA for farms in the US is between 3-6%" (Doehring-Profitability 2001). Using David Kohl's "Stoplight" performance rating system (for mostly owned assets), a farm receives a 'green light' for a ratio greater than 5%, a 'yellow light' for 1% to 5%, and a 'red light' for a ratio of less than 1% (Kohl, x). Using David Kohl's "Stoplight" performance rating system (for mostly rented/leased assets), a farm receives a 'green light' for a ratio greater than 12%, a 'yellow light' for 3% to 12%, and a 'red light' for a ratio of less than 3% (Kohl, x).
- ***Rate of return on farm equity.*** This ratio measures how profitable a farmer is in making a return on his or her equity—the higher the value for this ratio, the more profitable the operation. This metric is calculated [based on FFSC definitions] using the following equation: (Net farm income from operations – Owner withdrawals for unpaid labor and management)/Average total farm equity. When ROE exceeds ROA, the enterprise is "effectively using borrowed funds to increase the profitability of the operation" (Doehring-Profitability 2001). Using David Kohl's "Stoplight" performance rating system, this indicator is measured by looking at trends and comparing the performance of this investment to non-farm investments or investments in other farms (Kohl, x). The idea is that another investment may provide a better return on equity and thereby be a better investment than the family farm.
- ***Operating profit margin ratio.*** This ratio measures profitability in terms of "return per dollar of gross revenue" (FFSC, 1997). As described by the FFSC, a firm can either increase its profits by increasing its profit per unit or by increasing its production volume, thereby driving down its per unit costs through gains in economies of scale. The higher the return, the more profitable the operation. This metric is calculated [based on FFSC definitions] using the following equation: (Net farm income from operations + Farm interest expense – Owner withdrawals for unpaid labor and management)/Gross revenues. While there is no standard for this ratio, "a rule of thumb is between 20-30%" (Doehring-Profitability 2001). Using David Kohl's "Stoplight" performance rating system (for mostly owned assets), a farm receives a 'green light' for a ratio greater than 25%, a 'yellow light' for 10% to 25%, and a 'red light' for a ratio of less than 10% (Kohl, x).

- ***Net farm income.*** This figure is "the return to the farmer for unpaid labor, management, and owner equity" (FFSC, 1997). In other words, it is the income to the farmer on a pre-tax basis. This metric is calculated [based on FFSC definitions] using the following equation: Revenues – expenses + the gain or loss on the sale of farm capital assets. This figure will include regular operating activity in addition to events that "do not occur as often such as the sale of machinery or a tract of land" (Doehring-Profitability 2001).
- ***Net farm income from operations.*** This figure is the same as net farm income minus non-recurring income such as the sale of machinery or land.
- ***Unpaid labor, unpaid management, and unpaid equity (same as base labor wage).*** Farming enterprises are often family-run businesses where the operator of the enterprise "balances the books" by recording operating income and expenses together with family expenses. After all operating expenses are paid, income is used to cover unpaid family labor, unpaid family management, and unpaid equity (profits that can be reinvested into the operation or through other diversified means).
- ***Veterinary costs.*** "If a farmer's bet bills are high, it may be an indication that the management strategy he/she is employing is not very sustainable" (A69).
- ***Productivity/Yield per hectare (includes area of farm used for agriculture).*** Not relevant to dairy industry since cows may be confined—therefore productivity per cow can vary greatly.
- ***Share of disposable income consumer spent on food.*** This metric "captures the relative value that consumers place on food as compared to other goods such as material goods (clothes, electronic items, appliances, etc), travel, education, etc." A high percentage allocated to food would reflect a more sustainable agricultural sector. (A69)??????????
- ***Cash flow.*** Cash flow is measure of cash inputs and outputs of an enterprise over a given time period. Cash flows may not be a good indicator of profitability in that accounts receivable (payments owed to an enterprise) may not be paid immediately resulting in the appearance of a negative cash flow when in fact the business is profitable.
- ***Condition of the irrigation.*** Need to locate article. This indicator may be more applicable to cropping operations.
- ***% of income from off-farm labor (includes Secondary employment of farmers/spouse).*** Since 90% of farmers often have off-farm jobs to supplement farming income, the percentage of income from off-farm is a good indicator of how sustainable a farming enterprise is in and of itself in terms of providing the standard of living and quality of life desired by the farming family (A69).

Title of Indicator: Repayment Capacity

Definition or description of indicator: According to the FFSC, repayment capacity "measures the ability of the borrower to repay term farm debt from farm and non-farm income. Principal payments on term loans must come from net income (with depreciation added back) after owner withdrawals, income taxes, and Social Security taxes" (1997). The FFSC recommends two measures of repayment capacity: term debt and capital lease coverage ratio and capital replacement and term debt repayment margin.

Metric(s):

- ***Term debt and capital lease coverage ratio.*** This ratio "provides a measure of the ability of the borrower to cover all term debt and capital lease payments—the greater the ratio, the greater the margin to cover the payments" (FFSC, 1997). This metric is calculated [based on FFSC definitions] using the following equation: (Net farm income from operations +/- total miscellaneous revenue/expense + total non-farm income + depreciation/amortization expense + interest on term debt + interest on capital leases – total income tax expense – owner withdrawals (total))/ (Annual scheduled principal and interest payments on term debt + annual scheduled principal and interest payments on capital leases). Using David Kohl's "Stoplight" performance rating system (for mostly owned assets), a farm receives a 'green light' for a ratio greater than 150%, a 'yellow light' for 110% to 150%, and a 'red light' for a ratio of less than 110% (Kohl, x).
- ***Capital replacement and term debt repayment margin.*** This ratio "enables borrowers and lenders to evaluate the ability of the farm proprietor to generate funds necessary to repay debts with maturity dates longer than one year and to replace capital assets" " (FFSC, 1997). This metric is calculated [based on FFSC definitions] using the following equation: (Net farm income from operations +/- total miscellaneous revenue/expense + total non-farm income + depreciation/amortization expense – total income tax expense – owner withdrawals (total)) = Capital replacement and term debt repayment capacity. Capital replacement and term debt repayment capacity – Payment on unpaid operating debt from prior period (loss carryover) – principal payments on current portions of term debt – principal payments on current portions of capital leases – total annual payments on personal liabilities (if not included in withdrawals) = Capital replacement and term debt repayment margin.

Title of Indicator: Financial Efficiency

Definition or description of indicator: According to the FFSC, financial efficiency "measures the intensity with which a business uses its assets to generate gross revenues and the effectiveness of production, purchasing, pricing, financing, and marketing decisions" (1997). In other words, financial efficiency "seeks to understand…if an operation is spending excessive amounts on operating expenses, interest, depreciation, etc." (Doehring-Efficiency 2001). The FFSC recommends two measures of financial efficiency: asset turnover ratio; and operational ratios.

Metric(s):

- ***Asset turnover ratio.*** This ratio measures "how efficiently farm assets are being used to generate revenue" (FFSC, 1997). This metric is calculated [based on FFSC definitions] using the following equation: gross revenue/average total farm assets. A higher asset turnover most often implies a more efficient use of the operations asset base (Doehring-Efficiency 2001). Doehring goes on to explain that most agriculture businesses have asset turnover ratios between .2 and .8 "with livestock operations being on the upper end." This metric is calculated [based on FFSC definitions] using the following equation: gross revenues/average total farm assets. Using David Kohl's "Stoplight" performance rating system, this ratio varies depending on whether the operation is owned or leased (Kohl, x). A farm with a lot of leased equipment will have a higher turnover ratio than one where much of the equipment is owned.

  Operational ratios: These four ratios reflect operating expense, depreciation and amortization, interest expense, and net farm income from operations as percentages of

gross revenues. The first three added together [based on FFSC definitions] equal "farm expenses per dollar of gross revenue." Using David Kohl's "Stoplight" performance rating system, a farm receives a 'green light' for a ratio less than 65%, a 'yellow light' for 65% to 80%, and a 'red light' for a ratio of greater than 80% (Kohl, x).

- ***Operating expense ratio.*** This metric is calculated [based on FFSC definitions] using the following equation: (Total operating expenses – depreciation and amortization expense)/ revenues. "A benchmark for the operating expense ratio is between 55-80%--a ratio over 80% often indicates profitability problems, while under 55% indicates great efficiency" (Doehring-Efficiency 2001). Using David Kohl's "Stoplight" performance rating system, a farm which has mostly leased assets receives a 'green light' for a ratio less than 75%, a 'yellow light' for 75% to 85%, and a 'red light' for a ratio of greater than 85% (Kohl, x). Using David Kohl's "Stoplight" performance rating system, a farm which has mostly owned assets receives a 'green light' for a ratio less than 65%, a 'yellow light' for 65% to 80%, and a 'red light' for a ratio of greater than 80% (Kohl, x).
- ***Depreciation/amortization expense ratio.*** This metric is calculated [based on FFSC definitions] using the following equation: Depreciation and amortization expense/gross revenues. This ratio "can range from 0% (for those operations with no debt) to over 20% (to those operations that are highly leveraged). This ratio is a good indicator of potential problems. As this ratio exceeds 15%, the chances that a farm or ranch business generates profit are very low. In the case where this ratio is 15%, then 15% of every dollar goes to pay the interest on borrowed funds, therefore the margin left to cover profit, depreciation, and other expenses is squeezed" (Doehring-Efficiency 2001).
- ***Interest expense ratio.*** This metric is calculated [based on FFSC definitions] using the following equation: Interest expense /gross revenues. The smaller the ratio, the less a farmer has to spend on interest as a percentage of gross revenue. Using David Kohl's "Stoplight" performance rating system, a farm receives a 'green light' for a ratio less than 12%, a 'yellow light' for 12% to 20%, and a 'red light' for a ratio of greater than 20% (Kohl, x).
- ***Net farm income from operations ratio.*** This metric is calculated [based on FFSC definitions] using the following equation: Net farm income from operations/gross revenues. This ratio can range from less than zero to 35% on the upper end (Doehring-Efficiency 2001). Using David Kohl's "Stoplight" performance rating system, Kohl recommends looking at trends and the cyclical nature of agricultural prices to determine whether farm income is sustainable (Kohl, x).
- ***Government payments as a percent of gross income.*** Government subsidies for farming products can be viewed as a subsidy for efficient business practices. According to Dr. Dick Levins, U of MN, "an entire generation of farmers have come to see government subsidies as an essential part of many types of farming; however, a fully sustainable system of farming should not require this type of continual assistance" (Levins, 1996). The amount received from agricultural program payments can be found on the Schedule F Income Tax form, Profit or Loss From Farming. This metric is calculated by dividing Agricultural Program Payments by gross income (Levins, 1996). Farmers that product crops are also eligible for subsidies for certain commodities which would increase the overall level of a farmer's income from government programs. Dr. John Durling of MSU explained that in general, subsidies for dairy farming are not substantial and therefore are not a good indicator of sustainability for dairy farming. Moreover, WTO agreements will lead to fewer and fewer subsidies of agricultural

products as member countries move towards greater forms of free trade (Flaten 2002). This indicator has been field-tested in both Michigan and Kansas.

- ***Hundredweight equivalent production.*** Because farms have multiple sources of income (milk, cull cows, crop sales, government subsidies, cooperative dividends, and income tax credits), the cost of producing milk cannot often be easily separated out from other costs. Therefore, economists created this measure to determine how much additional hundredweights of milk would need to be produced in order to make up for income generated through other sources. The measure is calculated by "summing the income from the sale of all products produced on the farm and then dividing by the price of milk" (Frank, x). The calculation for Total Farm Income is as follows: Total schedule F income + Form 4797 Income + Change in Feed Inventory + Change in livestock inventory + Other = Total Farm Income. This is then divided by the average US milk price for the given year of date. The lower the number, the better the sustainability of the farm in surviving off of milk production alone.
- ***Basic cost per hundredweight equivalent.*** Basic Cost per Hundredweight Equivalent is the cost to produce one unit of hundredweight equivalent production calculated above. Basic costs per hundredweight equivalent are those amounting to 'costs of goods sold' "excluding all wages and benefits, all interest costs, and all depreciation" (Frank, x). The measure is calculated by calculating total costs; subtracting interest, wages and benefits, and depreciation; and then dividing by the number of hundredweight equivalents. The calculation for Total Farm Income is as follows: Total schedule F expenses + the change in accounts payable – the change in prepaid expenses – total interest paid – wages and benefits paid – depreciation claimed/hundredweight equivalents of milk produced. This is then divided by the average US milk price for the given year of date. The higher the costs, the more inefficient the farming operation.
- ***By-product utilization/disposal costs.*** If farmers can "transform the costs of disposal of waste materials, such as manure, used bedding material, and crop residues, into income by feeding pigs with used bedding, growing vegetables from manure, and feeding chickens with discarded crop residues, then the economic sustainability of an operation is increased" (A69).
- ***Observed yield to expected ratio.*** CSS—Need to find article at school.
- ***Matching supply to sales to maximize profitability.*** CSS—Need to find article at school.

ECONOMIC INDICATORS FOR COMMUNITIES AND EMPLOYEES

This section covers the impacts of farming operations on communities. By supporting local communities through purchases and by providing jobs and affordable products, farmers increase the economic health of the communities in which they work. This section is divided into indicators for both sector health and community health.

Title of Indicator: Sector Health

Definition or description of indicator:
Metric(s):

- ***Change in the Number of Farms Over Time/Entry/Exit Ratio.*** This metric reflects how stable the farming industry in the area is. If farming is profitable, the entry/exit ratio would be somewhat stable or increase over time. If farming is

unprofitable and farmers are exiting the industry, or there is a lot of consolidation, then this ratio would decrease over time.

- ***Diversity of the Structure and Scale of Industry.*** Dairy framing will be "more sustainable for the individual farmer if large producers exist alongside small producers" (A69). Moreover, other studies have shown that "various measures of social well being (education, income, standard of living, and civic and social organizations in the community) were better in the presence of many smaller farms rather than fewer larger ones" (Flaten 2002).
- ***# of bank loans granted to non-conventional farms of small businesses.*** Need to research.
- ***Public/non-profit expenditure on agri-environmental research.*** Need to research.
- ***Ratio of locally-owned business to externally owned businesses.*** "As chain corporations move in, communities lose their unique sense of place, and pride in local ownership is replaced by minimum wage service jobs. This intervention of outside ownership not only alienates the interior community from itself, but also loses fundamental connections with the outlying agricultural community" (A69).

Title of Indicator: Community Health

Definition or description of indicator:

Metric(s):

- ***Support for local families as a percent of gross income (includes part-time/full-time ratio).*** The percentage of expenses spent on hired labor in the agricultural industry has fallen from 15% in 1950 to 9% in 1991 (Levins, 1996). In Minnesota, the average farmer spent $252,942 during 1993 of which less than $7,000 went for hired labor. Another study found that while almost 60% of cost savings achieved by large farms are from lower labor inputs, these cost savings result in loss of employment, especially in rural areas where there exist few other employment opportunities (Flaten 2002). This impacts the creation of local jobs and the support of local families. Dr. Levins created a metric based upon Schedule F Income Tax form, Profit or Loss From Farming, to assess local family support. This metric is calculated by summing tax expense categories: employee benefit programs, labor hired, pension and profit sharing plans, and net farm profit and dividing by gross income to determine what proportion of gross income goes to support local families (Levins, 1996). This indicator has been field-tested in both Michigan and Kansas.
- ***Amount of money/profit reinvested locally.*** Agricultural inputs (goods, labour, services) can be sourced from many places, but when they come from the local economy, the expenditure helps to sustain local businesses and livelihoods. Dr. Levins of the University of Minnesota used a proxy of the % of investments made within a 25 mile radius of the farm to measure local reinvestment in the Midwest (Leveins, 2003). He commented that that measure may need to be smaller or larger depending upon where the enterprise is located.
- ***Employment Level in Local Community.*** If employment is stable or growing, especially in farming, then the sustainability of the enterprise is sound in that demand for goods is probably on the rise.

ECONOMIC INDICATORS OF ENVIRONMENTAL PERFORMANCE

This section covers the impacts of farming operations on the environment.

Title of Indicator: Environmental Health

Definition or description of indicator:
Metric(s):

- ***Energy and machinery as percent of gross income.*** The amount and type of energy and materials consumed by a farmer greatly affects a farm's overall environmental performance through impacts such as emissions and nutrient run-off. Given this, the percentage of income spent on energy and machinery can be a proxy for the environmental impact of individuals operations. And the dollar amounts spent on these items are significant. In 1991, farmers "paid $19 billion for petroleum based inputs, $6.9 billion for repair and maintenance, $6.8 billion in non-mortgage interest, and $17.3 billion" in depreciation (Levins, 1996). Using this information, Dr. Levins developed a metric to measure the amount spent on energy and machines. Levins used Schedule F Income Tax form, Profit or Loss From Farming to estimate environmental impact. This metric is calculated by summing tax expense categories: chemicals; custom hire (machine work); depreciation on equipment and buildings; fertilizers and lime; gasoline, fuel and oil; rent or lease vehicles, machines & equipment; repairs and maintenance; and utilities and dividing by gross income (Levins, 1996). The greater percentage of income spent on this category, the greater the environmental impact. This indicator has been field-tested in both Michigan and Kansas.
- ***Indicator of feed production and use balance (same as Feed costs per litre of milk).*** Farmers that buy feed and spread manure themselves use more energy and incur more costs than farmers that graze their livestock. Moreover, if a farmer buys feed, he can not always ensure that it was raised in an environmentally sound way or if he sells feed, ensure that the animals eating the feed are well-cared for (Levins 1996). A sustainable farm buys and sells as little feed as possible (Ibid). Using this information, Levins created a metric to assess feed purchasing habits based upon the Schedule F Income Tax form, Profit or Loss From Farming. This metric is calculated by subtracting Gross Income from Crops Sold from Feed divided by Feed Purchased and dividing by gross income (Levins, 1996). This indicator has been field-tested in both Michigan and Kansas.
- ***Internalization of external costs of environmental regulations.*** "If costs associated with erosion, ground water depletion, water contamination and nitrogen accumulation were included in the cost of milk, farms that use sustainable practices would be at a much greater advantage" (A69). While this is a sound goal, it is difficult to design a program to require farms internalize their external costs to the environment or society without government intervention. Rather the social and economic portions of the template will allow Ben and Jerry's to determine to withhold sales from or help an enterprise improve its performance in these areas without developing a financial model for internalizing externalities.

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TITLE OF INDICATOR: NUTRIENT MANAGEMENT

Definition or description of indicator

- There is often an imbalance between the nutrients (Nitrogen, Phosphorus, Potassium – necessary for plant & animal growth) coming into the dairy farm system versus going out of the dairy farm system. This imbalance often takes the form of a surplus, with more nutrients entering the system than exiting the system. The imbalance creates a pollution problem in that leaching and runoff of excess nutrients can cause water pollution (agriculture is one of greatest contributors to groundwater & surface water pollution (IATP)) while gaseous and particulate emissions (possibly from volatization of ammonia – 4) create air pollution (acid rain, global warming, lung disease and problems with non-farm neighbors due to odors).- USDA nutrient site (*back up with data on size of problem in U.S.*).

  - U.S. study showed that 35 counties had manure nutrients in excess of total potential plant uptake and removal land, including pastureland (up from 6 in 1954) and 112 counties with excess levels of P (up from 38 in 1954); reflects areas of country with high livestock densities but insufficient cropland for manure disposal (10, p. 1020)
- Excess nutrients also mean inefficient use of resources because excess feed, fertilizer, and nutrients are going to waste (e.g. leaching or runoff) to result in pollution instead of contributing to crop growth.
- The problem is exacerbated by: shifting feed production from perennial forage crops to annual row crops, resulting in the need to purchase more feed and thus increase the amount of nutrients coming on to farm (USDA nutrient site)
- Research shows that N/P remaining on farm over one year's time ranges from 59-81% (Greg doc)
  - Feed and fertilizer are largest sources of nutrient import (89.5% N, 96% P) – Greg's doc
  - Milk or heifers (farms primary product) are largest exports
- Note that this indicator will only measure potential impact of nutrients: actual translation to water quality, soil quality, etc. will depend on climatic conditions, etc.
- A particular challenge for dairy is that many dairy farmers concentrate time and efforts on cows and milk production rather than crops, though crop yields and quality can greatly affect overall returns for the farm (1)
- Some calculations indicate that the amount of N fixed by human activity has doubled since advent of modern civilization and projected to double again in next 25 years (9, p. 27)
- Today, commercially manufactured chemical fertilizers are by far major source of applied plant nutrients in U.S. and commercial fertilizer accounted for 6.4% of total farm production expenses in 1997 (10 p. 1020)
  - 1997, comm.. fert. applied to 25% of total farmland
  - Comm. fert. use for corn very high: 98% of acreage in top 10 corn producing states received comm.. fert.
- Surplus of nutrients also detrimental to air quality (acidification) and global warming (ghg's); N loss can also happen through volatilization of ammonia to atmosphere from livestock housing and stored manure (17)
- Comm. fert. major source of nitrate contamination; nitrate-n levels exceeding VT public health std. of 10 mg/l (equiv. to ppm for water measure) nitrate-n have been found in many drinking water wells (15)
  - P is major surface water concern in VT
  - Nitrate levels in drinking water above federal and state drinking water stds. of 10 mg/l nitrate-n can pose a risk to some infants; young livestock also particularly susceptible to health problems from high n-n levels
- Nutrient losses: Ammonia → acidification, N → nitrate, P → eutrophication (comes from fertilizer used for fodder); N20 is a GHG (A70)

Metric(s)

- **Nutrient Yardstick/Nutrient balance/Hectare (ha)**: estimate of excess nutrients; difference between input (fertilizer, purchased manure, purchased cattle feed, roughage,

deposition and symbiotic N fixation) and output (main, by- and waste products leaving farm) of N/ha/year (4 & 5)

- U.S. version has inputs as fertilizers, manure, feedstuffs & roughage and outputs as milk, meat, wool, crops
  - Inputs/outputs registered by weight in yardstick worksheets to calculate balance of N, P and K
  - Enhances general understanding of flow, farmer would then have to do more detailed testing to evaluate where and how to improve performance (soil testing, crop-specific nutrient needs)
  - Nutrient flow can not, and should not, be in perfect balance – goal to minimize *avoidable* losses
  - Final score indicates pounds/acre excess N, P and K (can't do farm-farm or year-year comparisons b/c of changing conditions farm to farm and year to year, more meant to inform farmers about flow of nutrients)
    - Cash-grain farms tend to have minimal excesses in range of 0-50 lbs/acre while large hog feedlots may have 500 lbs.
  - Info needs:
    - Livestock farmers: weight gained by animals in last year, lbs. milk, wool, eggs or other animal products produced; weight and, if possible, nutrient content of manure removed from farm;
    - Crop farmers: amount of fertilizer used, amount of crops left on farm; for legumes: acreage, cutting and type of stand; nitrate content & volume of water used if using irrigation
    - General: acreage owned (crop, pasture), acreage rented (crop, pasture), total farmed acres
  - Adopted by ~1/3 of Dutch dairy farmers
- Could be calculated as gross balance as well as per cow, per acre or per unit of milk produced – looking at all three would be helpful for comparing across farms
- Note that surplus does not automatically mean a problem, rather, it is an indication of higher potential for a problem
- Per Greg Weber, this indicator could come down to imports only if necessary b/c the point is that the more nutrients coming on the farm, the more chance that they'll get into water supply
- Feed can represent entire input of P and largest input of N (3)
- Can translate results to **overall efficiency of nutrient use on farms**: calculated as N or P leaving farm as product (livestock itself, manure, forages, milk) divided by N or P imports (livestock itself, bedding, nitrogen fixation, fertilizer, purchased feed) multiplied by 100. (2)
- Yardstick best practices:
  - Soil cornstalk testing and fert. per Extension regs.
  - Credit manure and legumes
  - Intensive grazing to close nutrient cycle
  - Manure production not in excess of crop utilization
  - Manure effectively used throughout farm
  - Manure appropriately stored and applied to min. leaching and runoff
  - Crop managed using realistic yield goals
  - Diverse crop rotation used

        - Erosion and water runoff effectively managed through conservation tillage, strip cropping and other conservation practices
    - Factors beyond farmer's control
        - Unexpected weather/pest conditions: anything causing a less than expected yield means nutrients not being utilized by crops; weeds dec. growth of crop and capture nutrients for own growth
        - Severe weather: heavy rain can wash away significant amounts of nutrients, particularly early in the growing season
    - **Balance of nutrients/acre** (10, p. 1010)
- **Phosphorus Index**: tool to assess potential for P runoff from fields based on soil and field char. and mgmt. practices; more comprehensive than soil test b/c it considers erosion and runoff potential and manure and fertilizer P management; rather than attempting to estimate actual quantity of P lost in runoff, provides relative rating for risk of P runoff for indiv. fields in order to prioritize fields for nutrient and soil mgmt. (11, p. 1)
    - This version accounts for soil chemistry, landscape, and management practices common to VT (14)
    - Combines est. of P available for loss via runoff and erosion (P Source Potential) and transport mechanisms that could move P from field in runoff (P Transport Potential); site characteristics are weighted to account for relative importance in contributing to P runoff potential (11, p. 1)
    - Provides interpretations and recommendations for results (see papers 11 & 12);
    - P Index = P Transport x P Source Potential
    - P Soil Potential
        - Soil test P (STP): measure of plant-available P, which is well correlated with concentration of soluble P in runoff; measured as available P in Modified Morgan's extractant (ppm)
            - Modified Morgan P: very strong correlation with water soluble and CaCl2 solution P (14)
        - Fertilizer P (FP): readily available sources of P susceptible to runoff, adjusted for timing/method/placement;
            - Rate of fertilizer (lb. P2O5/acre) (BY YEAR?? NO DISTINGUISHING TYPES OF FERTILIZER??)
            - Sub-surface 1" or more below surface; incorporation means tillage to 3" or greater depth within 3 days application
            - P applied in non-growing season (Oct.-April) and left on surface has highest potential for run-off (14)
        - **Organic or manure P** (MP): readily available sources of P susceptible to runoff, adjusted for timing/method/placement
            - Rate of P applied as manure, compost, other organic material (lb. P2O5/acre)
            - Sub-surface 1" or more below surface; incorporation means tillage to 3" or greater depth within 3 days application
        - Reactive Al: Al in Modified Morgan's extractant (ppm); used b/c it is extractant used in crop nutrient recs.

        - Use only for non-surface-applied-fertilizer or manure – if manure not incorporated, presence of manure on surface will tend to outweigh the effect on increased soil test P, so no adj. made
        - Good indicator of how much the addition of P will increase the soil test P levels (low-moderate in Al show much greater increase in soil test P than those testing high)
    - =STP+(FP Rate x FP Method x Al) + (MP Rate x MP Method x Al)
  - P Transport Potential
    - Soil erosion (E): modified by factor for width of vegetated buffer between filed and adjacent drainage path or waterway
        - Ave. annual erosion rate in tons/acre per NRCS Revised Universal Soil Loss Eq. (RUSLE) (WHAT IS THIS??? HOW TO MEASURE IN ADVANCE??)
        - Tons/acre/year (HOW TO CALCULATE?? WHY MULTIPLY BY 1.5?)
    - Runoff (R): Runoff Class per % slope and either Runoff Curve Number or saturated soil conductivity (Low-med-high-PLEASE EXPLAIN)
    - Flooding (F) frequency: designation as defined in NRCS soil survey database for each soil mapping unit (???)
    - Buffer Width (BW): distance in feet of grass or other close-seeded vegetation, woody species, or a combination from field edge to waterway or path of seasonal concentrated flow (no manure or P fert should be applied to buffer)
        - Can retain portion of P in runoff, especially in particulate form (12, p. 3)
        - Prelim. results show sig. dec. in runoff P and sediment concentrations from grass-legume buffer strips at field edge
    - =((E x BW)+R+F)/25 → measured as value from .1 to 1.0; 25 is sum of highest possible scores
  - Irrigation erosion not included b/c use of irrigation in VT so limited (12, p. 4)
  - Assumes dominant loss mechanism for loading P to surface waters is runoff; minimal P lost to leaching (may be more in some areas) (12) – this is supported by Bernie's comments (Mich State)
  - If time limitations on testing all fields, can just do on those suspected to be problem
  - P-based manure application rates: generally indicates a manure rate based on the P content of manure and or P in soil or crop; P-based apps. recs. can be based on P crop need based on P soil test, Crop P removal (ie. applying only the amount of P that the crops will take up) or P soil test threshold level (12, p. 7)
  - May consider screening options (to prioritize fields most likely to have P runoff) for where to do P Index due to time intensity for site visit, measuring slope and other field char. (12, p 7)
    - Soil test P level (Fertility Index Value in MD)
    - Main consideration should be where potential loss from runoff or erosion is greatest, so they propose a P Runoff Screening Matrix (PRSM): has parameters that can be determined directly from soil survey database (runoff class, HEL classification, flooding freq) along with soil test P – doesn't require on-site field meas. (12)
- **Nitrate Leaching Index**: classifies fields as to amount of leaching expected under typical conditions to ID fields where nitrate leaching a concern (13, p. 1)

- Calculated from Soil Hydrologic Group, annual precipitation and non-growing season precipitation (???? – what is SHG?????)
- Plants have different N and P needs and manure P and N content is such that appropriate level of manure application will vary according to whether applying on P-base (lower app. rates) or N-base (will call for higher application rates for N-demanding crops like corn or grass hay); manure applied per P-base not likely to create N leaching problems and supp. N may be needed (13, p. 1)
- N-needs of crop depends on crop, expected yield, soil drainage, previous crop and past manure applications; use Pre-Sidedress Nitrate Test (PSNT) to evaluate N availability for corn and to determine if additional sidedress N is needed (see Nutrient Recs for Field Crops in VT from UVM Extension), 13, p. 1
  - Pre-Sidedress NT for corn: used annually on all fields, used for most fields most years, used occasionally, never used (16)
- Nitrate Leaching Index

- Questions to determine whether to use N or P Index: (13, p. 4)
  - 1) Does filed drain into p-sensitive surface waters?
    - Yes --> go to #2 (P Runoff Screen Test – see 13, p. 3)
    - No --> do N leaching index
      - Low or Moderate: use N-based manure app.
      - High or very high: need more restrictive N management (avoid fall manure application, attn. to app. rate (limit pre-plan N rate, use PSNT for additional fertilizer N need)
    - 2) Is PRSM rating high?
      - No --> use N-based manure application
      - Yes --> Run P Index determine how manure s/b applied
    - 3) P-Index rating
      - Very High: apply no manure and implement soil conservation practices
      - High: P-based manure app. (rate to supply p crop need; p crop removed as max); implement soil conservation practices
      - Low/medium: N-based manure app.
- **Routine soil testing (16): see sheet for parameters**
  - Frequency:
  - Sampling density
- **Existence/use of nutrient management plans (17)**
- **Use of soil tests (17)**
- **Manure management**
  - **Field selection**: 1) manure applied only to fields testing 7 ppm or less for available in soil test P 2) manure applied to fields testing 7-20 ppm for available in soil test P 3) manure applied only to fields testing greater than 20 ppm for available in soil test P (16)
  - **Animal units to spreadable acres ratio (see document for animal unit equivalency factors)**: 1) less than .5 animal units/acre of spreadable cropland 2) .5-1.0 animal units/acre of spreadable cropland 3) 1-2 animal units/acre of spreadable cropland 4) >2 animal units/acre of spreadable cropland (16)

- **Slope:** 1) applied on fields with slope of 0-2% 2) applied on fields with slope of 2-6% 3) applied on fields with slope of 6-12% 4) applied on fields with slope of >12% (16)
- **Application rate**: 1) not exceeding crop nutrient need for all fields 2) not exceeding crop nutrient need for most fields 3) exceeding crop nutrient need for most fields 4) manure application rate in fields unknown (16)
  - 1) manure spreader is calibrated and application rate estimated by counting loads or other reliable method 2) app. rate estimated visually 3) app. rate not estimated (16)
- **Application strategy:** 1) applied at rates to meet P need of crop 2) applied at rates not to exceed the crop removal of P and maintain current soil test P levels 3) applied at rates to meet N need of crop 4) applied without regard to crop need (16)
- **Timing & Method:** 1) Fall and/or spring applications injected or incorporated within 3 days of application 2) Fall and/or spring applications injected or incorporated within 4-7 days of application 3) Fall and/or spring applications left unincorporated >7 days 4) Fall applications left on surface (unincorporated) through winter (16)
- **Uniformity of applications**: 1) applied uniformly across fields over short period of time when emptying storage facility 2) applied relatively uniformly across fields on daily haul basis 3) applied in random or nonuniform manner across all fields (16)

- **Amount of inorganic N/P/K applied (/ha or /ton of product) (18)**
- **Proportion N fixed on site/imported (18)**
- **Balance of N/P/K over crop rotations (18)**
- **Emissions of N compounds to air (18)**
- **Nutrient management practices-crop nutrient application rates**: apply only the amount recommended or needed and time applications in order to prevent nutrients from leaving the field (prescriptive nutrient management techniques that can be used as a check/balance system as back-up to nutrient balance) (6)
  - Fertilizer applications comply with U or Extension crop and region-specific recommendations for rates and timing
    - U of VT Missisquoi Water Quality project used Pre-Sidedress Nitrate Soil Test for N recommendations; it accounts for changes in N availability as affected by soil and weather conditions (1)
    - Parameters can be 1) dn exceed, 2) over by 10-25%, over by 25-50%, over by >50% (16)
  - Nutrient application considers: soil type, previous crops, manures/composts, etc.
  - Use of various levels of nutrient management plans
  - Existence of procedures to record observations on indicators of success (e.g. algal blooms or excessive vegetation in water)
  - **Applied Minus Recommended Requirement of P2O5:** average of P2O5 application versus university-based recommendations (2)
  - Manure: Manure nutrient content: determined through lab analysis? Estimated using U of VT lab averages provided by UVM soil test report? Unknown? (16)
  - **Use of nutrient credits: (16)**
    - Manure: 1) credits confirmed through PSNT and fert app. rates reduced 2) manure nutrient credits calculated and fully deducted from fert. app. rates 3)

nutrient credits partially deducted (at least 50%) from fertilizer application rates 4) credits not deducted

- **Timing of P and K applications:** 1) immediate incorporation of broadcast applications OR ban application (such as starter fertilizer) 2) incorporation within 3 days of broadcast app. 3) broadcast app. to frozen soils of less than 6% slope 4) broadcast app. to frozen soils of less than 6% slope (16)
- **Starter fertilizer rates:** 1) starter fert. apps. that have less soil test values for P and K of optimum or less; app. rates based on soil test recs. 2) starter fert. apps. that have less soil test values for P and K of high or excessively high; app. rates based delivering app. 10-20 lbs. N, 15-30 lbs. P2O5, 10-30 lb. of K20 (such as 100 lb. of 10-20-10) 3) starter fert. apps. in excess of 10-20 lbs. N, 15-30 lbs. P2O5, 10-30 lb. of K20 on soils testing high or excessively high for P and K (16)
- **Calibration of fert. app. equip**: 1) app. equip. adjusted and calibrated at least 1x/year 2) app. equip. adjusted and calibrated at every other year 3) app. equip. not calibrated in last 5 years 4) never calibrated (16)
- **Record keeping:** 1) crop nutrient management decisions based on detailed field history records (yield, manure apps., crop rotation 4) no records (16)

- **Organic wastes (such as whey and sewage sludge)**: 1) applied to fields at rates not exceeding nutrient need of crop to be grown 2) applied to fields at rates exceeding crop need 3) application rate unknown (16)
- **Fertilizer storage & handling**: amount stored, type of storage, mixing and loading, other practices (15)
- **Organic indicators:** studies show that organic farms have lower N & P surpluses (5); to be used in conjunction with other indicators as a 'check'
- **Use of legumes**: could decrease need for N fertilizer (ATTRA)
  - Legumes: 1) legume N credits calculated acc. to U of VT guidelines (as in UVM soil test report) and fully deducted from N fert. app. rates 3) Legume N credits partially deducted (at least 50%) from fertilizer application rates 4) credits ignored/not deducted (16)
- **Soil Metrics**: specifically, organic content of soil due to findings that crops take up more N when soil organic matter increases (7-Mich State)
  - Particularly crop rotation (see Soil Quality)
    - **Soil measurements used in conjunction with management practice:** if P levels medium or higher (optimum range 4-7 ppm P), P fertilizer (30 lbs. P2O5/acre) did not increase yields; also, low-moderate additions of P fertilizer will maintain soil P levels and P declines only modestly with no application
      - Results for alfalfa-grass only – what is applicability to other crops?

Verifiability

- Data would be auditable, though audit process likely cumbersome. Possibly evaluate macro measures (eg. amount of purchased feed and fertilizer, grazing characteristics, soil quality, etc.) that could support a high or low nutrient balance.
- Preference would be to use three types of metrics: 1) Management practices, 2) Observation of farm characteristics and 3) Quantitative measures to allow for variability of reporting mechanisms as means of building in a check/balance system of results

Measurability

- Overall nutrient imports would be sufficient for the purposes of this study, per Greg. Though we would be ball-parking, level of accuracy and consistency across farms would be substantial enough. Caution on this would be accounting for base differences in the farms in terms of management practices (manure management, etc.), type of soil, type/acreage of crops, etc. Need further research on the specifics of these interactions.

Data collection

- Nutrient yardstick calcs. to take 30-60 minutes alone; simple but lengthy calculation tools
- Farmers should readily be able to provide (Greg/Greg study):
  - Field specific application rates for fertilizer and manure
  - Farm yields (loads/field, loads/acre)
  - Tons fertilizer purchased/applied (might not even need manure b/c manure nutrient content will be a function of nutrient in feed, which we are measuring separately)
  - Tons feed purchased/year
  - Nutrient content information for fertilizer and feed (should say on the product)
  - Applied available nutrients minus recommendations shows nutrient input and how well nutrient management plan is being followed
    - May be too complex due to large variations across field (some will have surplus, others not, so important to look at whole picture, which is total applied in first place, averaged over amount of farmland), crop type, variations in recommendation levels by state
    - Plus, consumed and sold nutrients typically less than total applied
  - Information should be gathered for annual time frame; think about timing of information request: will be able to get this information more easily around tax time when farmer has all information gathered/on-hand for doing taxes
- Could break down data into crop, feed and whole farm data; may help farmers with excess nutrients identify/correct source of problem
- Greg study looks at crop nutrients sold/fed to herd but requires conversion calculations (nutrient input to content in crops) too technical for our purposes (data results not worth it, estimation still a better approach)

Relevance to dairy

- Results will be extremely dependent on whether farm grows crops; per Greg Weber, this is the case for the majority of VT/NE farms and is an acceptable assumption to make
  - Greg study excluded "graze only"/"use no commercial fertilizer" farms from 'crop' portion of study b/c of difficulties in estimating nutrient application

Business case for farmer

- Farmers can lower amount of phosphorus supplements – could save U.S. dairy industry $100M annually while lowering risk of phosphorus pollution in surface waters (USDA)
- One farm decreased P2O5 application by 8.3 tons/year for savings of $4200/year. (2)

- By reducing P2O5 application by 40% (average reduction over a 3 year period), farms can reduce total fertilizer expenditures by an average of $2800/farm or $27/acre, while maintaining farm yields; further fertilizer reductions achieved by more precisely following expert recommendations would have resulted in additional savings of $6/acre (1, p. 2)
  - Note: it took 3 years for farmers to gain confidence in expert/consultant recommendations and reduce fertilizer application rates appropriately
- Benefits of system-related factors on minimizing pollution much more effective vs. mgmt. related factors, such as increasing animal performance per anima; per year (8)
  - Reducing N input of 100 kg N/ha more than doubly efficient in relation to the balance surplus than increasing average mile yield for 1000 kg/cow (8)

Interaction with other indicators

- Natural link to Water Quality/Pollution, Soil Quality, Air Emissions/Pollution
- Nutrient surplus can often be traced back to dietary phosphorus supplements and over-use of fertilizer; reducing the amounts of these inputs can lower farmers' expenses (Economic indicators) and may affect Herd Health
- Using rotational grazing can improve soil health (organic matter), herd health and economics (less costs for purchased/harvested feed)

Possible management strategies for improvement

- Uses tannin-containing alfalfa instead of normal alfalfa (USDA Nutrient site)
- Do not over-use phosphorus supplements (does not improve reproductive activity) (USDA)
- Adopt management intensive grazing (MIG) – decreases feed costs and manages nutrients (USDA)
- Precision in feeding and fertilizer application will allow for appropriate outputs/products with less nutrient input; must be careful that this does not affect production, which can affect profitability (not good for sustainability); it's an issue of risk-management: farmers over fertilize/feed to ensure production (Greg doc)

Interactions with Farm Characteristics

- Feeding/grazing/pasturing practices
- Manure management strategies
- Use of purchased feed/fertilizer
- Soil type (peat, sandy, clay, etc.)
- Stage of production on the farm
- Existence/type of ag crops

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TITLE OF INDICATOR: ORGANIC

Definition or description of indicator:

- The National Organic Program, implemented on October 21, 2002, dictates standards for organic food and livestock production in the United States. The regulations cover planning, production, handling, labeling, and record keeping.
- This standard is part of the Federal code, making it the only recognized standard for organic products in the United States (although programs from other countries may be granted USDA status). It is also the standard utilized by Ben & Jerry's for certification of its organic line.
- Organic production as an indicator is unique compared to the others that we have studied in that it addresses multiple aspects of farming as opposed to focusing on one indicator. Moreover, the regulations are a combination of metrics and best practices. Some requirements of the regulations are absolute in nature, such as the prohibition of non-organic seed stock. However, others are more qualitative such as the requirement to minimize soil erosion. In this case, certifying agents are expected to evaluate a farmer's performance regarding its environmental impacts. Therefore, some parts of the program rely upon absolute criteria whereas others rely upon non-absolute criteria and the certifying official's interpretation. See application form attached to review data collected by the certifying official. I am guessing that this is due to the fact that for most non-absolute criteria, specific measures such as pH balance in water, would vary depending upon the location of the farm within the US and definition of a specific metric would be impractical.
- Nonetheless, the system of organic farming provides a fairly consistent means of ensuring that most major environmental concerns are mitigated. Key environmental mitigations include a stable nutrient balance, sound water quality, little use of energy (due to low energy fertilizers/pesticides), and stringent animal welfare practices. Many of the benefits are gained due to the requirement of organic feed, given that feed production is responsible for many of the negative environmental impacts incurred during milk production (Cederberg, 1998).
- In an interview with Greg Larison from Organic Growers of Michigan, Larison asserted that organic farms are generally more labor intensive than large farms; therefore, they are generally smaller than conventional farms (generally less than 40 acres). And according to research, smaller farms lead to healthier civic participation and stronger communities (Loboa, 2001).
- Organic milk may also be sold at a premium allowing farmers to be economically viable in times of down milk prices. Today, government milk prices per hundred weight count are below the cost of production whereas organic milk is priced at nearly double the cost of non-organic milk. In a recent article, Stonyfield Farm president and CEO, Gary Hirshburg, committed to paying $21 per hundred pounds of milk compared to government prices set at $11. In the same article, Hirshburg quotes the price of milk production at $14 per hundred pounds of milk (Smallheer, 2003).
- This is all the more impressive given findings that organic harvests are typically 95% to over 115% that of conventional yields (Liebhardt, 2001, SARE, 2203). Yields may vary,

however, depending upon the amount of grazed forage compared to high-concentrate feed (Cederberg, 1998).

- The organic foods market is growing quickly. Currently, only 2% of the U.S. food supply is grown using organic methods, this leaves room for growth (Organic Farming Research Foundation, 2002), however, the market has grown approximately 20% per year since 1990 (Dimitri, 2002) with trends towards continuation.
- The downsides of using organic milk are price and availability. The price of organic milk is approximately 60% higher than conventional supply (ERS, 2003). This is in part due to higher labor and feed costs, but also due to the premium price the product can ascertain from the market.
- Large quantities of milk are also difficult to obtain given that more consumer sand producers are switching to organic milk. Ben & Jerry's itself has had to seek organic milk sources outside of the Northeast because the organic milk supply in the Northeast was already accounted for by other producers (Spinelli, 2003). This causes increased environmental impacts due to extra transport, etc., that may outweigh the environmental benefits of organic production.

Metrics

The following metrics to measure organic production are taken from the regulations and are divided into three categories: Overarching metrics, absolute metrics, and non-absolute metrics. The overarching metric, certification, means that all absolute and non-absolute requirements of the regulations are met. Absolute metrics are those criteria that must be met under the regulations, with no room for interpretation by the certifying official. Non-absolute metrics are requirements under the regulations that must be met, but lack strict definitions for "compliance" leaving the certifying official to evaluate performance in each category. We may choose to select any combination of these metrics for our template.

Metric(s) (Overarching):

- ***Certified Organic.*** Certification by a USDA certifying agent ensures that a producer is complying with both the absolute and non-absolute criteria outlined in the regulations and described in the two sections below.

Metric(s) (Absolute Criteria):

- ***Organic production and handling system plan.*** A producer or handler must provide a management plan which includes a description of the practices and procedures to be used and with what frequency, a list of substances to be used, a description of monitoring practices and procedures, a description of a recordkeeping system, and a description of management practices to prevent the commingling of organic and non-organic products.
- ***Livestock feed.*** Producers must provide organic livestock organic feed including pasture and forage. It may also provide non-synthetic and synthetic feed additive and supplements allowed under the rule. The producer must not use animal drugs, including hormones, to promote growth, provide feed supplements or additive above amounts needed for nutrition and health maintenance, feed plastic pellets for roughage, feed formulas containing urea or manure, feed mammalian or poultry slaughter by-products,

or feed additives or supplements in violation of the Federal Food, Drug, and Cosmetic Act.

- ***Use of drugs, vaccinations, hormones.*** Milk or milk products may not be sold if biologics have been administered within 30 days. Producers may not administer any drugs or vaccinations in the absence of illness, use growth hormones, administer synthetic parasiticides on a routine basis, administer parasiticides to slaughter stock, administer drugs in violation of the Federal Food, Drug, and Cosmetic Act, or withhold medical treatment from a sick animal in an effort to preserve its organic status. All appropriate medications must be used to restore a sick animal to health. Livestock treated with prohibited substances may not be represented as organic.
- ***Land requirements.*** Any parcel of land must have been managed according to the soil fertility and crop nutrient practice standard (see below) and have had no prohibited substances applied to it for at least three years preceding harvest of any crops.
- ***Origin of livestock.*** Livestock must be under continuous organic management from the last third of gestation. Milk or milk products must be from animals that have been under organic management for at least one year. If a grower wanted to convert an entire herd, he or she must provide a minimum of 80% organic feed for 9 months, provide 100% organic feed for the last three months, and ensure organic management for the last 3rd of gestation. Livestock may be brought onto an operation as long as it is not later than the last third of gestation. Livestock removed from an organic operation may not be sold as organic. All management must be continuous. Records must be maintained to identify organically managed animals.
- ***Separate organic and non-organic handling systems.*** The handler must implement measures necessary to prevent commingling of organic and non-organic products and protect products from prohibited substances. He or she must not package goods in containers that have a synthetic fungicide preservative or fumigant or use or reuse any container that could contaminate the integrity of an organic product.
- ***Product labeling.*** Products sold as '100% organic' must contain by weight or fluid volume, excluding water and salt, 100% organically produced ingredients. Products sold as 'organic' must contain (by weight or fluid volume excluding water and salt) not less than 95% organically produced products. Products sold as 'made with organic (specified ingredients or food group(s)' must contain (by weight or fluid volume excluding water and salt) not less than 70% organically produced products. These products may not use the USDA seal. No ingredients may be produced using prohibited practices such as using sewage sludge or ionizing radiation. Products with less than 70% organically produced ingredients may identify each ingredient that is organic with the word organic and if the percentage of organic contents is shown on the information panel. These products may not sue the USDA seal. [There is a lot more on this, but I thought that it wasn't really applicable].

Metric(s) (Non-Absolute Criteria):

- ***Soil fertility and crop nutrient management practice standard.*** The producer must implement tillage and cultivation practices that maintain or improve the physical, chemical, and biological condition of soil and minimize soil erosion; manage crop nutrients and soil fertility through rotations, cover crops, and the application of plant and animal materials; and manage plant and animal material to maintain or improve soil

organic matter content "in a manner that does not contribute to the contamination of crops, soil, or water by plant nutrients, pathogenic organisms, heavy metals, or residues of prohibited substances." Specific direction is included for raw animal matter, composted plant and animal materials, and uncomposted plant materials. In addition, methods for managing crop nutrients through other means are provided.

- ***Crop pest, weed, and disease management practices standard (for feed producer).*** The producer must use management practices to prevent crop pests, weeds, and diseases through crop rotation, sanitation measures, and cultural practices such as "selecting plant species and varieties that are resistant to pests, weeds, and diseases." When natural methods cannot control pests, weeds, and diseases, an allowed synthetic substance may be used as long as it is documented in the organic plan.
- ***Crop rotation practice standard (for feed producer).*** The producer must "implement a crop rotation including, but not limited to sod, cover crops, green manure crops, and catch crops" to maintain or improve soil organic matter content, provide for pest management, manage nutrients, and provide erosion control.
- ***Livestock health care practice standard.*** The producer must provide and maintain health care practices including: selection of species and types of livestock with regard to suitability for site-specific conditions; provide a feed ration sufficient to met nutritional requirements; establish appropriate housing; pasture conditions and sanitation practices; provision of conditions which allow for exercise, freedom of movement, and reduction of stress; performance of physical alterations to minimize pain and stress; administer vaccines and biologics.
- ***Livestock living conditions.*** The producer will provide living conditions that accommodate the health and natural behavior of animals including: access to outdoors, shade, shelter, exercise areas, fresh air, and direct sunlight; access to pasture for ruminants; clean dry bedding; and shelter designed for natural maintenance, comfort behaviors, and opportunity to exercise, temperature level, air circulation, and reduction of potential for injury. The producer may provide temporary confinement due to inclement weather, animal's stage of production, conditions where health and safety may be jeopardized, or for risk to soil or water quality. The producer must manage manure in a manner that does not contribute to contamination of crops, soil or water and optimized recycling of nutrients.
- ***Facility pest management practice standard.*** The producer or handler must use practices to prevent pests, including, but not limited to: removal of pest habitat, food sources, and breeding areas; prevention to access facilities; and management of temperature, light, humidity, etc. Pests may be controlled through: mechanical or physical controls, lures and repellents allowed under the rule, or methods not allowed under the rule if the handler and certifying agent agree on the method and the handler updates the management plan accordingly.
- ***Organic handling requirements.*** Mechanical or biological methods may be used to process organic products for the purpose of retarding spoilage or preparing goods for market. Allowed nonagricultural substances and non-organically produced substances may be used if the product is not commercially available in organic form or may be labeled as "made with organic (X)."

ORGANIC: GENETICALLY MODIFIED ORGANISMS

Definition or description of indicator.

- Genetically modified organisms (GMOs) and genetically modified micro-organisms (GMMs) are defined as "organisms (and micro-organisms) in which the genetic material (DNA) has been altered in a way that does not occur naturally by mating or natural recombination" (The European Commission, 2002).
- According to the Genomes Project of the US Department of Energy Office of Science, genetic modification is a "special set of technologies that alter the genetic makeup of such living organisms as animals, plants, or bacteria….Combining genes from different organisms is known as recombinant DNA technology, and the resulting organism is said to be 'genetically modified,' 'genetically engineered,' or 'transgenic'." The office goes on to purport the wide use of genetically modified crops in over 40 countries and on 6 continents, but 99% of genetically modified crops are grown in four countries, the United States (68%), Argentina (23%), Canada (7%), and China (1%).
- DOE goes on to describe the potential benefits of and controversies surrounding the use of GMOs. Benefits identified by the Department of Energy include:

    - **Crops:** Enhanced taste and quality; reduced maturation time; increased nutrients, yields, and stress tolerance; improved resistance to disease, pests, and herbicides; and new products and growing techniques.
    - **Animals**: Increased disease resistance, productivity, hardiness, and feed efficiency; better yields of meat, eggs, and milk; and improved animal health and diagnostic methods.
    - **Environment:** "Friendly" bioherbicides and bioinsecticides; conservation of soil, water, and energy; bioprocessing for forestry products; better natural waste management; and more efficient processing.
    - **Society**: Increased food security for growing populations.

- Potential problems with use of GMOs identified by DOE include:
    - **Safety Risk:** Potential human health impact including allergens, transfer of antibiotic resistance markers, and other unknown effects as well as potential environmental impacts including unintended transfer of transgenes through cross-pollination, unknown effects on other organisms (e.g., soil microbes), and loss of flora and fauna biodiversity.
    - **Access and Intellectual Property**: Domination of world food production by a few companies; increasing dependence on Industrialized nations by developing countries; and bio-piracy—foreign exploitation of natural resources.
    - **Ethics:** Violation of natural organisms' intrinsic values; tampering with nature by mixing genes among species; objections to consuming animal genes in plants and vice versa; and stress for animal.
    - **Labeling**: Not mandatory in some countries (e.g., United States) and mixing GM crops with non-GM confounds labeling attempts.
    - **Society**: New advances may be skewed to interests of rich countries.

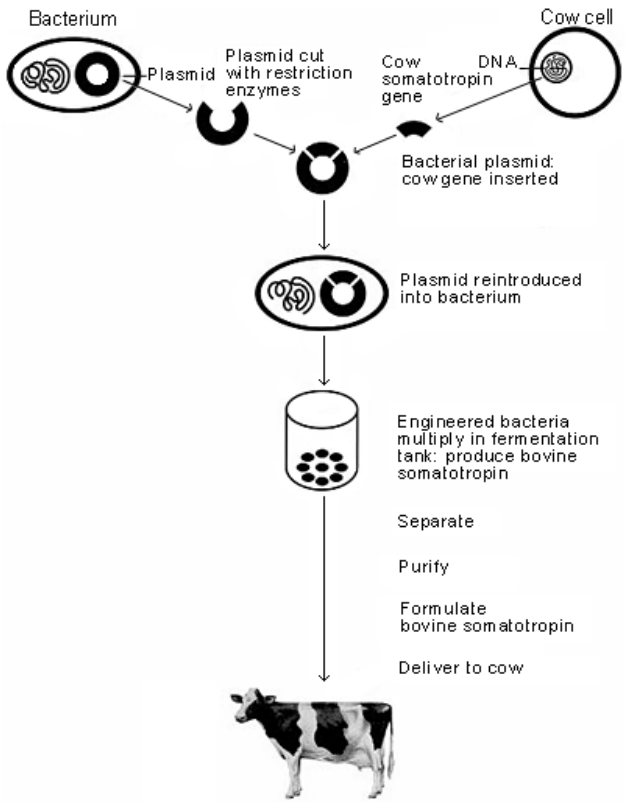
- Controversies over use of GMOs have been especially strong in Europe where strict regulations have been instituted for approval of GMOs (Directive 2001/18/EC, Directive 90/220/EEC, and EU Memo). The newest directive, Directive 2001/18/EC, requires in-depth environmental assessments and public comment on the approval and release of any new GMOs. 16 GMOs were approved for use under the 1990 regulations. No GMOs have been approved under the new 2001 regulations.
- In the US, three federal agencies, the Food and Drug Administration (FDA), the Environmental Protection Agency (EPA), and the U.S. Department of Agriculture (USDA), have regulatory responsibilities. According to the Department of State, "FDA provides voluntary pre-market consultations with food companies, seed companies, and plant developers to ensure that biotechnology derived foods meet regulatory standards for safety; the USDA's Animal and Plant Health Inspection Service (APHIS) licenses field testing of crops prior to commercial release of newly developed plant strains; and the EPA registers pesticides in U.S. commerce (including plants engineered to produce pesticides) and establishes levels at which pesticides in foods are permitted" (Department of State, 2003).
- The White House outlined this approach in a 1986 document entitled Coordinated Framework for Regulation of Biotechnology. A number of GMOs have been approved for use in the US (Biotechnology Industry Organization, 2003).
- GMOs are used in the dairy industry primarily in processed foods, cattle feed and to produce recombinant Bovine Growth Hormone (rBGH).
- Public backlash against GMOs has caused concern both in the US and Europe. As early as 1999, Archer-Daniels-Midland asked US producers to separate GMO and non-GMO stock due to increasing demands for non-GMO products in Europe and Asia (Dorey, 1999).

Metric(s):

- ***Use of GMO feed:*** Whether or not the organization uses genetically-modified organism feed to make its products. Problems associated with the use of GMO feed are similar to the problems listed above. However, in the US, obtaining this feed may be cost prohibitive for farmers; currently, Stonyfield farms does not require GMO-free feed by its conventional dairy farmers for cost reasons (Stonyfield, 2003).

- ***Use of hormones (rBGH) to affect product attributes:*** Whether or not the organization uses rBGH. Bovine growth hormone, or bovine somatotropin (BST), is produced by the pituitary gland in cows and effects milk production. Genetically engineered microorganisms have been developed to create to produce an almost identical hormone [recombinant bovine growth hormone (rBGH)] that when injected into dairy cattle, can increase milk production by 10% to 15% (Department of State, 2003). The process for making BST is shown below.

Bovine somatotropin production (Monsanto, 2003)



rBGH when injected into cows can also be passed into offspring and create genetic modifications in the strains (Spinelli, 2003). Negative effects of rBGH include excess milk production and probable udder pain for cows, increased udder infections, bacteria, pus, and antibiotic resistance (HFA, 2003). These impacts in cows can be passed on to humans with links to increased risk of cancer and antibiotic resistance (Ibid).

The Biotechnology Industry Organization estimates that over 30% of U.S. dairy cows are injected with recombinant BST to increase milk yield (Biotechnology Industry Organization, 2003). Monsanto is currently the only company producing rBGH under the brand name Posilac® Bovine Somatotropin (BST).

ORGANIC: CERTIFICATION

- ***Definition or description of indicator.*** Environmental certification is one way to ensure continuous environmental improvement (as is the case with ISO 14000) or that a certain environmental standard in production is met (as with the organic regs discussed above). ISO 14000 is a system employed by generally large companies who can afford to invest in often complex tracking systems and the certification process. Therefore, I would not recommend that this indicator be used. For a discussion of organic certification, please see above. Ben & Jerry's could also require that its suppliers be certified by the Food Alliance or a similar organization. This process would ensure

sustainable environmental performance, but may be too costly for farmers who are already struggling to remain in operation given current depressed milk prices. Initial fees are $500 plus program fees, arranged on a sliding scale varying between $250 for farms with sales under $25K to $4,375 for farms with sales between $750k and $1M. Certification is one way to achieve 3rd party verification and eliminate Ben & Jerry's need to complete environmental sustainability assessments of suppliers themselves.

Metric(s):

- ***Record of Certification from a credible organization.*** The certification would be selected by Ben & Jerry's.

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TITLE OF INDICATOR: PEST MANAGEMENT

Definition or description of indicator

- Chemical pesticides (herbicides, insecticides, fungicides, rodenticies, etc., and chemicals like plant growth regulators) reduce human labor needs/costs but harm wildlife/environment, cause human health problems (chronic, long-term health problems for farmers and farm workers), may result in residues on food (children particularly at risk), can contaminate ground and surface water
- Synthetic pesticides and herbicides 1st introduced to ag in the 1940's; U.S. pesticide use increased 10-fold from '45 to '89 yet total crop loss from pests nearly doubled in that time period from 7 to 13% (6, p. 1021); insects and weeds developed resistance so need more powerful chemicals needed and pesticides killed indiscriminately, killing wildlife and degrading ecosystems in addition to targeted insects and plants (4, p. 1)
  - Rise in crop losses due to abandoning crop rotations and increased crop homogeneity (6, p. 1021)
- Pesticides can be damaging to water supplies:
  - Large quanitities (spill or backsiphoage accident) can cause acute health effects (moderate to severe depending on toxicity/amount of exposure)
  - Trace levels can result in chronic exposure (prolonged or repeated exposure to low doses) that can be hazardous to people or livestock

Metric(s)

- **Soil quality indicators**: healthy soil may prevent soil born pestilence; also, use of cover crops can reduce weeds and non-beneficial insects
- **Existence of IPM planning measures** (Food Alliance recommends use of 2-4 of below):

- Use of pest & disease resistant crops
- Crop rotation
- Site selection for crop establishment
- Canopy humidity management (plant density, irrigation, raised beds)
- Soil/plant tissue sampling for fertility management
- Field insect population sampling to inform pest management
- Field sanitation as preventative measure
- **IPM knowledge and skills (7)**
  - Farmer and consultant (if hired) understand key pest life cycle factors and exploit "weak links" for effective management. Pest ID and scouting info. Always used to manage pests & beneficial organisms
  - Farmer knows key pest species of crops, has been trained in pest ID, OR employs certified consultant. Scouting information often used to manage pests. Information on beneficials is not used.
  - Farmer knows key pest species of crops and has been trained in pest ID, but does not routinely use scouting information to manage pests.
  - Farmer has not been trained to ID pests OR does not seek advice from professional consultant when managing pests.
- **Crop rotation (7)**
  - Rotation with more years of small grains (oats, wheat, etc.) and/or legumes than row crops. Additional crop diversity is used, including stripcropping, and cover crops.
  - Three-crop rotation used including a legume and/or small grain. OR Rotation of row crop with legume or small grain every other year.
  - Rotation of row crops with a legume or small grain at least one out of every three years.
  - Continuous intense row crop(s) with no rotation.

- **Reduced pesticide application rates**: lowest is following mfr.'s label, spot spraying/alternate row spraying (medium-when target pest doesn't require complete coverage), applications adjusted for specific circumstances (match density and severity of problem, preserve beneficial insects, concentrate (low-volume) applications, match density/size of plants), no pesticides used (best) (2)
  - Amount of pesticides (active ingredient) applied (/ha or / ton of product) (9)
  - **Use of non-chemical pest control methods, use of IPM** (8)
  - Pesticide use & risk (8)
  - Appropriateness to pest/crop/degree of pest problem
  - **Quantity of chemical inputs/unit of production** (6, p. 1010)
  - **Treatment threshold (7)**
    - Pesticide applications are made only when pests reach a predetermined treatment threshold. "Weak link" of pest's life cycle is targeted for pesticide applications.
    - Pesticide application is based on pest population levels determined by scouting, but treatment threshold is not used.
    - Pesticide application is made at first sign of pests.
    - Pesticide application is based only on calendar date or stage of crop development.
  - **Application rate (7)**

        - Farmer uses pesticide below label rates in conjunction with cultural practices (e.g. banding with cultivation or ridge tillage). Spreader is calibrated. Records are kept of materials applied. .
        - Farmer uses sprayer technologies and methods to reduce amount applied. Spreader is calibrated. Records are kept of materials applied.
        - Farmer applies pesticide at label rates based on needs determined by scouting. Spreader is calibrated. Incomplete records kept of materials applied.
        - Pesticides are applied over the label rate, and/or not according to label. Sprayer is not calibrated. Records not kept of materials applied.
    - **Spill response plan (7)**
        - Spill response plan is written, kept current, and reviewed by family and employees. Authorities are notified immediately after a spill of a hazardous compound.
        - Spill response plan is written and routinely reviewed by family and employees.
        - Phone numbers of emergency response are next to phone.
        - Spill response plan is developed but not routinely reviewed by family and employees.
        - Farm has no written response plan.
- **Pesticide equipment calibration**: once/year, once/season, >once/season or continuously, written calibration and spray record, calibration adjusted to control amount and distribution, use technology to keep particle size <150 microns, use equipment specific to conditions (e.g. hooded sprayers) (2)
- **Minimize drift:** Existence of buffer zones, use of surfactants, pesticide application under optimal weather conditions/weather conditions monitored (low wind speed, not raining, adiabatic barometric pressure conditions)
    - **Weather**: applications scheduled appropriately for weather-dependent pests and/or varieties selected to avoid weather-related diseases common to the location
    - Weather Conditions (wind speed and rain forecast) (7)
        - Weather forecasts are used to plan pesticide applications. No spraying is done when wind would move it off target. Applications are made during label-required rain-free periods.
        - Weather forecasts are considered when planning to spray.
        - Pesticide application are made during rain-free periods and at low wind speeds.
        - Spraying is done on windy days OR post-emergence pesticides are applied when rain is imminent.
        - Weather forecasts are not considered when planning to spray. **Spraying in weather conditions contrary to the label.**
    - Residue management & cover crops (7)
        - Crop residues and cover crops are always used to minimize pesticide leaching, runoff, and erosion by wind
        - Crop residues and cover crops are frequently used to minimize pesticide leaching, runoff, and erosion by wind.
        - Crop residues and cover crops are sometimes used in fields highly susceptible to leaching, wind erosion, or runoff of pesticides.
        - Crop residue and cover crops are not used anywhere on the farm.
- **Pesticide type**: use only pesticides registered in state as approved for target pests/crops/ livestock (no mixtures prohibited on label), mix/alternate pesticides

(different chemical class/mode of action starting Y1) to reduce risk of resistance development, pesticides labeled "Danger" used only in emergencies
  - **Type applied:** profiling, positive list, weighting factor (9)
- **Crop monitoring:** 1) keep production records (chemical and fertilizer inputs, yields, quantity), 2) crops sampled for insect, disease, etc. 3) records used to inform pest & nutrient mgmt.
- **Pesticide record keeping:** 1) legal requirements for record keeping met (date, field ID, pesticide name/EPA #, formulation, rate & # of acres treated), 2) weekly (ideal) pest scouting with records (for verification, should see evidence of pest scouting: sticky traps, sweep nets, hand lenses, etc.), 3) pesticide application timing/quantity correspond with needs (per records), 4) monitor and tabulate toxicity rankings to see progress in decreasing amt. of high toxicity pesticides
- **Hazardous material storage:** hazardous materials (pesticides, fertilizers, fuel, lubricants) stored in facilities in original containers at least 150 ft. from wells and 200 ft. from surface water or flame sources, management practices including approved container disposal/recycling, separation of materials by type (herbicide, pesticide, fungicide, etc.), flammable/non, hazardous/non (e.g. feed, seed, etc.), storage area labeling, storage facility characteristics (locked, sealed floor, well ventilated, FIFO inventory management, written inventory maintained), minimized use of hazardous materials (labeled 'Danger' or 'Caution') and/or special storage for such materials (2 – see source for more detail)
  - Keep pest in orig. container with label (5)
  - Never mix pesticides unless rec. by label (5)
  - Keep all containers dry during storage and transport
  - Drive carefully
  - Triple rinse or pressure rinse containers and pour rinsate into spray tank so all product purchased is used acc. to label directions (5, p. 10)
  - Many pest. dealers sponsor collections to recycle clean pesticide containers (5, p. 10)
  - **Transport**: (5, p. 10)
    - Transport in back of truck or trunk (never where passengers are)
  - **PESTICIDE STORAGE (7)**
  - **Amount stored**
    - No pesticides stored at any time.
    - Less than 1 gallon or less than 10 pounds of each pesticide.
    - More than 1 gallon or more than 10 pounds of each pesticide.
    - More than 55 gallons or more than 550 pounds of each pesticide.
  - **Leachability (**Use Pesticide Leachability Table to determine the risk factor.)
    - No chemical stored.
    - Chemicals classified as having low leaching potential.
    - Chemicals classified as having medium leaching potential.
    - Chemicals classified as having high leaching potential.
  - **Liquid or dry formulation**
    - No liquids. All dry.
    - Some liquids. Mostly dry.
    - Mostly liquids. Some dry.
    - All liquids.

- **Spill or leak control in storage area**
  - Impermeable surface (such as concrete) does not allow spills to soak into soil. Curb installed on floor to contain leaks and spills.
  - Impermeable surface with curb installed has some cracks, allowing spills to get to soil**. OR** impermeable surface without cracks has no curb installed.
  - Permeable surface (wooden floor) has cracks. Impermeable surface has no curb. Spills could contaminate wood.
  - Permeable surface (gravel or dirt floor). Spills could contaminate floor.
- **Containers**
  - Original containers clearly labeled. No holes, tears or weak seams. Lids tight.
  - Original containers old. Labels partially missing or hard to read.
  - Containers old but not leaking. Metal containers showing signs of rusting.
  - Containers have holes or tears that allow pesticides to leak. **No labels.**
- **Security**
  - Fenced or locked area separate from all other activities. Signs at storage area.
  - Fenced area separate from most other activities.
  - Open to activities that could damage containers or spill chemicals.
  - Open access to theft, vandalism and children. No signs.
- **CONTAINER DISPOSAL (7)**
- Disposal location
    - Triple-rinsed containers returned to dealers or taken to licensed landfill or municipal incinerator. Bags returned to supplier or hazardous waste collection service used.
    - Unrinsed containers and empty bags taken to licensed landfill, municipal incinerator or dump.
    - Disposal of unrinsed containers or empty bags on farm. Disposal of triple-rinsed containers on farm. Disposal of container in a manner inconsistent with label.
    - Disposal of partially filled plastic or paper containers on farm. Disposal of container in a manner inconsistent with the label.
- **Use of atrazine**: standard herbicide for maize in U.S. and Europe, banned in Sweden in 1992 due to high soil mobility and persistence leading to high risk for groundwater contamination (1)
- **Portion of harvest lost due to pests, diseases** (6, p. 1010)
- **Frequency & magnitude of pesticide application/pesticide metrics**: how often/how much pesticide applied vs. need/recommended; can measure with (1)
  - % unsprayed area over a year (also '8')
  - Treatment frequency
  - Amount of weeks in grain crops at heading growth stage (visually assessed)
  - Level of toxicity and risk of leaching or volatization of each pesticide (1)
- **% uncultivated area** (1)
- **Use of trap crops**: insects prefer these plants as food source (3)
- **Organic metrics**
- **Pesticide Applicator Certification**: private and commercial applicators must pass written exam appropriate for use of pesticides; class A and B dealer must also pass licensing exam (5)

- Any person producing an ag product on land they own or rent or who wants to apply pesticide for hire, who wants to use restricted use pesticides, must be certified; must be knowledgeable about VT Regulations for Control of Pesticides (Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) regulates pest. use in US, p. 4)
- **Pesticide training (7)**
  - People who mix, load, and apply all pesticides are certified through a state regulatory agency, and keep current on pest control strategies between certifications.
  - People who mix, load, and apply all pesticides are certified, but do not stay current on new pest control strategies between certifications.
  - People seek certification only to mix, load, and apply restricted-use pesticides.
  - People who mix, load, and apply restricted-use pesticides are not certified.
- **# of violations/complaints/inquiries lodged against farm under VT Regulations for the Control of Pesticides/FIFRA**:
- **Procedural requirements of the EPA's Worker Protection Standard**: WPS requires employer to take steps (information about exposure/protection against exposure/ways to mitigate exposure) to reduce risk of pesticide-related illness/injury for workers; WPS is a US EPA reg. adopted by many states; all orig. regs. still valid but can check for updates through VT Dept. of Ag., Food and Markets
  - **Information**: WPS requires (5, p. 5 & 6)
    - Pesticide safety training for workers/employers
    - Pest. safety posters
    - Access to labeling info. for pest. handlers & early entry workers
    - Access to application list of pesticide treatments
    - **WPS Posting Requirements:** (5, p. 8)
      - Field Notification: required when workers within .25 mile of treated areas during pest. app. or while REI in effect; most products allow oral or field sign notification, except where double notification required on pest. labels
      - Central posting: requires
        - EPA WPS safety poster
        - name address and phone of nearest emergency medical facility
        - Pesticide recordkeeping for ALL applications (kept for 30 days after REI)
        - Product name, EPA registration #, and active ingredients
        - Location and description of treated area
        - Time and date of application and REI
  - **Protection**:
    - Prohibit handlers from applying pesticide in way that will expose workers
    - Exclude workers from pest. treatment areas or areas under restricted entry interval (REI: time after pest. app. when workers can't enter area; found on pest. labels)
    - Protect early entry workers doing work in REI area

    - Special instructions/duties related to correct use of personal protective equipment (PPE): PPE required for pest. handlers and early entry workers as directed on pesticide labels
    - Notify workers about treated areas
    - Required monitoring while handling highly toxic pesticides
- **Mitigation**:
    - Decontamination sites appropriate for pest. apps.: must be kept up to 30 days after app. of pesticide requiring them per 1992 rule based on info. on pest. persistence
    - Available transportation to medical facility and information on type of pesticides used in case of poison/injury
    - Training options exist for **WPS Training Verification**
- **Steps to avoid pesticides becoming waste**: pesticides become waste when no longer usable/wanted: exposed to extreme heat, cold, dampness; cancelled or suspended (obsolete); unidentifiable; not needed or wanted
    - Mnimize use and storage of pesticides
    - Purchase only what is needed for one season and only mix what is needed for each application to avoid leftovers
    - If needing to save pest. from year to year, make sure container is secure, store in safe & dry location; use pesticides ASAP
    - See if dealer will take back unused pesticides
- **Avoidance of needing pesticide disposal options**: options include (5, p. 9 & 10)
    - Hazardous waste hauler for collections (state EPA will have list of licensed ahz. waste haulers in state)
    - Local solid waste district to see about programs for farmers, small businesses; less costly than haz. waste hauler

- **MIXING AND LOADING PRACTICES (7)**
    - Location of well in relation to mixing/loading area
        - 200 or more feet downslope from well.
        - 200 to 100 feet downslope from well.
        - 100 to 50 feet downslope from well, or 100-500 feet upslope.
        - Within 50 feet downslope or within 100 feet upslope from well.
    - Mixing and loading pad (spill containment)
        - Concrete pad with curb keeps spills contained. Sump allows collection and transfer to storage. Concrete pad with curb keeps spills contained. No sump. Mixing in clay fields.
        - Concrete pad with some cracks keeps some spills contained. No curb or sump. Mixing in silt field.
        - No mixing/loading pad. Mixing on permeable soil (sand). Spills soak into ground.
    - Water source
        - Separate water tank.
        - Water supply away from well.
        - Water supply near well.

        - Obtained directly from well, river or pond.
    - Backflow prevention on water supply
        - Anti-backflow device installed or 6-inch air gap maintained above sprayer tank.
        - Anti-backflow device installed. Hose in tank above waterline.
        - No anti-backflow device. Hose in tank above waterline.
        - No anti-backflow device. Hose in tank below waterline.
    - Filling supervision
        - Constant
        - Frequent
        - Seldom or never
    - Handling system
        - Closed system for all liquid product transfers.
        - Closed system for most liquids. Some liquids hand poured. Sprayer fill port easy to reach.
        - All liquids and dry product hand poured. Sprayer fill port easy to reach.
        - All liquids and dry product hand poured. Sprayer fill port hard to reach.
    - Sprayer cleaning and rinsate (rinse water) disposal
        - Sprayer washed out in field. Rinsate used in next load and applied to labeled crop.
        - Sprayer washed out on pad at farmstead. Rinsate used in next load and applied to labeled crop.
        - Sprayer washed out at farmstead. Rinsate sprayed less than 100 feet from well.
        - Sprayer washed out at farmstead. Rinsate dumped at farmstead or in nearby field.

Verifiability

- For pesticide record keeping, should see evidence of pest scouting: sticky traps, sweep nets, hand lenses, etc.

Business case for farmer

- Goodwill from use of biologically-based IPM
- Lower liability risk

Interaction with other indicators

- Economics
- Social: human health, food safety, workers rights/safety
- Soil quality
- Water use and water quality

Interactions with Farm Characteristics

- Climatic and ecosystem characteristics of region
- Regional pest problems

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COMMUNITY HEALTH INDICATOR: QUALITY OF LIFE

Farming families are often living from season to season depending on the fluctuations of the market and of the weather. The unpredictability of these factors has recently increased, making farming undesirable. To help this situation, it is important to preserve and perhaps even enhance the farmer's quality of life. For example, if the time spent on the farm is significantly greater than the time spent with family, then the social sustainability of the farm will be in jeopardy.

Indicator #1: Quality of Life of the farmer. Social sustainability includes quality of life for labor and families on farm. This includes good communication, trust, and mutual support.

Metrics[CSS, 53]

i. Full Family Participation. Full family participation implies that quality of life is high.
ii. Time spent on property
iii. Hours of labor to income
iv. Hours of labor to yield
v. Hours spent with family/leisurely activities'
vi. Are you doing things to improve the quality of life for you and your family? (ATTRA, 4)
vii. Psychological Well Being of farmers

viii. Multiple Job Holdings. In recent years, almost 60% of US Farm households had either the spouse, operator, or both employed in off-farm work and approximately 80% had higher cash incomes from off farm earnings (including wages, rent, interest), than from the farm. (A.. Weersink et all, 128). Dual employment has been studied as a reason for a reduction in

agricultural labor force and the trend towards larger farms, fewer owners/farmers. The reasons for pursuing off farm jobs are obvious. In the case of low farm returns, off farm earnings provide for basic necessities and maintain the dairy farm business. In addition, off farm income provides a chance to raise living standards and protect again fluctuations in farm income, provide health insurance for the family. However, dual jobs also impact the psychology of farmers. According to Diane Bothfeld of the St. Albans Cooperative, farmer's wives who leave the house to work are also exposed to different people, vacation schedules, predictability and security in wages and lifestyle. Coming home to their husband's hectic lifestyle often strains the relations at home. (Bothfeld interview).

Indicator #2: Physical Health of Farmer. According to the Census of Agriculture, the average age of farm operators in 1997 was 54.3 years, and 61% of the operations were 55 and over. In 1954, only 37% of farmers were 55 and over. This trend is exacerbated by fewer young farmers; the percentage of farmers under 35 years of ago dropped 15% in 1954 to 7.8% in 1997. (Heller/ Keoleian).

Metrics

i. Percent of chronic physical problems related to hard manual labor
ii. Average age of farmers – Average age of farmers vs. Average age of other local professionals.
iii. Percent of workers with health benefits

Relevance to Dairy Farmer in Vermont. Trends indicate that the average age of farmers has increased – reducing the long term sustainability of farming. A good spread of ages within the farming community should help to maintain a balanced structure within rural society. There is however, nothing to suggest that any specific age distribution in farming is more or less sustainable than, or is to be preferred on any other basis to, any other distribution. (hertz.uk.com/). Additionally, farming has one of the highest work related fatality rates of all occupations, according to the US Department of Labor.

Indicator #3: Infrastructure for the Farm. This indicator looks at the number of equipment retailers, seed merchandisers, and other agriculturally related stores to assess the ability to acquire the necessities for agriculture.

Metrics:
Proximity of equipment retailers, seed merchandisers, agricultural stores, buyers/coop (measure in miles or km)

Indicator #4: Social Health of Farmer.
Metrics

i. Healthy Trade relationship
ii. Level of Farmer Education
iii. Number of farms per capita
iv. Entry of new farmers into agriculture

Indicator #5: Ecological Conscience. Producers should help protect community watersheds and forests (SAN)

Metrics

i. % Of farmers involved in environmental partnerships with wildlife
ii. Is the environment integrated into the programming of the farm?
iii. Do they leave cows out of the water?
iv. Do they attract turkeys off season (habitats for turkeys and deer)
v. Wildlife management
vi. Provide hedge roads for birds?

Indicator #7: Farm Planning/Production Goals. According to ATTRA, Farm planning and production goals are both on going processes that require farm families to define a goal as well as a path to get there. Farmers may have a general idea, but lack specific numbers or data points.

Metrics

i. What are your short term production goals?
i. What are your long term production goals?
ii. Are you thinking of expanding your dairy operation?
iii. Do you have plans for when milk prices are high? When they are low?
iv. Does your enterprise income support your quality of life goals?
v. What is your income goal?
vi. Would diversification with out animal species add some benefit or add extra income?

Indicator #7: Use of Technology. How advanced is the technology used on farmers? Agricultural production technologies must be more carefully tailored to local environmental conditions than has been the case in the past.

Metrics:

i. What is the age of your equipment?
ii. Technological advancement of equipment

Indicator #8: Rate of Innovation (Unilever, 11). Diversification of crops and landscape architectural designs are both innovative methods of sustaining an economic and environmental livelihood. Agricultural intensification is often necessary to achieve more sustainable systems. This requires shifts to crops with higher yield or value, ore inputs per unit of production or higher standards of management (more knowledge intensive). This generally results in higher output per farmer and consequently fewer farmers per unit area, but also more job opportunities in the agricultural sector. (World Bank, 14).

Metrics

i. Organic vs. Conventional farming vs. ipm; use of IPM per acre
ii. Who is going through a conventional process? Rate of transition from one type of farming to the other? What about reverse transition? Then what? And why:?
iii. Diversification of crops. Diversity can be enhanced through crop rotations and sequences and in space in the from of cover crops, intercropping,

agroforestry, crop/livestock mixtures, etc. Diversification can also take place outside the farm. For example, a farmer can set up crop field boundaries with windbreaks, shelterbelts, and living fences, which can improve habitat for wildlife and beneficial insects, provide source of wood, organic matter, resources for pollinating bees and modify wind speed and microclimate. (Altieri 29)

iv. Agrarian hospitality (paying for college by selling corn)

TITLE OF INDICATOR: SOIL QUALITY

Definition or description of indicator

- Soil is the farm's natural basis for production, providing nutrients, water, physical support and biological interaction with roots; healthy soil will require less imported nutrients
- Soil is considered a renewable resource, though it takes 500-1000 years to develop one inch of topsoil (most farms have erosion 3-10 times this) (Food Alliance)
- National Resources Inventory of the USDA (1999b) reports that 1700 megatonnes (Mt=million metric tonnes) of soil eroded from US land in 1997,760 Mt from wind and 960 from sheet and rill (caused by water) (6, p. 1019)
  - This 1700 Mt. would fill a freight car train loaded to capacity that would encircle planet 7 times
  - In 2000, no-till used on 21M ha (17.5% of planted cropland), 3 fold increase over 1990
  - In 1997, 45.3 M ha (30% of cropland) determined to be excessively eroding (erosion rates greater than deemed tolerable), totaling 1200 Mt eroded soil/year in 1997 (6)
  - Historic policy focused on soil conservation but in 1980's shifted to water Q
  - Conservation Reserve Program (CRP), establ. in 1985, allows USDA to enter 10-15 agreements with owners/operators to remove highly erodible and other env. sensitive cropland from productions (6, p. 120); 13.6 M ha under protection as of 2000
- Quality and conservation of soil is perhaps the most important long-term issue in sustainable ag; Soil Science Society of America in 1995 defines soil quality as "the capacity of a soil to function for specific land uses or within ecosystem boundaries. This capacity is an inherent characteristic of a soil and varies from soil to soil. Such indicators as organic matter content, salinity, tilth, compaction, available nutrients, and rooting depth help measure the health or condition of the soil—its quality—in any given place." (4)
  - Soil quality indicates capacity of specific kind of soil to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation (EQIP)
  - 1993 National Research Council report stats that soil quality should be used to guide recommendations for conservation practices and for targeting federal programs (4, p. 26)
- Soil quality is a function of soil characteristics and has direct impact on water resources (5 & EQIP):

- Fertility
- Chemical characteristics: electro-conductivity, extractable amounts of nutrients, chemical contaminants
- Biological: organic matter, biomass of soil arthropods & microbes
- Physical char: Structure & depth, infiltration, bulk density and water holding capacity
- Erosion/loss of topsoil
- Compaction
- Poisoning (e.g. by heavy metals) (5)

- Enhancing soil quality essential for maintaining ag. productivity; some degradation reversible (organic matter loss) and others not (erosion) (9)

Metric(s)

- **Number of ha run over with loads >10mg** (5)
  - Effects on soil by farm machinery (RISE, measured as ha of farmland)
- **Soil improvement/management practices (Food Alliance, EQIP, RISE & ATTRA)**:
  - **Tillage practices** (minimizes erosion & compaction and improves organic content): conservation tillage (leaves crop residues on soil surface), strip tillage (certain areas only), farm traffic controlled (only certain areas, not when wet),
    - Use of low/minimal-tillage systems and result in a 20% increase in soil organic matter can be achieved within 10 years on sandy soils (use of compost/manure increases this percentage)-Michigan State Ag School
    - Conservation tillage leaves a cover of crop residues on soil surface and dec. # of times tillage equipment passes over a filed, significantly reducing poss. of soil erosion (6, p. 1020)
  - **Crop rotation**: growing same crop continuously can reduce available nutrients in soil; crop rotation also improves soil organic content (EQIP)
    - Before all herbicides, pesticides and synthetic fertilizers became available in 60's, farmers depended on crop rotation to manage diseases, pests, nutrients and nematodes in soil (1, p. 5)
    - Integrated crop rotation systems need less synthetic fertilizer, herbicides and pesticides, especially nematicides, than does a conventional system with little crop diversity; also gives diversity of products for farmers to fall back on if one crop does poorly and decreases need for chemical inputs (crossover with Economic health) (1, p. 5, 6)
    - Greater quantity and diversity of organic materials in soil results in more diverse abundant and active soil biota will be (1, p.6)
    - 4-year rotation of corn-corn-soybeans-wheat can be beneficial (1, p. 6)
      - Soybeans fix N in soil
      - Wheat planted in fall then holds residual N and other nutrients in place to prevent N leaching in winter and promotes growth of beneficial insects, which can then continue to control pests for soybeans and corn
      - Corn then benefits from N and other nutrients held in soil and beneficial organisms; first-year corn (after rotation) better able to mineralize N compared to corn in monoculture fertilized soil and diverse system needed no additional N added

        - For leaching, wheat never loses more than 20 lbs. of N/acre/year into groundwater but continuous corn leaches up to 100 lbs. N/acre/year; various rotations able to reduce N leaching 30-50% v. continuous corn (1, p.6)
    - **Management practices: 1)** rotation with more years of grass or legume forage crops than row crops 2) rotation of row crops with a grass or legume forage crop at least on of every 3 years 3) rotation of row crops with small grain (oats, wheat, etc.) crops 4) continuous corn or other high intensity row crops (8)
- **Pasture or rotational grazing systems**: distribute manure back on pastures rather than in isolated areas (improves organic content) (Food Alliance and ATTRA)
    - 'Managed intensive Rotational Grazing (MIRG) systems (aka: prescriptive, rotational or controlled grazing): managing both the cows AND pasture in grazing systems (1, p. 18)
    - Managed grazing provides ground cover to: protect soil from erosion & runoff, provide habitat for beneficial insects, birds and animals; foster high levels of microbial activity to increase organic matter; provide water infiltration (1; p. 20)
    - Problem that management intensive grazing can have a negative impact on water quality due to application of N fertilizer; study in northeast US showed that a substantial amount of N applied as fertilizer is leached below the root zone of orchardgrass managed as an intensive pasture (7, p. 203)
        - In drought years, NO3-N leaching increased dramatically in swards containing alfalfa or white clover (7)
- **Utilizing manure or compost:** improves soil organic content and improves tilth
    - **Tons of finished compost/acre farmed**: addresses soil and water quality (2-no details)
    - Consolidation of confined livestock into large specialized production facilities with little associated cropland makes use of manure infeasible (6, p. 1020)
- **Use of cover crops (aka 'green manure'):** improves soil organic content, prevents erosion by improving drainage & preventing soil compaction and improves tilth; probably the best way to maintain the soil over the long term (1, p. 8); (9)
    - **# of days/year soil covered with vegetation/proportion of time soil covered with crop (9, 3)**
    - Legumes fix atmospheric N into plant usable form: crimson, clover (white clover: can convert 60-100 lbs.N/a/y), alfalfa (can convert 50-150 lbs. N/acre/year), hairy vetch and sweet clover (1, p. 7)
        - Clover (legume cover crop) frost-seeded into wheat (per crop rotation above) adds N to soil and holds nutrients in place until spring when time to plant corn again; wheat/cover crop addition can increase corn yields 15-18% (v. 8-11% increase in yield from corn/soybean rotation) (1, p. 6)
    - Non-legumes:
    - Without cover crops, wind and precipitation can erode soils and nutrients and cause runoff; also curb nutrient loss, add nutrients and improve tilth by increasing soil biota activity that helps increase fertility and soil organic matter (1, p. 7)
    - Cover crops can also suppress weed growth and decrease herbicide use by absorbing nutrients and water that weeds need; can also increase insect diversity (good & bad) for more balanced insect community (1, p 8)

    - **Number of acres cover crops per unit of production**: (2)
  - **Use of least oxidizing inorganic fertilizers**: improves soil organic content (e.g. ammonium nitrate v. anhydrous ammonia)
  - **Strip cropping with annuals or perennials**: improves organic content of soil
    - **% of ag land in perennial ecosystem state**: soil lost at such rapid rate because more acreage put into production without windbreaks or hedgerows or other soil retention management strategies; good for prairie or wooded landscapes (provide additional benefit of shade for cows) (2, p. 54)
  - **Banding or split applications of fertilizers:** improves organic content of soil and improves nutrient balance
  - **Erosion prevention**: diversion ditches, grassed waterways and buffer zones, contour tilling/planting/buffer strips and conservation tillage/restricted/no tillage (better) (also good for soil organic content), terracing, windbreaks, wetlands, cover crops/inter seeding, rotational grazing to incorporate plant matter, organic matter incorporated into fields (mulch, compost – also good for organic content), perennial crops (erosion prevention, improves organic content, soil compaction prevention)
    - Risk of soil erosion by water, wind (9)
  - **Irrigation techniques/scheduling, soil moisture monitoring**: irrigation can lead to erosion and increased soil and surface water salinity (EQIP)
  - **Runoff reduction strategies**: increase time of travel and infiltration and decrease runoff of nutrients, sediments, pesticides (conservation crop rotation, contour farming/buffer strips, cover and green manure, diversion, terrace, grassed waterway)
  - **Soil conservation practices:** 1) farm conservation plan is followed that does not allow tolerable soil loss (T) to be exceed for any cropland fields 2) farm conservation plan is followed only on highly erodible land (HEL) and does not allow tolerable soil loss (T) to be exceed for any cropland fields 3) farm conservation plan is followed that allows erosion in excess of tolerable soil loss (T) 4) no farm conservation plan being followed (8)
- **Measurable soil quality indicators (Food Alliance, EQIP, RISE & ATTRA)**:
  - **Soil quality/trends in soil quality (measurement of soil quality can also be a management indicator)**: tilth, compaction, contamination by fertilizers, salts, organics, pesticides; erosion; increased org. matter, decreased compaction (EQIP; RISE: fertilizers and pesticides only, measured as ha of farmland)
    - **Soil fertility/health: Number of beneficial organisms (Earthworms/acre/sq. m):** widely accepted with no discussion at CSS conference (2, 3), # of predatory mites, # of beneficial micro-organisms, soil organic carbon (measure of healthy soil structure)
    - **Soil organic content**: organic matter is critical to functioning of ecosystems; provides substrate for biotic reactions, nutrients for biological activity, maintenance of soil structure and permeability and resistance to wind and water erosion; critical for C and N turnover and nutrient retentions (4, p 27)
    - Use **biological/physical indicators of soil health** (EQIP):
      - Biological: organic matter, biomass of soil arthropods & microbes
      - Physical char: Structure & depth, infiltration, bulk density and water holding capacity
    - RISE: "**State of soil** (measured in ha of farmland?)"
      - Nutrients, carbon, pH, moisture, salinity

        - Erosion
    - **Soil microbial activity** (6, p. 1010)
    - **Soil carbon levels**: measured as t/ha (W94-no details)
    - **Earthworms/acre:** widely accepted with no discussion at CSS conference (2, 3)
    - **Nematode populations**: nematodes have diverse feeding habits and are most numerous animals in soil so presence/absence is clear indication of soil health and what else is in soil; diverse nematode population = diverse bacterial, fungi and other microbes in soil; generally believed that diverse microbial soil population is indicator of healthy-biologically active soil (1, p. 10)
        - Also key to nutrient cycling and transport: ingest organic material and excrete mineralized organic matter that is taken up by crops; research indicates that nematodes play major role in making nutrients available to plants
        - Integrated compost system and transition organic system have greatest diversity while conventional cropping has lowest; difference is amount of organic matter developed in soil by crop rotation, cover crops, compost and manure instead of synthetic chemical inputs
        - Mich. State has developed nematode diversity index and rating system for soil quality
  - **Erosion evidence**: presence of channels/gullies, soil deposits at field perimeters, soil loss evidence around plants
    - **Soil erosion rates**: %/year or t/ha/yr (W94-no details, 3)
    - **Tons of soil erosion/unit of production** (2)
    - **Soil erosion index:** no details (4, p. 26)
        - **Rate of soil loss v. regeneration** (6, p. 1010))
- **ATTRA characteristics:** what does handful feel like? Soil pH, salinity & Na saturation? how deep is dark surface later? earthworms hard to find? how fast do manure piles and forage thatch degrade? how long for standing water to seep in?
- **Organic metrics**

Verifiability

- May vary, depending on 'proof' of self-reporting of management practices; may be able to double check management practice reports with quantitative/'verifiable' metrics such as soil quality characteristics, erosion evidence, etc. (i.e. 3rd party could go to farm to confirm reported data for erosion evidence)
- Preference would be to use three types of metrics: 1) Management practices, 2) Observation of farm characteristics and 3) Quantitative measures to allow for variability of reporting mechanisms as means of building in a check/balance system of results

Measurability

- Will also vary: self-reports of management practices will be easy; need to speak to experts/gather more details on soil quality measurements

Relevance to dairy

- Results will be extremely dependent on whether farm grows crops; per Greg Weber, this is the case for the majority of VT/NE farms and is an acceptable assumption to make
- Need to assess manure management to see effects/relevance for straight dairy farms.

Business case for farmer

- Better soil quality may result in more efficient use of nutrients and better outputs with less monetary and nutrient input (Nutrients, Economic)
- Similarly, less erosion can also mean more success with crops (output) (Economic)
- Soil quality directly impacts Water Quality, which may be regulated further.
- Use of cover crops prevent environmental contamination by agricultural chemicals and decrease synthetic fertilizer use to save farmers money; may ultimately result in higher profits from larger crop (as result of healthier soil) (1, p.8) (Pest Management, Economic)

Interaction with other indicators

- Water Quality and Nutrients: Healthy and productive soils help increase rainfall infiltration and storage in the soil and may require fewer nutrients (Food alliance)
  - Soil with inadequate infiltration prone to runoff
- Air Quality: erosion can lead to suspended particulate material (EQIP)
- Manure management
- Organic

Possible management strategies for improvement

- See management strategy metrics

Interactions with Farm Characteristics

- Existence of agricultural crops on farm
- Soil type (peat, sandy, clay, etc.)
- Landscape (hilly, flat, gullies, etc.)
- Climate (rain, wind, etc.), irrigation used, crops that will grow, etc.

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TITLE OF INDICATOR: WATER QUALITY

Definition or description of indicator

- Availability of uncontaminated water is necessary for proper agricultural/dairy functioning as well as functioning of humans, animals, fish, etc.
- Water quality can be affected by excess nutrients, pesticides, salinity, soil quality, suspended sediments, pathogens, toxic substances (Greg work, EQIP)
  - On-farm nutrient imbalance creates a pollution problem in that leaching and runoff of excess nutrients can cause water pollution
  - Nitrogen (N) tends to be limiting in salt water, phosphorus (P) in fresh water
    - Additional problem with N is that it can get down into drinking water via leaching (Greg IV)
  - Soil compaction affects water quality: soil with inadequate infiltration prone to higher levels of runoff that contains soil particles and fertilizers
  - Soil erosion and nutrient leaching among primary sources of water pollution from ag. production; National Summary of Water Quality Conditions reported that ag is the leading source of pollution in the nation's rivers, lakes and wetlands (5, 1020)
    - Siltation alters habitat, can suffocate fish eggs and bottom-dwelling organisms, can interfere with drinking water treatment processes and recreational use of water (5, p. 1021)
    - Nutrients contribute to accelerated eutrophication, disrupting ecosystems and health and diversity of native populations
    - MS River: Upper MI River Basin states have highest % of total land in ag, highest use of N fertilizers and greatest amount of artificially drained soil in country: N output to Gulf of Mex has increased 3- to 7- fold vs. pre-settlement and G of M is 3rd largest hypoxia zone (O2 deficient 'dead zone' due to N input) in the world; nitrate flux into gulf from '60 to '98 would have been reduced by 33% with a 12% dec. in N-containing fertilizer used in MI River basin (5, p. 1021)
- Water can be considered renewable resource: can be used over and over if quality is not degraded
- Vermont specific: Missisquoi Bay is one of the most eutrophic in Lake Champlain with high phosphorus loads, a significant portion of which is attributed to runoff from ag

nonpoint sources such as manure, fertilizer and cropland erosion (likely due to high concentration of dairies; very little urban or suburban development) (1, p. 1)
  - Lower Missisquoi River is in NW corner of VT and part of Lake Champlain watershed; Lake Champlain critical water resource with declining water quality due to sediment, P and N, most of which originate from ag sources such as barnyards and manured or fertilized fields (2, p.1)
  - Most of the land area of VT drains into surface waters that are P-limited (growth of algae and other nuisance plants limited by the concentration of available P in water) an dadditions of P can lead to excess algae growth and eutrophic conditions (6, p.1)
- Agricultural ecosystems can be managed to protect waste supplies if we understand and incorporate principles of hydrology; maintain soil quality, manage nutrients, pesticides, animal and other residues; and maintain plant cover on soil during periods of intense rainfall (4)
- Fecal bacterial in livestock waste can contaminate groundwater if waste seeps into nearby wells causing such infectious diseases as dysentery, typhoid and hepatitis

Metric(s)

- **Nutrient metrics**: excess nutrients can pollute ground or surface water (interaction with water is through crops system as well as feed system if manure with excess nutrients is used on farm)
  - Degree that nutrient levels will affect water quality will depend on other practices such as irrigation management, manure management, buffer strips
- **Soil metrics:** in many cases, an impact to the soil system affects water quality
- **Pesticide metrics**: pesticide runoff will affect water quality
- **Organic metrics**
- **Presence, dimensions & positioning of buffer strips around waterways: (**Food Alliance)
  - Cultivated areas >25 feet from riparian areas (good)
  - Buffer zones 50-100 feet in width and vegetated to prevent erosion and migration of nutrients, pesticide, etc. to waterways (better)
  - Buffer zone size adjusted for slope of landscape (>10% slope, >50 feet wide buffer areas)
  - Mich State: existence of control structures at end of field drains (can regulate water table in corn fields, decreasing nitrates leaching into drainage waters and improving crop productivity)
  - Stream banks are significant source of eroded soil when runoff enters stream directly; banks should be protected but there is concern over loss of productive land (4. p. 28)
- **Concentration of animals in feed lots**: can be measures as animals/ha (EQIP)
  - Can result in increased runoff of animal waste and pathogens
  - Livestock concentration areas can be built to eliminate runoff (2, p. 2)
- **Manure management:** composting facility**,** manure transfer, waste storage facility/waste utilization to decrease nutrients to ground water, salts, heavy metals, pathogens
  - Presence of waste storage structures to better manage animal wastes (2, p. 2)

- **Long-term storage system (180 days or more)**: steel, glass-lined (liquid-tight design, above ground) OR concrete stave (liquid-tight design) OR poured concrete (liquid tight design): 1) designed and installed according to accepted engineering standards and specs and properly maintained 2) designed and installed according to accepted engineering standards and specs, not maintained 3) Leaking tank/concrete cracked on low permeability (like clay, allow water to flow through slowly) soil, >3 feet to water table and bedrock 4) Leaking tank/concrete cracked on high permeability (high perm. soils like sand and gravel, allow faster water movement) soil, <3 feet to water table or fractured bedrock (9)
  - **Earthen waste storage pit (below ground)**: 2) designed and installed according to accepted engineering standards and specs and properly maintained 3) not designed to engineering standards, in low permeability (like clay, allow water to flow through slowly) soil, >3 feet to water table and bedrock, earthen lining eroding 4) not designed to engineering standards, in high permeability soil, <3 feet to water table and bedrock, earthen lining perforated, >10 years old (9)
- **Short-term storage; usually 30-90 d, sometimes up to 180):**
  - Stacked in field (on soil base): 3) stacked on high ground on low perm. soil, >3 feet to water table and bedrock 4) stacked on high ground on high perm. soil, <3 feet to water table and bedrock (9)
  - **Stacked in yard**: 1) covered concrete yard with curbs, gutters and settling basin; concrete yard with curbs and gutters; grass filter strips installed and maintained 3) earthen year on low per. soils, >3 feet to water table and bedrock 4) earthen yard on high per. soils, <3 feet to water table and bedrock (9)
  - **Other water-tight structure designed to accepted engineering standards and specifications:** 1) designed and installed according to accepted engineering standards and specs, all liquid contained, properly maintained 2) designed and installed according to accepted engineering standards on low perm. soil, >3 feet to water table and bedrock 3) designed and installed according to accepted engineering standards on high perm. soil, >3 feet to water table and bedrock 4) designed and installed according to accepted engineering standards, not properly maintained, water treatment and diversion structures allowed to deteriorate (9)
  - **Stacked in open housing**: 1) building has concrete floor, protected from surface water runoff, adequate bedding provided 2) building has earthen or concrete floor on low perm. soils, protected from surface water runoff, >3 feet to water table and bedrock, 3) building has earthen or concrete floor on low perm. soils, subject to surface water runoff, <3 feet to water table and bedrock 4) building has earthen or concrete floor on high perm. soils, subject to surface water runoff, <3 feet to water table and bedrock (9)
- **Location of storage relative to drinking water well:** 1) manure stack or earthen waste storage pit >250 feet downslope from well; manure storage structure (liquid tight) >200 feet downslope from well 2) manure stack or earthen waste storage pit >250 feet upslope from well; manure storage structure (liquid tight) >200 feet upslope from well 3) manure stack or earthen waste storage pit <250 feet downslope from well; manure storage structure (liquid tight) <200 feet downslope from well 4) manure stack or earthen waste storage pit <250 feet upslope from well; manure storage structure (liquid tight) <200 feet upslope from well (9)

- **Nutrient/pesticide application:** Time applications of fertilizer, manure, etc. to prevent runoff; use pesticides/herbicides tactically for localized infestation (ATTRA)
- **Silage storage:** improper handling of silage can lead to significant flow of juices/leachate from silo; if it enters stream, high organic content feeds bacteria that rob water of O2; groundwater contaminated with silage has bad smell and shows increased levels of acidity, ammonia, nitrates and iron; low pH of silage leachate can free up and release naturally occurring metals in soil and aquifer and increase concentrations in ground water; nitrate is most important potential contam: 20-40 mg/l can cause livestock problems, especially if feed contains more than 1000 ppm nitrate-N; water with levels over 100 mg-l n-n should not be used for livestock (8)
  - Silage moisture content; storage location, floor or surface condition; storage cover condition, lining, leachate collection system
- **Cleaning-in-place (CIP) processes**: cleaning processes (defined as circulation of cleaning liquids through machines and other equipment) can be major contributors to eutrophication potential from dairy processing (80% of total); loss of milk products to waste water results in higher levels of COD, BOD (biochemical), N and P (3, p 303)
  - N and P content of detergents did influence eutrophication potential somewhat but milk residues were of greater importance (p. 311)
  - Wastewater treatment can decrease eutrophication potential of both detergents and product residues; membrane filtration reduced use of detergents and emissions (vs. no waste water treatment, biological treatment at dairy and municipal treatment), though it was not suitable for complex detergents (one-phase alkaline cleaning and enzyme cleaning (p. 312)
  - Study could not identify 'best' CIP process due to difficulty in assessing cleaning agent toxicity impact, though one-phase alkaline method (with acid chemical disinfection) likely best environmentally (vs. conventional alkaline/acidic, enzyme-based and pH-2 methods)
  - **Milk house waste treatments systems** to eliminate milk house waste in surface water (2, p. 2); a 100-cow free-stall operation may use 100-1000 gallons of water/day in milking center alone; milking center wastewater contaminated with organic matter, nutrients, chemicals and microorganisms; can contaminate water with ammonia, nitrate, P, detergents and disease-causing organisms (10)
    - **No wastewater discharge**: 1) wastewater delivered directly to liquid manure storage; no discharge expected, 4) wastewater delivered to undersized or leaking manure storage (10)

Pretreatment (before discharge to soil absorption bed/field):
Milking cleanup practices: 1) 1st pipeline rinse captured and added to barn manure; waste milk never poured down drain; manure and excess feed removed from parlor before wash-down 2) waste milk poured down drain 10% of time; manure and excess feed usually removed from parlor before wash-down 3) waste milk poured down drain 50% of time; manure and excess feed often washed down drain 4) all waste milk poured down drain; manure and excess feed frequently washed down drain (10)
Storage/settling tank liner: 1) properly sized concrete or plastic tank; baffles in working order; 2) clay lined storage or undersized concrete, plastic or metal tank; baffles not working 3) cracked or porous liner or leaking tank with no baffles 4) no tank or liner to prevent seepage (10)
Settling tank cleanout: 1) every 3-4 months 2) every 6 months 3) annually 4) never (10)

Liquid storage period following settling: 1) 9-12 months; 2) 1 week-9 months 3) >1 week 4) no storage/settling; wastewater discharged directly to soil as generated

- **Distance from milkhouse (waste) to drinking water well:** 1) >200 feet downslope from well, 2) >300 feet upslope from well, 3) <200 feet up downslope from well 4) less than 300 feet upslope from well (10)
- **Discharge methods:**
  - **Field application:** 1) applied to growing crops at 27K gallons/acre or less per week; vegetation removed regularly 2) applied to uncropped fields at less than 27K gallons/acre/week; vegetation removed occasionally 3) applied to cropped or uncropped fields at less than 27-54K gallons/acre/week; vegetation never removed 4) applied to same area at more than 54K gallons/acre/week; vegetation never removed (10)
  - **Surface flow:** 1) applied in sheet flow to slowly permeable soil* (see sheet); vegetation regularly removed; greater than 3 feet to bedrock or water table; OR applied to properly designed constructed wetland 2) applied in sheet flow to slowly permeable* soil; vegetation sometimes removed; less than 3 feet to bedrock or water table 3) applied in sheet flow to moderately or highly permeable* soils or soils with less than 3 feet to bedrock or water table 4) applied in concentrated flow (10)
  - **Below-ground absorption:** 1) discharge into properly installed and maintained organic matter bed; located on slowly permeable soils with over 3 feet to bedrock or water table 2) discharge into properly constructed conventional wastewater treatment system used only for dairy waste 3) discharge into domestic wastewater treatment system 4) discharge into a dry well or cesspool (10)

- **Barn Yard Management**: livestock yards (holding areas and feedlots) are areas of concentrated livestock wastes and can be a source of nitrate and bacteria contamination of groundwater (9)
  - **Distance from livestock yard to drinking water well:** 1) >200 feet downslope from well, 2) >300 feet upslope from well, 3) <300 feet up upslope from well 4) less than 100 feet from well (9)
  - **Soil depth and permeability**: 1) well-drained medium or fine textured soils (loam, silt loam, clay loams, clays); depth to bedrock >40 inches with low permeability (silt and clay) 2) well-drained or moderately well drained medium or fine textured soils (loam, silt loam, clay loams, clays); depth to bedrock 30-40 inches with moderate permeability (loamy) 3) moderately well-drained coarse-textured soils (sands, sandy loam); depth to bedrock is 20-30 inches and/or high permeability (sandy) 4) excessively well-drained coarse-textured soils (sands, sandy loam) to gravel and/or poorly drained soils to poorly drained soils; depth to bedrock is <20 inches and/or very high permeability (course sand) (9)
  - **Surface water diversion:** 1) all upslope and roof water diverted 2) most upslope and roof water diverted 3) No surface water diverted; some roof water collected and redirected, 4) All water (surface and roof) runs through yard (9)
  - **Lot runoff control system**: 1) No yard runoff (either barn or roof area) 2) all runoff collected from curbed lot; solids separated; water directed onto filter strip, 3) Most of lot runoff collected; some solids removed; no filter strip, 4) lot runoff uncontrolled (9)

- **Yard cleaning and scraping practice:** 1) no yard (animals confined), 2) 1x/week 3) 1x/month, 4) rarely (9)
- **Concentration of dairy cows on yard (sq. ft./animal):** 1) no yard; confined to barn or roofed yard; 2) 75 sq. ft./animal or more on fenced, curbed concrete pad and/or 400 sf/a on graded earthen surface; more than 1800 sf/a in exercise area 3) 50 sf/a or more on concrete and/or 200-300 sf/a on earthen surface; more than 1200 sf/a in exercise area 4) some concrete (<50 sf/a) and earth (< 100 sf/a) (9)

- **Characteristics of water/farm:**
  - **Observance of water quality:** examination of physical, chemical and biological components (Food Alliance & EQIP)
    - Farm ponds have algae? Downstream aquatic organisms as indicators of water Q? (ATTRA)
    - Physical char: water temperature, clarity, flow rate (EQIP)
    - Chemical: nutrient concentration, salinity, conductivity, contaminant concentration (pesticides, heavy metals) (EQIP)
    - Biological: phytoplankton biomass, biomass of invertebrates and fish (EQIP)
    - **No. of contaminated or eutrophic bodies of surface water or groundwater** (5, p. 1010)
    - Organic materials can lend bad taste and odor to drinking water (9)
  - **Existence of pasture & hay planting**: may decrease pathogens & nutrients leaching to groundwater and decrease salinity of waters infiltrating to ground water (EQIP)
  - Orchardgrass appears to leach less NO3-N and exhibit lower concentrations than did the swards containing ryegrass (7, p. 210)
  - White clover was superior to alfalfa on controlling NO3 leaching losses (7, p. 210)
  - **Chemical & particulate accumulation in groundwater**: suggestions included nitrate measures, atrazine ppm, other contaminants in part per unit, as appropriate (2)

Measurability

- Will also vary: self-reports of management practices will be easy; need to speak to experts/gather more details on specifics of water quality measurements

Relevance to dairy

- Some metrics only relevant to farmers that grow agricultural crops; per Greg Weber, this is the case for the majority of VT/NE farms and is an acceptable assumption to make.
- Need to further assess manure management indicator and livestock concentration/feeding habits, etc. to see effects/relevance for straight dairy farms.

Business case for farmer

- Optimize use of fertilizers, pesticides, etc. to prevent runoff (therefore ultimately requiring less because they are being used more efficiently)
- Fines and policy related to water quality
- Compliance with Clean Water Act

- Conservation Reserve Program: highly erodible erosive lands placed under voluntary long-term lease and only perennials planted; soil Q improvements, dec. erosion rates and better water quality of surface water in watersheds (4. p. 28)

Interaction with other indicators

- Soil quality
- Nutrient management
- Manure management
- Pesticide use
- Organic

Possible management strategies for improvement

- See management strategy metrics

Interactions with Farm Characteristics

- Landscape features and soil type (peat, sandy, clay, etc.)
- Presence of agricultural crops
- Manure management strategies
- Nutrient management strategies

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9. Vermont Farm*A*Syst; Worksheet #9: Assess the Risk of Groundwater Contamination from Barn Yard Management
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TITLE OF INDICATOR: WATER USE

Definition or description of indicator

- Refers to the amount of water used on the farm. Water use includes: drinking by dairy cattle, cleaning of cows before milking, cleaning of dairy equipment, sprinkling cows to cool, flushing manure, irrigating crops grown to recycle nutrients from manure, and irrigating additional crops. (1)

Metric(s)

- Absolute Measure (would expect to vary depending on size of farm/ # of cows):
    - Total amount of water consumed (3)
    - Total amount of water that is recycled or reused. This metric includes wastewater and other "used" water (for cooling, etc.) as part of this amount. (3)
- Relative Measure (per some measure of output)
    - Water consumption per kg of milk solids (12)
    - Water consumption per cow (WR)
    - Water consumption for irrigation per ha of farmland (7,8)
    - Water consumption for irrigation per tonne of product (8)
    - Amount of water pumped per kWh of electricity (12)
- Management Practices
    - Track, monitor, analyze and interpret water usage and eliminate wastage. (Food Alliance)
    - Factor weather conditions, soil moisture, mulching/ground cover and plant need in irrigation strategies. (Food Alliance)
    - Replace older, less efficient irrigation systems with newer more efficient systems. (Food Alliance)
    - Test water conversation strategies. (Food Alliance)
    - Water is collected and recycled for other uses. (Food Alliance)
    - Irrigation system uses: furrow irrigation, gated head pipe, drop nozzles, low pressure, micro-sprinklers, trickle tape, or soil moisture sensors. (Food Alliance)
- Other Measures
    - Drainage patterns into and from the farm (13) (should be readily available information)
    - Efficiency of retaining water on the farm and in the soils (13) Farmers know and understand their farm's soil type (clay based, organic matter, etc) and its performance with retaining water). This allows collection (into cistern) and reuse.
    - Which watershed the farm is part of. This is easy information to get from Water Resource Department, National Resources Conservation and would be very applicable for Vermont farms. Conduct further research in this area as we move forward.
    - Water sources and related ecosystems/habitats significantly affected by use of water (3)
    - Stability of water source (at farm level) (7)
    - Level of groundwater (12)

- The trend of the level of groundwater – i.e. is it consistently decreasing over years? (WR) This requires identifying the aquifer and understanding on how sensitive it is.
- Annual withdrawals of ground and surface water as a percent of annual renewable quantity of water available from the sources (3)
- Water withdrawal compared to recharge rate (5)
- Soil absorb and retain rainfall (13) This allows collection (into cistern) and reuse.
- Which watershed the farm is part of. This is easy information to get from Water Resource Department, National Resources Conservation and would be very applicable for Vermont farms. Conduct further research in this area as we move forward.
- Percent of irrigation water stored in the root zone. (12) Difficult, if not impossible for farmers.
- Percent of rainfall stored in the root zone. (12) Difficult, if not impossible for farmers.

Verifiability

- Data would be auditable. A few measures seem more subjective and difficult for an outsider to check. Broad range of measurements is better than none. Maybe use more bucket type categories instead of requesting exact measurements.

Measurability

- Some measures seem precise and discrete, though further analysis of data may have to be done if need to draw result to specific action that needs to be changed. Other measures seem more subjective and difficult to measure (such as water recharge rate).

Data collection

- Unsure if farmers will already have this information or how easy to obtain/measure. Need further research and discussions with farmers, other stakeholders who work closely with farmers.

Relevance to dairy

- Water scarcity is becoming the number one concern regarding water and agriculture is responsible for using 65 – 70% of fresh water resources in the US and the world. (2)
- Another source indicated that in only the US in 1995, 507 million cu. meters/day, of freshwater were withdrawn for irrigation purposes (39% of total freshwater withdrawal), 185 million cu meters/day of this from ground-water sources. Water consumption for livestock totaled 20.8 million cu. meters/day in 1995, 41% from ground water. Irrigation uses more than twenty times as much water as livestock. Withdrawal from groundwater is greater than natural recharge rates of aquifers. While irrigation rates have decreased over recent years, it has still not reached sustainable levels. (5)
- In terms of irrigation, the top six irrigated crops (corn, hay, pasture, cotton, soybeans, and wheat) account for 38 million irrigated acres or almost 70% of the total in all crops (more facts and $ amts if want additional info). (2)

Business case for farmer

- Water scarcity has been identified as the most significant water issue of the 21st century. Rising water cost and demand are likely to continue. The change of water control from Federal to state and/or private may allow the market to dictate price (most likely increasing price, based on anticipated shortages of water). Competition for water, especially in western states, is expected to have significant impacts on ag. (2)
- As water levels in aquifer drop, pumping becomes more costly. (5)
- Related to water use (and irrigation) is drainage management: 70% of the 110 million acres of ag land in US which benefited from artificial drainage was land with crops. The remaining 12% was pasture, 16% woodland, and 2% misc. Public outlets provide for 60% of area. A significant amount of money is also used in these drainage facilities: the capital value of all US farm drainage facilities in 1985 was over $40 billion; 64% ($24 billion) was in on-farm systems; and 36% ($15 billion) was in public drains. (2)
- Cost saving opportunities exist by using less water. By conserving/reusing, less electricity is required to pump and heat water.

Interaction with other indicators

- Waste management system
- Water quality. Most water contamination is non point source pollution, with an indirect or general source, such as surface run-off compared to point source pollution, which originates from a direct source. This non point source pollution affects the entire watershed area. Again, when revisit this indicator look further into watershed research.
- Nutrients and nutrification. Nutrification is the process when run-off nutrients contribute to more than normal amounts of plants growing in a body of water, which sucks up oxygen from the water source. This leads to a decrease in fish and eventually the body of water chokes itself to death.
- Total water management system must include both irrigation and drainage. (2) Drainage system - without one, salinization (salt deposits which affect nutrient base) will occur.
- Community resources (i.e. access to water, surrounding ecosystems)
- Farm financial health

Possible management strategies for improvement

- Reuse water that is used at the dairy for irrigation purposes (assuming dairy waste management system is designed to utilize flushed manure nutrients through cropping systems growth under irrigation – need further research to fully understand process of "cropping systems growth"). (1)
- Update irrigation system and take various factors, such as weather and soil moisture, into account when irrigating. (Food Alliance)
- Scrape and haul manure from high use areas such as feeding bard, so manure can be managed off the dairy. (1)
- Use grass-based and/or seasonal dairying to eliminate need to wash off manure from high use areas. (13)
- Use wastewater instead of fresh water to flush feeding areas and free-stall barns. (1)

- Use housing system that keeps cows clean enough so eliminate need to wash cows before milking. (1)
- Alternative cleaning of equipment strategy. (6)

Interactions with Farm Characteristics

- Manure management strategies
- Additional crops (which can reuse water)
- Drainage practices (2)
- Pasture/Grazing management/ Pasture utilization which affects Gross Margin (4)

Programs organized around the issue

- National Program Component action plan (2)
- National Drought Policy Act of 1998 – makes USDA responsible for developing cost-effective strategies to mitigate the effects of drought on producers and rural communities (2)
- Agricultural Research Service (ARS) – has national research program involving experimental farms and ranches – concerned with tie-in with watershed issues (2)
- RISE – farm level assessment tool

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(1) http://agnews.tamu.edu/drought/drghtpak98/drght38.html (typical amts for FL-based dairy included in source)
(2) http://www.nps.ars.usda.gov/programs/ (if irrigation is big part of dairy farms, then revisit – especially irritation section)
(3) W105 (also discussion re: absolute and/or normalized reported #'s)
(4) W106 (and lists what is considered "normal fodder")
(5) A11
(6) A71 (very detailed info examining different cleaning practices)
(7) A61
(8) W89
(9) W61
(10) A11
(11) A68
(12) http://www.maf.govt.nz/mafnet/rural-nz/sustainable-resource-use/irrigation/testing-irrigation-best-management-guidelines/httoc.htm
(13) W7

APPENDIX C: EXPERT INTERVIEWS

DIANE BOTHFELD, ST. ALBANS COOPERATIVE CREAMERY (JULY, 2003)

Diane is the cooperative relations mangers who handles membership services, product quality, and supervises some field staff.
Phone # **1-800-559-0343**

St. Albans consists of 570 dairy farmers that operate in 11 of the 14 counties in Vermont, in NY, and in NH (only 1 farm in NH). Each member is a partial owner and gets a vote. The members elect 8 board members who have staggered terms. The board hires a general manager who hires and oversees staff. The coop employs 60 people and is considered small in comparison to other commercial businesses. St. Albans runs a processing facility. Everything is processed and sold in bulk. They sell cream and skim milk. The cream goes to Ben & Jerry's and the skim milk is sold or processed into condensed skim and non-fat dry powders. St. Albans contracts with a local business for transport of the milk from the farms to its facility and from its facility to Ben & Jerry's factory.

The majority of St. Albans producers do not use BGH on cattle. There is a small group that does, but the milk is segregated from the BGH-free milk. Farmers are paid a premium if they do not use BGH.

Federal order #1 sets milk prices. The prices are based on national sales for each product (butter, skim, cream, non-fat, etc.). Using these prices, St. Albans sets up individual contracts with buyers and charges premiums for its services including processing, BGH, and pays a special premium for milk quality.

Milk quality is judged through bi-monthly laboratory tests in which scientists measure raw bacteria count, pasteurized bacteria count, somatic cell count, and preliminary incubation count.

St. Albans has 36 organic producers and they are adding 6 more farms. They do have a certified organic processing line, but they are limited in terms of production, because they don't have a large organic milk source.

In terms of customer services, St. Albans may help with group buying of health insurance, but has little other input on the financial/social operations of the member farms. It does allow members to donate to United Way and does legislative tracking and lobbying. It does not have specific environmental requirements of its farmers.

Diane recommended that we look at NRCS, FSA, EQUIP, CREP for more info on sound environmental practices. She also said that the Vermont Dept of Ag has acceptable practices at www.Vermontagriculture.com. Follow links plant/industry/pesticides.

Diane said she would be happy to sit on an advisory board. She also said that she has a young farmers group that she works with that would probably be willing to field-test our

template. They have monthly meetings from Sept.-April. She said that we could meet with that group if we wanted to when we visit in the fall.

Same interview, but on financial indicators.
Diane recommended looking at the Yankee Farm Credit, a lending association. Yankee Farm Credit collects financial info from farmers and provides them feedback on their performance—but only to people who lend from them. She said that farmers will be willing to share environmental info if they are promised something in return.

Diane recommended the following indicators:
Cost of producing milk
Employment
Amount purchased from local businesses
# of people working off farm.
Amount of governmental subsidies.

With regards to the processing facilities, she said that the premium for processing is about $1/hwc. The price is dependent upon the class of product produced:
1st class—bottle
2nd class—soft products—ice cream/yogurt
3rd class—hard cheeses
4th class—dried milk powder/butter

She said that processing practices are mandated and monitored more stringently than on farms. Farm compliance is complaint-driven. She suggested that health/environmental wrongs are probably less likely at processing facilities. She indicated that the biggest environmental impacts of processors are from the energy/waste disposal.

DIANE BOTHFELD, SEPTEMBER 16TH

1.802.524.6581, extn 205
Ruchi and Wendy

Young Farmers Mtg MOVED to October 14th! At 7:30.
12 young farms
8 senior board members
= max of 20 people.

Animal Welfare

Typical Co-op farm characteristics:
20 – 1000 cows (young farmers group spreads 75 – 500/600 cows);
avg = 100 – 110 milking cows
variations in mgmt practices based largely on # of cows (in terms of housing, feeding, etc.)

Nutrients – usually the grain seller is the one providing "nutrient" insight.

Large farm may also have an on-sight specialist (although not very typical). Smaller farms are very likely to rely on the grain seller.

Vet may also thru in nutritional suggestions.

If cows demonstrate acidosis (which indicates receiving improper mix of feed), then farmers are likely to switch to different grain provider (or may consult with them).

Housing method

Large – tend to have free stall barn – allow cows to roam around. Feed is brought to the center aisle. Milked in separate facility.

Smaller – may have ??high stall barn?? – where cow is tied to stall for milking. Released in the summer to graze. But in winter spend 22 – 23 hours/day inside. Provide feed to animals.

Can only be outside from late April to mid October due to inclement weather

Bedding is typically cow mattress and sand underneath it. Concrete will be used in aisle ways, while lay down in stall. May stand in aisle to get feed and when walking to and from milking parlor. (in confinement setting).

Feeding method

Hard to grow grain in NE, so tend to purchase (energy and grain components). But tend to grow r0ughage portion, which includes 3 main types: corn for silage, grass/alfalfa for silage, and dry hay.

Breakout by type:

Intensive rotational grazing – 20%

Fed outside in pasture and supplement with stuff in barn – 20%

Total confinement – 40% (all food brought to them)

Rotational/confinement/variation of any and all – 20%

Timed pregnancies to coincide with when nature is producing most grain/forage. Only 3 farms of co-op participate in such a program. Is hard b/c economics – no milk produced for short duration.

Milking Technology. Some may have milking parlor with electronic identification, amt of milk recorded, in computer system. Get report by cow, how compare to previous milking. This is gaining. Around 40% (mainly confinement) have that kind of technology.

Vet's involvement –

90% of all farms have monthly herd health clinic (onsite) that is focused on reproductive side of things and overall health.

May be called out to farm an additional 2 times/month, due to emergency

Main diseases.

Mastitis

Metabolic disorders – milk fever (lack calcium) – most farmers can fix w/o vet. Ketosis – inbalance of key-tones – in bodies that are near calving.

Acidosis – digestion problems. Too much grain and not enough forage. May result in requiring operation.

Culling rates are around 20 – 30%.

Breeding traits depends on type of farm.

If grazing, they want aggressive cows that are willing to get own feed (like jerseys or "colored cows" = non black/white cows). Holsteins produce more milk but are lazy grazers.

Want big, round cows – lots of space for feed (and producing milk)

Fat and protein levels in milk – will receive additional $ for higher levels

Volume

If confinement, then want strong feet and legs.

Specific metrics

Nutrition - % of intake that's crude protein, degradable (and not) – very common terms. Farmers may or may not know off-hand what it is. Could find out info by asking grain seller (if they think its important and/or want to dive into "managing" that end of things)

Five point plan – had heard of it. Isn't a very well known concept/tool that is used.

(body) condition score – may not calculate and record specific body condition, but pretty much all farmers can tell you roughly speaking if cow is heavy, thin or about right. Will vary depending on what stage of pregnancy that they are in. can either acertain by visual or by feeling/pinching. About 20 –25% may be already doing this. Get very thin for the 100 days following calving (b/c all nutrients are going out – hence they get skinny).

Somatic cell count. Co-op tests twice a month and pays premium (for low count) at the farm level. There is an association (Dairy Herd Improvement Association) which helps with management tool and as part of it will send an expert to the farm to measure counts at the cow level. Maybe cost $.50/cow – so pretty cheap. If want additional services, such as protein, butter milk content, then will require additional cost. Can also record what cow's pregnant and help to alert farmer to various activities. About 30 – 40% of farms from co-op are involved with this association. Co-op also has interest in helping farms achieve good counts. Will send people out to help and also hold workshops around these issues.

Social

Franklin country, VT – large dairy community

# of farms is decreasing, but # of acres is remaining constant – maybe expanding farms to make more profitable.

community relations

differs based on size/amt of farmers compared to other professions

offer career center – workshops and activities for farmers in evenings

farmer interaction on Select Board, more active, on school board

larger communities they will then be the minority

very small number of people who leave and return to small dairy farm (1 out of 12 decided to start farming that didn't inherit it from family) – majority are handed down. They encourage children to leave farm due to economic strains.

Typical farmer. Avg age 55 – 60. Work week 60 – 65 hrs. some don't get to leave/vacation farm.

Smaller farm may be just a family and they do all work.

Larger farm may be extended family and be able to rotate and take some time off.

All spouses work away from farm and see everybody else having "normal" workweek and vacation time and be able to take off and do other things. Can create tensions between them.

Insurance. Farmers are risky to insure. B/c independent small businesses and not regulated. Once certain # of employees then may need to abide. Safety issues. Economic times of difficulty and will drop health insurance b/c too expensive. Dangerous profession and dangerous not to have coverage. Sons and daughters w/ spouse working off farm can use the spouse's health insurance.

Production goals given variability. Larger farms w/ more debt are encouraged (required with lender) to do goal setting. Smaller farmers may not do the same planning amount. Any services available to do this? Had goals in head, may not be formal, written down. Educational workshops provided by lender or others, may assist in that.

Farm land technology. Technology around animals. Some may have milking parlor with electronic identification, amt of milk recorded, in computer system. Get report by cow, how compare to previous milking. This is gaining. Around 40% (mainly confinement) have that kind of technology. Around 10% of internet access. Getting more info this way. Very progressive are tracking what's going on with futures and locking on prices. Don't know of anybody using GPS in field – although have experimented with it. Computer used to decide what parts of field need more pesticides, etc.

Farm labor. Of larger farms, how many pay base wage (federal minimal) vs higher. All farms owned by families (w/in Co-op). Larger farms, more employees, many cases must pay more than base wage to get worker. May offer other benefits – provide milk and meat or housing in addition to pay. Have incentive programs, premiums on quality. If can obtain this quality premium, we'll split the benefit. Majority have to pay at least $7/8 to stay up with Mcd's. And have seen influx of Spanish (Mexican) labor. Outside person would need to pass certain standards. If family member there is no minimal age for use of labor. There is a push for age specific (so a 10 year old isn't driving a vehicle), but isn't set in stone. Typically don't collect wage payment.

ALLEN DUSAULT INTERVIEW (SUSTAINABLE CONSERVATION), JUNE 2003 (415-977-0380, X303)

- CA Dairy Quality Assurance Program (CDQAP) targets water, expanding to air; best management practices, what to do to get certified

  - Deanne Myer at UC Davis heads up: 530-752-9391; will know of a good herd health person (tail docking, size of stall, treating sick cows, climate control)
- He works with organic and conventional (does most damage)
- Biggest environmental issues:
  - Surface water quality: surface runoff from nutrients, pesticides, hormones, sediments, pathogens
  - Ground Water: salts, nitrates
  - Land degradation: build up of constituents in soil
  - Air Quality: CA problem getting bigger; ammonia, PM-10, VOC's, odors (Hydrogen sulfide)
  - GHGs: CH4, CO2, NOx
  - Animal health and welfare
  - Biohazards: safety of farm works, food safety (USDA and CA Dept. of Food and Ag would have management practices on food safety)
  - Energy: water pumping, cooling, CH4 digesters are new big thing; electricity bill can be $50-$60k
- Management practices for dealing with/improving this easier to tackle than science and measurement
- Surface water quality relatively easy to document; varies by manure management type:
  - Flush process: move manure with water to closed container
  - Vacuum system
  - Hybrid of the two
- Pasture or not is issue as well: outside v. inside manure
- Measuring is specific to region or system (manure handling system):
  - Size, location, landscape, climate
  - Manure mgmt. strat.
  - Feed
  - Corral, carousel, stanchion
- Pasture or not? Mixed results:
  - Most cows in CA are not pastured but are still healthy, low incidence of mastitis, mild production as good or better than pastured, better able to tailor feed/diet, protected from weather extremes
  - Other side: manure spread, cows get exercise, not sitting in own urine and feces, fresh air, 'enjoying' themselves
- Food safety is an issue: when producer sells mild to processor, they test milk for food safety, pathogen issues

MARIE GUYE, LOAN OFFICER, YANKEE FARM CREDIT (OCTOBER, 2003)

Collect annually at year-end
Current assets and liabilities. Mostly on a cash basis—not accrual. If they don't keep track of owner's equity, we calculate it based on assets/liabilities
Cash—generally not split out.
Ask receivables—mail check twice a month from buyer market (milk). Grow crops, but not generally for resale. May have land that rent.
Have a few bigger farms that grow for resale.

Ask for inventory. Crops grow, harvest, store. Tons of corn, haylage. If sold, liquid asset cash. Have pre-paid supplies. May buy at end of year (fuel), don't consider pre-paid, but it is. Mutual funds may be assets. Don't separate it out between farms/families.
Don't go into personals for collateral.

Intermediate assets. Livestock—count head and break into 4 categories. Milking/dry. Bred heffers. Yearlings. Calves. Value based on sales data and could fluctuate year to year.
Vehicles—farm and personal. Machinery equipment. Value based on IM solutions guide (Iron Solutions Guide). 4 times per year.
Coop stock. Farm credit systems are coops and have equity.
Retirement funds. IRAs. Something can't get at.

Long-term assets. Real estate. Valuing on market trends (have a fair market appraisal).
Win Pap. Home grown profit. Creates balance sheet and income. Biggest is profitability.

Liability side. Current liabilities. Operating loans or current portions of debt (what to pay back in 1 year period). Working capital. Really need to look it. Can't be misguided by how you valued inventory.

As loan officers, check for inconsistencies. Farmers fill out paper-based system.

Intermediate liabilities. 1 year plus. Anything amoritized up to 7 years and not payback in one year. Machinery/equipment loans. Capital loans—bank notes. Mostly for livestock and equipment.

Long-term liabilities. Mostly real estate purchases.

Loan officers take all info, due adjustments and create accrual statement and provide projections.

Character. Evaluate based on 1-5. Average, above average, excel. Management abilities.
Capacity. What payment is vs. net income and how many times that will work. 110% payment.
Capital. Do this on market value.
Conditions. Is operation moving forward/behind? Normal generally.
Collateral. Not financials. What are they pledging against loan. Try not to go over 75%. Machinery, equipment, land.

Going to Empower.

Can you send me copies of what you ask for from farmers?
Most farmers join to get loans? Or to understand financials? Average length of membership?

Schedule F.
Supplemental Data Sheet.
Balance Sheet Worksheet. We create this stuff through Basis.
NE Dairy benchmark program—have very good data.

Why want to know just about my dairy?
I'm not sure if I'd give it to them. Have to think about why. Why would B& J go to that length when they create ice cream products?

Environmental issues will impact the quality of the product that I produce. B&J has a stake in what

Ave cost production 13.25
12.49 for pay.
In the last month, farmer's can't cut it and have not more give. Even with MILC. One's that weren't healthy are going out.

HAL HAMILTON, EXECUTIVE DIRECTOR OF THE SUSTAINABILITY INSTITUTE (JULY 7, 2003)

When farming, Hal enrolled in a record keeping system managed by the U of KY that provided him a printout of performance based upon his data compared to others data. It gave him information in terms of productivity per acre, per unit capital invested, per labor hour. It also gave him info on milk per cow, if spending too much money on feed, etc. He agreed that net household income was important, but had to look at whether or not the operation was a partnership or another type of operation. He shared this type of information because he was able to get something back in return.

For dairy, he thought that the biggest costs were imported feed, debt service, and machinery (depreciation, repairs, and new capital). He said that in the NE there is lots of off-farm feed purchased, but there is a movement towards grazing.

He told me about an interesting case comparing Organic Valley to Horizon. He said that Organic Valley was able to provide a larger premium back to the farmers than Horizon, because the owners liked to maintain a small-farmer zeal to them. He recommended contacting Teresa Marquez or the CEO George ?.

On the social side, he indicated that local employment, time for civic affairs, and cooperation amongst farmers were good indicators of sustainability.

On the environmental side, he said that manure handling, cropping, and eroding cow paths were some of the main issues.

INTERVIEWS WITH BILL JOKELA, UVM CROP & SOIL SPECIALIST, SEPTEMER 16 AND 25, 2003

Questions about Phosphorus Index Tool (answers in bold):

- **Erosion test is key: CAN'T IGNORE THAT; can ask if the farmer has had a Conservation Plan done, if so, they will have erosion index**
- Why P specifically? **Water quality situation in VT, problem with Lake Champlain**
- What are main differences between Phosphorus Index (PI) and Nutrient Yardstick (NY)? Should we use both? **NY more about long-term effects on water quality, P Index more 'on the ground' and useful to fix it now**

- **Quick changes that can be done now:**
  - **Amount of P in the feed**
  - **P supplements: dairy operations supplement feed with P due to historic fear that it is vital to production – can lower amount of inorganic P supplements**
- How common/easy to obtain is information in PI?
  - Fertility Index Value**: same as soil test P; other states rank it on a scale to present #'s**
  - Soil test P: **generic name for any soil test where cores are taken and sent to lab; any farm that does nutrient management planning will do this**
  - P Runoff Screening Matrix: **introduced by UVM & NRCS, not tested very well yet (stick to P index)**
  - Modified Morgan extract P: **specific brand of soil test P**
  - For all of the above, how common are they? How easy to administer? Who administers?
- What about Nitrate Leaching Index? How is that calculated from the Soil Hydrologic group information? **Looked at annual/growing season precipitation, nitrate leaching potential; NY did project around this and has a fact sheet on it**
  - Pre-Sidedress Nitrate Test (PSNT) – how common? How administered? By whom? Cost or time intensive? **soil test when crop is actually growing to determine exactly what nutrients it needs; not a big % use it, costs $5 and has to be done yearly**
- "Soil Test P" test give us any other information about soil quality? **$9-10/sample (may include 20 soil test portions combined); some fertilizers dealers will do for customers; do general soil sample every 1-3 years or when you rotate the crop; soil sample measures pH, lime, aluminum (higher Al, more readily P absorbed by plant)**
- What are options for translating to other states/conditions? Key elements that will change?
- No irrigation erosion used in VT – why?
- Poor relationship between Modified Morgan test and P increase levels?
- Can full P Index really not be done without a site visit? What are options to modify it for our purposes? Should we expect to only be able to use screening tools?
  - Screening tools would be Modified Morgan extract P (STP) and P Runoff Screening Matrix (PRSM)? How common are these? Where are there more details about PRSM?

- P Index better as nutrient management or water quality indicator? Other 'best' indicators of water quality?
- Nutrient yardstick has: **calculating whole thing will be a fair amount of work for farmer**
  - Animal weight gains & lbs. of nutrients in animals (from weight gain)
  - Nutrients in animal products leaving farm
  - Manure nutrients removed from farm
  - Purchased feed, forages and minerals**: this is the majority of what is coming on to farm**
  - Nutrients in sold crop products

  - Nutrients in purchased fertilizer and manure
  - N fixated by legumes (N credits)
  - N from deposition (what is VT deposition rate? not listed) and irrigation water (need to test water, can farmers do that?)
  - What can be left out? What is insignificant enough that not worth calculation?
- How common is following for VT dairies? **Primary crops are hay, alfalfa grass, clover grass or regular grass and corn for silage; a few with soybeans, barley or other small grains; large %age do corn with some sort of rotation**
  - Crop rotation: (corn-corn-soybeans-wheat) – what do they grow?
  - Typical seasonal cycle (compared to MI)?
- Types of nutrients vary in importance? N? P? K? **N more of a problem where highly leachable soils; K not significant from an environmental point of view**
- What other programs does he know of/recommend? **We should look into Farm-A-Syst: program for each state that captures what we are trying to do; LPES curriculum**
- **Questions to determine whether to do N or P Index is a new proposal – not yet fully embraced by community**

HELEN KEEP, CORPORATE RELATIONS DEPARTMENT, UNILEVER; (OCTOBER 2003)

Ms. Keep:

- Works on Unilever's reporting regarding sustainable agriculture. T
- They start with a definition; have a set of broad indicators. Need to be able to explain the indicators to farmers;
- Unilever has a working group with Nestle – but nestle's supply chain is very different than that of Unilever's. Unilever uses mostly dairy products such as skim milk powder, not raw milk. Ben & Jeryry's uses raw skim milk.
- Three areas they believe are important: 1) main sustainability issues, 2) best practices, 3) impact of biodiversity.
- Working Group with Nestle will focus on farm management practices vs. measuring the sustainability of the practices.
- Organic Farming:
- carries a price premium and a cost
- all farmers think that it costs money and reduces the yield
- Unilever is not willing to pay more and is still using pesticides and fertilizers.
- Farmers in Europe get income support by using certain green measures under the Common Agricultural Program
- Biggest Challenge – global system for supporting food production

TOM KRIEGL, UNIVERSITY OF WISCONSIN CENTER FOR DAIRY PROFITABILITY (JUNE 18, 2003)

FFSC—

There are no official guidelines in practice—the closest thing is the FFSC standard.

There is no regulation regarding record-keeping. Each farmer has to file taxes—the IRS defines taxable income, but it can be calculated in a number of ways. In some European countries, this method is better defined.

Not sure if there is an EU equivalent, but was engaged in fairly extensive discussions with individuals from Germany and Denmark and a standard did not arise. However, many of the same indicators were used.

Farmers generally understand net farm income and net farm income from operations, but most of the other indicators and ratios would probably not be readily understood without explanation and definition.

Tom warned us not to rely on too few #s. Each data point provides different information. But he rarely used repayment capacity.

Most software programs (FinPak, DFBS from Cornell, AMES, and AGVA) all comply with the FFSC, but Tom estimates that only 20-30% of farmers use software. Some do hire accountants which follow GAPP principles.

Ag lenders are in a similar position to B&J (trying to judge sustainability of investment and if they can recoup their loan. Tom thinks that they probably don't collect enough info.

Milk price setting—the price of milk is regulated by USDA. There are 4 different classes. The MILC program is the only dairy specific price support for milk, however, if farmers product grain, they could access grain supports for their farm as well.

Tom suggested looking at the solvency of the coop vs. the farm. Calculating numbers will differ based upon which enterprise you use. Assets will especially differ.

Tom recommended that I look at the annual Wisconsin dairy analyses on the U of Wisconsin website to find averages for most of the FFSC indicators to use as a baseline.

GREG LARISON, ORGANIC GROWERS OF MICHIGAN (JULY, 2003)

Build soil instead of mine it. How we measure it is nebulous—we "suggest" soil testing at least every 3 years. Can't legally require it under the Federal law. We can require that a grower demonstrate that they build their soil. And traditionally it's been various kinds of soil testing.

Soil erosion—ask about erosion potential of land and what do to prevent it. Confirms what people are doing. Feel, smell, tilth of soil.

Herd health—keep close track. Butterfat content and bacterial counts. Availability to open air year round.

Diversity—edges, hedgerows. Want to encourage beneficial insets to have good home.

Maintaining wildlife habitat—buffer zones between fields and wildlands

Dairies do random samples on hormones, etc. We only do it if we expect a problem.

If not growing feed selves, inspect bills of record to ensure organic audit trail.

Annual application and annual inspection. If we find something, a non-compliance—we may send an inspector back after they have corrected the problem. If somebody has issue, like county has sprayed roads, might call for inspection.

Organic has a less per acre cost than conventional growing and after 3-4 years, the field is equally productive. The farms are typically not as big as commercial farms (maybe 40 acres).

4-18-03 MEETING WITH MARC LAVINE (FORMER INTERN WITH CHIQUITA N.A.)

- Chiquita wants to use the Better Banana Project as a competitive advantage and are treating the certification/relationship with RAN as proprietary and not allowing it to be used by other companies (note: it's too bad, as this reveals that the motives for doing this are pure business; if they were doing it b/c it's the right thing to do, they would want every other company to do it to continue improving social/environmental operations and would want to share the tools to do so)
- The view from the U.S. is very much that the problems with their practices are 'down there' and do not question farm worker practices domestically
- Jeff Zalla's background in finance (MBA from Wharton) is beneficial in that it drove the creation/adoption of sustainability indicators that are quantitative and measurable (may be more valid and easier to evaluate progress against goals)
    - Overall the finance emphasis was a positive thing for the standards
    - However, the project/Jeff's ability to drive it has gotten to a point that makes his background limiting; initial low-hanging-fruit changes have been made and they are now at a point where further changes will require expertise in corporate change and organizational design
    - Is BSR board-member
    - Buddies with Kelly Mc
    - Santiago G is his right-hand man. May want to ask questions to him.
- Better Banana Project is primarily environmental so they adopted the SA8000 labor standard and signed labor agreement with their workers in order to balance out the social side
    - Encouraging these two organizations to look at the other and consider expanding indicators to balance more with social/environmental (note: why don't they work together to combine their indicators rather than each working individually to develop two similar systems?)
- Thoughts for B&J
    - Why are they doing this? To please internal stakeholders? Consumers? Marketing driving? Industry credibility? What's the motivation?
- Companies good to check out
    - Stonyfield (part of Danon)
    - Cropp Co-op, from Wisconsin (make organic milk, cottage cheese, don't think ice-cream)
    - Straus Family Creamery from CA
    - Donnybrook Farm of NY
    - Cascading Farms (part of General Mills)

Organizations and Individuals to Contact

Martha Lumbeck – former B&J employee. Believes still in VT. Is UMBS alumni – can look up on alumni site

Thomas Nelson, tnelson@foodsecurity.org
Would be an excellent person to ask who one should talk to in order to find out more about trends, and certification programs that pertain to sustainable dairy operations. Thomas is a close friend and he should point you in the right direction. His wife Judith Redmond is the former Exec. Dir. of CAFF, and a head of the California Sustainable Agriculture Working Group.

Check out his organization:

http://www.foodsecurity.org

Community Alliance With Family Farmers
http://www.caff.org/

California Sustainable Agriculture Working Group
http://www.calsawg.org/

Here is the website for the Food Alliance, The group that does some certifying work. The guy who runs that part of the operation is Jonathan Moscatello. I don't know him well, but I've spoken to him and he is a friend of Thomas Nelson's.
http://www.thefoodalliance.org/

Martha Reeves who works for the Pesticide Action Network, has apparently been very involved in national standards and certifying issues through her work with Cal SAWG. Her website is:
http://www.panna.org/

Sustainable Agriculture Network (SAN)

Organic Dairy Related

The California farm operation. The person I knew who was connected to the business was Ellen Straus, the matriarch, who died last Fall. I could get you contacts there if you need them

http://www.strausmilk.com/
This is the operation other than Horizon and Stonyfield that competes nationally in organic dairy. The interesting part is that they are a farmers co-op.

http://www.organicvalley.com/

I came across this list and thought you might find it useful.

- http://www.organicconsumers.org/rbgh/rbghlist.cfm

DICK LEVINS, UNIVERSITY OF MINNESOTA (JULY 9, 2003)

Dick Levins is concerned that B&J's wants to develop its own standard instead of relying upon 3rd party certification. He believes that a 3rd party would provide B&J a buffer from any liabilities it might incur. Dr. Levin gave similar advice to Unilever as a whole as part of a separate consulting initiative. Recommended Farm Management Association as the best solution—B&J would need to require that all its suppliers belong to the FMA. The FMA would collect and review financial performance data and help the farmers become more efficient at the enterprise level. It would ensure consistent collection and analysis of data which would allow B&J to evaluate suppliers on equal grounds—many FMAs use FinPak from U of Minnesota. The FMA could easily function across industries. Farmers would benefit by gaining data on their performance relative to the performance of other suppliers. B&J may have to front the money to support the Farm Management Association. He recommended that we contact the Extension Service in Vermont to find out if an FMA already exists. He warned that profitability can be a bad measure for sustainable dairy because many farmers might be farming to supplement their income and are not looking to be as profitable as possible—just to run a sustainable operation. He recommended that we contact Roy Black at the extension service of Kent Olson (U Wis FMA expert at 612-625-7723.

On the social side, Dr. Levins recommended looking at unpaid labor and % of supplies bought in the local economy (w/in 25 miles in the Midwest). He recommended that we speak with Dr. Cornelia Flora in the Dept of Rural Sociology at Iowa State in Aimes. She has done a lot of research on small family farms.

On the environmental side, Dr. Levins indicated that his 4 economic indicators had been field-tested and did help predict social and environmental impacts of farming. But again, he recommended that certification at the enterprise level could be a more effective, more accepted measure of sustainability (especially on the environmental side), plus they would have already developed templates for many products including dairy. He recommended the Midwest Food Alliance and for us to contact Jim Ennis at 651-265-3684. He warned that lawsuits could arise if B&J successfully certified a 'bad actor.' He said we could also check with Farm Assist for a checklist on environmental performance and call Jim Anderson if we have questions at 612-625-8209 or call Joe Schimmel at the MN Pollution Control Agency at 651-296-7756.

Milk pricing. The Federal Milk Marketing Order Program provide direct payments to farmers when the market price is to low. The gov. sets a minimum price for milk and if the prices fall, the government will buy the milk. I should check with Roy Black for extension publications on milk pricing because it is very complicated. In Vermont, he recommended contacting Robert Wellington, of Agramark, a competitor of St. Albans regarding the milk pricing standards because he was involved with the special NE legislation guaranteeing NE farmers special price breaks. 978-689-4442.

MIKE SPINELLI, BEN & JERRY'S ORGANIC LINE MANAGER (JULY 16, 2003)

Ben & Jerry's is producing its organic line in accordance the new Organic Regulations passed in October of 2002. Ben & Jerry's is not requiring anything above and beyond the regulations. To meet the regulations, Ben & Jerry's must ensure that 95% of the mass of its

products was produced and handled in accordance with the regulations. This means that 4.99% of the product can be conventionally grown. For Ben & Jerry's ice cream, Mike commented that sugar was the biggest roadblock because it is almost impossible to source 100% organic sugar. He could only get 98.7% organic. He also said that sourcing enough milk in the Northeast was also a roadblock. In order to find enough milk, Ben & Jerry's entered into a contract with Organic Valley in Wisconsin. Organic Valley is a large cooperative that operates regional dairy processing facilities (for example, St. Albin's in Vermont is certified by Organic Valley). In the Northeast, the organic milk supply was already taken by other producers (mainly Stonyfield), so they are producing and processing organic milk in Wisconsin and shipping it to the factory in Vermont in order to process it into ice cream. The ice cream is being piloted in Boston, San Fran, Seattle, Denver, and Portland. Ben & Jerry's is hoping to attract new customers as opposed to "switchers," people who switch from non-organic Ben & Jerry's to organic Ben & Jerry's. Ben & Jerry's found that most organic products were typically sold for a 20-30% price increase over conventionally-produced goods. Ben & Jerry's has instituted a 7.5% price increase ($4.29 vs. $3.99 for conventional). I didn't get into the specifics of why the price point was so low or if Ben & Jerry's was taking a lower margin to keep the price low—but economically they must believe that this model will work. Mike noted that organic is more expensive because feed is more costly to produce, vaccinations can't be used, rBGH is prohibited, and synthetic fertilizers can't be used. These additional costs up the per unit cost of production. He said that there may also be more labor required on the cropping side for organic production.

On the environmental side, Mike noted that the regulations speak to no GMOs, no pesticides, proper animal husbandry techniques, watershed monitoring and groundwater contamination, fertilizer practices, and manure management. He noted that items of controversy in putting the regulation together included issues over use of synthetic fertilizers, pesticides, composting (temperature in time requirements), and organic feed requirements. A modification to the regulations allowed farmers to purchase conventionally-grown feed if the price for organic feed was significantly above the price for conventionally-grown feed. This portion of the regulations has since been repealed. He did note that much of the evaluation of organic practices rely upon the stringency of the certifying agents (i.e., what constitutes proper soil erosion prevention practices). There are no requirements for energy consumption.

DR. CAROLYN STALL - ANIMAL WELFARE EXPERT AT CDQA = CALIFORNIA DAIRY QUALITY ASSURANCE

530-752-0855
Her research focuses around the transportation of cattle (dairy and meat) and horses

Main concerns of Animal Welfare?
Two ways to answer this question, from the consumer perspective, and what's really important to the animal. These lists are different.
The consumer is concerned with 1. how the farmer handles downer cows (downer cows are those that can't walk around the farm). Consumers are concerned with the slaughter process and once the cows leave the dairy. 2. BST, 3. the amount of mud the cows must wade thru to get around the farm and that they get covered with.

From the cow's perspective, 4 main things:

1. How handled/treated when downers – animals go down and can't walk on farm. This can occur from lameness, or calving paralysis.

To prevent calving paralysis, must do nutritional manipulation before they have calf. Manipulate magnesium calcium in feed (suggested further research on web to learn more specifics – outside her area). May have to do with age, because lower calcium available for milk production, then draws calcium from cow's own body.

Lameness and other reasons for being put down can be from a repetitive injury that may be caused by slippery surfaces, standing on concrete, etc.

2. Shelter from extreme weather – heat or cold, wherever they are

VT – humidity, heat – shade available? Wind blocks? Barn available?

3. How handled during transport

Must handle appropriately – in terms of how you load, sort, handle, unload (quietly, facilities for housing/storing available). Don't travel in heat of day. Load trailer appropriately – if tight, can slide, to loose, slide around – need right amount. Also social behavior does impact – if one aggressive cow, will bully rest of cows in load. Instead should put in separate pen and not with the non-aggressive cows.

Dairy cows transported pretty limited. Transported to slaughterhouse or when arriving on farm. Not much movement in between.

4. How put to sleep on farm – euthanasia

Some farmers go to slaughterhouses and others are put down on farm. Can be shoot in the head or receive a chemical injection (from vet).

Areas I cover that she didn't mention yet:

Nutrition isn't big concern – usually fed quite well because associated with milk production. Balanced diet (grain and forage) – required for milk production. Variations across country because of what feed is available.

Diseases – every dairy has some mastitis – handled on an individual cow basis. If mastitis is prevalent, then farmers can't sell milk.

Specific metrics (learned thru research) - how applicable/feasible??

- Somatic cell – milk sample. Very well known by industry. No idea about cost.
- Protein levels - MUN = milk urea nitrogen, BUN = blood urea nitrogen. Tells you what type of nitrogen in feed and amount of milk production. Doesn't tie into welfare.
- Rumen - ADF = acid detergent fiber, NDF = neutral detergent fiber. Determines type of fiber and how digestive it is. Indication of nutrition quality. Doesn't tie into animal welfare. Does indicate quality of feed (fiber).

- Body condition. More objective than just skinny, fat, just right. Is visual evaluation of percent of fat in body. If its too low, then means they are digesting their own protein. Too fat, once birth, will have problems. Want score between 3 – 7. Lactation (post calving) will drop score. When pregnant, not lactating.

Additional questions

How much record keeping?
Type of records likely to have include information relevant to: milk yield, when pregnant, mastitis treatment, medical treatment, nutritional, not much body scoring.

Do most have computerized system to track milk yield, disease incidence?
A lot have some computer record keeping. Farms with over 400 cows have lots of record. 20% of farms have no records – typically your smaller farms.

Average age for CA cows is 5/6 years, but can probably milk until teens. Natural life span 20 –25 years.

JAN KEES VIS, UNILEVER SUSTAINABLE AG PROGRAM, 9-9-03

- Programs around ag sustainability: University of Bern sustainability
- REPRO: U of Howell in Germany
- U of Wagoning: program making dairy farming systems sustainable through improvements in water use/quality:
  - Contact is
- One way to bring farmers on board is rating tool; other is to give them management practices on how to improve
  - Ultimately we will need to have both
- B&J VT with us is more advanced than in Netherlands
  - International Dairy Board may have initiative
- Sustainable dairy standard: collection of recommended practices for dairy
- Their approach: starting with a definition and indicators to develop a practical approach for farms
  - Went to farmers to ID metrics to see what are key performance indicators – next question is "What farm practices drive improvement of these indicators?"
  - Worked well; limitations where sustainability issues exceed farm level: biodiversity, economic development
- He has two 50-page documents that describe metrics in detail; based on theoretical models: fertilizers type and models for decomposition; also depends on soil type
- Interaction with Nestle: working group on SAI
  - Nestle dairy supply chain very different from Unilever because leader in infant formula: need to have control over entire dairy chain; set up monitoring program and execute it; in India, 1 litre/farmer/day
  - Unilever uses mostly dairy products (whey powder, skim milk) – very removed from the farmer, only one product uses raw milk; B&J, use raw whey skim milk

  - Performance level to which you want to raise farmer depends on product; quality much more important for infant formula than for ice cream
- Country differences: dairy industry structure, company structure
  - Has to be about yields, no negative impacts on env., beneficial effect, minimize use of non-ren. res. – 4 principles as base that can lead to metrics and management practices
  - Level at which you ID main sustainability issues will be cross-regional, etc.
  - Thinks they can
- Program not focused on managing indicator values b/c simply too many of them; manage program in different way: make sure farmers are asking correct questions, know about correct in
- Farmers always assume it will cost money or decrease yields; not true, in 10-11 programs around the world, do not see increase costs or decreased yields; they have done value chain analysis and found that effect is negative or beneficial
  - Lots of farmers do fertilizer based on intuition, experience, etc.; don't do soil sampling, analysis, etc.
  - Always worked with Unilever farms or farms under specific contract with Unilever; have 50-70 year relationships with them and have always practiced sustainability – now looking to expand these considerations incorporating new research and information
  - Innovators within group are the first on board: this is not that difficult; the greater challenge is getting others on board; not offering a premium for products
  - Not talking about organic, still use fertilizers and pesticides, etc.; recommend that pesticides/fert. not applied at perimeter so they lose some acres of proucti
  - EU Common Ag Program: farmers in Europe get income support for adopting green measures; moving away from volume incentives
  - In UK, co-ops have not developed but in almost all other cases, farmers do form co-ops; Unilever farm co-ops provide basis for negotiations but do not purchase inputs for farms, extension advice for members and purchases all produce
- Greatest challenge to sustainable ag: internalizing some of externalities that farms create; but is limit to how much you can reduce/internalize impacts
  - As long as producers do NOT internalize these, and subsidy systems support that, they will always be able to provide cheaper products
  - Has to happen at USDA level; these subsidies make it impossible for devg. countries to compete; our surplus dumped in Africa and Asia at cost so low that local producers
  - Buy food in supermarket, part of taxes, pay to have externalities cleaned up (in Europe, 1/3 of drinking water costs is cleaning up pesticides out of it)
  - Global system for supporting food production has to change;
- He'll send indicator parameter documents for palm oil,
- He wants to stay informed of our progress, either directly or via Andrea; he will talk to Andrea about this

<u>Questions for Jan Kees Vis</u>:

- Understand that he will be talking to Andrea about our project tomorrow so our goal is to learn more about what you are doing

- CEMP and project background
- How going about project? What other similar projects looking at?
- Talks to buyers and supply chain mgrs. at Unilever to promote sustainable ag.; also policy-makers and other food co's. What's at farm level – Colworth farm? Anything at dairy level?
- Talks about efficiency gains and that emphasis now is on finding market mechanisms to increase D for sustainably grown crops.
- "11 lead programs" around the world – what are they?
- Established baseline for sustainability indicators - What work have they done influencing farmers? How was that approached? Received? (Technical guidance and Monitoring guidelines page under construction)
- Do they have back-up on sustainability indicators? How arrived at? How was stuff measured? Specifically for Nutrients: "Emissions of N compounds to air?
- Greatest challenge?

7/9/03: GREG WEBER INTERVIEW, BEN & JERRY'S VERMONT DAIRY FARM SUSTAINABILITY PROGRAM (518-561-5919)

- Nitrogen (N) tends to be limiting in salt water, phosphorus (P) in fresh water
  - Additional problem with N is that it can get down into drinking water via leaching
- Metrics used in Greg's work too complicated for what we want to achieve; we are better off using higher level, less-accurate but simpler measures
- We could also use practice-based metrics: e.g. do you follow the **Environmental Quality Incentives Program** (set of guidelines/designated environmental practices for farmers), etc.
- Greg recommends we use the following:
  - **Overall mass balance**: nutrients applied on a per acre basis: fertilizer/manure applied to XX number of acres will tell you the pounds of n/p on the land
  - Bottom line is how much is coming on to farm (export not as important) because if there is more coming on to the farm, there is a higher chance that the excess nutrients can get in the water
    - Water interface is through the crops which can then become runoff or can leach into the ground
    - Majority of dairy farms in NE grow own crops, though he can not speak to other segments of the country
  - Overall import/export of bedding (though this amount is pretty insignificant, almost nothing), purchased/sold manure, forage (aka bought feed), purchased/sold animals
    - For bought/sold animals, translate into nutrient info; there is a standard amount XX per pound
    - Look at NRAES bulletin: NE Regional Ag. Engineers
  - On feed side, farmers will usually know P concentration in feed (usually .38-.4%) or it will be printed on the feed they purchase (like nutritional labeling for humans)
    - P concentration in feed should be within a certain range, if not, excess will end up on land
    - N is much more complex to deal with, too much for what we are trying to accomplish

- We should try to talk to an extension agent (people who work in the fields with the farmers) at an ag. school about that
  - Michigan State should have this; they actually have yardsticks or something that is very similar to exactly what we are looking for

ANN WELLS, ATTRA ORGANIZATION, HEIFER TASK FORCE PARTICIPANT, JULY 30TH, 7:30 PM, SUBJECT: ANIMAL WELFARE, 1-800-346-9140

Objectives:

- Background on B&J
- Her work at ATTRA/ what's her area
- Participation in Heifer Program
- Main Animal Welfare Issues
- Specific terms

Definitions

BST = rBGH, so not issue for B&J
Milk fever = consequence of increased milk production. Result of not having enough calcium in cow's blood, metabolic disease. Causes seizures but can be immediately stopped by shot of calcium.
Tail docking = removing tail so doesn't get nasty with manure, urine, etc. Done in dairy cows (as well as sheep). Necessary and good in sheep, but not necessary in dairy cows, but done so tail can't swipe at farmers when milking. And without tail, can't keep off flies.
Problem with high milk production is that it sucks out the nutritions within the cow.

Big Issues WR identified

Lameness, associated with standing
Mastitis, inflammation of udder, maybe from lack of hygiene
Living conditions (stalls, inside/outside)
BST – causes increased productivity but other problems (can't meet own nutritional needs)
Nutritional food/diet
Hygiene
Genetics
Tail docking – this and below, Ann referred to as Physical Alterations
Dehorning – Ann's advice, do as young as possible. England has started using anesthetics, but giving it is probably as painful as actual procedure
Reproduction capability
Slaughter house – Ann referred to as Animal Handling. Not big problem with dairy, b/c are handled quite a lot w/ milking
Other diseases? Milk fever

Ann's Background

Involved in development of Sustainable Beef Farm Check Sheet. Did a lot of research, similar to ours – in hopes of finding indicators and wanting to provide informative, farmer level information to be used by individual farmer to move forward. Found that all farms are unique and there is no one perfect model. Also, very little done already – mostly around soil and waste mgmt. Most research in South Dakota or The Netherlands. Next developed Dairy Cows Ck Sheet (which is in need of updating as suggested by NC State, to include

more questions around farmer's goals) and is currently working on the Sheep and Goat ck sheet. NC State is doing a lot of grass-based research. They work in partnership with CFES, Center for Ecological System and NCA&T and NCDA. Interacts and provides workshops to farmers and education agents (like NRCF) and others that work with farmers. She may be sanity check of what farmers would and wouldn't know.

Heifer project

Nonprofit organization started more in developing countries, where people are living off the land with subsistence farming. Idea is to give seed stock to farmers, pass along first heifer to another family. Each farmer must meet certain qualifications, such as shelter, how to care, appropriate food, etc. Ann is part of task force (which will change to committee), role as an outside member of community, looking in. To fend off animal rights' activist, Heifer is having to present criteria they use for qualifying "farmers." Emailed me list of criteria – they are common language, easy to understand BUT so much individual interpretation. Terry Wollen (sp?) is veterinarian who created guidelines.

Ann's Initial Thoughts

Ann sees a need to fill a gap between city and farm. Too often lack of understanding between the groups. Farms says, we understand what our animals need, bug off. City people drive by and see cows grazing on little plots (for controlled grazing = grass based grazing, where graze on little plot for 12 hrs – 1 day before they move on to the next lot). In the NE especially, there is a lot of city folk concerned that animals are mistreated (when in fact it may be a better practice). Very excited about our project – think it's a great next step and will help to educate and bridge this type of gap. Seemed very willing and eager to be involved in any way possible. Also very interested in what we learn/create. Possible Advisory Board member?

Top Areas (BST ignored b/c of B&J's existing policy)

1. Confinement operations. Grass Based Dairy, but confine during winter. CA has many very large farms, where they spend much of the time on the concrete. About 50/50 between control grazing and not (? Unsure if this was exactly right. Should clarify b/f use). Ideally cows consume ruminants (grass/fiber) and grain (more nutrients in this). Their digestive system is different than ours and need to have both. The ruminants occur earlier in the process than the monogastric (which is what humans, horses, pigs are). The more grain they have, the more milk they can produce, but need the fiber, b/c otherwise they will have something similar to our acid reflex. Bacteria in rumen break down grass is different than the bacteria used to break down the grain. Grass based may produce 50 – 60 pounds of milk per cow based on majority of grass feed. Confinement will produce 80 – 100 lbs of milk/cow. Most grass based farming systems are in New England and Wisconsin. Less than 20% of farms in the US is grass-based. Only last October was the exact organic criteria established, including "actual open/access to pasture". In terms of one causing more methane output, Ann wasn't aware of one food type causing more gas than another. Have freedom of movement, along with other benefits. Vermont research, which had GREAT conventional farm system, with great sanitation and had no more problems than organic herds with mastitis, etc. Semi-confinement = grass-based, but will confinement during Winter.

2. Nutritional needs. Some confinement operations have on-site nutritionalists and do a great job of insuring that cows get exactly what they need. Own nutritionalists maybe if greater than 500 cows on farm – maybe 1000? If less, may just get consultation. Wonder if Co-op would have "shared" nutritionalists. Grass-based systems find this more difficult b/c no way to know exactly what the cows have eaten and what not. However, all have grain for the cows just outside the milking room or even inside as well. Lots of research about how to provide ruminants better and cheaper.

3. Sanitation. Impacts on feet/legs, and mastitis. Confinement is always in search of finding better bedding. Even tried waterbeds. Varies a lot by individuals. Sand so far seems the best option.

…hazy line between the #3 and #4…

4. "Cow Comfort." Bedding comfort. When cows are uncomfortable, they don't milk as well. Get sick and have other physiological conditions.

Other Information

Grass based dairies have less mastitis as a result of being in a dryer environment. No matter how hard, is impossible to keep bedding dry.

Standing, lack of nutrition, and not getting what need when need can all cause stress.

Foot and leg problems resulting from confinement.

Book in stress, "Fevers Don't Blush" – about stress levels in animals. Very readable.

Also Organic Livestock Workbook on ATTRA's web-site, provides a checklist/scoring basis. Ann will send hard copy (being reformatted so easy to read right now, will be out in about a month?). Person who worked on this is MSU guy. May want to contact in future? Once had time to review document.

Left it with Ann that I may circle back when we get closer to developing/identifying exact metrics to use. Again, she's very eager to stay involved in our project/process.

ANN WELLS, OCTOBER 27, 2003

1-800-346-9140

Inform of Upcoming Conference Call:

Tuesday, Nov 4th, 1 – 3 pm

Will send prep materials Friday, 31st

Including list of all Advisory Board members

10 modules – scanning enviro concerns, social and financial

Looking for feedback from Ann, primarily focused on animal welfare as well as interconnections with other modules.

Review what topics are covered in Animal Welfare Module:

Nutrition
Overall health
Health of incoming animals
Milk quality (SCC)
Lactations
Housing/handling areas
Stalls
Parasites – keep? – delete, per Ann
Milk Equipment – keep? Important to cow comfort? Far more important than parasites (which are not as important for dairy cattle).

Other areas:
Confinement/outside – get this information thru foot question
Feet and legs problems – incidence, how they deal with it. Preventative methods
Types of bedding and stalls. How many have feet and leg problems. Hairy heel worts – infectious agent, difficult to deal with. Can be dealt effectively – when to worry about it. Lots of herds have. Caused by contagious, infectious agent. Can be transmitted between animals.

Ann is also veterinarian! Grazing does improve animal's health, but understands and thinks its fine to approach subject via other ways (versus asking directly and potentially alienating famers).

Contact in PA, who worked with NRCS. Dairy farms that moved from confinement to grazing operations, which is a big decision. Need land available, but can do with large head of cows. Milk production decreases but not as much as operating costs (so net benefit).

Don't have too high expectations on what these people/farmers are going to be willing to do.
What's the carrot for doing this? Is B&J's already paying above the minimum? How much? Will to pay extra for farmers willing to participate in the program?

Organic dairy is usually about $20/wt, which is two times as much as regular.

Regulations within the US?
More talk but everything is pretty voluntary. No regulations in place (even in EU). Staying voluntary with animal rights activist – keep people/groups off backs and being kind to animals. Relate to antibiotic usage. Voluntary and PR coverage – public perception, are the bigger motivators.

APPENDIX D: PARAMETER SCREENING SPREADSHEET

This appendix includes detailed information on each parameter that the team identified. Within the spreadsheet, a series of "farm level" questions are listed next to each parameter. Each question is evaluated against a set of criteria listed in the section entitled "parameter level." Questions with an X in any of these columns were eliminated for the reason listed in that column. Any parameters that were not eliminated were evaluated using the questions listed in the "Farm/Template Level" section. The results of this analysis were used to select the "best" parameters for inclusion in the final Educational Modules as described in the Methodology.

				Parameter Level											Farm/Template Level							
					If no, is it b/c (X if applicable):																	
Indicator	Sub-Indicator	Parameter	Farm-level Question	Parameter recommended for inclusion in template? (Y or N)	Data is not comparable?	Time investment is not worth info?	Cost investment is not worth info?	Limited research info available for parameter?	Provide limited info on indicator?	Expert recommends drop	Irrelevant to dairy?	Other parameters are more comprehensible?	Not important to VT?	Other reason?	Type of measurement (M=Management, D=data/quantitative informtion, O=Observation)	How measured? (What are discrete measurement units?)	Time required (min)	Additional time required for record keeping (beyond normal, during the yr) ? (L=low, M=med, H=high)	Outsrce agency needed to answer question2	Cost for measurement?	Are there "acceptable" parameter levels?	Ease of verifiable (E=easy, M=med, D=difficult)?
Animal Welfare	Animal Nutrition	Availability of water and food	Sufficient trough space to allow all animals to feed at once?	Y?					x			x			O	sq m	15 min	L	N	0	?	E
Animal Welfare	Animal Nutrition	Availability of water and food	Equal distribution of animal feed?	Y?					x			x			O/M?	y/n	1 min	L	N	0		E
Animal Welfare	Animal Nutrition	Availability of water and food	Availability (location) of clean drinking water?	Y?				x				x			O	placement	1 min	L	N	0	yes	E
Animal Welfare	Animal Nutrition	Availability of water and food	Availability (quantity) of clean drinking water?	Y?				x				x			O	gallons	5 min	L	N	0	yes	E
Animal Welfare	Animal Nutrition	Chemical use	Use of synthetic fertilizers or pesticides on grazeland? (tied into CB's and MM's?)	N				x	x													
Animal Welfare	Animal Nutrition	Variety of feed stuffs/feed analysis/calculation of diet and feeding patterns	How much time do milking animals spend chewing their cud? (indication of fiber amt)	Y											O	min	60 min	L	N	0	?	M
Animal Welfare	Animal Nutrition	Variety of feed stuffs/feed analysis/calculation of diet and feeding patterns	NDF levels? (NDF determines intake of feed - related to fiber and working the rumen)	Y											D	score	?	M	Y	?	y	E
Animal Welfare	Animal Nutrition	Variety of feed stuffs/feed analysis/calculation of diet and feeding patterns	ADF levels? (ADF determines digestibility of feed - related to fiber and working the rumen)	Y											D	score	?	M	Y	?	y	E
Animal Welfare	Animal Nutrition	Variety of feed stuffs/feed analysis/calculation of diet and feeding patterns	Ratio of grain to milk produced? (grain = energy amount)	Y											D	ratio (bales?, gallons)	5 min	L	N?	0	?	E
Animal Welfare	Animal Nutrition	Variety of feed stuffs/feed analysis/calculation of diet and feeding patterns	Body condition score?	Y											O	score 0 - 10; skinny, on, fat	dep. on level of accur acy req'd	L	N	range	yes, 1-5, hope for 3.75-4	M
Animal Welfare	Animal Nutrition	Variety of feed stuffs/feed analysis/calculation of diet and feeding patterns	Is an animal nutritionist involved to ensure proper mix of fiber and grain?	Y											M	y/n	1 min	L	N	0	n	E

				Parameter Level											Farm/Template Level							
					If no, is it b/c (X if applicable):																	
Indicator	Sub-Indicator	Parameter	Farm-level Question	Parameter recommended for inclusion in template? (Y or N)	Data is not comparable?	Time investment is not worth info?	Cost investment is not worth info?	Limited research info available for parameter?	Provide limited info on indicator?	Expert recommends drop	Irrelevant to dairy?	Other parameters are more comprehensible?	Not important to VT?	Other reason?	Type of measurement (M=Management, D=data/quantitative informtion, O=Observation)	How measured? (What are discrete measurement units?)	Time required (min)	Additional time required for record keeping (beyond normal, during the yr)? (L=low, M=med, H=high)	Outside agency needed to answer question?	Cost for measurement?	Are there "acceptable" parameter levels?	Ease of verifiable (E=easy, M=med, D=difficult)?
Animal Welfare	Animal Nutrition	Variety of feed stuffs/feed analysis/calculation of diet and feeding patterns	MUN tests (Appropriate protein amounts)	Y											D	score	15 min	H	Y	may be costly	?	E
Animal Welfare	Animal Nutrition	Variety of feed stuffs/feed analysis/calculation of diet and feeding patterns	BUN tests? (Appropriate protein amounts)	Y																		
Animal Welfare	Animal Nutrition	Variety of feed stuffs/feed analysis/calculation of diet and feeding patterns	% of intake that is crude protein? degradable intake protein (DIP)? undegradable protein?	Y											D	%	10 min - probably get info from grain seller	L	Y (feed sellers)	0	yes	M
Animal Welfare	Animal Nutrition	Variety of feed stuffs/feed analysis/calculation of diet and feeding patterns	% of feed bought versus produced?	N?																		
Animal Welfare	Animal Nutrition	Variety of feed stuffs/feed analysis/calculation of diet and feeding patterns	Level 1. >95% of the feed needed for the herd is purchased. Level 2. <65% of the feed needed for the herd is purchased. Level 3. <35% of the feed needed for the herd is purchased. Level 4. <10% of the feed needed for the herd is purchased	N									x									
Animal Welfare	Animal Nutrition	Variety of feed stuffs/feed analysis/calculation of diet and feeding patterns	Quality of forage?	N?																		

				Parameter Level											Farm/Template Level							
					If no, is it b/c (X if applicable):																	
Indicator	Sub-Indicator	Parameter	Farm-level Question	Parameter recommended for inclusion in template? (Y or N)	Data is not comparable?	Time investment is not worth info?	Cost investment is not worth info?	Limited research info available for parameter?	Provide limited info on indicator?	Expert recommends drop	Irrelevant to dairy?	Other parameters are more comprehensible?	Not important to VT?	Other reason?	Type of measurement (M=Management, D=data/quantitative informtion, O=Observation)	How measured? (What are discrete measurement units?)	Time required (min)	Additional time required for record keeping (beyond normal, during the yr)? (L=low, M=med, H=high)	Outside agency needed to answer question?	Cost for measurement?	Are there "acceptable" parameter levels?	Ease of verifiable (E=easy, M=med, D=difficult)?
Animal Welfare	Animal Nutrition	Variety of feed stuffs/feed analysis/calculation of diet and feeding patterns	Level 1. Herd nutrition is inadequate or not monitored. Level 2. Herd nutrition is monitored and adjusted as needed. Producer understands nutritional issues and can explain them. Harvested feed is properly stored for maximum nutritive value. Vitamin and mineral supplements are provided as needed. Level 3. As per Level 2, and all feed rations are balanced as per regular testing and monitoring of herd health. Producer can explain how various ration fractions are provided. Records are kept/available on rations. Purchased or off-farm rations have documentation of nutritive value and method of ration balancing. All rations meet NRC guidelines for dairy cattle nutrition. Level 4. As per Level 3, and Herd nutrition may be optimized by intensive, rotational grazing of high quality forages during the growing season. Rations may be formulated to modify / reduce excess nutrients passing through cows into the manure	Y											M		<1	L	N	0		
Animal Welfare	Herd Health	Animal handling	Level 1. Restraining and handling facilities and equipment are inadequate or used improperly. Level 2. Facilities and equipment are adequate, and all cattle handlers are properly trained. Floors and ramps are kept clean. Level 3. As per Level 2, and protective headgear and footwear are worn where appropriate. Sharp edges and projections are corrected in handling areas and on equipment. Level 4. As per Level 3, and floors and ramps that are often wet are of non-skid materials.	y											M, O		5 min	L	N	0		

				Parameter Level											Farm/Template Level							
					If no, is it b/c (X if applicable):																	
Indicator	Sub-Indicator	Parameter	Farm-level Question	Parameter recommended for inclusion in template? (Y or N)	Data is not comparable?	Time investment is not worth info?	Cost investment is not worth info?	Limited research info available for parameter?	Provide limited info on indicator?	Expert recommends drop	Irrelevant to dairy?	Other parameters are more comprehensible?	Not important to VT?	Other reason?	Type of measurement (M=Management, D=data/quantitative informtion, O=Observation)	How measured? (What are discrete measurement units?)	Time required (min)	Additional time required for record keeping (beyond normal, during the yr)? (L=low, M=med, H=high)	Outside agency needed to answer question?	Cost for measurement?	Are there "acceptable" parameter levels?	Ease of verifiable (E=easy, M=med, D=difficult)?
Animal Welfare	Herd Health	Overall	Level 1. Herd health is inadequate or not monitored. Animals without known health histories are brought onto the farm. Level 2. Herd health is monitored and recorded by individual animal, including milk production, body condition, diseases, parasites, vaccinations and medications. Vaccinations are given on time and sick animals are promptly and properly treated. Antibiotics are not administered unless disease or infestation has been accurately diagnosed. Dead animals are disposed of properly. Animals brought in are from herds with known health status and effective vaccination programs, and are carefully examined for health issues and washed thoroughly (e.g., foot bath, cleaned of manure) prior to bringing them in. Level 3. As per Level 2, and herd is scouted daily for potential health problems. Electrified prods are not used. Purchased cattle are transported only in clean vehicles. A footbath is used to clean visitors' boots before entering barns. Animal delivery to renderers and cattle dealers is done outside of barns, without contact between these individuals and other animals. Sick cows a Level 4. As per Level 3, and producer works with veterina	y											M		<1	L	N	0		
Animal Welfare	Herd Health	Parasites	Level 1. Producer uses dewormers inconsistently. Producer is unsure if animals suffer from internal parasites. Level 2. Producer uses a strategic deworming system. Treatments are timed to give maximum control. Animals are monitored and are healthy. Level 3. As per Level 2, and producer uses one of the following practices to control internal parasites: multi-species grazing, matching treatments to cattle age, matching treatments to pasture phenology, consulting with a veterinarian or animal health group, using non-synthetic dewormers, reducing parasite levels farm-wide with a long-term treatment program. Level 4. As per Level 3, and producer uses two of the above practices, OR monitoring results indicate that there is no need for deworming. Animals are in excellent health.	N						x												

				Parameter Level											Farm/Template Level							
					If no, is it b/c (X if applicable):																	
Indicator	Sub-Indicator	Parameter	Farm-level Question	Parameter recommended for inclusion in template? (Y or N)	Data is not comparable?	Time investment is not worth info?	Cost investment is not worth info?	Limited research info available for parameter?	Provide limited info on indicator?	Expert recommends drop	Irrelevant to dairy?	Other parameters are more comprehensible?	Not important to VT?	Other reason?	Type of measurement (M=Management, D=data/quantitative informtion, O=Observation)	How measured? (What are discrete measurement units?)	Time required (min)	Additional time required for record keeping (beyond normal, during the yr)? (L=low, M=med, H=high)	Outside agency needed to answer question?	Cost for measurement?	Are there "acceptable" parameter levels?	Ease of verifiable (E=easy, M=med, D=difficult)?
Animal Welfare	Herd Health	Lactating cows/preventative measures	Level 1. Milking equipment and facilities are not maintained in good operating order. Level 2. Milking equipment and facilities are adequate and in good working order to avoid injury to handlers and cows. Milking facilities pass State milk (State milk license) inspections. Level 3. Milking equipment is tested for proper function and facilities are designed and maintained for animal comfort. Adequate bedding is used and milking area is well ventilated. Level 4. As per Level 3, and newborn calves are monitored in the first 48 hours to ensure they consume sufficient colostrum.	Y											M, O		<1 min	L	N	0		
Animal Welfare	Herd Health	Animal well being	Average age?	N?										x	M						Y	
Animal Welfare	Herd Health	Animal well being	Culling rate?	N?								x		x	M	%	10 min	M?	N	0	Y	M
Animal Welfare	Herd Health	Animal well being	Reason for culling?	N?					x						M	attributes	<1	M	N	0	N?	M
Animal Welfare	Herd Health	Animal well being	Signs of stress?	N?					x						D	lbs	uter depen	L	N	0	Y	M
Animal Welfare	Herd Health	Animal well being	Level 1. Producer does not monitor the number of lactations per cow. Level 2. Producer monitors the number of lactations per cow as an indicator of animal health and husbandry. The farm's herd averages less than 3 lactations per cow Level 3. As per Level 2, the herd averages between 3 and 5 lactations per cow. Level 4. As per Level 3, and the herd averages greater than 5 lactations per cow.	Y?											M		10 min	M	N	0		
Animal Welfare	Herd Health	Animal well being/milk quality	Level 1. Milk quality is not monitored on the farm. Level 2. Milk quality is monitored periodically on the farm. Temperatures and bulk tank levels are checked. Somatic cell counts (SCC) are used as one of the indicators of milk and animal health. Producer can relate how he/she uses milk quality (particularly SCC) as an indicator of animal health. Average monthly SCC is less than 400,000. Level 3. As per Level 2, and SCC counts are monitored regularly. Average monthly SCC is less than 250,000. Level 4. As per Level 3, and average monthly SCC are less than 150,000.	Y											M	SCC	10 min	M	Y	1.50/cow		
Animal Welfare	Herd Health	Conception rate	Average cow's reproductive life span?	Y											D	years *use bkts)	3 min					

				Parameter Level											Farm/Template Level							
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Indicator	Sub-Indicator	Parameter	Farm-level Question	Parameter recommended for inclusion in template? (Y or N)	Data is not comparable?	Time investment is not worth info?	Cost investment is not worth info?	Limited research info available for parameter?	Provide limited info on indicator?	Expert recommends drop	Irrelevant to dairy?	Other parameters are more comprehensible?	Not important to VT?	Other reason?	Type of measurement (M=Management, D=data/quantitative informtion, O=Observation)	How measured? (What are discrete measurement units?)	Time required (min)	Additional time required for record keeping (beyond normal, during the yr)? (L=low, M=med, H=high)	Outsiide agency needed to answer question?	Cost for measurement?	Are there "acceptable" parameter levels?	Ease of verifiable (E=easy, M=med, D=difficult)?
Animal Welfare	Herd Health	Conception rate	Avg milk production amount (per cow)?	Y											D	lbs	computer dependent	L	N	0	Y	M
Animal Welfare	Herd Health	Conception rate	Avg pounds of milk sold per acre?	Y											D	lbs	1- 15 min	L-H	N	0	Y	E
Animal Welfare	Herd Health	Conception rate	Avg pounds of milk sold per cow?	Y											D	lbs	1 - 15 min	L-H	N	0	Y	E
Animal Welfare	Herd Health	Conception rate	Body condition index?	Y											O	score 0 - 10; skinny, on, fat	depends on level of accuracy req'd	L	N	range	Y, 1-5, hope for 3.75-4	M
Animal Welfare	Herd Health	Conception rate	Conception rate?	Y											D	percent; use buckets	5 min	M	N	0	are avg's anyways	M
Animal Welfare	Herd Health	Conception rate	Proper nutrition?	Y																		
Animal Welfare	Herd Health	General appearance	Are cows performing to satisfaction?	Y											O	y/n	<1	L	N	0	Y?	M
Animal Welfare	Herd Health	General appearance	Body condition score?	Y											O	score 0 - 10; skinny, on, fat	depends on level of accuracy req'd	L	N	range	Y, 1-5, hope for 3.75-4	M
Animal Welfare	Herd Health	General appearance	Do animals appear content?	Y											O	y/n	<1	L	N	1	Y	E
Animal Welfare	Herd Health	General appearance	Do animals appear thrifty	Y											O	y/n	<1	L	N	2	Y	E
Animal Welfare	Herd Health	General appearance	Do you inspect animals two times per day?	Y											M	y/n	<1	L	N	0	Y	M
Animal Welfare	Herd Health	General appearance	Signs of stress? (what % of your cows show signs of stress?)	Y											O	y/n?	5 min	L	N	0	Y	E
Animal Welfare	Herd Health	Lameness	# of cubicles compared to # of cows?	Y											D	# of cubes/# of cows	5 min	L	N	0	Y	M
Animal Welfare	Herd Health	Lameness	% of time spent standing on concrete surfaces?	Y											D	%	5 min	L	N	0	Y	E

				Parameter Level											Farm/Template Level							
					If no, is it b/c (X if applicable):																	
Indicator	Sub-Indicator	Parameter	Farm-level Question	Parameter recommended for inclusion in template? (Y or N)	Data is not comparable?	Time investment is not worth info?	Cost investment is not worth info?	Limited research info available for parameter?	Provide limited info on indicator?	Expert recommends drop	Irrelevant to dairy?	Other parameters are more comprehensible?	Not important to VT?	Other reason?	Type of measurement (M=Management, D=data/quantitative information, O=Observation)	How measured? (What are discrete measurement units?)	Time required (min)	Additional time required for record keeping (beyond normal, during the yr)? (L=low, M=med, H=high)	Outside agency needed to answer question?	Cost for measurement?	Are there "acceptable" parameter levels?	Ease of verifiable (E=easy, M=med, D=difficult)?
Animal Welfare	Herd Health	Lameness	Breeding criteria?	Y											O	y/n	<1	L	N	0	Y?	E
Animal Welfare	Herd Health	Lameness	Build-up of slurry?	Y											O	y/n	<1	L	N	0	Y	E
Animal Welfare	Herd Health	Lameness	Inappropriate cubicle size or design?	Y											O	y/n	<1	L	N	0	Y	E
Animal Welfare	Herd Health	Lameness	Incidence of lameness?	Y											D	%		M	N	0	Y	M
Animal Welfare	Herd Health	Lameness	Incidence of outer claw on hind foot?	Y											D	# of cows	<1	H?	N	0	Y	D?
Animal Welfare	Herd Health	Lameness	Poor quality walking surfaces? (too rough or smooth concrete)	Y											O	attributes	5 min	L	N	0	Y	E
Animal Welfare	Herd Health	Lameness	Proper nutrition (too much energy/protein)?	Y											D	?BUN, MUN						
Animal Welfare	Herd Health	Lameness	Rapid changes in diets?	Y											M							
Animal Welfare	Herd Health	Lameness	Regular inspection of feet of all cattle?	Y											M	y/n	lots	M?	N	0	Y	D
Animal Welfare	Herd Health	Lameness	Severity of disease?	Y											D	high, med, low	<1	L	N	0	Y	D
Animal Welfare	Herd Health	Lameness	Signs of stress?	Y											D	high, med, low	<1	L	N	0	Y	D
Animal Welfare	Herd Health	Lameness	Use of footbaths?	Y											O	y/n	<1	L	N	0	?	M
Animal Welfare	Herd Health	Lameness	What do cows do after being milked?	Y											O	behavior	5 min	L	N	0	Y?	M
Animal Welfare	Herd Health	Lameness	Where do animals lie?	Y											O	locations	5 min	L	N	0	?	M
Animal Welfare	Herd Health	Mastitis	Assess milking machine performance annually?	Y											M	y/n	<1	L	N	0	Y	D
Animal Welfare	Herd Health	Mastitis	Breeding criteria?	Y											M	attributes	5 min	L	N	0	Y?	D
Animal Welfare	Herd Health	Mastitis	Correct maintenance of the milking machine	Y											M	y/n						
Animal Welfare	Herd Health	Mastitis	Culling chronically affected cows	Y											M							
Animal Welfare	Herd Health	Mastitis	Do they have dry bedding/ How often do you change bedding? /For what reason do you change bedding?	Y											M	y/n	<1	M	N	0	Y	E
Animal Welfare	Herd Health	Mastitis	Dry bedding?	Y											O	y/n	5 min	L	N	0	Y	E
Animal Welfare	Herd Health	Mastitis	Dry cow therapy	Y											O	y/n	5 min	L	N	0	Y	E
Animal Welfare	Herd Health	Mastitis	How is the milking equipment cleaned?	Y											M	?	<1	L	N	0	N?	M
Animal Welfare	Herd Health	Mastitis	How often is milking machine washed?	Y											M	days, wks, etc.	<1	L	N	0	Y	M

				Parameter Level											Farm/Template Level							
					If no, is it b/c (X if applicable):																	
Indicator	Sub-Indicator	Parameter	Farm-level Question	Parameter recommended for inclusion in template? (Y or N)	Data is not comparable?	Time investment is not worth info?	Cost investment is not worth info?	Limited research info available for parameter?	Provide limited info on indicator?	Expert recommends drop	Irrelevant to dairy?	Other parameters are more comprehensible?	Not important to VT?	Other reason?	Type of measurement (M=Management, D=data/quantitative informtion, O=Observation)	How measured? (What are discrete measurement units?)	Time required (min)	Additional time required for record keeping (beyond normal, during the yr)? (L=low, M=med, H=high)	Outsiide agency needed to answer question?	Cost for measurement?	Are there "acceptable" parameter levels?	Ease of verifiable (E=easy, M=med, D=difficult)?
Animal Welfare	Herd Health	Mastitis	Hygienic teat management	Y											M	y/n	<1	L	N	0	Y?	M
Animal Welfare	Herd Health	Mastitis	In what order do you milk cows?	Y											M	?	<1	L	N	0	N?	D
Animal Welfare	Herd Health	Mastitis	Incidence of mastitis (clinical)?	Y											D	# of cows	<1	M	N	0	Y	E
Animal Welfare	Herd Health	Mastitis	Mastitis check as part of routine vet inspection?	Y											M	y/n	<1	L	Y	vet visit = $300?	Y?	M
Animal Welfare	Herd Health	Mastitis	Part of routine vet visit?	Y											M	y/n	<1	L	N	0		M
Animal Welfare	Herd Health	Mastitis	Prompt treatment of clinical mastitis	Y											M	y/n	<1	L	N	0	Y	M
Animal Welfare	Herd Health	Mastitis	Records as to which cows have mastitis and frequency?	Y											D	y/n	100	M	N	0	Y	E
Animal Welfare	Herd Health	Mastitis	Severity of mastitis (clinical/subclinical)?	Y											O	clinical/subclinical	<1	M	vet?	Y	vet visit = $300	E
Animal Welfare	Herd Health	Mastitis	Somatic cell average?	Y											D	SCC/ml	5 min	H	Y	$.5/cow	150 - 700?	E
Animal Welfare	Herd Health	Mastitis	Stress level? Signs of stress?	Y											O	unsure how to capture	2 hr/wk	M	N	0	Y	D
Animal Welfare	Herd Health	Medical attention	Regular scheduled herd health check with vet? (mgmt strategy) What vaccinations do you give? (mgmt strategy) When, how often and on what basis do you deworm? (mgmt strategy)	N										x								
Animal Welfare	Herd Health	Metabolic diseases (milk fever, ketosis)	Incidence of metabolic diseases?	Y											D	# of cows	<1	M	N	0	Y	E
Animal Welfare	Herd Health	Metabolic diseases (milk fever, ketosis)	Pounds of milk sold per acre?	Y											D	lbs	5 min	L-H	N	0	Y	E
Animal Welfare	Herd Health	Metabolic diseases (milk fever, ketosis)	Pounds of milk sold per cow?	Y											D	lbs	5 min	L-H	N	0	Y	E
Animal Welfare	Herd Health	Metabolic diseases (milk fever, ketosis)	Proper nutrition?	Y											D							D
Animal Welfare	Herd Health	Metabolic diseases (milk fever, ketosis)	Severity of disease?	Y											D	0	0	0	0	0	0	D
Animal Welfare	Herd Health	Metabolic diseases (milk fever, ketosis)	Signs of stress?	Y											O	0	0	L	N	0	N?	E
Animal Welfare	Herd Health	Physical Manipulation	Physical manipulations, such as dehorning and tail docking? (mgmt strategy)	N					x						O			L	N	0	N?	E
Animal Welfare	Herd Health	Priority of livestock	Priority of livestock? (% of profit)	Y											M	%	5 min	L	N	0	N?	D
Animal Welfare	Herd Health	Record keeping	Records of diseases	Y											M	y/n	10 min	M?	N	0	Y	E
Animal Welfare	Herd Health	Record keeping	Records of feed inputs?	Y											M	y/n	5 min	M?	N	0	Y	E

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Animal Welfare	Herd Health	Record keeping	Records of production records	Y											M	y/n	5 min	M?	N	0	Y	E
Animal Welfare	Herd Health	Record keeping	Records of treatments	Y											M	y/n	5 min	M?	N	0	Y	E
Animal Welfare	Living Conditions	Animal behavior	% of time they use their free stalls properly?	Y											O	%	5 min	L	N	0	Y	E
Animal Welfare	Living Conditions	Animal behavior	Do they appear stressed during weather extremes?	Y											O	y/n	<1	L	N	0	Y	E
Animal Welfare	Living Conditions	Animal behavior	Do they lay down and chew their cud? Where do they rest?	Y											O	y/n; location	<1	L	N	0	Y	E
Animal Welfare	Living Conditions	Animal behavior	Do they stand for more than 4 hours at a time?	Y											O	y/n	5 min	L	N	0	Y	E
Animal Welfare	Living Conditions	Animal behavior	Where do they drink? Feeders and waterers clean?	Y											O	locations	5 min	L	N	0	Y	E
Animal Welfare	Living Conditions	Animal density	How many animals are currently in the barn?	Y											D	# of cows	5 min	L	no	0	Y	E
Animal Welfare	Living Conditions	Animal density	Number of animals barn can hold?	Y											D	# of cows	5 min	L	no	0	Y	E
Animal Welfare	Living Conditions	Animal density	Number of animals/unit of area (hectare, sq. foot of inside space, etc.)	Y											D	cows/area	5 min	L	no	0	Y	E
Animal Welfare	Living Conditions	Calf raising conditions	Raise own replacement heifers? How do you raise them? Disease incidence? What do you feed them?	N				x	x													
Animal Welfare	Living Conditions	Cubicle condition	Allow for ventilation?	Y											O	yes/no	5 min	L	N	0	Y	E
Animal Welfare	Living Conditions	Cubicle condition	Bedding type?	Y											M	straw; hay; sand	<1	L	N	0	N	E
Animal Welfare	Living Conditions	Cubicle condition	Clean bedding?	Y											M	yes/no	5 min	L	N	0	Y	E
Animal Welfare	Living Conditions	Cubicle condition	Dry bedding?	Y											O	y/n	5 min	L	N	0	Y	E
Animal Welfare	Living Conditions	Cubicle condition	Frequency of cleaning of manure? bedding?	Y											O	y/n	<1	L	N	0	Y	D
Animal Welfare	Living Conditions	Cubicle condition	Is the cubicle wide enough to rest?	Y											O	y/n	<1	L	N	0	Y	E
Animal Welfare	Living Conditions	Cubicle condition	Is there a gentle downward slope in the cubicles?	Y											O	y/n	<1	L	N	0	Y	E
Animal Welfare	Living Conditions	Cubicle condition	Is there a lime application on cubicle base?	Y											M	y/n	<1	L	N	0	Y?	E
Animal Welfare	Living Conditions	Cubicle condition	Is there sufficient head room in the cubicles?	Y											O	y/n	<1	L	N	0	Y	E
Animal Welfare	Living Conditions	General housing characteristics	Allow for ventilation?	Y											O	yes/no	5 min	L	N	0	Y	E
Animal Welfare	Living Conditions	General housing characteristics	Amount of slanted floors?	Y											D	sq feet	480	L	N	0	Y	M

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Animal Welfare	Living Conditions	General housing characteristics	Amt of locomotion area?	Y											D	area	15 min?	L	N	0	Y	E
Animal Welfare	Living Conditions	General housing characteristics	Are they on slick concrete (housing, milking parlor)?	Y											O	y/n	<1	L	N	0	Y	E
Animal Welfare	Living Conditions	General housing characteristics	Bedding type?	Y											M	straw; hay; sand	<1	L	N	0	N	E
Animal Welfare	Living Conditions	General housing characteristics	Clean bedding?	Y											M	yes/no	5 min	L	N	0	Y	E
Animal Welfare	Living Conditions	General housing characteristics	Dry bedding?	Y											O	y/n	5 min	L	N	0	Y	E
Animal Welfare	Living Conditions	General housing characteristics	Frequency of cleaning of manure? bedding?	Y											M	days, weeks	5 min	L	N	0	Y	D
Animal Welfare	Living Conditions	General housing characteristics	Frequency of cleaning of slurry?	Y											M	days, weeks	10 min	L	N	0	Y	D
Animal Welfare	Living Conditions	General housing characteristics	Is there appropriate lighting in the housing facility?	Y											O	y/n	<1	L	N	0	Y	E
Animal Welfare	Living Conditions	General housing characteristics	Kerb height?	Y											D	inches	10 min	L	N	0	Y	E
Animal Welfare	Living Conditions	General housing characteristics	Space for cows to stand, move about, and for bullying and avoidance of dominate cows?	Y											O/D?	y/n; sq ft	<1	L	no	0	Y	E
Animal Welfare	Living Conditions	General housing characteristics	Wide enough passage ways for cows to pass with ease?	Y											D	y/n	<1	L	N	0	Y	E
Animal Welfare	Living Conditions	General housing characteristics	Level 1. Housing and handling areas are inadequate, causing undue stress. Level 2. Housing and handling areas are maintained in clean and dry conditions, with adequate clean bedding, feeders and water stations. Outdoor shelters and feeding areas are adequate and cleaned regularly. Level 3. As per Level 2, and housing and handling areas are maintained to allow normal social behaviors and minimize cattle stress. Fences, gates and chutes have smooth or padded surfaces. Level 4. As per Level 3, and any new or renovated housing/handling areas implement advanced design features to minimize stress (e.g., Temple Grandon designs).	Y											M		10 min	L	N	0		
Animal Welfare	Living Conditions	Housing practices	Are the animals tethered?	Y											O/M?	y/n	<1	L	N	0	Y	E
Animal Welfare	Living Conditions	Housing practices	Level 1. All animals confined >95% of the time. Level 2. All animals confined <65% of the time. Level 3. All animals confined <35% of the time. Level 4. All animals confined <10% of the time.	Y?											D	%	5 min	L	N	0	Y?	
Animal Welfare	Living Conditions	Housing practices	Confinement or grazing	Y											M	Y/N	<1	L	N	0	N	

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Animal Welfare	Living Conditions	Housing practices	Level 1. Pastures are open grazed, undivided and are inadequate or inaccessible to calves, heifers, lactating and dry cows. Level 2. Pastures are adequate and accessible for all cattle. If cattle are wintered outside, conditions are carefully monitored and provisions are made to ensure adequate food, water, bedding and shelter during severe weather; shelter and teat care are adequate to prevent frostbite; sufficient extra feed is provided to maintain body condition; cattle are clean and dry when turned out after milking; and manure from wintered cattle is not allowed to contaminate surface water. Level 3. As per Level 2, and at least four paddock divisions are maintained. Rotations are scheduled to maintain adequate regrowth. Animals are managed to minimize bloat and parasite problems. Pastures are used on a limited basis during the winter Level 4. As per Level 3, and forage species are managed for maximum, vegetative production. Forage stubble heights maintained by species and paddocks harrowed, fertilized and clipped as necessary. Supplemental feed, water and shelter sites within paddoc	Y?											M	level	<1 min	M	N	0	N?	
Animal Welfare	Living Conditions	Housing practices	Cubicles used?	Y															N	0	?	
Animal Welfare	Living Conditions	General housing characteristics	Level 1. Bedding is provided for housed animals. Level 2. As per Level 1, and producer can relate how bedding and animals are monitored on the farm. The farm uses a system for bedding that meets farm goals and provides dry organic (e.g. plant products, sand) bedding for animals. Level 3. As per Level 2, and the farm uses a system of all-organic or a mix of organic-inorganic bedding that provides dryness, cushioning, warmth, and disease prevention. Animals are free from sores and/or abscesses attributable to inadequate bedding. Level 4. As per Level 3, and bedding is provided throughout confined housing allowing animals their choice of bedding areas. Animals are in excellent health. Producer can relate the health benefits of their bedding system and the key indicators they monitor for optimal animal health.	Y											M	levels	<1	L	N	0	Y	
Animal Welfare	Living Conditions	Housing practices	Use of stanchion barns?	N										x								

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Animal Welfare	Living Conditions	Husbandy practices	For calves? Are animals tethered? Frequency of exercise for tethered animals?	N								x										
Animal Welfare	Living Conditions	Milk parlor condition	How calm are they while being milked? (obs) How long are they in the milking parlor? (obs) Do you feed in the milking parlor? (obs) Feeders clean?	N					x													
Animal Welfare	Living Conditions	Outdoor condition	Time animals spend outdoors (%, total hours) Free to move outdoors? Outside access to shade? Windbreaks? Water? Cooling mechanisms? Deep mud?	Y?				x					x	x	M, O	???					yes	
Biodiversity	GMOs	Use of GMO feed	Use of GMO feed	Y											M	yes/no	5	L	no	0	yes	M
Biodiversity	GMOs	Use of rBGH	Use of rBGH	Y											M	yes/no	5	L	no	0	yes	E
Biodiversity	Genetic Diversity	Breed diversity (cattle)	total number breed/total number cows	Y											D	#	5	L	no	0	no	?
Biodiversity	Genetic Diversity	Cultivar diversity (crops)	total number cultivars/total number acres	Y											D	#	5	L	no	0	no	?
Biodiversity	Species Diversity	Species richness	# species	N		x																
Biodiversity	Species Diversity	Abundance of species	# of times species occurs in area	N		x																
Biodiversity	Species Diversity	Shannon-Weiner biodiversity index rating	# of species, # of times species occurs in area	N		x																
Biodiversity	Species Diversity	Wildlife habitat	Levels like Food Alliance: "few wild areas" to "actively manage for wild areas"	Y											O	Levels	1	L	no	0	yes	E
Biodiversity	Species Diversity	Wildlife habitat	acres of cultivated vs. natural area	Y											D	#	1	L	no	0	yes	E
Biodiversity	Species Diversity	Riparian area management	Levels like Food Alliance: "free cattle access to water" to "restricted access, etc."	Y											O	Levels	1	L	no	0	yes	E
Biodiversity	Species Diversity	Wetland loss		N								x										
Biodiversity	Ecosystem Diversity	Structure of landscapes	# of acres of woodland	Y											D	#	1	L	no	0	no	E
Biodiversity	Ecosystem Diversity	Structure of landscapes	# of acres of pasture	Y											D	#	1	L	no	0	no	E
Biodiversity	Ecosystem Diversity	Structure of landscapes	# of cropped acres	Y											D	#	1	L	no	0	no	E
Biodiversity	Ecosystem Diversity	Structure of landscapes	# of wild acres	Y											D	#	1	L	no	0	no	E
Biodiversity	Ecosystem Diversity	Structure of landscapes	total # of acres	Y											D	#	1	L	no	0	no	E
Biodiversity	Ecosystem Diversity	Structure of landscapes	# of riparian acres	Y											D	#	1	L	no	none	no	E
Biodiversity	Ecosystem Diversity	Pasture and cropland monitoring	Levels like Food Alliance: "no monitoring" to "uses records to improve mngt"	Y											O	Levels	1	L	no	0	yes	E
Biodiversity	Ecosystem Diversity	Environmental planning for new plantings	Levels like Food Alliance: "without regard" to "design for environment"	Y											O	Levels	1	L	no	0	yes	E
Biodiversity	Ecosystem Diversity	Pasturing techniques	Levels like Food Alliance: "pastures open" to "rotational grazing"	Y											O	Levels	1	L	no	0	yes	E
Biodiversity	Ecosystem Diversity	Crop rotation plan	See Carey's	Y																		

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Biodiversity	Ecosystem Diversity	Cover crop	Levels like Food Alliance: "does not manage" to "manages and maintains"	Y											O	Levels	1	L	no	0	yes	E
Biodiversity	Ecosystem Diversity	Cover crop	# of acres of cover crops to total cropped acres	Y											D	%	1	L	no	0	no	E
Biodiversity	Ecosystem Diversity	Weed control	Levels like Food Alliance: "use herbicides" to "use biological methods"	Y											O	Levels	1	L	no	0	yes	E
Biodiversity	Ecosystem Diversity	Pesticide use	# of acres sprayed to total acres	Y											D	%	1	L	no	0	no	E
Biodiversity	Ecosystem Diversity	No/Low-till plowing	See Carey's	Y																		
Biodiversity	Ecosystem Diversity	Conservation of ecosystem around farms	Levels like Food Alliance: "areas not managed" to "areas managed"	Y											O	Levels	1	L	no	0	yes	E
Biodiversity	Conservation of ecosystem around farms	Planting trees in buffer zones		N								x										
Community Health	Community Relations	Community Awareness of Farms	# of Annual Harvest Festivals per year	Y											O	#	10	M	Y	L	N	E
Community Health	Community Relations	Community Awareness of Farms	Do citizens see farming as a cultural asset or a nuisance because of the smells, dust, etc?	Y											O	#	1	M	Y	L	N	E
Community Health	Community Relations	Community Awareness of Farms	Are there farm organizations that overlap in agrarian and civic activities	Y											O	Y/N	1	M	Y	L	Y	D
Community Health	Community Relations	Community Awareness of Farms	# of children field trips to local farm lands	Y											O	Y/N	1	M	Y	L	Y	D
Community Health	Community Relations	Community Awareness of Farms	# of educational programs that incorporate the local and agricultural community	Y											D	#	4	M	Y	L	Y	E
Community Health	Community Relations	Ratio of Farmer's Markets to Direct Sales	# of farmer's markets	Y											D	#	4	M	Y	L	Y	E
Community Health	Community Relations	Ratio of Farmer's Markets to Direct Sales	Amount of direct sales of produce	Y											D	#	2	M	Y	L	Y	D
Community Health	Community Relations	Ratio of owner operated farms to tenant operated	# of owner operated farms	Y											D	lbs	20	H	Y	L	Y	E
Community Health	Community Relations	Ratio of owner operated farms to tenant operated	# of tenant run farms	Y											D	#	20	H	Y	L	Y	D
Community Health	Community Relations	Number of farms per capita	How many farms are there in this town?	Y											D	#	3	L	Y	L	Y	D
Community Health	Community Relations	New Farmer Entry	How many new farms in this past year?	Y											D	#	3	L	Y	L	Y	D
Community Health	Community Relations	Farm Population Persistence	# of inidvidual farms to go out of business in last 5 years	Y											D	#	3	M	Y	L	Y	D
Community Health	Community Relations	Farm Population Persistence	# of inidvidual farms to go out of business in last 5 years	Y											D	#	3	M	Y	L	Y	D
Community Health	Infrastracture	Access to Facilities	Access to Transportation?	Y											D	#	3	M	Y	L	Y	D

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Community Health	Infrastructure	Access to Facilities	Potable Water?	Y											M	Y/N	1	M	Y	L	Y	D
Community Health	Infrastructure	Access to Facilities	Education?	Y											M	Y/N	1	M	Y	L	Y	D
Community Health	Infrastructure	Access to Facilities	Electricity?	Y											M	Y/N	1	M	Y	L	Y	D
Community Health	Infrastructure	Access to Facilities	Sewage Systems?	Y											M	Y/N	1	M	Y	L	Y	D
Community Health	Farm labor	Ratio of Migrant Workers to Local Laborers	Number of Migrant Workers	Y											M	Y/N	1	H	Y	L	Y	D
Community Health	Farm labor	Ratio of Migrant Workers to Local Laborers	Number of Local Laborers	Y											D	#	1	H	Y	L	Y	D
Community Health	Farm labor	Demographics	What is the average age?	Y											D	#	1	M	Y	L	Y	D
Community Health	Farm labor	Demographics	Ethnic diversity?	Y											D	#	1	M	Y	L	Y	D
Community Health	Farm labor	Permanent Employees	# of Permanent employees	Y											O	H/M/L	1	M	N	L	Y	D
Community Health	Farm labor	Permanent Employees	# of families permanently living on farms	Y											D	#	1	M	N	L	Y	D
Community Health	Farm labor	Permanent Employees	Extent of Landcare	Y											D	#	1	L	N	L	Y	D
Community Health	Farm labor	Permanent Employees	Provide input on farm operations?	Y											M	H/M/L	3	L	N	L	Y	D
Community Health	Farm labor	Seasonal Employees	# of seasonal employees	Y											M	H/M/L	3	L	N	L	Y	D
Community Health	Farm labor	Seasonal Employees	Where do seasonal employees come from?	Y											D	#	2	M	N	L	Y	D
Community Health	Farm labor	Seasonal Employees	Access to Transportation?	Y											O	location	1	L	N	L	Y	D
Community Health	Farm labor	Seasonal Employees	Potable Water?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Farm labor	Seasonal Employees	Education?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Farm labor	Seasonal Employees	Electricity?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Farm labor	Seasonal Employees	Medical Facilities?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Farm labor	Seasonal Employees	Sewage Systems?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Quality of Life	Time spent on property	# of hours per day	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Quality of Life	Hours spent with family/leisurely activities'	Are you doing things to improve the quality of life for you and your family?	Y											D	# of hrs.	1	L	N	L	Y	D

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Community Health	Quality of Life	Proximity to Retailers	Proximity of equipment retailers	Y											O	Y/N	1	M	N	L	Y	D
Community Health	Quality of Life	Proximity to Retailers	Proximity of seed merchandisers	Y											D	miles	1	M	N	L	Y	D
Community Health	Quality of Life	Proximity to Retailers	Proximity of agricultural stores	Y											D	miles	1	M	N	L	Y	D
Community Health	Quality of Life	Proximity to Retailers	Proximity of buyers/coop	Y											D	miles	1	M	N	L	Y	D
Community Health	Physical Health	Local farmer suicide rates	Local farmer suicide rates	Y											D	miles	1	H	N	L	Y	D
Community Health	Physical Health	Chronic Physical Problems	% of chronic physical problems related to hard manual labor	Y											O		3	H	N	L	Y	D
Community Health	Physical Health	Average age of farmers	Average age of farmers	Y											O		1	M	N	L	Y	D
Community Health	Physical Health	Percent of workers with health benefits	Do you have health benefits? Why not?	Y											D	#	1	L	N	L	Y	D
Community Health	Production Goals	Long Term Production Goals	Are you thinking of expanding your dairy operation?	Y											O	Y/N	1	L	N	L	Y	D
Community Health	Production Goals	Long Term Production Goals	Do you have plans for when milk prices are high?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Production Goals	Long Term Production Goals	Do you have plans for when milk prices are low?	Y											M	Y/N	3	L	N	L	Y	D
Community Health	Production Goals	Long Term Production Goals	Does your enterprise support your quality of life goals?	Y											M	Y/N	3	L	N	L	Y	D
Community Health	Production Goals	Short Term Production goals	What are your short term goals?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Production Goals	Use of Technology	How old is your equipment?	Y											M		1	L	N	L	Y	D
Community Health	Production Goals	Use of Technology	How sophisticated is your technology?	Y											D		1	L	N	L	Y	D
Community Health	Production Goals	Rate of Innovation	Open to new trends?	Y											D	H/M/L	1	L	N	L	Y	D
Community Health	Labor Rights	Base Wage/Compensation	How often do you pay your workers?	Y														L	N	L	Y	D
Community Health	Labor Rights	Base Wage/Compensation	How much do you pay your farm laborers above/below minimum wage?	Y											M	time	1	L	N	L	Y	D
Community Health	Labor Rights	Base Wage/Compensation	Are wages adjusted according to seniority?	Y											D	$	1	L	N	L	Y	D
Community Health	Labor Rights	Base Wage/Compensation	Are wages adjusted according to performance?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Base Wage/Compensation	Are wages adjusted according to changing crop conditions?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Base Wage/Compensation	Are Bonuses are given to reward productivity of the group?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Base Wage/Compensation	Are farm profits shared among laborers?	Y											M	Y/N	1	L	N	L	Y	D

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Community Health	Labor Rights	Base Wage/Compensation	Do you have an advanced wage system?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Base Wage/Compensation	Is the advanced wage system explained clearly?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Base Wage/Compensation	Do you conduct regular performance evaluations?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Chlid Labor	Do you have a written child labor policy?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Chlid Labor	Do you have a written policy in languages required?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Chlid Labor	Do you employ legal minors only during non school hours?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Chlid Labor	Do you have special training for minors and/or farm family's children?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Chlid Labor	Do you communicate with the parents of minors regarding the employment of children?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Chlid Labor	Do you provide daycare for employee's children?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Chlid Labor	Do you train supervisors on the special management needs of minors?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Are workers closely supervised by a licensed pesticide applicator?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Have all workers have taken a pesticide application course	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Are emergency eye washing facilities are provided near the storage, mixing/loading and/or application sites?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Are showers and changing rooms are provided near storage, mixing/loading and/or application sites?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Is spare clean clothing provided?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Protective clothing is used?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Respirators are kept in protective packaging?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Respirator pads are changed regularly?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Are the pesticide applicators applying highly toxic chemicals equipped with powered filtered-air respirator and positive/ pressure cabs?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Do the workers handling solvents, fertilizers , etc, with potential to cause injury, have access to the appropriate safety equipment?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Pesticide safety training for workers/employers (EPA)	Y											M	Y/N	1	L	N	L	Y	D

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Community Health	Labor Rights	Worker Safety - Pesticides	Pest. safety posters(EPA)	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Access to labeling info. for pest. handlers & early entry workers (EPA)	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Access to application list of pesticide treatments (EPA)	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Field Notification: required when workers within .25 mile of treated areas during pest. app. or while REI in effect; most products allow oral or field sign notification, except where double notification required on pest. Labels (EPA)	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Central posting requirements met? (EPA WPS safety poster & name address and phone of nearest emergency medical facility) (EPA)	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Pesticide recordkeeping for ALL applications (kept for 30 days after REI) (EPA)	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Product name, EPA registration #, and active ingredients (EPA)	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Location and description of treated area (EPA)	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Time and date of application and REI (EPA)	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Prohibit handlers from applying pesticide in way that will expose workers (EPA)	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Exclude workers from pest. treatment areas or areas under restricted entry interval (REI: time after pest. app. when workers can't enter area; found on pest. labels) (EPA)	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Protect early entry workers doing work in REI area (EPA)	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Special instructions/duties related to correct use of personal protective equipment (PPE): PPE required for pest. handlers and early entry workers as directed on pesticide labels (EPA)	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Notify workers about treated areas (EPA)	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Decontamination sites appropriate for pest. apps.: must be kept up to 30 days after app. of pesticide requiring them per 1992 rule based on info. on pest. Persistence (EPA)	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	Available transportation to medical facility and information on type of pesticides used in case of poison/injury (EPA)	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Pesticides	WPS Training Verification (EPA)	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Hazardous Materials	Are all spills in storage, mixing/loading or application sites are cleaned up promptly?	Y											M	Y/N	1	L	N	L	Y	D

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Community Health	Labor Rights	Worker Safety - Hazardous Materials	Are spill response kits are readily available where hazardous materials are stored?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Hazardous Materials	Are emergency washing facilities such as showers, eyewash and spare clean clothing provided near storage, mixing/loading and application sites?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Hazardous Materials	Are identification and phone numbers for person who should be contacted readily available?	Y											M	Y/N	1	L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Hazardous Materials	Procedures and equipment to be used,	Y											M	Y/N		L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Hazardous Materials	Are there copies of complete labels of hazardous materials used or where fixed storage sites are?	Y											M	Y/N		L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Sanitation & General Safety	Do employers provide clean drinking water and clean latrines with hand washing stations?	Y											M	Y/N		L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Sanitation & General Safety	Do all hand washing stations have soap and water?	Y											M	Y/N		L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Sanitation & General Safety	Upon inspection, are all facilities are clean?	Y											M	Y/N		L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Sanitation & General Safety	Do employers provide general safety training?	Y											M	Y/N		L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Sanitation & General Safety	Do employer provide a shower facility with warm water for employees to wash and change after the work day?	Y											M	Y/N		L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Sanitation & General Safety	Do you contract professional firms to provide safety training?	Y											M	Y/N		L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Sanitation & General Safety	Have you developed training checklists specific to jobs to ensure each employee gets training?	Y											M	Y/N		L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Sanitation & General Safety	Do you set goals for safety and track success?	Y											M	Y/N		L	N	L	Y	D
Community Health	Labor Rights	Worker Safety - Sanitation & General Safety	Do you give bonuses when safety goals are met?	Y											M	Y/N		L	N	L	Y	D
Energy	Direct Energy Use	Energy used on milk cleaning	Energy used on production of containers	Y											D	kwH	5	L	Y	L	Y	H
Energy	Direct Energy Use	Energy used on milk cleaning	Energy used on production of detergents	Y											D	kwH	5	L	Y	L	Y	H
Energy	Direct Energy Use	Energy used on milk cleaning	Energy used on transport to dairy	Y											D	kwH	5	L	Y	L	Y	H
Energy	Direct Energy Use	Energy used on milk cleaning	Energy used on cleaning process	Y											D	kwH	5	L	Y	L	Y	H

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Energy	Direct Energy Use	Energy used on milk cleaning	Energy used on rinsing	Y											D	kwH	5	L	Y	L	Y	H
Energy	Direct Energy Use	Energy used on milk cleaning	Energy used on waste management	N											D	kwH	5	L	Y	L	Y	H
Energy	Direct Energy Use	Energy used on milk cleaning	Energy used on effluent management	N											D	kwH	5	L	Y	L	Y	H
Energy	Direct Energy Use	% of food from grazing		Y											D	kwH	5	L	N	L	N	D
Energy	Efficiency	Use of methane from manure to generate energy	Amount of methane reused	Y											D	kwH	5	L	Y	H	N	D
Energy	Efficiency	Total energy input/total energy output		N											D	kwH	5	L	N	L	Y	D
Energy	Efficiency	Rural energy transition to enhance productivity		Y											M	kwH	5	L	N	L	Y	D
Energy	Efficiency	% of total waste utilized as resource		Y											M	kwH	5	L	N	L	Y	D
Energy	Indirect Energy Use	Total energy products purchased by farmer	Amount of heat purchased/month	Y											D	kwH	5	L	N	L	N	D
Energy	Indirect Energy Use	Total energy products purchased by farmer	Amount of electricity purchaed/month	Y											D	kwH	5	L	N	L	N	D
Energy	Indirect Energy Use	Amount of chemical fertilizer used		Y											D	kwH	5	L	N	L	N	D
Energy	Indirect Energy Use	Use of imported/conventional feed		Y											D	kwH	5	L	N	L	N	D
Energy	Renewable	Ratiio of renewable energy/to total energy use		Y											D	kwH	10	L	N	L	N	D
Energy	Renewable	Ratio of renewable energy to non renewable energy		Y											D	kwH	10	L	N	L	N	D
Energy	Renewable	Ratio renewable over non-renewable energy inputs		Y											D	kwH	10	L	N	L	N	D
Farm Financials	Liquidity	Current ratio.	Total current farm assets	Y											D	#	60	H	yes	?	yes	D
Farm Financials	Liquidity	Current ratio.	Total current farm liabilities	Y											D	#	10	L	no	0	yes	M
Farm Financials	Liquidity	Working capital.	Total current farm assets	Y											D	#	60	H	yes	?	yes	D
Farm Financials	Liquidity	Working capital.	Total current farm liabilities	Y											D	#	10	L	no	0	yes	M
Farm Financials	Solvency	Debt/asset ratio	Total farm liabilities	Y											D	#	30	L	no	0	yes	M

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Farm Financials	Solvency	Debt/asset ratio	Total farm assets	Y											D	#	60	H	yes	?	yes	D
Farm Financials	Solvency	Equity/asset ratio	Total farm equity	Y											D	#	30	L	no	0	yes	M
Farm Financials	Solvency	Equity/asset ratio	Total farm assets	Y											D	#	60	H	yes	?	yes	D
Farm Financials	Solvency	Debt/equity ratio	Total farm liabilities	Y											D	#	30	L	no	0	yes	M
Farm Financials	Solvency	Debt/equity ratio	Total farm equity	Y											D	#	60	H	yes	?	yes	D
Farm Financials	Solvency	Flexibility of production system		N								x										
Farm Financials	Profitability	Rate of return on farm assets.	Net farm income from operations	Y											D	#	15	L	no	0	yes	M
Farm Financials	Profitability	Rate of return on farm assets.	Farm interest expense	Y											D	#	15	L	no	0	yes	M
Farm Financials	Profitability	Rate of return on farm assets.	Owner withdrawals for unpaid labor and management	Y											D	#	15	L	no	0	yes	M
Farm Financials	Profitability	Rate of return on farm assets.	Average total farm assets	Y											D	#	60	L	no	?	yes	D
Farm Financials	Profitability	Rate of return on farm equity.	Net farm income from operations	Y											D	#	15	L	no	0	yes	M
Farm Financials	Profitability	Rate of return on farm equity.	Owner withdrawals for unpaid labor and management	Y											D	#	15	L	no	0	yes	M
Farm Financials	Profitability	Rate of return on farm equity.	Average total farm equity	Y											D	#	60	L	yes	?	yes	D
Farm Financials	Profitability	Operating profit margin ratio.	Net farm income from operations	Y											D	#	15	L	no	0	yes	M
Farm Financials	Profitability	Operating profit margin ratio.	Farm interest expense	Y											D	#	15	L	no	0	yes	M
Farm Financials	Profitability	Operating profit margin ratio.	Owner withdrawals for unpaid labor and management	Y											D	#	15	L	no	0	yes	M
Farm Financials	Profitability	Operating profit margin ratio.	Gross Revenues	Y											D	#	15	L	no	0	yes	M
Farm Financials	Profitability	Net farm income.	FFSC definition	N	x																	
Farm Financials	Profitability	Net farm income from operations.	FFSC definition	N	x																	
Farm Financials	Profitability	Unpaid labor, unpaid management, and unpaid equity (same as base labor wage).		N	x																	
Farm Financials	Profitability	Veterinary costs.		N?					x													

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Farm Financials	Profitability	Productivity/Yield per hectare (includes area of farm used for agriculture).	Productivity per hectare	Y											D	#	5	L	no	0	no	M
Farm Financials	Profitability	Productivity/Yield per hectare (includes area of farm used for agriculture).	Productivity per cow	Y											D	#	5	L	no	0	no	M
Farm Financials	Profitability	Share of disposable income consumer spent on food.		N	x																	
Farm Financials	Profitability	Cash flow.		N	x																	
Farm Financials	Profitability	Condition of the irrigation.		N				x														
Farm Financials	Profitability	% of income from off-farm labor (includes Secondary employment of farmers/spouse).	Income from off-farm	Y											D	$	5	L	no	0	yes	E
Farm Financials	Profitability	% of income from off-farm labor (includes Secondary employment of farmers/spouse).	Income from farm	Y											D	$	5	L	no	0	yes	E
Farm Financials	Repayment Capacity	Term debt and capital lease coverage ratio.	Net farm income from operations	Y											D	#	15	L	no	0	yes	M
Farm Financials	Repayment Capacity	Term debt and capital lease coverage ratio.	Total miscellaneous revenue/expense	Y											D	#	15	L	no	0	yes	M
Farm Financials	Repayment Capacity	Term debt and capital lease coverage ratio.	Total non-farm income	Y											D	$	10	L	no	0	yes	E
Farm Financials	Repayment Capacity	Term debt and capital lease coverage ratio.	Depreciation/amortization expense	Y											D	$	5	L	no	0	yes	E
Farm Financials	Repayment Capacity	Term debt and capital lease coverage ratio.	Interest on term debt	Y											D	$	5	L	no	0	yes	E
Farm Financials	Repayment Capacity	Term debt and capital lease coverage ratio.	Interest on capital leases	Y											D	$	5	L	no	0	yes	E
Farm Financials	Repayment Capacity	Term debt and capital lease coverage ratio.	Total income tax expense	Y											D	$	5	L	no	0	yes	E
Farm Financials	Repayment Capacity	Term debt and capital lease coverage ratio.	Owner withdrawals (total)	Y											D	#	15	L	no	0	yes	M
Farm Financials	Repayment Capacity	Term debt and capital lease coverage ratio.	Annual scheduled principal and interest paymjents on term debt	Y											D	#	5	L	no	0	yes	M
Farm Financials	Repayment Capacity	Term debt and capital lease coverage ratio.	Annual sheduled principal and interest payments on capital leases	Y											D	#	5	L	no	0	yes	M

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Farm Financials	Repayment Capacity	Capital replacement and term debt repayment margin.	Net farm income from operations	Y											D	#	15	L	no	0	yes	M
Farm Financials	Repayment Capacity	Capital replacement and term debt repayment margin.	Total miscellaneous revenue/expense	Y											D	#	15	L	no	0	yes	M
Farm Financials	Repayment Capacity	Capital replacement and term debt repayment margin.	Total non-farm income	Y											D	$	10	L	no	0	yes	E
Farm Financials	Repayment Capacity	Capital replacement and term debt repayment margin.	Depreciation/amortization expense	Y											D	$	5	L	no	0	yes	E
Farm Financials	Repayment Capacity	Capital replacement and term debt repayment margin.	Total income tax expense	Y											D	$	5	L	no	0	yes	E
Farm Financials	Repayment Capacity	Capital replacement and term debt repayment margin.	Owner withdrawals (total)	Y											D	$	15	L	no	0	yes	M
Farm Financials	Repayment Capacity	Capital replacement and term debt repayment margin.	Payment on upaid operating debt from prior period	Y											D	$	5	L	no	0	yes	M
Farm Financials	Repayment Capacity	Capital replacement and term debt repayment margin.	Principal paymments on current portions of term debt	Y											D	$	5	L	no	0	yes	M
Farm Financials	Repayment Capacity	Capital replacement and term debt repayment margin.	Principal paymments on current portions of capital leases	Y											D	$	5	L	no	0	yes	M
Farm Financials	Repayment Capacity	Capital replacement and term debt repayment margin.	Total annual payments on personal liabilities	Y											D	$	5	L	no	0	yes	M
Farm Financials	Financial Efficiency	Asset turnover ratio.	Gross revenues	Y											D	$	15	L	no	0	yes	M
Farm Financials	Financial Efficiency	Asset turnover ratio.	Average total farm assets	Y											D	$	60	H	yes	?	yes	D
Farm Financials	Financial Efficiency	Operating expense ratio.	Total operating expenses	Y											D	$	15	L	no	0	yes	E
Farm Financials	Financial Efficiency	Operating expense ratio.	Depreciation/amortization expense	Y											D	$	5	L	no	0	yes	E
Farm Financials	Financial Efficiency	Operating expense ratio.	Revenues	Y											D	$	5	L	no	0	yes	E
Farm Financials	Financial Efficiency	Depreciation/amortization expense ratio.	Depreciation expense	Y											D	$	5	L	no	0	yes	E
Farm Financials	Financial Efficiency	Depreciation/amortization expense ratio.	Gross Revenue	Y											D	$	5	L	no	0	yes	E
Farm Financials	Financial Efficiency	Interest expense ratio.	Interest expense	Y											D	$	5	L	no	0	yes	E

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Farm Financials	Financial Efficiency	Interest expense ratio.	Gross revenue	Y											D	$	5	L	no	0	yes	E
Farm Financials	Financial Efficiency	Net farm income from operations ratio.	Net farm income from operations	Y											D	#	15	L	no	0	yes	M
Farm Financials	Financial Efficiency	Net farm income from operations ratio.	Gross revenue	Y											D	$	5	L	no	0	yes	E
Farm Financials	Financial Efficiency	Government payments as a percent of gross income.	What was your gross income?	Y											D	$	1	L	no	0	no	E
Farm Financials	Financial Efficiency	Government payments as a percent of gross income.	What was the total you received in Agricultural Program Payments?	Y											D	$	1	L	no	0	no	E
Farm Financials	Financial Efficiency	Hundredweight equivalent production.	Long list compiled from info from Schedule F and Form 4797	Y											D	#	30	L	no	0	no	M
Farm Financials	Financial Efficiency	Basic cost per hundredweight equivalent.	Long list compiled from info from Schedule F and Form 4797	Y											D	$	30	L	no	0	no	M
Farm Financials	Financial Efficiency	By-product utilization/disposal costs.		N				x														
Farm Financials	Financial Efficiency	Observed yield to expected ratio.		N				x														
Farm Financials	Financial Efficiency	Matching supply to sales to maximize profitability.		N				x														
Farm Financials	Sector Health	Change in the Number of Farms Over Time/Entry/Exit Ratio.	Has the number of farms in the area been increasing, decreasing, or the same over the last five years?	Y											O	Levels	1	L	no	0	yes	E
Farm Financials	Sector Health	Diversity of the Structure and Scale of Industry.	Select the description which best describes the diversity and scale of industry in your county.	Y											O	Levels	1	L	no	0	yes	E
Farm Financials	Sector Health	# of bank loans granted to non-conventional farms of small businesses.		N		x																
Farm Financials	Sector Health	Public/non-profit expenditure on agri-environmental research.		N		x																
Farm Financials	Sector Health	Ratio of locally-owned business to externally owned businesses.		N		x																
Farm Financials	Community Health	Support for local families as a percent of gross income (includes part-time/full-time ratio).	Sum of employee benefits, labor hired, pension and profit sharing plans, and net farm profit from Schedule F	Y											D	$	5.00	L	no	0	no	E

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Farm Financials	Community Health	Support for local families as a percent of gross income (includes part-time/full-time ratio).	Gross income from Schedule F	Y											D	$	5.00	L	no	0	no	E
Farm Financials	Community Health	Amount of money/profit reinvested locally.	% of investments made within 25 miles of home	Y											D	%	5.00	L	no	0	no	D
Farm Financials	Community Health	Employment Level in Local Community.	Unemployment rate	Y																		
Farm Financials	Environmental Health	Energy and machinery as percent of gross income.	Sum of expense categories chemicals, custom hire, depreciation on equipment and buildings, fertilizers and lime, gasoline, rent or leas vehicles, machines and equipment, reparis and maintenance, and utilities from Schedule F	Y											D	#	5.00	L	no	0	no	D
Farm Financials	Environmental Health	Energy and machinery as percent of gross income.	Gross income from Schedule F	Y											D	$	5.00	L	no	0	no	E
Farm Financials	Environmental Health	Indicator of feed production and use balance (same as Feed costs per litre of milk).	Crops sold for feed from schedule F	Y											D	$	5.00	L	no	0	no	D
Farm Financials	Environmental Health	Indicator of feed production and use balance (same as Feed costs per litre of milk).	Feed purchased from Schedule F	Y											D	$	5.00	L	no	0	no	D
Farm Financials	Environmental Health	Indicator of feed production and use balance (same as Feed costs per litre of milk).	Gross income from Schedule F	Y											D	$	5.00	L	no	0	no	E
Farm Financials	Environmental Health	Internalization of external costs of environmental regulations.		N								x										
Nutrients	Animals & Crops	Animal nutrient inflows/outflows	Animal weight gains & lbs. of nutrients in animals (from weight gain)	Y											D	lbs.	2	L	N	0	See NY	M
Nutrients	Animals & Crops	Animal nutrient inflows/outflows	Type of cows	Y											D	Cow breed	<1	L	N	0	See NY	E
Nutrients	Animals & Crops	Animal nutrient inflows/outflows	Animal products leaving farm & nutrients in animal products leaving farm	Y											D	lbs.	3	L	N	0	See NY	M
Nutrients	Animals & Crops	Animal Units/Acre (Animal Density)	Sometimes promoted as an indicator of farm nutrient balance	N				x	x	x												

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Nutrients	Animals & Crops	Animal Units/Acre (Animal Density)	Animal units to spreadable acres ratio: 1) less than .5 aminal units/acre of spreadable cropland 2) .5-1.0 aminal units/acre of spreadable cropland 3) 1-2 aminal units/acre of spreadable cropland 4) >2 aminal units/acre of spreadable cropland	N				x	x	x												
Nutrients	Animals & Crops	Crop nutrient outflows	Crop products sold & nutrients in crop products sold	Y											D	lbs.	3	L	N	0	See NY	M
Nutrients	Animals & Crops	Feed Nutrient Conversion Efficiency	Retained N or P (nutrients converted to milk/tissue in growth or reproduction) divided by intake of N or P	N		x			x	x		x										
Nutrients	Animals & Crops	N fixation from crops	Legume credits: 1) legume N credits calculated acc. to U of VT guidelines (as in UVM soil test report) and fully deducted from N fert. app. rates 3) Legume N credits partially deducted (at least 50%) from fertilizer application rates 4) credits ignored/no	Y											M	Category of Practice	1	M?	N	0	1-Best, 4-Worst	M
Nutrients	Animals & Crops	N fixation from crops	Use of legumes to manage N?	Y											M	Y/N	<1	L	N	0	Y-Best, N-Worst	E
Nutrients	Animals & Crops	N fixation from crops	Proportion N fixed on site/imported	Y											D	Ratio	1	L	N	0	Relative comparison?	D
Nutrients	Animals & Crops	N fixation from crops	Balance of N/P/K over crop rotations	Y											D	lbs.	8	L	N	0	Relative comparison?	D
Nutrients	Animals & Crops	N fixation from crops	Acres of legumes & N fixated by legumes (N credits)	Y											D	acres/lbs.	2	L	N	0	See NY	E
Nutrients	Feed, Forages & Supplements	Net Feed Nutrient Import In Animal Products	intake of purchased concentrate N or P minus N or P in milk	N																		
Nutrients	Feed, Forages & Supplements	Purchased feed inflows	Purchased feed & nutrients in purchased feed	Y											D	lbs.	2	L	N	0	See NY/Relative Comparison?	E
Nutrients	Feed, Forages & Supplements	Purchased feed inflows	Purchased forages & nutrients in purchased forages	Y											D	lbs.	2	L	N	0	See NY/Relative Comparison?	E
Nutrients	Feed, Forages & Supplements	Purchased minerals and supplements	Purchased minerals/supplements being fed to cows	Y											D	%	1	L	N	0	See NY/Relative Comparison?	E

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Nutrients	Fertilizer & Manure	Application Amount	Applied Minus Recommended Requirement of P2O5	Y											D	lbs. (?)	2	Y	N	0	0-negative best, higher worst	M
Nutrients	Fertilizer & Manure	Application Amount	Fertilizer applications comply with U or Extension crop and region-specific recs for rates and timing? (1) dn exceed, 2) over by 10-25%, over by 25-50%, over by >50%	Y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	M
Nutrients	Fertilizer & Manure	Application Amount	Nutrient application considers: soil type, previous crops, manures/composts, etc./	Y											M	Y/N or # of Y's	<1	L	N	0	More Y's better	E
Nutrients	Fertilizer & Manure	Nutrient Management/Planning	Use of (various levels) of nutrient management plans	Y											M	Y/N	<1	L	N	0	More Y's better	E
Nutrients	Fertilizer & Manure	Nutrient Management/Planning	Existence of procedures to record observations on indicators of success (e.g. algal blooms or excessive vegetation in water)	Y											M	Y/N	<1	M	N	0	Y	E
Nutrients	Fertilizer & Manure	Application Amount	Manure Application rate: 1) not exceeding crop nutrient need for all fields 2) not exceeding crop nutrient need for most fields 3) exceeding crop nutrient need for most fields 4) manure application rate in fields unknown	Y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	M
Nutrients	Fertilizer & Manure	Application Amount	Manure nutrient content: determined through lab analysis? Estimated using U of VT lab averages provided by UVM soil test report? Unknown?	Y											M	Y/N	<1	L	N	0	Y better	E
Nutrients	Fertilizer & Manure	Application Amount	Manure Nutrient Credits: 1) credits confirmed through PSNT and fert app. rates reduced 2) manure nutrient credits calculated and fuly deducted from fert. app. rates 3) nutrient credits partially deducted (at least 50%) from fertilizer application r	Y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	M
Nutrients	Fertilizer & Manure	Application Amount	Starter fertilizer rates: 1) starter fert. apps. that have less soil test values for P and K of optimum or less; app. rates based on soil test recs. 2) starter fert. apps. that have less soil test values for P and K of high or excessively high; app. rat	Y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	M
Nutrients	Fertilizer & Manure	Nutrient Management/Planning	o Record keeping: 1) crop nutrient management decisions based on detailed field history records (yield, manure apps., crop rotation 4) no records	Y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	M
Nutrients	Fertilizer & Manure	Application Amount	Application strategy: 1) applied at rates to meet P need of crop 2) applied at rates not to exceed the crop removal of P and maintain current soil test P levels 3) applied at rates to meet N need of crop 4) applied without regard to crop need (16)	Y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	M

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Nutrients	Fertilizer & Manure	Application Amount	Uniformity of applications: 1) applied uniformly across fields over short period of time when emptying storage facility 2) applied relatively uniformly across fields on daily haul basis 3) applied in random or nonuniform manner across all fields	Y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	M
Nutrients	Fertilizer & Manure	Application Amount	Amt of inorganic N/P/K applied: /ha or /ton of product	Y											D	%age	10	L	N	0	Relative comparison-lower ratio better	D
Nutrients	Fertilizer & Manure	Application Amount	Application rate: 1) / 2) not exceeding crop nutrient need for all/most fields 3) exceeding crop nutrient need for most fields 4) manure application rate unknown	Y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	M
Nutrients	Fertilizer & Manure	Application Equipment	Calibration of fert. app. equip: 1) app. equip. adjusted & calibrated at least 1x/year 2) every other year 3) not calibrated in last 5 years 4) never	Y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	M
Nutrients	Fertilizer & Manure	Application Equipment	Application rate: 1) manure spreader is calibrated and application rate estimated by counting loads or other reliable method 2) app. rate estimated visually 3) app. rate not estimated	Y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	M
Nutrients	Fertilizer & Manure	Application Integration/Timing	Timing of P and K applications: 1) immediate invorporation of broadcast applications OR ban application (such as starter fertilizer) 2) incorporation within 3 days of broadcast app. 3) broadcast app. to frozen soils of less than 6% slope 4) broadcast app.	Y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	D
Nutrients	Fertilizer & Manure	Application Integration/Timing	Timing & Method: 1) Fall and/or spring applications injected or incorporated within 3 days of application 2) Fall and/or spring applications injected or incorporated within 4-7 days of application 3) Fall and/or spring applications left unincorporated >7	Y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	D
Nutrients	Fertilizer & Manure	Application Integration/Timing	Fertilizer/manure integration practice (per P Index)	Y																		
Nutrients	Fertilizer & Manure	Application Integration/Timing	Fertilize/manure application timing (per P Index)	Y																		
Nutrients	Fertilizer & Manure	Application Integration/Timing	Application frequency varies according to type of vegetable/cropland?	Y											M	Y/N	<1	L	N	0	Y-Better	D
Nutrients	Fertilizer & Manure	Emission of Nitrous Oxide Per HA:	sum of direct (soil & urine deposition) and indirect emissions	N			x		x	x												

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Nutrients	Fertilizer & Manure	Field Selection	Field selection: 1) manure applied only to fields testing 7 ppm or less for available in soil test P 2) manure applied to fields testing 7-20 ppm for available in soil test P 3) manure applied only to fields testing greater than 20 ppm for available in so	Y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	M
Nutrients	Fertilizer & Manure	Field Selection	Slope: 1) applied on fields with slope of 0-2% 2) applied on fields with slope of 2-6% 3) applied on fields with slope of 6-12% 4) applied on fields with slope of >12% (16)	Y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	M
Nutrients	Fertilizer & Manure	Fertilizer inflows/outflows	Purchased fertilizer & nutrients in purchased fertilizer	Y											D	lbs.	3	L	N	0	See NY	E
Nutrients	Fertilizer & Manure	Manure inflows/outflows	Purchased manure & nutrients in purchased manure	Y											D	lbs.	3	L	N	0	See NY	E
Nutrients	Fertilizer & Manure	Manure inflows/outflows	Manure removed from farm & Manure nutrients removed from farm	Y											D	lbs.	3	M	N	0	See NY	D
Nutrients	Fertilizer & Manure	Soil Testing	Soil Test P (available P in Modified Morgan's extractant (ppm): parameters are soil P potential rating	Y											D	ppm (Analysis results)	1	M	Y	$9-10/sample (1-3 years common rec)	0-8: Low, 8.1-20: Med, 20-40: high, >40: V. high	E
Nutrients	Fertilizer & Manure	Soil Testing	Reactive Al: Al in Modified Morgan's extractant; parameters are soil P potential rating	Y											D	ppm (Analysis results)	1	M	Y	see STP	>80 low/none, 41-80 M, 21-40 H, <20 v. H	E
Nutrients	Fertilizer & Manure	Soil Testing	Pre-Sidedress Nitrate Soil Test for N recommendations: Administration/results of test; for corn: used annually on all fields, used for most fields most years, used occasionally, never used	Y											D	?	1	M	Y	$5/sample, 1 sample/field, ntbd every year	Y - ?	E
Nutrients	Fertilizer & Manure	Soil Testing	Sampling density (number of soil cores collected)	Y											D	#	1	L	N	0	higher # better (~20 ave.)	D
Nutrients	Fertilizer & Manure	Soil Testing	use soil tests for farm planning?	Y											M	Y/N	<1	L	N	0	Y best	E
Nutrients	Fertilizer & Manure	Fertilizer Storage & Handling:	Amount stored (liquid): 1: none, 2: >55 gal, 3: 55-1500 gal, 4: >1500 gal	Y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	M
Nutrients	Fertilizer & Manure	Fertilizer Storage & Handling:	Amount stored (dry): 1: none, 2: >1 ton, 3: 1-20 tons, 4: >20 tons	Y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	M

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Nutrients	Fertilizer & Manure	Fertilizer Storage & Handling:	Type of storage: 1)/2) covered in impermeable surface/clay; spills collected, 3) partial cover on loamy soil, spills not collected 4) no cover on sandy soils, spills not collected	y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	E
Nutrients	Fertilizer & Manure	Fertilizer Storage & Handling:	Mixing and loading location from drinking water	y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	E
Nutrients	Fertilizer & Manure	Fertilizer Storage & Handling:	Containers (see Farm-A-Syst)	y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	E
Nutrients	Fertilizer & Manure	Fertilizer Storage & Handling:	Security of storage area (see Farm-A-Syst)	y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	E
Nutrients	Fertilizer & Manure	Fertilizer Storage & Handling:	Mixing and loading area	y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	E
Nutrients	Fertilizer & Manure	Fertilizer Storage & Handling:	Water source, backflow prefention	y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	E
Nutrients	Fertilizer & Manure	Fertilizer Storage & Handling:	Filling supervision	y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	D
Nutrients	Fertilizer & Manure	Fertilizer Storage & Handling:	Handling system	y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	D
Nutrients	Fertilizer & Manure	Fertilizer Storage & Handling:	Clean-up & disposal practices 1) Sprayer washed out in field. Rinsate used in next load and applied to labeled crop. 2) Sprayer washed out on pad at farmstead. Rinsate used in next load and applied to labeled crop. 3) Sprayer washed out at farmstead. Rinsate sprayed less than 100 feet from well, 4) sprayer wased out at farmstead; rinsate dumped at farmstead or in nearby field	y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	D
Nutrients	Fertilizer & Manure	Use of Organic Wastes	Organic wastes (such as whey and sewage sludge): 1) applied to fileds at rates not exceeding nutrient need of crop to be grown 2) applied to fileds at rates exceeding crop need 3) application rate unknown	Y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-Worst	D
Nutrients	Nutrient Balance	Nutrient "yardstick"	Overall and /ha, /animal, Nutrient use efficiency: (N/P/K exports over N/P/K imports)	N		x				x					D	lbs. Nutrients	10	L	Y?-B&J?	0	Rel. compar.	D
Nutrients	Nutrient Balance	Phosphorus Index	P Transport x P Soil Potential: potential for P movement from site	N		x	x	x							D	Ratio	45	H	Y	?	<6: L, 6-12 M, 12-25 H, >25 v. H	E
Nutrients	Transport Portential	Air emissions	Emissions of N compounds to air	N	Captured in Air Pollutants																	

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Nutrients	Transport Portential	Buffer areas	Buffer Width (BW): distance of grass or other vegetated bufer from field edge to waterway or path of seasonal concentrated flow (part of P transport potential rating)	Y											D	Feet	15	L	N	0	>100 L/N, 41-100 M, 16-40 H, <15 v. H	E
Nutrients	Transport Portential	Runoff	Flooding (F) frequency: as defined on NRCS soil survey database for each soil mapping unit (for PRSM and P-index)	Y											D	timing/frequency	<1	L	N?	0	0: Rare/None (L/N), 3 occas. (M), 5 frequent (v. H)	E
Nutrients	Transport Portential	Nitrate leaching & ammonia volatization	: calculated with computer program STANK or other models	N	x	x			x	x		x										
Nutrients	Transport Portential	Nitrate Leaching index	Calculate from table	N		x				x				x	D	Index rankin						
Nutrients	Transport Portential	Runoff	Runoff (R): Runoff Class per % slope and either Runoff Curve Number or saturated soil conductivity (Phosphorus Runoff Screening Matrix (PRSM) or P-Index P-Transport potential)	Y											D	Class designation	60	H	Y	?	L, M, H, v. H	E
Nutrients	Transport Portential	Runoff	Phosphorus Runoff Screening Matrix (PRSM): : Highly Erodible Land (HEL) Class	Y											D	Class designation	?	?	?	?	Non-HEL, Potential HEL, HEL	M
Nutrients	Transport Portential	PSRM	Compilation of runoff class, HEL class, flooding freq. & soil test P	Y											D	Calculation	2	See data points	Y	?	Low, M, H	E
Nutrients	Transport Portential	Soil erosion rates:	Soil erosion (E): average annual erosion rate using NRCS Revised Universal Soil Loss Eq	N-captured in soil/can roll data up from there											D	Calculation	5	M	?	?	?	M
Nutrients	Transport Portential	Soil erosion rates:	Soil erosion in tons/acre/year (P transport potential)	N-captured in soil/can roll data up from there											D	t/a/y	15	M	?	?	0-4 L/N, 4 8 M, 8-12 H, >12 v. H	D
Nutrients	Transport Portential	Weather Inflows/Outflows	N from deposition (total farmed acres x deposition rates)	Y											D	lbs. N	1	L	N	0	NA	y
Nutrients	Transport Portential	Weather Inflows/Outflows	N from irrigation water (test water for nitrate content; nitrate content x acres x irrigation levels	Y											D	ppm N	2	M	Likely	?	See NY	E
Organic	Certification	Certification		N										x								
Organic	Organic Dairy	Certified Organic	Certified organic	Y											M	yes/no	0	L	no	0	yes	E
Organic	Organic Dairy	Organic production and handling system plan.	Description of monitoring practices	Y											M	yes/no	0	L	no	0	no	E

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Organic	Organic Dairy	Organic production and handling system plan.	List of substances to be used	Y											M	yes/no	0	L	no	0	no	E
Organic	Organic Dairy	Organic production and handling system plan.	Description of practices and procedures	Y											M	yes/no	0	L	no	0	no	E
Organic	Organic Dairy	Organic production and handling system plan.	Description of management practices	Y											M	yes/no	0	L	no	0	no	E
Organic	Organic Dairy	Livestock feed.	100% organic feed	Y											M	yes/no	0	L	no	0	yes	E
Organic	Organic Dairy	Use of drugs, vaccinations, hormones.	No drugs, vaccinations, hormones on a routine basis	Y											M	yes/no	0	L	no	0	yes	D
Organic	Organic Dairy	Use of drugs, vaccinations, hormones.	Provide drugs to sick animals	Y											M	yes/no	0	L	no	0	yes	D
Organic	Organic Dairy	Land requirements.	Land managed as organic for 3 years	N										x								
Organic	Organic Dairy	Origins of livestock.	Track origins of livestock	N																		
Organic	Organic Dairy	Separate organic and non-organic handling systems.	Separate handling systems	N										x								
Organic	Organic Dairy	Product labeling.		N										x								
Organic	Organic Dairy	Soil fertility and crop nutrient management practice standard.	Improve the physical, chemical, and biological conditions of soil and minimize erosion	Y																		
Organic	Organic Dairy	Crop, weed, and disease management practices standard.	Use management practices to prevent crop pests, weeds, and diseases	Y																		
Organic	Organic Dairy	Crop rotation practice standard	Use a crop rotation	Y																		
Organic	Organic Dairy	Livestock healthcare practice standard.	Provide for health of livestock	Y																		
Organic	Organic Dairy	Livestock living conditions.	Provide living conditions that accommodate health and natural behavior	Y																		
Organic	Organic Dairy	Facility pest management practice standard.	Use practices to prevent pests	Y																		
Organic	Organic Dairy	Organic handling requirements.		N										x								
Pest Management	IPM	Crop Choice	Use of pest & disease resistant crops?	Y											M	Y/N	<1	L	N	0	Y-best	E
Pest Management	IPM	Crop Monitoring	1) keep production records (chemical and fertilizer inputs, yields, quantity), 2) crops sampled for insect, disease, etc., 3) records used to inform pest & nutrient mgmt.	Y											M	Mult. Ch./levels	<1	L	N	0	More practices-best	E

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Pest Management	IPM	Crop rotation	· Rotation with more years of small grains (oats, wheat, etc.) and/or legumes than row crops. Additional crop diversity is used, including stripcropping, and cover crops. · Three-crop rotation used including a legume and/or small grain. OR Rotation of row	Y											M	Mult. Ch./levels	<1	L	N	0	More practices-best	E
Pest Management	IPM	Existence of IPM planning measures	Crop rotation? Site selection for crop establishment? Practice canopy humidity management (plant density, irrigation, raised beds)? Practice soil/plant tissue sampling for fertility management? Practice field insect population sampling to inform pest mana	Y											M	Y/N	<1	L	N	0	Y-best	E
Pest Management	IPM	Pesticide mixing	Location of well in relation to mixing/loading area 1) 200 or more feet downslope from well. 2) 200 to 100 feet downslope from well. 3) 100 to 50 feet downslope from well, or 100-500 feet upslope. 4) Within 50 feet downslope or within 100 feet upslope from well.	Y											M	Mult. Ch.	<1	L	N	0	1-best, 4-worst	E
Pest Management	IPM	Trap Crops	Use trap crops as favorable food source for pests?	Y											M	Y/N	<1	L	N	0	Y-best	E
Pest Management	IPM	Natural Ecosystems	% uncultivated area	N																		
Pest Management	IPM	Weed Levels in crops	Amount of weeds in grain crops at heading growth stage (visually assessed)	N				x	x													
Pest Management	Pesticide Application	Frequency & magnitude of pesticide application	% unsprayed area over a year	Y											D	%	3	L	N	0	Lower-better	M
Pest Management	Pesticide Application	Frequency & magnitude of pesticide application	Treatment frequency	Y											D	frequency	1	L	N	0	higher-better	M
Pest Management	Pesticide Application	Frequency & magnitude of pesticide application	Amount of pesticides (active ingredient) applied (/ha or / ton of product)	Y											D	Applied amount	1	L	N	0	Lower-better	M
Pest Management	Pesticide Application	Frequency & magnitude of pesticide application	3) pesticide application timing/quantity correspond with needs (per records),	Y											M	Y/N	<1	L	N	0	Y-best/more Y's better	M
Pest Management	Pesticide Application	Frequency & magnitude of pesticide application	use only pesticides registered in state as approved for target pests/crops/livestock (no mixtures prohibited on label)	Y											M	Y/N	<1	L	N	0	Y-best/more Y's better	M
Pest Management	Pesticide Application	Frequency & magnitude of pesticide application	mix/alternate pesticides (different chemical class/mode of action starting Y1) to reduce risk of resistance development	Y											M	Y/N	<1	L	N	0	Y-best/more Y's better	M

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Pest Management	Pesticide Application	Frequency & magnitude of pesticide application	Follow mfr.'s label (lowest)	Y											M	Y/N	<1	L	N	0	Lowest acceptable answer	M
Pest Management	Pesticide Application	Frequency & magnitude of pesticide application	Application rate § Farmer uses pesticide below label rates in conjunction with cultural practices (e.g. banding with cultivation or ridge tillage). Spreader is calibrated. Records are kept of materials applied. . § Farmer uses sprayer technologies and m	Y											M	levels	<1	M	N	0	Y	
Pest Management	Pesticide Application	Frequency & magnitude of pesticide application	spot spraying/alternate row spraying (medium-when target pest doesn't require complete coverage)	Y											M	Y/N	<1	N	N	0	Y	Y
Pest Management	Pesticide Application	Frequency & magnitude of pesticide application	applications adjusted for specific circumstances (match density and severity of problem, preserve beneficial insects, concentrate (low-volume) applications, match density/size of plants),	Y											M	Y/N	<1	N	N	0	Y	Y
Pest Management	Pesticide Application	Frequency & magnitude of pesticide application	no pesticides used (best)	Y											M	Y/N	<1	N	N	0	Y	Y
Pest Management	Pesticide Application	Frequency & magnitude of pesticide application	Appropriateness to pest/crop/degree of pest problem	Y											M	Y/N	<1	N	N	0	Y	Y
Pest Management	Pesticide Application	Frequency & magnitude of pesticide application	Quantity of chemical inputs/unit of production	Y											D	?	5	Y	N	0		Y
Pest Management	Pesticide Application	Frequency & magnitude of pesticide application	applications scheduled appropriately for weather-dependent pests and/or varieties selected to avoid weather-related diseases common to the location	Y											M	y/n			N			
Pest Management	Pesticide Application	Frequency & magnitude of pesticide application	Treatment threshold Pesticide applications are made only when pests reach a predetermined treatment threshold. "Weak link" of pest's life cycle is targeted for pesticide applications. Pesticide application is based on pest population levels determined by	Y											M	levels			N			
Pest Management	Pesticide application	Application Training/Certification	Pesticide training People who mix, load, and apply all pesticides are certified through a state regulatory agency, and keep current on pest control strategies between certifications. People who mix, load, and apply all pesticides are certified, but do not	Y											M	levels			Y?			
Pest Management	Pesticide application	Application Training/Certification	Appropriately certified by state/federal agency?	Y											D				Y?	?		

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Pest Management	Pesticide Application	Minimizing drift	Existence of buffer zones	Y											O		<1 min		N	0		
Pest Management	Pesticide Application	Minimizing drift	use of surfactants	Y											O	y/n				0		
Pest Management	Pesticide Application	Minimizing drift	pesticide application under optimal weather conditions/weather conditions monitored (low wind speed, not raining, adiabatic barometric pressure conditions)	Y											M		5 min			0		
Pest Management	Pesticide application	Minimizing drift	Weather Conditions (wind speed and rain forecast) Weather forecasts are used to plan pesticide applications. No spraying is done when wind would move it off target. Applications are made during label-required rain-free periods. Weather forecasts are cons	Y											M	levels				0		
Pest Management	Pesticide Application	Pesticide equipment calibration	Frequency: once/year, once/season, >once/season or continuously	Y											M	levels			N	0	Y?	M
Pest Management	Pesticide Application	Pesticide equipment calibration	written calibration and spray record	Y											O	y/n			N	0		
Pest Management	Pesticide Application	Pesticide equipment calibration	calibration adjusted to control amount and distribution	Y											O	y/n			N	0		
Pest Management	Pesticide Application	Pesticide equipment calibration	use technology to keep particle size <150 microns,	Y											D	y/n			N	0		
Pest Management	Pesticide Application	Pesticide equipment calibration	use equipment specific to conditions (e.g. hooded sprayers)	Y											O	y/n			N	0		
Pest Management	Pesticide Application	Pesticide mixing	Never mix pesticides unless rec. by label (5)	Y											O	y/n			Y	?		
Pest Management	Pesticide application	Pesticide use violations	· # of violations/complaints/inquiries lodged against farm under VT Regulations for the Control of Pesticides/FIFRA:	Y											D		10 min					
Pest Management	Pesticide Application	Toxicity	Level of toxicity and risk of leaching or volatization of each pesticide	Y											D		10 min			0	Y	
Pest Management	Pesticide Application	Toxicity	minimized use of hazardous materials (labeled 'Danger' or 'Caution') and/or special storage for such materials	Y													more			0	Y	
Pest Management	Pesticide Application	Toxicity	pesticides labeled "Danger" used only in emergencies	Y											M							D
Pest Management	Pesticide Application	· Use of atrazine	Use of atrazine	Y	Too narrow?										M, D							

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Pest Management	Pesticide Mixing	Backflow prevention on water supply	Anti-backflow device installed or 6-inch air gap maintained above sprayer tank. Anti-backflow device installed. Hose in tank above waterline. No anti-backflow device. Hose in tank above waterline. No anti-backflow device. Hose in tank below waterline.	Y											M	levels	<1 min					
Pest Management	Pesticide Mixing	Filling supervision	Constant Frequent Seldom or never	Y											M	levels	<1 min					
Pest Management	Pesticide Mixing	Handling system	Closed system for all liquid product transfers. Closed system for most liquids. Some liquids hand poured. Sprayer fill port easy to reach. All liquids and dry product hand poured. Sprayer fill port easy to reach. All liquids and dry product hand poured.	Y											M	levels	<1 min					
Pest Management	Pesticide Mixing	Mixing and loading pad (spill containment)	Concrete pad with curb keeps spills contained. Sump allows collection and transfer to storage. Concrete pad with curb keeps spills contained. No sump. Mixing in clay fields. Concrete pad with some cracks keeps some spills contained. No curb or sump. Mix	N																		
Pest Management	Pesticide Mixing	Spill response plan:	Spill response plan is written, kept current, and reviewed by family and employees. Authorities are notified immediately after a spill of a hazardous compound. Spill response plan is written and routinely reviewed by family and employees. Phone numbers of	N																		
Pest Management	Pesticide Mixing	Sprayer cleaning and rinsate (rinse water) disposal	Sprayer washed out in field. Rinsate used in next load and applied to labeled crop. Sprayer washed out on pad at farmstead. Rinsate used in next load and applied to labeled crop. Sprayer washed out at farmstead. Rinsate sprayed less than 100 feet from wel	N																		
Pest Management	Pesticide Mixing	Water Source	Separate water tank. Water supply away from well. Water supply near well. Obtained directly from well, river or pond.	Y											M	levels				0	Y	E
Pest Management	Pesticide Storage/Disposal	Pesticide Containers	Disosal: Triple rinse or pressure rinse containers and pour rinsate into spray tank so all product purchased is used acc. to label directions	Y											M	Y/N	<1	L	N	0	Y-best	E

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Pest Management	Pesticide Storage/Disposal	Pesticide Containers	· Disposal location § Triple-rinsed containers returned to dealers or taken to licensed landfill or municipal incinerator. Bags returned to supplier or hazardous waste collection service used. § Unrinsed containers and empty bags taken to licensed landfil	Y											M	location	<1	L	N	0	?	E
Pest Management	Pesticide Storage/Disposal	Pesticide Formulations	Leachability	Y											D	index	10?	L	?	0	lower leachability better	E
Pest Management	Pesticide Storage/Disposal	Pesticide Containers	approved container disposal/recycling?	Y											M	Y/N	<1	L	N	0	Y-best	M
Pest Management	Pesticide Storage/Disposal	Pesticide Containers	Keep pest in orig. container with lable (5)	Y											M	Y/N	<1	L	N	0	Y-best	E
Pest Management	Pesticide Storage/Disposal	Pesticide Containers	keep all containers dry during storage and transport	Y											M	Y/N	<1	L	N	0	Y-best	M
Pest Management	Pesticide Storage/Disposal	Pesticide Containers	1) Original containers clearly labeled. No holes, tears or weak seams. Lids tight. 2) Original containers old. Labels partially missing or hard to read. 3)Containers old but not leaking. Metal containers showing signs of rusting. 4) Containers have holes or tears that allow pesticides to leak. No labels.	Y											M	Mult. Ch.	<1	L	N	0	1-best, 4-worst	E
Pest Management	Pesticide Storage/Disposal	Pesticide Formulations	Liquid or dry formulation No liquids. All dry. Some liquids. Mostly dry. Mostly liquids. Some dry. All liquids.	Y											O	Mult. Ch.	<1	L	N	0	?	E
Pest Management	Pesticide Storage/Disposal	Storage facilities	hazardous materials (pesticides, fertilizers, fuel, lubricants) stored in facilities in original containers at least 150 ft. from wells and 200 ft. from surface water or flame sources	Y											M	Y/N	<1	L	N	0	Y-best	E
Pest Management	Pesticide Storage/Disposal	Storage facilities	storage area labeling	Y											M	levels	<1	L	N	0	Proper labeling best	E
Pest Management	Pesticide Storage/Disposal	Storage facilities	storage facility characteristics (locked, sealed floor, well ventilated, FIFO inventory management, written inventory maintained)	Y											M	levels	<1	L	N	0	Best practice	E
Pest Management	Pesticide Storage/Disposal	Storage Practices	separation of materials by type (herbicide, pesticide, fungicide, etc.), flammable/non, hazardous/non (e.g. feed, seed, etc.)	Y											M	levels	<1	L	N	0	Best practice	E
Pest Management	Pesticide Storage/Disposal	Storage Practices	Drive carefully & Put in trunk or truck bed during transport (never with people)	Y											M	Y/N	<1	L	N	0	Y-best	E

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Pest Management	Pesticide Storage/Disposal	Storage Practices	Amount stored: 1) No pesticides stored at any time. 2) Less than 1 gallon or less than 10 pounds of each pesticide. 3)More than 1 gallon or more than 10 pounds of each pesticide. 4) More than 55 gallons or more than 550 pounds of each pesticide.	Y											M	Mult. Ch.	<1	L	N	0	1-best, 4-worst	E
Pest Management	Pesticide Storage/Disposal	Security of facilities	1) Fenced or locked area separate from all other activities. Signs at storage area. 2) Fenced area separate from most other activities. 3) Open to activities that could damage containers or spill chemicals. 4) Open access to theft, vandalism and children. No signs	Y											M	Mult. Ch.	<1	L	N	0	1-best, 4-worst	E
Pest Management	Pesticide Storage/Disposal	Spill or leak control in storage area	1) Impermeable surface (such as concrete) does not allow spills to soak into soil. Curb installed on floor to contain leaks and spills. 2) Impermeable surface with curb installed has some cracks, allowing spills to get to soil. OR impermeable surface without cracks has no curb installed. 3) Permeable surface (wooden floor) has cracks. Impermeable surface has no curb. Spills could contaminate wood. 4) Permeable surface (gravel or dirt floor). Spills could contaminate floor.	Y											M	Mult. Ch.	<1	L	N	0	1-best, 4-worst	E
Pest Management	Pesticide Storage/Disposal	Pesticide/chemical waste prevention	Mnimize use and storage of pesticides	Y											M	amt?		L	N	0		
Pest Management	Pesticide Storage/Disposal	Pesticide/chemical waste prevention	Purchase only what is needed for one season and only mix what is needed for each application to avoid leftovers	Y											M			L	N	0		
Pest Management	Pesticide Storage/Disposal	Pesticide/chemical waste prevention	If needing to save pest. from year to year, make sure container is secure, store in safe & dry location; use pesticides ASAP	Y											M			L	N	0		
Pest Management	Pesticide Storage/Disposal	Pesticide/chemical waste prevention	See if dealer will take back unused pesticides	Y	More of a best mgmt. Rec										M			M			Y	
Pest Management	Record Keeping	Crop Monitoring	2) weekly (ideal) pest scouting with records (for verification, should see evidence of pest scouting: sticky traps, sweep nets, hand lenses, etc.)	Y											M			M				E
Pest Management	Record Keeping	General application	1) legal requirements for record keeping met (date, field ID, pesticide name/EPA #, formulation, rate & # of acres treated), ,	Y											M			M				E

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Pest Management	Record Keeping	General application	Pesticide recordkeeping for ALL applications (kept for 30 days after REI)-Part of EPA Worker safety std.	Y											M			H				E
Pest Management	Record Keeping	Toxicity	4) monitor and tabulate toxicity rankings to see progress in decreasing amt. of high toxicity pesticides	Y														M				E
Soil Health	Grazing	Erosion	Use pasture or rotational grazing/management intensive rotational grazing??	N				x	x			x		x	M	Y/N	<1	L	N	0	?-research shows mixed results	E
Soil Health	Erosion	Land Management	diversion ditches	Y											M	Y/N	<1	L	N	0	Y-better	E
Soil Health	Erosion	Land Management	grassed waterways and buffer zones	Y											M	Y/N	<1	L	N	0	Y-better	E
Soil Health	Erosion	Land Management	contour tilling/planting/buffer strips	Y											M	Y/N	<1	L	N	0	Y-better	E
Soil Health	Erosion	Land Management	Use windbreaks?	Y											M	Y/N	<1	L	N	0	Y-better	E
Soil Health	Erosion	Land Management	Use grass filter strips?	Y											M	Y/N	<1	L	N	0	Y-better	E
Soil Health	Erosion	Land Management	terracing	Y											M	Y/N	<1	L	N	0	Y-better	E
Soil Health	Erosion	Land Management	wetlands,	Y											M	Y/N	<1	L	N	0	Y-better	E
Soil Health	Erosion	Use of Crops	conservation crop rotation, cover and green manure	Y											M	Y/N	<1	L	N	0	Y-better	E
Soil Health	Land Management	Conservation Strategies	Soil conservation practices: 1) farm conservation plan is followed that does not allow tolerable soil loss (T) to be exceed for any cropland fields 2) farm conservation plan is followed only on highly erodible land (HEL) and does not allow tolerable soil loss (T) to be exceed for any cropland fields 3) farm conservation plan is followed that allows erosion in excess of tolerable soil loss (T) 4) no farm conservation plan being followed (8)	Y											M	Mult. Ch	<1	L	N	0	1-best, 4-worst	M
Soil Health	Erosion	Soil erosion rates:	loss of topsoil in %/year of t/ha/yr	Y											D	T/HA/YR??	10?	M	N?	0	lower-best	D
Soil Health	Erosion	Soil erosion rates:	Tons of soil erosion/unit of production	Y											D	TONS/UNIT OF PRODUCTION	2	L	N	0	lower-best	D
Soil Health	Erosion	Soil erosion rates:	Soil erosion index	Y											D	Index level	30?	L	Y?	?	?	E
Soil Health	Erosion	Soil erosion rates:	Rate of soil loss v. regeneration	Y											D	ratio	10?	M	N?	0	lower-best	D
Soil Health	Erosion	Soil Loss Evidence on Farm	presence of channels/gullies on field	Y											O	Y/N	<1	L	N	0	N-best	E
Soil Health	Erosion	Soil Loss Evidence on Farm	soil deposits at field perimeters	Y											O	Y/N	<1	L	N	1	N-best	E
Soil Health	Erosion	Soil Loss Evidence on Farm	soil loss evidence around plants	Y											O	Y/N	<1	L	N	2	N-best	E

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Soil Health	Erosion	Land Management	conservation tillage/restricted/no tillage	Y											M	Y/N	<1	L	N	0	Y-better/inc. # of Y's better	E
Soil Health	Erosion	Use of Crops	§ # of days/year soil covered with vegetation	Y											D	# days	3	L	N	0	higher # better	M
Soil Health	Erosion	Use of Crops	Use cover crops/inter seeding	Y											M	Y/N	<1	L	N	0	Y-better/inc. # of Y's better	E
Soil Health	Erosion	Use of Crops	Use perennial crops	Y											M	Y/N	<1	L	N	0	Y-better/inc. # of Y's better	E
Soil Health	Erosion	Water content	Do soil moisture monitoring?	Y											M	Y/N	<1	L	N	0	Y-better/inc. # of Y's better	E
Soil Health	Soil Organic Matter	Fertilizer use	Use of least oxidizing inorganic fertilizers	Y											M	y/n	<1	L	N	0	Y-better/inc. # of Y's better	E
Soil Health	Soil Organic Matter	Land Management	% of ag land in perennial ecosystem state	Y											D	%	2	L	N	0	Higher % better	E
Soil Health	Soil Organic Matter	Use of crops	Type of cover crop used? (legume or non-legume)	Y											D	crop type	2	L	N	0	?	E
Soil Health	Soil Organic Matter	Use of Crops	1) rotation with more years of grass or legume forage crops than row crops 2) rotation of row crops with a grass or legume forage crop at least on of every 3 years 3) rotation of row crops with small grain (oats, wheat, etc.) crops 4) continuous corn or other high intensity row crops	Y											M	Mult. Ch	<1	L	N	0	1-best, 4-worst	M
Soil Health	Soil Organic Matter	Use of Crops	Utilize university research or other means to develop optimal crop rotation? (eg. Corn-corn-soybeans-wheat)	Y											M	Y/N	<1	L	N	0	Y-better/inc. # of Y's better	E
Soil Health	Soil Organic Matter	Use of Crops	Strip cropping with annuals or perennials	Y											M	y/n	<1	L	N	0	Y-better, inc. # of Y's better	E

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Soil Health	Soil Organic Matter	Use of manure/compost	rotational grazing to incorporate plant matter	Y											M	y/n	<1	L	N	0	Y-better, inc. # of Y's better	M
Soil Health	Soil Organic Matter	Use of manure/compost	Use manure or compost as fertilizer?	Y											M	y/n	<1	L	N	0	Y-better, inc. # of Y's better	E
Soil Health	Soil Organic Matter	Use of manure/compost	Tons of finished compost/acre farmed	Y											D	tons/acre	2	Y	N	0	Y-better, inc. # of Y's better	M
Soil Health	Soil Quality	Compaction	conservation tillage	Y											M	y/n	<1	L	N	0	Y-better, inc. # of Y's better	E
Soil Health	Soil Quality	Compaction	strip tillage (certain areas only)	Y											M	y/n	<1	L	N	0	Y-better, inc. # of Y's better	E
Soil Health	Soil Quality	Compaction	farm traffic controlled (only certain areas, not when wet)	Y											M	y/n	<1	L	N	0	Y-better, inc. # of Y's better	E
Soil Health	Soil Organic Matter	Organic Content	Soil organic content	Y											D	analysis results	30	L	Y?	?	higher better	E
Soil Health	Soil Quality/Testing	Acidity	pH	Y											D	analysis results	30	L	Y?	?	y	E
Soil Health	Soil Quality	Biological Activity	biomass of soil arthropods & microbes	Y											D	analysis results	30	L	Y?	?	higher better	E
Soil Health	Soil Quality	Biological Activity	Microbial activity	Y											D	analysis results	30	L	Y?	?	higher better	E
Soil Health	Soil Quality	Biological Activity	# predatory mites	Y											D	analysis results	30	L	Y?	?	higher better	E
Soil Health	Soil Quality	Biological Activity	# of beneficial micro-organisms	Y											D	analysis results	30	L	Y?	?	higher better	E
Soil Health	Soil Quality	Biological Activity	§ Earthworms/acre/sq. m	Y											D	# worms	30	L	Y?	?	higher better	E
Soil Health	Soil Quality	Biological Activity	Nematode population	Y											D	analysis results	30	L	Y?	?	higher better	E
Soil Health	Soil Quality	Biological Activity	earthworms hard to find	Y											O	Y/N	<1	L	N	0	Y better	E

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Soil Health	Soil Quality	Biological Activit	how fast do manure piles and forage thatch degrade	Y											O	open end	2	L	N	0	?	M
Soil Health	Soil Quality/Testing	Carbon	Carbon levels	Y											D	analysis results	30	L	Y?	?	?	E
Soil Health	Soil Quality	Contamination	contamination by fertilizers, salts, organics, pesticides	Y											D	analysis results	30	L	Y?	?	y	E
Soil Health	Soil Quality	Nutrients	Banding or split applications of fertilizers	Y											M	Y/N	<1	L	N	0	Y-better	M
Soil Health	Soil Quality/Testing	Nutrients	Soil Na saturation	Y											D	analysis results	30	L	Y?	?	lower-best?	E
Soil Health	Soil Quality	Physical Features	what does handful feel like? ? ? ? ? ?	Y											O	open end	2	L	N	0	?	M
Soil Health	Soil Quality	Physical Features	how deep is dark surface layer	Y											O	open end	2	L	N	0	?	E
Soil Health	Soil Quality/Testing	Salinity	Salinity	Y											D	analysis results	30	L	Y?	?	y	E
Soil Health	Soil Quality	Compaction	• Number of ha run over with loads >10mg	Y											D	# HA	2	0	N	N	?	Y
Soil Health	Soil Quality	Compaction	Structure & depth	Y											D	?	?	?	?	?	?	?
Soil Health	Soil Quality	Compaction	Bulk density	Y											D	?	?	?	?	?	?	?
Soil Health	Soil Quality	Physical Features	Positive trends in soil quality measures	Y											O	Y/N	<1	M	Y?	0	yes better	E
Soil Health	Soil Quality	Use of crops	Number of acres cover crops per unit of production	Y											D	# acres/u of prdctn.	5	L	N	0	higher better	E
Soil Health	Soil Quality	Water	Practice water conservation?	y											M	Y/N	<1	L	N	0	Y-better	M
Soil Health	Soil Quality	Water	o Irrigation techniques/scheduling,	y											M	Y/N	<1	L	N	0	Y-better	M
Soil Health	Soil Quality	Water	infiltration	y											D	?	30	L	Y?	?	Y?	E
Soil Health	Soil Quality	Water	Water holding capacity	y											D	?	30	L	Y?	?	Y?	E
Soil Health	Soil Quality	Water	Soil moisture	y											D	?	30	L	Y?	?	Y?	E
Soil Health	Soil Quality	Water	how long for standing water to seep in	y											O	time	3	M?	N	0	med better than faster, slower	E
Water	Water Quality	Cleaning-in-place (CIP) processes	CIP best practice?	N				x	x													
Water	Water Quality	Runoff/Leaching prevention: Barn Yard Management	Concentration of dairy cows on yard (sq. ft./animal): 1) no yard; confined to barn or roofed yard; 2) 75 sq. ft./animal or more on fenced, curbed concrete pad and/or 400 sf/a on graded earthen surface; more than 1800 sf/a in exercise area 3) 50 sf/a or more on concrete and/or 200-300 sf/a on earthen surface; more than 1200 sf/a in exercise area 4) some concrete (<50 sf/a) and earth (< 100 sf/a)	Y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-worst	E
Water	Water Quality	Runoff/Leaching prevention: Barn Yard Management	Distance from livestock yard to drinking water well: 1) >200 feet downslope from well, 2) >300 feet upslope from well, 3) <300 feet up upslope from well 4) less than 100 feet from well (9)	Y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-worst	E

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Water	Water Quality	Runoff/Leaching prevention: Barn Yard Management	Surface water diversion: 1) all upslope and roof water diverted 2) most upslope and roof water diverted 3) No surface water diverted; some roof water collected and redirected, 4) All waterh (surface and roof) runs through yard	Y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-worst	E
Water	Water Quality	Runoff/Leaching prevention: Barn Yard Management	Lot runoff control system: 1) No yard runoff (either barn or roof area) 2) all runoff collected from curbed lot; solids separated; water directed onto filter strip, 3) Most of lot runoff collected; some solids removed; no filter strip, 4) lot runoff uncon	Y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-worst	E
Water	Water Quality	Runoff/Leaching prevention: Barn Yard Management	Soil depth and permeability: 1) well-drained medium or fine textured soils (loam, silt loam, clay loams, clays); depth to bedrock >40 inches with low permeability (silt and clay) 2) well-drained or moderately well drained medium or fine textured soils (lo	Y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-worst	M
Water	Water Quality	Runoff/Leaching prevention: Barn Yard Management	Yard cleaning and scraping practice: 1) no yard (animals confined), 2) 1x/week 3) 1x/month, 4) rarely	Y											M	Mult. Ch.	<1	L	N	0	1-Best, 4-worst	M
Water	Water Quality	Physical protection of water sources	Mich State: existence of control structures at end of field drains (can regulate water table in corn fields, decreasing nitrates leaching into drainage waters and improving crop productivity)	Y											M	Y/N	<1	L	N	0	Y best	E
Water	Water Quality	Physical protection of water sources	Stream banks protected (taken out of use)?	Y											M	Y/N	<1	L	N	0	Y best	E
Water	Water Quality	Physical protection of water sources	1) Cultivated areas >25 feet from riparian areas (good), 2) Buffer zones 50-100 feet in width and vegetated to prevent erosion and migration of nutrients, pesticide, etc. to waterways (better), 3) Buffer zone size adjusted for slope of landscape (>10% slope, >50 feet wide buffer areas), vegetated with diverse mix of species containing >50% mixed, multi-aged native and non-invasive species, seek maximum diversity in new grass plantings, trees & shrubs supply second story of cover & habitat	Y											M	Mult. Ch.	<1	L	N	0	Ranking of options	E
Water	Water Quality	Runoff/Leaching Prevention: Manure Management	Storage: § Presence of waste storage structures to better manage animal wastes	Y											M	Y/N	<1	L	N	0	Y best	E
Water	Water Quality	Runoff/Leaching Prevention: Manure Management	Storage: Composting facility	Y											M	Y/N	<1	L	N	0	Y best	E
Water	Water Quality	Runoff/Leaching Prevention: Manure Management	Storage: Waste transfer	Y											M	Y/N	<1	L	N	0	Y best	E

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Water	Water Quality	Runoff/Leaching Prevention: Manure Management	Long-term storage system (180 days or more): steel, glass-lined (liquid-tight design, above ground) OR concrete stave (liquid-tight design) OR poured concrete (liquid tight design): 1) designed and installed according to accepted engineering standards and specs and properly maintained 2) designed and installed according to accepted engineering standards and specs, not maintained 3) Leaking tank/concrete cracked on low permeability (like clay, allow water to flow through slowly) soil, >3 feet to water table and bedrock 4) Leaking tank/concrete cracked on high permeability (high perm. soils like sand and gravel, allow faster water movement) soil, <3 feet to water table or fractured bedrock (9)	Y											M	Mult. Ch.	1	L	N	0	1-Best, 4-worst	E
Water	Water Quality	Runoff/Leaching Prevention: Manure Management	Earthen waste storage pit (below ground): 2) designed and installed according to accepted engineering standards and spec and properly maintained 3) not designed to engineering standards, in low permeability (like clay, allow water to flow through slowly)	Y											M	Mult. Ch.	1	L	N	0	1-Best, 4-worst	E
Water	Water Quality	Runoff/Leaching Prevention: Manure Management	Short-term storage; usually 30-90 d, sometimes up to 180): Stacked in field (on soil base): 3) stacked on high ground on low perm. soil, >3 feet to water table and bedrock 4) stacked on high ground on high perm. soil, <3 feet to water table and bedrock	Y											M	Mult. Ch.	1	L	N	0	1-Best, 4-worst	E
Water	Water Quality	Runoff/Leaching Prevention: Manure Management	Short-term storage; usually 30-90 d, sometimes up to 180): Stacked in yard: 1) covered concrete yard with curbs, gutters and settling basin; concrete yard with curbs and gutters; grass filter strips installed and maintained 3) earthen yeard on low per. soils, >3 feet to water table and bedrock 4) earthen yard on	Y											M	Mult. Ch.	1	L	N	0	1-Best, 4-worst	E
Water	Water Quality	Runoff/Leaching Prevention: Manure Management	ST Storage: Other water-tight structure designed to accepted engineering standards and specifications: 1) designed and installed according to accepted engineering standards and specs, all liquid contained, properly maintained 2) designed and installed according to accepted engineering standards on low perm. soil, >3 feet to water table and bedrock 3) designed and installed according to accepted engineering standards on high perm. soil, >3 feet to water table and bedrock 4) designed and installed according to accepted engineering standards, not properly maintained, water tratment and diversion structures allowed to deteriorate	Y											M	Mult. Ch.	1	L	N	0	1-Best, 4-worst	E

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Water	Water Quality	Runoff/Leaching Prevention: Manure Management	ST Storage: Stacked in open housing: 1) building has concrete floor, protected from surface water runoff, adequate bedding provided 2) building has earthen or concrete floor on low perm. soils, protected from surface water runoff, >3 feet to water table and bedrock, 3) building has earthen or concrete floor on low perm. soils, subject to surface water runoff, <3 feet to water table and bedrock 4) building has earthen or concrete floor on high perm. soils, subject to surface water runoff, <3 feet to water table and bedrock	Y											M	Mult. Ch.	1	L	N	0	1-Best, 4-worst	E
Water	Water Quality	Runoff/Leaching Prevention: Manure Management	Location of storage relative to drinking water well: 1) manure stack or earthen waste storage pit >250 feet downslope from well; manure storage structure (liquid tight) >200 feet downslope from well 2) manure stack or earthen waste storage pit >250 feet upslope from well; manure storage structure (liquid tight) >200 feet upslope from well 3) manure stack or earthen waste storage pit <250 feet downslope from well; manure storage structure (liquid tight) <200 feet downslope from well 4) manure stack or earthen waste storage pit <250 feet upslope from well; manure storage structure (liquid tight) <200 feet upslope from well	Y											M	Mult. Ch.	1	L	N	0	1-Best, 4-worst	E
Water	Water Quality	Milkhouse waste	Distance from milkhouse (waste) to drinking water well: 1) >200 feet downslope from well, 2) >300 feet upslope from well, 3) <200 feet up downslope from well 4) less than 300 feet upslope from well	Y											M	Mult. Ch.	1	L	N	0	1-Best, 4-worst	E
Water	Water Quality	Milkhouse waste	Milkhouse waste discharge methodField application: 1) applied to growing crops at 27K gallons/acre or less per week; vegetation removed regularly 2) applied to uncropped fileds at less than 27K gallons/acre/week; vegetation removed occasionally 3) applie	Y											M	Mult. Ch.	1	L	N	0	1-Best, 4-worst	M
Water	Water Quality	Milkhouse waste	Milkhouse waste discharge methodSurface flow: 1) applied in sheet flow to slowly permeable soil* (see sheet); vegetation regularly removed; greater than 3 feet to bedrock or water table; OR applied to properly designed constructed wetland 2) applied in sh	Y											M	Mult. Ch.	1	L	N	0	1-Best, 4-worst	M
Water	Water Quality	Milkhouse waste	Milkhouse waste discharge method: Below-ground absorption: 1) discharge into properly installed and maintained organic matter bed; located on slowly permeable soils with over 3 feet to bedrock or water table 2) discharge into properly constructed conventi	Y											M	Mult. Ch.	1	L	N	0	1-Best, 4-worst	M

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Water	Water Quality	Milkhouse waste	Storage/settling tank liner: 1) properly sized concrete or plastic tank; baffles in working order; 2) clay lined storage or undersized concrete, plastic or metal tank; baffles not working 3) cracked or porous liner or leaking tank with no baffles 4) no ta	Y											M	Mult. Ch.	1	L	N	0	1-Best, 4-worst	M
Water	Water Quality	Milkhouse waste	Settling tank cleanout: 1) every 3-4 months 2) every 6 months 3) annually 4) never (10)	Y											M	Mult. Ch.	1	L	N	0	1-Best, 4-worst	M
Water	Water Quality	Milkhouse waste	Liquid storage period following settling: 1) 9-12 months; 2) 1 week-9 months 3) >1 week 4) no storage/settling; wastewater discharged directly to soil as generated	Y											M	Mult. Ch.	1	L	N	0	1-Best, 4-worst	D
Water	Water Quality	Milkhouse waste	Milkhouse waste treatment systems?	Y											M	Y/N	>1	L	N	0	Y best	E
Water	Water Quality	Milkhouse waste	Milking cleanup practices: 1) 1st pipeline rinse captured and added to barn manure; waste milk never poured down drain; manure and excess feed removed from parlor before wash-dow 2) waste milk poured down drain 10% of time; manure and excess feed usually	Y											M	Mult. Ch.	>1	L	N	0	1-Best, 4-worst	D
Water	Water Quality	Milkhouse waste	No wastewater discharge: 1) wastewater delivered directly to liquid manure storage; no discharge expected, 4) wastewater delivered to undersized or leaking manure storage	Y											M	Mult. Ch.	>1	L	N	0	1-Best, 4-worst	M
Water	Water Quality	Nutrient/pesticide application	use pesticides/herbicides tactically for localized infestation?	N										x	M	Y/N	>1	L	N	0	Y best	M
Water	Water Quality	Nutrient/pesticide application	Minimize Drift: Residue management & cover crops Crop residues and cover crops are always used to minimize pesticide leaching, runoff, and erosion by wind Crop residues and cover crops are frequently used to minimize pesticide leaching, runoff, and erosio	N										x	M	Mult. Ch.	>1	L	N	0	1-Best, 4-worst	E
Water	Water Quality	Nutrient/pesticide application	Time applications of fertilizer, manure, etc. to prevent runoff	N										x	M	Y/N	>1	L	N	0	Y best	D
Water	Water Quality	Runoff/Leaching prevention: Silage Storage	Sillage moisture content; storage location, floor or surface condition; storage cover condition, lining, leachate collection system	Y											M	Mult. Ch.	>1	L	N	0	1-Best, 4-worst	E
Water	Water Quality	Milkhouse waste	Nitrate measures	Y											D	Analysis?	30	L	Y	?	Lower-better	E
Water	Water Quality	Physical protection of water sources	Evidence of sedimentation reaching watercourses? Or contained by buffer?	Y											O	Y/N	<1	L	N	0	N best	E
Water	Water Quality	Physical protection of water sources	Wetland area in degraded state?	Y											O	Y/N	<1	L	N	0	N best	E
Water	Water Quality	Physical protection of water sources	Stream banks seem stable with no evidence of bank falling into water?	Y											O	Y/N	<1	L	N	0	Y best	E
Water	Water Quality	Physical protection of water sources	Livestock access to riparian areas controlled?	Y											M	Y/N	<1	L	N	0	Y best	E

				Parameter Level											Farm/Template Level							
					If no, is it b/c (X if applicable):																	
Indicator	Sub-Indicator	Parameter	Farm-level Question	Parameter recommended for inclusion in template? (Y or N)	Data is not comparable?	Time investment is not worth info?	Cost investment is not worth info?	Limited research info available for parameter?	Provide limited info on indicator?	Expert recommends drop	Irrelevant to dairy?	Other parameters are more comprehensible?	Not important to VT?	Other reason?	Type of measurement (M=Management, D=data/quantitative informtion, O=Observation)	How measured? (What are discrete measurement units?)	Time required (min)	Additional time required for record keeping (beyond normal, during the yr)? (L=low, M=med, H=high)	Outside agency needed to answer question?	Cost for measurement?	Are there "acceptable" parameter levels?	Ease of verifiable (E=easy, M=med, D=difficult)?
Water	Water Quality	Physical protection of water sources	Use pasture based livestock system?	Y											M	Y/N	<1	L	N	0	Y best	E
Water	Water Quality	Animal Density in feedlots	Animals/ha	N					x					x								
Water	Water Quality	Attributes (clarity, flow, temp)	Water clarity	y											O	Mult. Ch/Open end	5?	L	N	0	Clearer-better	E
Water	Water Quality	Attributes (clarity, flow, temp)	Flow rate	y											D/O	Slow-Med-Fast? #?	>1	L	N?	0	Faster-better?	E
Water	Water Quality	Attributes (clarity, flow, temp)	Water temperature	y											D	degrees	20	L	Y	0	Not higher than other bodies of water	E
Water	Water Quality	Biological Activity	Farm ponds have algae?	Y											O	Y/N	5	L	N	0	N better	E
Water	Water Quality	Biological Activity	Downstream aquatic organisms as indicators of water Q	Y											O	#/type of organisms?	30	L	Y	?	?	E
Water	Water Quality	Biological Activity	Existence of phytoplankton biomass	Y											O	Y/N	5	M	N	0	?	E
Water	Water Quality	Biological Activity	Biomass of invertebrates and fish	Y											O	Y/N, amt.?	5	M	N	0	?	E
Water	Water Quality	Conductivity	conductivity,	Y											D	?	30	L	Y	?	?	E
Water	Water Quality	Contaminants	nutrient concentration	Y											D	PPM?	30	L	Y	?	Lower-better	E
Water	Water Quality	Contaminants	salinity,	Y											D	PPM?	30	L	Y	?	Lower-better	E
Water	Water Quality	Contaminants	contaminant concentration (pesticides, heavy metals	Y											D	PPM?	30	L	Y	?	Lower-better	E
Water	Water Quality	Contamination	Atrazine ppm	Y											D	PPM	30	L	Y	?	Lower-better	E
Water	Water Quality	Contamination	other contaminants in part per unit	Y											D	ppm?	30	L	Y	0	Lower-better	E
Water	Water Quality	Drinking water (taste, smell)	Drinking water have bad taste or smell?	Y											O	Y/N	<1	L	N	0	N-best	E
Water	Water Quality	Eutrophication	No. of contaminated or eutrophic bodies of surface water or groundwater	N?-off-farm											D	# contam. Bodies of water	30	L	Y	?	Lower-better	E
Water	Water Quality	Use of Crops	Existence of pasture & hay planting:	N?											O	Y/N	1	L	N	0	Y-best	E
Water	Water Use	Affect on ecosystem	Related ecosystems/habitats significantly affected by use of water	Y											O	y/n; h, m, l	10 min	M	N	0	yes	M
Water	Water Use	Irrigation use	Percent of irrigation water stored in the root zone	Y											D		lots	M				D
Water	Water Use	Irrigation use	Irrigation system uses: furrow irrigation, gated head pipe, drop nozzles, low pressure, micro-sprinklers, trickle tape, or soil moisture sensors.	Y											M	y/n	<1	L	N	0	Y	E
Water	Water Use	Irrigation use	Replace older, less efficient irrigation systems with newer more efficient systems.	Y											M							

				Parameter Level											Farm/Template Level							
					If no, is it b/c (X if applicable):																	
Indicator	Sub-Indicator	Parameter	Farm-level Question	Parameter recommended for inclusion in template? (Y or N)	Data is not comparable?	Time investment is not worth info?	Cost investment is not worth info?	Limited research info available for parameter?	Provide limited info on indicator?	Expert recommends drop	Irrelevant to dairy?	Other parameters are more comprehensible?	Not important to VT?	Other reason?	Type of measurement (M=Management, D=data/quantitative informtion, O=Observation)	How measured? (What are discrete measurement units?)	Time required (min)	Additional time required for record keeping (beyond normal, during the yr)? (L=low, M=med, H=high)	Outside agency needed to answer question?	Cost for measurement?	Are there "acceptable" parameter levels?	Ease of verifiable (E=easy, M=med, D=difficult)?
Water	Water Use	Irrigation use	Factor weather conditions, soil moisture, mulching/ground cover and plant need in irrigation strategies.	Y											M	y/n	5 min	L	N	0	Y	D
Water	Water Use	Irrigation use	Water consumption for irrigation per ha of farmland	Y											D	gallons/ha	5 min	L	N	0	Y	M
Water	Water Use	Irrigation use	Water consumption for irrigation per tonne of product	Y											D	gallons/tonne	5 min	L	N	0	Y	M
Water	Water Use	Record keeping	Track, monitor, analyze and interpret water usage and eliminate wastage. (will have to split into multiple questions or ck all)	Y											M	y/n	<1	L	N	0	Y	D
Water	Water Use	Reuse	Is water is collected? (how much water is collected - +'al info may not be worth +al data)	Y											O/M?	y/n	<1	L	N	0	Y	E
Water	Water Use	Reuse	Is water recycled for other uses?	Y											M	y/n	<1	L	N	0	Y	E
Water	Water Use	Reuse	Do you test water conservation strategies?	Y											M	y/n	<1	L	N	0	Y	D
Water	Water Use	Reuse	Total amount of water recycled/reused.	Y											D	gallons	5 min	M	N	0	Y	D
Water	Water Use	Soil interaction	Soil absorb and retain rainfall	Y										Covered more by soil indicator.	O	amt?						
Water	Water Use	Soil interaction	Percent of rainfall stored in root zone	N										Covered more by soil indicator.								

				Parameter Level											Farm/Template Level							
					If no, is it b/c (X if applicable):																	
Indicator	Sub-Indicator	Parameter	Farm-level Question	Parameter recommended for inclusion in template? (Y or N)	Data is not comparable?	Time investment is not worth info?	Cost investment is not worth info?	Limited research info available for parameter?	Provide limited info on indicator?	Expert recommends drop	Irrelevant to dairy?	Other parameters are more comprehensible?	Not important to VT?	Other reason?	Type of measurement (M=Management, D=data/quantitative informtion, O=Observation)	How measured? (What are discrete measurement units?)	Time required (min)	Additional time required for record keeping (beyond normal, during the yr)? (L=low, M=med, H=high)	Outside agency needed to answer question?	Cost for measurement?	Are there "acceptable" parameter levels?	Ease of verifiable (E=easy, M=med, D=difficult)?
Water	Water Use	Soil interaction	Efficiency of retaining water on the farm and in the soils	Y										Covered more by soil indicator.	D					?		D
Water	Water Use	Stability of water source	Stability of water source (farm level)	Y											D	y/n?; bucket amts?	<1	M	Y?	0	Y	M
Water	Water Use	Stability of water source	Water sources significantly affected by use of water	Y											O	y/n	<1	L	N	0	Y	M
Water	Water Use	Stability of water source	Drainage patterns into and from the farm	Y											O	?	<1	L	N	0	?	E
Water	Water Use	Stability of water source	Watershed farm belongs to	Y											D	watershed	30 min	L	Y?	0	N	M
Water	Water Use	Stability of water source	Water withdrawal compared to recharge rate	Y											D	rate - gallons/time				0		D
Water	Water Use	Stability of water source	Level of groundwater	Y											D					?	N?	
Water	Water Use	Stability of water source	Trend in groundwater	Y											O	levels	<1	M	?	?	Y	M
Water	Water Use	Stability of water source	Annual withdrawals of ground/surface water as percent of annual renewable quantity of water available from source	N											O					?		D
Water	Water Use	Total use	Total amount of water consumed.	N	x										D					N		D
Water	Water Use	Use compared to farm production	Water consumption per kg of milk solids	Y											D	gallons/kg	5 min	L	N	0	Y	M
Water	Water Use	Use compared to farm production	Water consumption per cow	Y											D	gallons/cow	5 min	L	N	0	Y	M

APPENDIX E: NOTES FROM FIRST VERMONT TRIP: FARM VISITS, MEETING, YOUNG COOPERATORS FOCUS GROUP, OCTOBER 13 & 14, 2003

MEETING WITH UNILEVER SUSTAINABLE AG GROUP:

Participants: International marketing director for Ben & Jerry's US, Ben & Jerry's Public affairs rep, Marketing director in UK, Anique in Rotterdam, Andrea, Wendy, Mindy

Project SMILE is a B&J initiative to try to differentiate the B& J brand in Europe since the rBGH-free applies to all brands in Europe. They are going to complete a gap analysis of existing practices and figure out what practices are unique to Unilever and how they can differentiate their brand. Anniek suggested differentiating based upon animal welfare practices. B&J US was skeptical of that focus because of past PETA problems. They are going to be working with a PhD student who is developing a sustainability index for dairy farming in Holland. They are also going to team with Lxxxx University's animal science group that studies practical research for cattle farming. They want a global non-profit to support the initiative. Jan Kis has already made initial contacts with the WWF.

FARM VISITS

Farm #1

Spouse helps out part time. 40 cows. Breed: Jerseys. 30-35 of the cows currently producing milk. 75% have two calves in their lifetime.

Farm practices intensive grazing-based management with 38 paddocks. Cows are rotated every 12 hours. Feed is determined by broker – track each cow as to what they should eat. Owner is conscientious about which cows may steal from each other – arrange them within barn in such a way to minimize "stealing." Even when inside for the winter, get to go outside for 1 – 1 ½ hrs/day.

The gravity flow manure pit was grandfathered in (i.e. no energy required). It was built to meet old NRCS engineering specs. Spread manure onto fields, but don't have own tractor – hire spreader. To care for paddocks, they lime the fields and are careful not to over-graze. They bush-hog in May (cut down long grass so soft, new ruminants grow). Farm has culverts over brook so that cows don't go into the brook.

Farmer registers cows to increase sale value of jerseys out west. Registering cows (National Farm Animal Identification and Records) requiring tracking genetic lineage and paying attention to genetic diversity. Registry could also be used for bio-security tracking—government is trying to start a program now. Milking time is 6-9 minutes per cow for a total of 1-1.5 hours per milking, 2 times per day. Culling rate is 15-20% of cows (which is low for industry). Reasons include milk fever (higher incidence with age), old age, SCC, and stepped on tits. Farmer uses the Dairy Herd Improvement Association program to track dairy health—about 25-40% of St. Albans cows use this service. Reports produced contain cow-specific information – such things as SCC. Costs about $150/month (which is a lot for farmers). They need it while other larger farms may have own "elaborate" computer system to track per cow basis, while they lack this sophistication.

The average farm produces 2.2 million thousand pounds of milk per year. This farm produces 650 thousand pounds. For the St. Albans coop, approximately 20% of the farmers make 50% of the milk and becoming more concentrated. Farmer uses Quickin to track expenses, but says that many people use Yankee Farm Credit and access AgraFax. Yankee Farm provides financial benchmarks depending on size and number of cows. Use an accountant to do their taxes for them. Percent of farmers that do their own computer stuff is very small. Very skeptical of farmers entering/using financial software. Husband, as part of UVM's Extension service provided crop-related software. Sat down with farmers, walked them through individually how to use software, all had good intentions but NONE got around to doing it (and this was required of them). Therefore, doubtful we can expect them to use financial software.

The milking equipment has a variable pump (runs at different speeds based upon need) to save energy. They also use heat from equipment to heat water to clean the equipment.

Two daughters also raised and help on farm. First daughter has no interest in going into farming (at least directly). Second daughter is very interested in it. Both grew up being actively involved with 4H. Feel negative thoughts/opinions from urban people regarding farms – largely due to environmental concerns (or what they've heard). Also figure farmers are dumb, missing teeth, etc. Makes it hard on relationships with spouse working off farm.

Farm #2

This farm is run by a father and his son. They have two full time and one part-time men helping them. One man feeds and moves the cows, 1 man works the parlor. The men have worked for them 11 years and 8 years – feels wrong to call them "hired help." Isn't the right place for young kids wanting to roam around – better life style for older help who are ready to settle in. They provide the men every other weekend off, paid vacations, a bonus, and healthcare. The men work from 3:15 am to 8am, have an hour off for breakfast, an hour for lunch, and end their day around 6pm.

They have about 105 PRODUCING? cows (total of 160 head). Breed: Holsteins. They group their cows into High producer, Low producer, and "fresh" pregnant cows (expecting in 2-3 wks) (MM – and based on milk quality → SCC?). Have 90 stalls, but 100 cows right now in certain grouping (this isn't great, but okay b/c different cows eating, laying down, etc – not all in one place. Besides you want them to stand more, b/c the more they stand, the more they'll eat and the more milk they'll produce). The different groups are given different food rations, 2 times a day. Rations include a citrus mix and pellets as supplements. Bordeaux Brothers determines ration. Samples/checks in on them 1/month. Track herd health and milk quality. Bad SCC for them is 1,000,000 – prefer to see 3 – 400,000 and180 – 250,000 is normal. If they get quality bonus from Co-op, b/c of low SCC, men get a bump of increase as well (profit-sharing). The average milk produced is about 70 lbs per cow per day. Milk the low group last in the morning and first at night to cut down on mastitis (how does this cut down on potential mastitis?) Dry cows are put out to pasture.

Cows are in an open free style barn. The stand on rubber mats to feed and lay on rubber mats covered with sawdust to rest. They walk to the milking parlor each day. Manure is cleaned out of the main aisle 8 times per day. The beds are hoed 2 times per day. Fresh

bedding is put down every couple of weeks. Have side curtains for ventilation on barn. Automatic temperature-controlled barn - close curtains to maintain appropriate temperature (set for 38 degrees F). A hoof trimmer comes in once a month. Get all vaccinations possible. Purchase all their replacement heifers. All new arrivals are administered vaccinations b/f coming on site. They are housed immediately within the same farm/housing as the others. Lights are efficient, use a variable speed pump and have a plate cooler (acts as a pre-cooler and decreased the amt of time the compressor must run → decreased energy required.) No registration or genealogy lineage.

Parlor is sprayed once/month in summer b/c flies cause trouble. May get into the milk (unsure how?). Spray their fields when cutting and also "scout" corn. Have tested some soil types. Last year they planted GMO corn with built in insecticide to control insects. Previous year had problems with root-worm – no problems this year. Best harvest they've ever had and is planning on using again this next year. GMO corn cost $115/bag vs regular which costs $100/bag (takes multiple bags for field). Have 200 tillable acres. Try to rotate crops (but cover crops cost money and do not get harvested – so why bother? Is just an expense). Work with ASEC. Work w/ Bordo Brothers on NPK (take test samples) and compare with VT standards. Do take soil type into account. Have heavy clay soil. Too much manure. Believe that they get more use out of the land by not grazing. Used to have only 90 cows with grazing – now able to support more cows w/ same amt of land. Do select specific crops for specific land/area. Have 3 corn varieties.

Have a spring but no water. Do see turkeys, gees, and deer. Use tires on top of plastic sheets to protect hayage. If able to decrease amt of O2 that gets in, then there's less spoilage.

Share's farming equipment with brother-in-law. Tap 1000 sugar maples for syrup. Use an accountant. Sold development rights to farm.

Farm #3

Father farms with two sons and 1 hired part-time. Sons run farm with one managing feeding and one managing milking. 220 milking cows and 100 dry cows. Breed: Holstein.

They breed all their own substitute heifers. Send newborns to be raised elsewhere. He charges $1200 per cow to raise them to maturity, which is less than what you can buy a cow for.

They milk 100 cows per hour using 24 milking stations two times per day. Cows are in an open free style barn—they never leave the barn as a means of controlling diet and disease. Dry cows are put out to pasture. Loose lot practice. Split into groups based on production – springers, low, fresh and high. Different groups get different protein amounts. Avg age is 3 years. Even have scratching post for cows "comfort." Hoof clipper comes every 2 weeks. Does about 6-8 cows/visit. Stand on rubber when eat. Have rubber tire mattress with sawdust on top. Use about 1 tractor of sawdust/month.

They use variable pump equipment in the milking stations and in the pre-cooler. The Somatic Cell Count for this herd is between 70-150 thousand. They (outside to farmers – unsure if Bordeaux brothers?) check milk equipment/monitor.

They (Bordeaux brothers) test fields for NPK every 5 years – last time was 2-3 years ago. Found cornfields lacking last year so applied 200 tons of lime. They have 20 fields (all less than 10 acres) and took one core sample from each field. They are trying to turn more acreage into corn as they look to expand the farm. Tap 1000 sugar maples for syrup.

Have a spring with large water source. Have 4 pumps running on it to pull out water.

YOUNG FARMER'S MTG, OCTOBER 14, 2003

INTRO: ANIMAL WELFARE—

- Each one of us has fine-tuned our herds to both of these. I'm sure that you saw some pretty nice cows. I think that in the last year, it has taken out the bottom layers (poor farmers who don't take care of their cows/manage expenses and become more efficient). It's made everyone become better farmers.
- You'll always find the one or two farms that are not taken care of. Most of them are top notch.
- I went to an auction today and the cows were very spooky and you could tell the living conditions were poor. If they aren't happy, you're not going to have a lot of fun.
- Nutrition—Most of us are at level two. We're at level three in a lot of ways. You're not going to be giving your cows stuff that they don't need. We've cut back on phosphorous. If you can see kernels of corn in their manure you know that the nutrition is out of whack. There's a nutritionist at each of our farms once a week. Each farm is different, most try to stay the same. Balance is the central issue.
- Health—Herd is monitored on all of these farms. Most of us have a clinic once a month, or is every week. Health issues are reviewed. Vaccines, health checks, some vets trim feet for lameness. I have some issues with level three. It seems as if you don't let your cows out, they're not healthy. Most of the large herds are confined herds. The new facilities are more comfortable. If they let them out early in the spring or fall, then they can get more diseases. That is a management thing. If you turn them out too early in the spring you get issues. If you don't get the water in the right spots, you get problems as well. There are some stanchion barns that are better than free stall barns. You're looking for a healthy environment.
- Health—The coop measures somatic cell counts twice a month and we test with DHI (Dairy Herd Improvement Association) for individual counts. I think that you need both questions. Somatic cell count is tied to only one issue. Body condition will go with the nutritional part. The levels seem more judgmental. Take out the word level.
- Housing—Cubicles should be called stalls. I don't know if I've seen a padded gate. I don't know that I've ever seen 10% more cubicles than cattle. That is not economically feasible. It's just the opposite. Not all cows are laying down or eating at the same time. The only way that it could become a reality is if you could get more money per

hundredweight. Ability to separate sick animals at the hospital pen. Time in holding area waiting to be milked—no more than 3 hours per day.

BIODIVERSITY

- Haven't heard of term b/f. Makes sense once MM explained
- First question – Natural Area Conservation. Remove levels. Largely dependent on geographical area. So much land – much too hilly, wet, stony. Provides habitat for animals/crops that you're going after. May be somewhat predetermined by VT land (especially in VT, b/c can't till all of it). Fox, deer, geese, and feed wildlife. If overgrown, then not seeing benefit. Prefer to clear land even if not using it. Every year, less land is used/pastured by cattle. Have more animals than feed, so need to keep extending the amount of land that they're using. Have to pay taxes, might as well use it. Need to balance economic (buying vs. growing own stuff) w/ wildlife habitat.
- Some practices are possible. Have question about mgmt practices, so educate on the potential different alternatives that allow growing things, while improving mgmt. Concern that VT will require 100 foot buffers along water ways.
- Will need to articulate a VERY strong argument! Very skeptical group.
- First question may not be so applicable in VT, b/c the land is dictating the wooded area.
- Federal programs require certain practices for VT farmers, which are better/more applicable for CA farmers.
- Add to first question, if leave crops to support wildlife thru-out winter. Amt of wildlife.
- Mgmt of rivers/lakes – remove level. Change cattle to cows. Not too many keep them out of water and brooks and streams (unless confined). If pasture, then they have access and typically in water, drinking, etc. Govn't has strong regulations about it.
- Water is being polluted by other things than cows….golf course, lawns. Farmers are first to get blamed. Include broader description of why this is an important concern (larger than water). Concerned about image/media coverage. Worked w/ UVM on study b/c of large amt of land by water.
- Registering cattle. Common even w/o registration. Keep track of genetics and what you need to improve on it. DHI also contributes to it. It's a cost. Breeding w/ artificial insemination – could create incest, if you don't keep track of it. Have to keep certain baseline/basic records. Kurt buys replacements vs breeding. All others use artificial insemination. Holsteins don't matter if registered or not, unless you are in the very elite. Trend is moving away from registration.
- Add question looking at genetics of cows and/or registration. Tied more strongly to record keeping (are they using AI = artificial insemination). Are they raising replacements. Costs $6-10/cow and certain age maximum requirement.
- What makes a good bull. Good feet and legs. Blood lines. Calving ease. Fat protein %. Teat placement. Udder size/shape. SCC.

COMMUNITY HEALTH—

- Over the past 5 years, the number of farms in your county has decreased, mainly due to sprawl by houses (closer to Burlington). Add this option to the question!

- 99.9% of the corn that is sprayed now is sprayed commercial. It is sprayed on ground. We decide when it needs to be sprayed. When plants just barely poking through. Most people custom hire done their spraying. You're also got your insecticides. The other issue is milkhouse chemicals. Insecticides may soon need an applier—getting to point where need license to do anything. An applicator currently helps you form a pesticide plan.
- Wage—covers it. Add below minimum wage with no benefits.
- Labor pool—Add--No hired hands or Does not apply, only family works farm. Good farm help is hard to find and you have to pay him really well in order to keep them.

FARM FINANCIAL HEALTH

- What do you use for financials? If you can pay all bills, you're doing good. We work w/ lending agency, so they help w/ profits/loss.
    - Another one wings – checkbook and bank – guy who does loans. Has pretty good on how I'm doing based on how much/how fast I'm paying down debt-load – in 7 yrs/5 yrs paying off. Use quickbooks.
    - Have on-farm program. Do financial statements thru that. Major purchases thru lender. How much sense it makes. Farm financial program (software). Wife and sister do data entry and help on that end – separate than farm workers. Used Red-Wing and think has switched.
    - Have pretty good idea how much its going to cause.
    - Red-Wing Financial Services – a couple use. Has been nation-wide
    - Quickbooks. Can use to print off reports and statements.
    - My wife has worked w/ mom- in-law. Work close with lender/bank
    - Debt per cow. Cull rate. Get milk check every 2 weeks. If knowledgeable, can tell how you're doing.
- Possible to compare self to others? Information/data can be comparable. Lenders will provide this type of information.
- Does help to have both national and even more important local. Also having yearly comparisons.
- In the future, how to track? Fulfilled by lending institutes?
    - Think computer makes good sense.
    - If you can't update program, and can't afford to hire somebody, then you have to get it installed/updated. Will make difference in future.
- Sample report from finpack. Have to fill this out if you want to apply for loan. Provides for better view. This is how you get credit line. Some are using this and some aren't. think everybody ought to use this.
- What types of training would you provide? How to use software? Purchase? How to interpret?
- If given balance sheet from bank. Training to tell you which numbers to focus on first. How to interpret. What are appropriate numbers. Basics of how to read balance sheet and what are most important numbers and then ranges. "How do you do read (and understand) a balance sheet." Why look at them, and why helpful. Some point of how to create your own, can be important as well. Maybe color code numbers on your sheet.
- Maybe link into lending institute. Can they provide this worksheet?

- Final questions: openness to new practices – most are open to these new techniques. Very appropriate to co-op.
- Production goals and planning? Good question. Change words Production plan to business plan. Think of milk production otherwise, where business plan is more encompassing.
- Labor supply. Add category Use high school kids as part timers. Eliminate the % portion of the question. Add separate question about quality of labor supply. The decreasing **quality** of labor supply is one reason to switch from tie stall to free style barns – able to have more cows w/ less time/effort req'd. Big issue is people who want to work. Mexicans will work as much as they can. There are few people who want to work the hours and are dependable. Takes certain dedication to get up that early everyday and trust that the other person will get there.
- A number of farms are turning to migrant workers. Large question around legal to work here. Also has racial profiling. If different color – attract attention for INS – documentation is difficult to provide. Migrant workers WANT to work. Used to be able to find anybody/somebody to work on the farm. But mostly looking for higher quality.
- During cropping season – fluctuate widely. Depends how much help you've got. If you find a good worker or two, can have more time off. Everybody wants to spend more time with their family.
- Thank goodness mine works off the farm – b/c of paycheck.
- Maybe word to get at days/hrs – more quantitative vs. subjective. Take into account cropping season.
- Another question – dealing with how much income is coming in off the farm. And benefits being provided from off-farm.
- Live on/luxuries come from wife's job. Food, car, health insurance. Get health insurance from off-farm spouse employment.

Follow-up with module review.
A lot coming down in the next 5 years. Especially w/ manure spread. Seems best to stay on top of it.

APPENDIX F: FIRST ADVISORY BOARD CONFERENCE CALL NOVEMBER 4, 2003

ANIMAL WELFARE

- Description.
    - Last bullet, add larger picture.
- Benefits to Management
    - Add Health of animal will be improved.
    - Public Image: Farmers are unfortunately ??!? under critical review by a public body that may or may not truly understand the actual needs of the animals. ?? I don't see both sides of the coin here. Certainly the public (for the most part, a generation or more removed from the farm) is greatly unaware of farming activities. However, as the public learns more about the industrialization of animal agriculture, it may be a welcome critique. It does the farmer no good to say…"Why yes, chickens, hogs, and cows have always been raised indoors their entire lives. They're safer that way." Even the uneducated public understands and can relate to confinement and senses something "wrong" about this picture – i.e. doesn't old MacDonald's farm have animals outside? Don't I as a person like to go outside? Thus, how can animals not want to go outside? Didn't they live outside when we first domesticated them? In this sense, the public understands very well the needs of animals. The increasing threat of (unwanted attention from animal activist groups??) is this the real threat? Or is it a general threat of the farmer being "found out"? That is, breaking the trust given to him/her to husband animals well…taking advantage of the general public's lack of farm knowledge to treat animals as less than animals? And can't anyone who's interested find this out? encourages the farmer to proactively modify their animal welfare practices. I would rewrite the entire above "Public Image" section to provide a more balanced view of the subject.
- Assessment Questions.
    - People who handle animals, if trained appropriately.
    - only address calves on last question. how calves are raised and replacement heifers.
    - Health of incoming/outgoing Animals.
        - also when entering into barn.
        - Biosecurity - monitoring milk contamination by criminal/entry of outsiders onto farm. – ck w/ Diane
    - Housing/Handling Areas
        - maybe combine w/ stalls – maybe handle as do fertilizer, silage.
    - These questions are a good base. Do cows need to be able to go outside for their welfare? Is this natural and healthy? Do farms need pastures and/or exercise yards? Or can cows live inside all their lives – moving from the barn to the milking parlor back to the barn? What if the barn has open sides and is just a roof, is that "being outside"?

BIODIVERSITY

- Description.

- GMO's in questions but need to add to description – how it impacts +/_'ly

- Benefits to Management
  - Concern about discussing price premium that comes from organic sales. A second board member also thinks that it is not as in-line with the rest of the conversation, regarding organic certification.
- Assessment Questions
  - Genetic diversity of cows.
    - Holsteins lack Genetic diversity. Need description to include this concern. Primarily Holsteins in VT – maybe move or delete out.
    - Three board members don't think of cow diversity – delete from here and move to AW? Think of biodiversity as interaction btwn natural ecosystem and features – flora and fauna
    - Registered cows: These seem like contrary goals. Registered herds are usually purebred and lack genetic diversity. I'd like to see the producer relate how he/she manages the genetic diversity of their herds to achieve farm goals while keeping genetic diversity high.
  - New Plantings/Pastures.
    - New planting and pastures, option #4 relates more to crops than to pastures. Leaves out just letting biodiversity take over – lack of mgmt. May cause some farmer confusion if looking at planting a new field.
    - #1 and #2 make sense, but #3 and #4 don't make sense. Trouble b/c plantings and pasture are grouped together.
  - Adjacent Area Management.
    - Referring to connectivity? in addition to managing for habitat, are you all thinking about connecting habitat fragments.
    - If farmers know if there are rare or endangered species in their area and are they working with someone in the area, regarding this mgmt.
  - Management of Rivers/Lakes: "Watering sites are developed and located away from stream courses, and cattle are not allowed direct access to streams." I think the science on streamsides and grazing is regionally dependent. See Water, Grass & Livestock: An Annotated Bibliography of Riparian Grazing Publications www.landstewardshipproject.org/resources-pubs.html

COMMUNITY HEALTH

- Assessment Questions.
  - undocumented not illegal - always. don't ck if have documents or not, some prefer not to know so don't ck documents. ck doc's and wonder about some. don't ck doc. ck validity of doc. ck doc's of EVERYBODY. i only employ . question is documentation. how much time do farmers spend ck'ing documents. I-9 requires 2 forms of id – not req'd to ck validity of doc's. most people i hire are from around here? i hire people from out of state? if doing something illegal, then won't want to complete. find out where labor is from – ask where born – give good idea of international or not.

- Labor. reword (as commented above).
- I see two "community health" threads here: 1) On-farm relations with labor, and 2) Relations between the farm and the community. These overlap to the extent that farm labor comes from the community. Again, these are big topics and it's hard to decide the best assessment questions. Concerning farm labor, Food Alliance has a substantial set of assessment questions for "safe and fair working conditions" that might be considered for inclusion. e.g. Grievances, hiring, discipline, training, non-discrimination, benefits, housing, etc…. I might include some of these to flesh out this module.
- Number of farms increasing or decreasing in your community
    - Good questions! The "involvement" with community checkbox table seems one-sided. It represents the farm in the community, but does not include the community coming to the farm… e.g. farm tours, farm events, pick-your-own or similar setups, making the farm a collaborator in community activities, etc…
    - Other ideas to consider as assessment questions: Are you a resident of your farm/community vs. an absent owner? Do you manage your farm or does someone else do it for you? Do you own the crops and animals you produce? Is your farm a family operation (whether proprietorship, LLC, LLP, or family corporation)? Does your farm buy goods and services from the community? Does your farm provide jobs for folks who live in the community? How many and of what type?

<u>ENERGY</u>

- Description
    - <u>Direct Energy:</u> Two main sources include fuel and electricity: **these are not sources, rather sinks or losses or uses of direct energy**
- Assessment Questions.
    - When it comes to milking my cows.
        - Not consistent order of levels – move last to first. Awareness or usage question - which trying to find out?
        - Last response, spin positively – am aware of vacuum pump but ….i've looked into but not
    - Vehicle Selection.
        - All farmers have pick-up truck with medium efficieincy (exempt from CAFÉ). Is there a better question to replace it with? Re: vehicles or larger issue.
    - Cleaning processes contribute to 30% of the energy use on dairy processing farms, the primary contributor. What type of milk cleansing methods do you use?
        - Concern that levels aren't moving from least to most, like other questions thus far. Add a 1, 2, 3, 4 in front of them.
    - Add question.
        - Overall energy use on dairy farm – how big of a contributor is your vehicles. What are the big drivers. is really big fuel use farm truck

OR farm tractor – has it been maintained to ensure that its running as efficiency as possible. Get data from AA.

- Calculate the amount you spend on energy and machinery as a percentage of gross income:
  - Any guidance on what this % might be? How do farms know how they're doing relative to other dairy farms?
- Indirect energy
  - I don't see many of the "indirect energy" types listed here. e.g. How much is fertilizer costing and how have you reduced its use? How much feed did you buy, and what is its energy content? Is there information on what % of energy use is involved in these indirect efforts?
  - I also do not see grazing, one of the largest energy saving practices available. Graziers harvest less feed, store less feed, and feed less feed. The cows do the work instead of people and machinery. Graziers typically till less and apply fewer fertilizers; they have less machinery. They typically have fewer buildings and require less electricity.
- Renewable energy
  - I like the work being done with methane digesters as on-farm energy generation. However, I don't see any discussion of whether this is a good idea from a nutrient management standpoint – e.g. what happens to the waste products of the digestion? What's in them and how do they fit in a farm nutrient balance?
  - I also don't see any discussion of animal welfare. I would say that the industrialization of milk production has had a negative effect on dairy cow welfare and the environment. If we now add energy industrialization to the cows' responsibilities, how will we guard against further erosion of the cow's stature as a living being on the farm?
- Ventilation equipment accounts for 22% of all energy usage on a dairy farm. When it comes to ventilation,
  - Is there use data for all the energy use categories on a dairy farm? e.g. Lighting accounts for XX%, Milking accounts for xx%, Fuels account for XX%, etc…. And is the data for a "typical" dairy farm? (to my mind, 22% seems awfully high for ventilation)

<u>FARM FINANCIAL HEALTH</u>

- Description.
  - Last bullet, add: Healthy work life balance.
  - Quality of life- do you have enough vs do you have a lot?
  - Separate quality of life (stress) - see them as 2 separate sections. from standard of living.
  - Farm financial health also standard of living. But doesn't put quality of life as part of it – the balance is quality of life. Can't assess balance.
- Benefits to Management

- May not have initial cost reduction. Should pose it as cost efficiencies.
- Monitoring results /benchmark. Is a big tool for a lot of farmers.

- Assessment Questions.
  - Financial Ratios.
    - Repayment Capacity? able to repay my debt and have a bit more. Hard to interpret actual formula that's given. Will give farmers terms in layman's terms.
    - Are these farm five terms the best one? Like that chose one measure from each area and relate back to farmer. Most farmers in VT will understand these terms in layman's terms. If they don't understand, will get them to think.
    - Measure for payback on sustainability – but tough. How to do? Measure? One other dimension to think about adding.
    - Way for farmer to track what benefits from financial
    - Substitute wife for spouse.
    - These all look like they might generate interesting results and discussion, but do farmers really have a handle on these numbers? What percentage has this type of information? What percentage has no idea? And do they compare with other dairy farms? Other farms? Other businesses?
  - Quality of Life:
    - When it comes to the fluctuations in the markets of my job.
      - what does this mean? Do you want to know if they have a plan? I plan for the future by having (ck all that apply) (even though future is very uncontrollable) add cat' that don't plan b/c future is so unstable. Getting ready for the future. Prepare for future.
    - What is your feeling towards adopting new farming practices?
      - Is this a quality of life question??
    - Farm Income. Investment required to implement new technology.
    - This is a good start on "quality of life." However, it's hard to say what the best 5-10 assessment questions might be – this is an awfully large topic. I don't see goal setting or questions about achieving personal, family, and farm goals. And if this module is titled "Farm Financial Health," how is quality of life a subset? I would think that financial health might be a subset of quality of life.

NUTRIENTS

- Description.

Last bullet on description, Board member noticed and liked that we realize single farm is not the only contributor, but maybe suggest playing an active role in being leader/work collaboratively. Maybe in intro for larger set of all modules. Important that they aren't the only contributor. Maybe add something similar for water. Pull caveat out front.

- Benefits to Management
  - Cost savings: Good movitation for farmer.

- Regulatory environment and funding: Scared in other parts of the country and becoming more stringent.

- Assessment Questions
  - Use of Phosphorus Supplements:
    - Delete off (.37% phosporus) from options #2 and 3
    - Manure pit – in winter ground in frozen. May have additional application (cut hay 3 times/yr). Have to empty pits atleast annually. Section on mgmt best practices? W/in water quality. Make reference to other section.

- This module does a good job with application rates and timing, but leaves some nutrient questions unaddressed especially for animal agriculture.

- 1. For example, is there a limit to a farm's stocking rate? Is there a nutrient management difference between a 100-acre farm that has 50 cows vs. 250 cows?
  - USDA-ERS Bulletin #771 examines confined animal production and manure nutrients across the United States. Averaging over all U.S. animal types and farms (a gross assumption, but a basic starting point), you need 0.9 acres /AU (animal unit) to agronomically use N and 3.7 acres/AU to agronomically use P. A dairy cow is about 1.35 AU – thus a farm needs about 1.2 acres/cow if it's concerned with balancing N, and 5.0 acres/cow if it's concerned with balancing P.
  - Obviously soil types, topographies and other factors come into play, but stocking rates are important to overall farm nutrient balances. How could this being incorporated into this indicator? Does it need to be?

- If dairy farms concentrate manures and then use them on fields, is it important how these manures are handled in between? Should they be composted? Sheltered from the elements? Stored in a lagoon or basin? Are there limitations on such storage?

- 3. Are there alternatives to concentrating manures – e.g. grazing animals? How should this practice (as it avoids intermediate manure handling) be assessed?

<u>ORGANIC</u>

- Description.
  - Works well. Is heavy. But if want to go into organic, need to understand
  - Didn't find it heavy.
- Benefits to Management
  - Benefits to the farmer. Stony gets all milk from organic – wonder why that quote is in there?
  - Benefits to the community. Tough – if large farmers may react and say hard conclusion to draw. Ann – doesn't know of any organic that are less than 40 arcres. Looks like lumped have included organic vegetable farms in that number.
- Assessment Questions.
  - Livestock

- Origin of livestock. Major source of confusion – will continue. National organic program is not going to change it anytime soon. Have stated it as it is in the rule. But difficult to explain. Some farmers want to go . Recommendation from last 3rd. some flexibility currently – those currently organic, don't have to raise organic . confusion to interpret – reference to website for NOP – where they have to go to get accurate information on it.

PEST MANAGEMENT

title is interesting as it isn't pesticide or integrated pest mgmt

- Description.
    - Add to second bullet that w/ pesticide use, Other farmer production risk is mitigated w/ use
- Benefits to Management
    - additional benefits to include? different focus from pest mgmt – align pest mgmt and pesticide.
- Assessment Questions
    - Add/move a question? Worker safety - thinking manual safety and not realize pesticides. Then wondered why wasn't within this mgmt.
    - Record Keeping. in barn yard itself – no idea what they are spraying….what spraying in barn
    - Specific Management Practices
        - Will they know/be familiar w/ these practices?
        - Which of the following practices do you use to control *flies;* Third bullet would be MAXIMIZE (not minimize) sanitation
- This module seems directed at pest management AFTER a decision has been made to scout and spray. I don't see "pesticide management." That is, I don't see assessment questions for avoiding pesticides altogether. I don't see an IPM continuum.
    - I might include ideas such as: crop rotation to break pest cycles, trap crops, insectaries, the use of phenology (e.g. growing degree days) to direct farm activities, manipulation of plantings and irrigation to reduce humidity and disease pressure, choosing disease resistant varieties, etc…
    - I might also include: spot spraying, block spraying, and border spraying as pesticide use options.
- And if this module covers plant and animal pests, then these need to be split out. Animal pests might be part of animal welfare and pest management.

SOIL MANAGEMENT

- Description.
    - Soil quality particularly around pasture. Mostly raising feed for cows. Good understanding of soil. Think most farmers have understanding at some level/ common sense not technical. Connection back to biodiversity – strengthen tie btwn 2 indicators. Really likes interaction chart – add

something to intro regarding it. Add section to 5 pagers addressing these interconnections. Add box and column pix for each one.
    - Address tillage vs. others in intro section and when ask questions that they must include crops AND pasture.
- Assessment Questions.
    - Use of Cover Crops.
        - Some farms use them a lot others may not at all. Cost concern re: cover crop. Point to economic benefit of using cost upfront of cover crop – organic matter and nitrogen. All the interactions. Also address in the resource section – that being a more complete discussion – reduction in soil loss, increase crops, decrease synthetic fertilizer.
    - Soil quality
        - I would be careful in defining soil quality, or appearing to do so with three indicators. It's certainly more than "nutrient levels, salinity and pH"… I'm not sure if you're giving those as examples or if that's the complete list. See "Building Soils for Better Crops" by Fred Magdoff and Harold van Es. is measured via soil tests every 5+ years but test results don't necessarily guide farm practices. Some effort is made to vegetate bare soil on the farm.
        - Some farmers will say they monitor soil quality by other means (e.g. earthworms, soil color, resistance to tillage, aggregate size, crop health). Are these acceptable? Preferable to lab testing? Bare soil is kept to a minimum via vegetative plantings.
        - It seems there are two things going on in this assessment question – soil quality and ground cover. They could be separate questions.

WATER MANAGEMENT

- Description.
    - 2nd to last bullet, Livestock use is primary use for , delete off irrigation.
    - Water quality on radar b/c of responsibility and lake champlain that they are blamed for. VT is viewed as having an abundance of water.
    - Not much irrigation in VT
- Assessment Questions.
    - Manure, Fertilizer and Silage Storage: Evaluate the following separately for each storage system.
        - Ask farmers if know how to complete.
        - Air pollutants – cover – but then other issues develop. Unless want to generate methane specifically. Dry manure shed? South is moving that direction – less storage space. Liquid is pulled off, solid is dried and then spread. Planted storage area w/ roof over top and liquid runs off. Is more enviro friendly.
    - Milkhouse Waste.
        - Concern #4, bad mgmt practice to feed waste milk to calves. B/c diseases are translitted that way – especially mastitis. More and more dairy specialists say shouldn't be fed to calves. Is controversial point. (and may ignore disease part within parenthesis). The other practices are fine. Okay to feed to other animals (pigs), etc.

- Water use plan.
  - Add to # 4, water –conserving "varieties and/or ground covers."
  - Ask about water availability within that area. – local supply. Watershed they belong to.

APPENDIX G: FARM VISITS (MODULE ROAD TESTS) NOTES FROM NOVEMBER 10-11, 2003

GENERAL TAKEAWAYS

- We met with an elite group of farmers:
  - Very involved in the community
  - Have been successful
  - Have expanded their farmlands
  - And have done most of the things in our ten modules
  - Have a lot of exposure to outside community

- This group of farmers represent anywhere from 10 to 50% of the total farmers in St. Albans Cooperative
  - Diane said 50%
  - Other farmers thought it was closer to 10% only

- 100% of the farmers get a lot of mail but ignore it.
  - government subsidies
  - energy saving program
  - environmental practices
  - social practices
  - cooperative newsletters

- 100% of the farmers we met source part (usually grain) of their feed off the farm.
  - Farmer #5 – 100% off the farm
  - Farmer #4 – sources GMO corn

- Cows-
  - No matter how many cows, the technology led farmers to milking 2 hours each morning and afternoon
  - Pregant Cows
    - Stop milking 60 days before their baby is due
    - Day of/after birth, back to milking

- Pest Management Sourcing
  - Farms used 1 of 2 experts to handle all this
    - Bourdeau brothers
    - ???
    - St. Albans has a payment plan set up with these two businesses so farmers are led to using one or the other

- Upfront Money
  - We heard more than once – that any new venture for a farm is costly. If companies provide upfront capital, then it reduces the risk and costs.

- Corn stubble always left over winter to retain soil

CONVERSATION WITH ANDREA (11/11/03):

- She wants the final paper printed on high recycled content (>30%) paper, double sided, with no plastic covers (we explained it would be bound like a book)
- She will come to our presentation (to all of SNRE) in Spring
- Priorities for modules (what they should accomplish):
  - Clear valuation of what farmer is doing,
  - How this compares to best practices and
  - Where they can get additional information to improve their practices
  - Make sure we are asking questions toward a specific goal – i.e. make it clear what we are trying to communicate/assess in each question (this is in reference to making sure the farmer understands what is a good, better, best answer, since we did not always use levels). She commented on this a couple of times so we should discuss
- When asked why doing this project, Andrea pointed to the fact that the core of their (B&J's) mission is to be involved with the community in which they operate – this project is a vehicle for that
- Key value add for this project may be bringing together into one source all of the different programs/agencies involved in these issues that the farmer could tap into: NRCS, Farm Service Agency, UVM, St. Alban's, State of VT

CONVERSATION WITH DIANE (11/10& 11/03):

- Diane will try to set up meeting for us to talk with Travis Forgues: organic dairy farmer
- Serves only as a marketer of the farmers milk – does not get involved with the management of the farm
- Disposal of manure generally not a problem although farmers may spread more manure on closer fields (easier, less time to get there), so they may have more than farther fields
- Co-op worked very hard with B&J and demands being placed on farmers to get BST-free milk; lost 10 farms over that
- With GMO's, B&J can't specify no-GMO's because it is hard for a farmer to be able to monitor that in feed; what is the alternative? Organic? This costs more – who would pay for that
- Public perceptions on anti-biotics more extreme than what happens on farms; there are regulations that no antibiotics can go into mil; if a farmer accidentally allows that and it spoils an entire truckload of milk, farmer has to pay for that
- Young cooperators group is training for leadership; this is their livelihood, YC's really understand how co-op runs and continue to learn more
- Farmers always leave cornstalk stubble over winter to hold soil and prevent wind and water erosion
- CAFO limit in VT is 675 milking head, may be dropping down to 200
  - Pressure on expansion: one farmer wanted to expand but neighbor's worried that manure pit would become too large
  - Neighbors have right to contest farm operations due to complaining about manure pit
  - CAFO could shut down farms on technicalities (neighbor's complaints); appeals process takes a long time and farms don't have resources to fight – could lose farm as a result

- Manure pit size is regulated

ST. ALBANS COOP.

- 570 members
  - 25-30% is active
  - 70% inactive; never come to the meetings no matter how important.
    - No proxy voting either. So this group's opinions are never represented.
    - Board members paid a per diem for there time and meet at least monthly
- Member of the Dairy Marketing Service (DMS) to help market their milk to bottlers (these most profitable use of milk)
  - DMS is partnership of S.A., Dairy Lea and DFA
  - Tom Magnant is on DMS board
- Became a member of the Dairy Farmers Association (DFA) last year. To market their fluid milk
  - S.A. needs to have 13-15 different places to sell milk; Dean Milk just bought out all of their buyers so now you need an 'in' to access those buyers – DFA gives S.A. that foot in the door
  - Ralph McNall is a board member
- There are 44 organic farms (a little less than 10%). Looked upon as "odd". "Why would someone go organic?" And those who aren't organic, speculate that those who are – are lying.
- That's why we want to talk to Travis Forgues:
  - His motivations for going organic?
  - How the process was for him?
  - Is he glad that he did it?
- Coop has meetings with all farmers but participation varies, even at annual business meeting where they hand out profit checks, not everyone (low percentage) shows up
- They send out a newsletter twice/month and starting to do e-mail – Diane has 60 e-mail addresses

GENERAL BACKGROUND

- Last year money that was designated for EQIP program was diverted to conservation (CRP) efforts in TX; now there is a line of people wanting to participate inNRCS projects and funding is not there
- If anything doesn't make sense economically, farmers will not do it
- VT has ban on spreading manure in the winter (12/15 – 4/1)

FARM VISITS:

Farm #1 (11/10/03)

- Farm.
  - 435 acres;
  - 100 cows approximately;
- Tractor scrapes manure from barn twice daily

  - Uses water from tank cleanings to wet manure to go through the gravity flow tubes
  - Waste water from cleaning milk equipment goes to manure pit
- COMMUNITY. Decided to become co-op board member because he thought it would be an interesting job
  - 18 years on the Coop board
  - last year joined the DFA board
  - Used to serve on the school board before that
  - Donated portion of farm land for community soccer field
  - Wife works as a Real Estate Appraiser
- BIODIVERSITY: Vermont is way more advanced than the rest of the state; don't spread manure anymore – although NY state still does. For economic reasons, he doesn't use cover crops but he would like to.
  - RE: GMO's, he has no need for them so doesn't see point in opening can of worms, recognizes that legislation is moving that way; it scares him because there are very few sensible ag. people in leg. and farmers will get dragged into it
- They think very highly of B&J but only want to see them as educators (ie. don't want any more regulations placed on them from B&J)
  - People/groups can get hung up on the little things like tail docking – this is small stuff
- According to him, farmers are way more educated that modules imply. Because of grants, extension services, public awareness, etc.
- Wanted to know: what is ben & jerry's going to do with this information? Farmers in this area do all of this already. And those who don't – will read it if it saves them money
- Farmers in general better educated now than in past 30-40 years; there is more availability of grants to try new things, help with money in case it doesn't work
- FINANCIAL: He has no formal financial plan, though knows what he is doing and works with lenders
  - Sometimes he goes against the advice given: he wanted to expand and UVM extension people said he couldn't; he did anyway and it worked fine
  - He has never been leveraged to the point that he would have to answer to a lender but a lot of people are (they have to work very closely with bank, checking in with banker 3-4 times/year b/c bank doesn't want them to fail)
  - People who don't have huge loans can manage their finances and pay the bills – likely will not pay attention to this
  - Common sense plays a large role in what they do
  - Never been totally out of debt and never will be, if he did try to go out of debt, it would be at the sacrafice of being able to try out new technology and maintainng his production levels and yields; also, you get tax credits for making investment in equipment
  - He works a lot with UVM extension on financial planning
- He serves on board of Dairy Farmers of America
- He believes in cover crops, has done it in past (winter rye), liked the results, and would like to do it again; he is not doing it, though, because the seeds cost too much ($1500)
- He does light coat of manure in spring and tills to 3-4", prefers several light coasts v. 1 heavy one; uses manure plus 250 pounds of corn starter, then top dress at 1.5 feet; drive

between rows and top dress per soil samples just before a rain or in a rain to soak it in (N and Potash – they are apt to be overloaded in P since it comes through cow manure)

- Doesn't sample manure to tes for nutrients; fails to see purpose of that b/e soil tests tell him what he needs
- Right now, it's a leap to go from research to implementation of practices for P
- Tillage done to max. production/acre
- Goals set expecting a lot os tonnage/roughage/acre; fertilize and plant courn with goal of 30-35 tons silage/ acre; could never do that with no till; they do everything they can to conserve topsoil, though
- High awareness of issues when crops are grown; 50-75% of farmers looking at these sorts of issues and there is money available for tillage and education (a lot more awareness than there used to be due to drive for change: states passed laws, economic considerations support it)

Farm#2

- Farm
  - 200 cows, no tie;
  - 800 acres: 200 corn, rest grass
  - Stony soil
  - maple tree operation
  - posts his farm for hunters
- ➢ ORGANIC: grew up with organic "pulling weeds by hand" – sees no point in going back to that; Stigma attached to organic that it is going backwards to the old way of doing things; farmers question sense in that
- He is well-aware of concept of not wasting/over-using fertilizer
- They try to cut every cost possible
- He uses pest management service and doesn't have to apply a lot of pesticides, mostly just use herbicides and fly control
- Uses crop rotation, though some places have continuous corn or continuous grass/hay; when doing rotation, do corn for a few years, then grass, then change, etc.
- Uses winter rye to prevent erosion
- Tried no till and strip till to save time in the spring and because it holds soil in better – knows soil erosion is a big issue in VT
- NO GMO corn, though 'corn bore resistant' GMO would be appealing if they had that problem
- NUTRIENTS: custom hire to do fertilizer applications; actually don't use very much commercial fertilizer
  - Some streams on property; do leave a grass strip along brook and doesn't spread manure to edge
  - Incorporate manure within a couple of days, unless soil is frozen
  - Putting manure on before a light rain actually cuts the smell and captures nitrogen
  - Manure applied to grasslands after each cut
  - Do soil sampling
  - Manure application, in spring put most corn on ground and what is left at the end of year spread (goal to clear manure pit)

- Little fertilizer on corn, little N on grass – usually use additional fertilizer; plan amount and then split application: spray after planting and then cpecifically on corn
- Yild goals 35K plants/acre, this year over 20 tons/acre (diff. from farmer #1 b/c of soil)
- Don't test manure
- Use PSNT yearly
- They realize manure has value and don't apply it before heavy rains
- N applied with herbicides as starter and on sidedress (vendor applied)
- Manure spreaders regulate app. rate by ground speed
- P in grain and a lot of haylage from farm – don't usually add P to cow diets

Farm #3

- Farm
  - 220 cows, no tie;
  - approximately 800 acres
  - 500 acres for grass
  - 200 acres for corm
  - grown corn and hay
  - cover cropping- winter rye
  - uses all the energy saving equipment
  - they sugar in winter
  - Farmer's wife works at Ag Ventures, which is like a VC firm for farmers
- Starting to monitor soil – will do it every 5 years
- Their father set up LLC partnership with sons, though son doesn't know details of it (sense that he doesn't really know financials well)
- ENERGY: he doesn't have numbers but could get them off the computer; they switched to energy efficient lighting, plate cooler (uses cool water to cool milk before it goes into tank), pump, etc. b/c of incentives from Central VT Public Service and cost savings
  - Any farm this size will have this kind of equipment
  - Elect. co. sends out info in mailers
  - 80-90% of farms don't do it, though, incentives are not as good as they used to be
  - General thought is that it takes $1M to get a digestor up and running; problems associated with transport of manure back and forth
- COMMUNITY HEALTH: with hired help, hard to get ppl. to work; they have someone who is part of family, been around 30+ years; more people are getting Mexicans b/c they are go-getters and want to work a lot; not very many people want to work on farm: get up at 4:30a and work until 6; pay OT when it is necessary – during planting or cropping; sometimes they'll work through the night – reward is getting the field planted so they don't have to spend money on feed
  - Their helper gets salary, house and utilities paid for – may give him a cow every once in a while
  - # of farms decreasing over time
  - He is volunteer in fire department – reason is to get off the farm; of 25 firemen, 20 are dairy farmers
  - Also 2 dairy farmers on school board; motivation is to have a say in what's going on
  - His family is fairly well-liked; some don't like them but it's not b/c of farming

  - Farm community is about mutual favors; e.g. trading use of backhoe for help with maple sugaring work
- SOIL/WATER/BIODIV:fields at certain levels have cover crops b/c they are required by NRCS (though NRCS doesn't pay for it)
  - So strict now that you have to ask permission to do anything
  - MILC payment: if you are not in good standing with farm agency, don't get MLC payment
  - If you don't do what you are supposed to do, you will get fined
  - Lots of woods around fields
  - Farm Service Agency gave a farm $100K to keep buffer strips along water
  - Historically didn't do soil testing unless fields didn't grow – now do it to ensure yields; performed by grain company
  - Couple of years did no-till to switch from grass to corn
  - They have buffer strip along the creek

Farm #4

- Farm
  - 180 cows, no tie;
    - 170 stalls; 180 cattle
  - Uses GMO corn in feed
  - Very particular about not affecting nearby water streams
- Biggest issue with modules is getting people to read it
- ORGANIC: Considers Organic "to each his own". Wont' do it – sort of negative stigma attached in community – doesn't see himself going organic, though he'd like the milk price
  - Franklin County, where he is, is pretty straight and narrow – going organic raises eyebrows
  - Module is straightforward and a good introduction, clear
  - He would be close to organic on health, care of cows, living conditions; land would be tricky b/c they spread a lot of manure, spray a lot of weeds and lots of purchased cows
  - Do have nutrient management plan
- ANIMAL WLFARE: cows have to go outside to get from barn to milking; like to be outside unless windy or rainy, cold doesn't bother them
  - Module not telling him anything he didn't know
  - Overall 'cows are more comfortable some days than we are' – hot days they have misters, farmers take care of the cows and the cows take care of the farmers; healthy cows perform better and need stability for amount and quality of milk
- WATER: they are not by bodies of water so not as much of an issue for them; other farms may have water
  - They have drainage tiles and drainage ditches
  - He has to work with Farm Service Agency; if they don't comply, federal aid would be in jeopardy; he wanted a 20 acre field and had to split it up because of one cattail
  - He has banks around manure storage pit that prevent runoff; clay lined for no seepage
  - No fertilizer storage

  - Silage is on cement; no catch basins for runoff but diversion ditches to keep water from the feed storage area
- He has plate cooler, var. speed pump and energy eff. lights – cost sharing is incentive to do this
- Enosburg, where he is, very community-oriented and lots of farmers
- Worked to get milk vending machines in schools

Farm#5

- Farm
  - 80 cows
  - was the case study for greg weber's study on nutrient management
  - his son helps run the farm: uses a PDA, which links into the computer to track the health and care of the cows
- SOCIAL: all PT help, one 16 year-old, others local help (no international), nephew also helps out
  - Most farmers that are not involved with the community are not because they don't have the time
  - He has time because he has his family to help him out; allowed him to be an auditor for the town, which he did part time between chores; spent 3 years on school board and then moved to chairman; son on school board and fire department
  - He puts help through training classes on milking practices and tractor safety
  - Farms definitely becoming fewer and larger
  - His father had 24 acres in 1935, now 310 acres (100 woods, 140 crop: 60 for corn and 80 for grass)
- NUTRIENTS: Paul Stanley does nutrient management and record keeping; he keeps computer records
  - Manure sampling doen once/year; started with government program that covered cost for 3 years and they kept doing it after that
  - He does PSNT tests; they don't buy a lot of commercial fertilizer; Paul does the soil tests every 3 years and makes recs. based on that; not too expensive but there can be a delay: did sample in July and just got the results back
  - Paul does PEST MANAGEMENT recommendations as well: weed scouting, licensed application
  - Participated in VDFSP and thought it was great; uses total mixed ration so cows can't root through it – ensures they get what they need; with nutrient management plan and VDFSP, noticed cost savings on fertilizers

Farm #6

- Farm
  - 30 cows
  - all jersey
- Community
  - Very involved in the community
- We are completely re-inventing the wheel, don't see what point of project is and want to know where we got idea that VT farmers want/need to be educated

- VDFSP was excellent project that gathered excellent data – that needs to be continued with funding to allow other farms to try out the recommendations
- Pest management, fertilizer and feed suppliers want to sell their products and are a TREMENDOUS FORCE in the community: have a lot of money, power and relationships – this goes back generations and will be extremely hard to break that hold and get farmers to try out new systems/ways of doing things
- What would motivate farmers to look at these modules? Both dire financial straights AND someone sitting down with them to walk through it
  - In past, recipients of U.S. loans were required to attend financial education classes
- Could put educational modules into curriculum of 2 x 2 programs (2 years training at technical school and 2 years studying ag at UVM, which results in a degree from UVM)
- They estimate that 50-90% of farmers would NOT view the info. in the modules as 'basic' and would actually learn something from it
- Farmer has more exposure to feed/fert./chemical suppliers than anyone else (such as govt., UVM, etc.)
- Bring in issue of educating the consumer (e.g. Stonyfield adopt-a-cow)

Farm #7

- Farm
  - Spreads manure
  - No system for milkhouse waste
- Hired labor
  - Doesn't hire illegal –wife works for the INS
  - Pays them a salary
  - Treats them really well – so they stay!
- Community
  - Leasing his farm and this is his dream. Did not inherit the farm from family.
  - Hopes to buy this farm or another one.
- WATER: All cement; not roofed but do try to control runoff – divert it to the manure pit
  - Barnyard has some cement and some ledge (thick rock); situated in a high areas so there is less mud and water
  - No liquids can run out of manure pit b/c it has ledge around it; his pit is such that manure is not 100% liquid but a mix; cement floor and clay lined dirt walls; it is above ground so no runoff; maintenance is building up walls to ensure no leakage/low spots in the spring;
  - He has to monitor water quality b/c stream feeds his uncle's property downstream; even if not, he would monitor anyway b/c he is outdoorsman and wants to preserve environment
  - Also has to keep water quality good from ponds on land which are used for cow drinking water; ponds are fenced off for when cows are pastured
  - Other water source is well: 1.5 gallons/minute; feeds house and milkhouse system
  - Silage storage is cement bottom, clay walls; water can not get in feed or it will spoil; built right next to manure pit so he has to make sure there is no leaching from either
  - Lots of cost sharing money is available to fence streams

  - Ponds are fed by beaver ponds; big and deep enough so don't need to worry about running out
  - Some people have plenty of water but it depends, if water source is springs instead of wells, could dry up in a drought year.
- In general first wash goes to manure pits (one farm was exception)

Farm #8 (11/11/03)

- 470 milking cows
- Electricity supplier is town of Enosburg
- Ventilation is natural, use of variable speed pump reduced energy from 18K to 15K kWh/month
  - but not change in bill due to increasing electricity prices
  - State program helped pay for pump
- He filled in chart in energy section and was surprised to find that 20% of his income went to energy
- Community section very important
  - Focus on this – farmers need to consider this
- Financials: he wants to work with a financial advisor to expand farm but it's not working out financially (something always comes up); people generally have expansion goals but they are not necessarily completely planned out
- He would be interested in seeing rest of modules
  - Follow up with sending him the rest (7)

Farm #9 (11/11/03)

- Increasing capacity from 120 to 210 milking cows (now milking 155)
  - Construction work on barn while cows are in there
- 250 acres total: 100 of corn, 150 of grass (25 of pasture)
- Only purchases concentrates – from feed merchant (grain from Midwest and Canada)
- General attitude:
  - All my practices are legal
  - And unless I HAVE to make a change, I won't.
- NUTRIENTS: The more you can include your own forage, the better (can be higher quality and cheaper); this module will be helpful if he is forced to pay attention to nutrients, other than that, he's not interested (expanding barn right now and has a lot on his plate); cost savings in the "$1,000's of dollars" range would be incentive for him
  - Farmers in general are pretty set in their ways
  - Fertilizer dealers don't push reductions
  - Some people, like Paul Stanley (independent crop and soil consultant) are pushing for more crop rotation, which is better for soils; also cover crops on corn, which he doesn't do, doesn't see necessity in it
  - Does do cover crops: oats, barley, peas to keep weeds away
  - Nutrient management handled by fertilizer company; manure and N on grass and corn; they have custom hirer for nutrient recommendations but they actually apply themselves (purchase amount from dealer and rent equipment), won't do it if heavy rain coming
  - Sometimes will apply more if plants don't look healthy

- He does broadcast and topdress, no PSNT
- Phosphorus is whatever's in mix itself; takes recs. of nutritionist and balances rations with grain; feed co. uses USDA minimum guidelines

OVERALL COMMENTS:

Animal Welfare

- Farmers seemed surprised that we had a section on this so detailed. According to our sample group – everyone has to be doing this. If they don't take care of the cows, the cows won't take care of them. Some of their quotes; "this is status quo" "the cows are more comfortable some days than we are."
- Land requirement: this is not always feasible for farmers if they don't have enough land; providing good facilities is just as important and just as effective at keeping cows healthy and producing quality milk
- RE: pathogens and mastitis: Variable speed pumps, in addition to energy savings, actually improves SCC pretty dramatically, one farmer was bumped into a different premium category because of variable speed pump
- Farmer commented on pastures being used too much as an example of what should be done; warned against this since it is not always the best solution (i.e. no agreement to that) and some farmers don't have the option of pasturing b/c they don't have enough land

Biodiversity

- No farmer would intentionally harm land; all will do what is economically feasible/best use of land; situation in VT is such that fields are small, can't have large hedgerows, plus landscape is such that it only allows for so much field (whether corn, hay/grass, or pasture), rest is left natural
- With use of GMO and rootworm problem, what is the trade-off? Who's to say GMO's aren't better than using chemicals to get rid of the pest?
- Mix of pasture/trees/hedgerows/swampy areas is such that can't have fields everywhere
- Because of the project with Greg Weber, one farmer was the only helpful input here on a per question basis.

Community Health

- One farmer brought up issue of how you treat help improves your ability to retain good help: farmer should do dirty work some of the time, bring them coffee, etc.
- Same farmer also pays salary so he is paying by the task, not by the hour; allows some flexibility if worker wants to take a break, has a visitor, etc.
- Insert section in here on management style

Economics

- Add question re: % of income from farm/off-farm (write out equation so it is clear) – ANDREA
- Add question RE: off-farm money that can be put away for future planning (long-term gain vs. paying off electricity bill) → % of savings or income to capital investments vs. bills

- Several farmers indicated that all farmers will be working with Yankee Farm Credit or other lender and will have this information based on that. When pushed, they admitted that farmers might not always know what the terms mean and, in that context, this was very clear and well-written and captured the major points
  - Every farmer will be proactive
- Farm #6 also had a pamphlet for a UVM cost-benefit educational program
- Suggestion to include estate planning question in module; i.e. if older farmers have plans for transferring ownership to younger farmers; problematic if not b/c, if father dies, even if son has been working on farm all of his life, there may be struggle over who gets the farm, also son may not know anything about financials if dad did this – could lead to problems when son takes over and doesn't know how to manage $$
- Good, basic and self-explanatory; good job of explaining the concepts, you get this sort of information with the reports from Yankee Farm Credit
- Guess that 80% of farmers/farm families have dual incomes

APPENDIX H: SECOND ADVISORY BOARD REVIEW

MARIE GUYE, YANKEE FARM CREDIT (DECEMBER 8, 2003)

Comments on Financial Health module:

Rate of return on farm assets question—for total farm assets, change income statement to balance sheet

Debt to equity ratio question—Yankee Farm uses the equity to asset ratio instead of the debt to equity ratio to look at net worth. May want to consider using equity to asset instead. Also, when Yankee Farm computes total farm liabilities, they generally do not include current farm liabilities. (The FFSC include current liabilities in total liabilities).

Rather than a cash flow statement, Yankee Farms provides an earnings statement. She suggested that we reference both an earnings statement or cash flow statement for all questions that currently refer just to cash flow statement.

For the term debt and capital lease coverage ratio—for formula #2 &3 (total misc. revenues and total misc. net income)—need to add phrase "if not already included in total revenues".

Liked the social section and wanted to share it with work-alcoholic farmers

Liked the attached sheet by David Kohl

ALLEN MATTHEWS, UVM CENTER FOR SUSTAINABLE AG, NOVEMBER 21 AND 25, 2003

Overall

- Delineate modules into 3 groups so as not to overwhelm users (some logical order, without emphasis on one or another); use table of contents or other introduction

Animal Welfare

- Change name of "animal welfare" – is it accusatory?
  Use this one to get direct farmer involvement—might be easiest for them to respond to. If it is first, it will create an opinion on the rest.
- Change questions from "inadequate" to "is it monitored?"

Biodiveristy

Crop diversity—change seed type to variety

Natural Area conservation—in northern Quebec, southern Quebec—don't necessarily have fence rows. Some farmers have been doing this for so long, they don't take credit for it, but many farmers don't do this.

Riparian—add in #1 & 2 that I have some areas of erosion.

Pasture management—update to increase emphasis on forage management.

GMOs—may want to describe

Bovine Growth Hormone is seen as a judgmental. rBST is a much more accepted term.

Book--Seeds of Deception—research that's been done on GMOs.

Community Health

Covers a lot about labor, but community health is only ½ page

Farmers are a part of a community. Farmers involve themselves in the farm so much and separate themselves from the community which leads to problems with the family and even neighbors

You would want to have a question around leisure time. There might be a question about how your community interacts with the farm (examples--my neighbors have been to dinner, we had inner-city kids come out to the farm, I often provide farm tours and on-farm demonstrations, it's important that when I spread manure that people have more of a feeling about me than that I spread manure). In the community where I grew up, it was hard not to find relatives living somewhere near—that's changed a lot.

For farmers' markets, there may not be an opportunity for dairy to go to those markets.

You asked if the number of farms in the area have changed—I don't know if any area will say that farms have increased. (This question has been taken out).

Energy

Didn't go through it.

Nutrient Management

Is it possible not to have a nutrient management plan?

Discussion under Question #2. When you're look at nutrient management record keeping—NRCS and local county conservation district staff (they will implement plans which come down from NRCS) will be just as involved more so or as much as the extension service so I would give them credit.

Commercial fertilizer application rate—what is sustainable about #4. How is this more sustainable than #3? #4—Need to say multiple soil tests per field (4, 6?)

SAMANTHA STURHAHN, DECEMBER 7, 2003

Money: do the farmers already know about all of the financing options available to them? If not, what about including a 'Resources' sheet that gives links to governmental, public, and private programs? It seemed like there might be some referenced in the footnotes of some of the modules (eg the Water Mgmt module).

Time: You mentioned that the Univ. of Vermont might take over this project? would there be a way to help meet some of farmers' time/labor needs through educational projects (ie, grad students ? farmer partnerships?)

Confidence: You mention in the St. Albans notes that most farmers haven't adopted nutrient management plans. What would convince them to? You list a great set of resources in the nutrient module ? were the farmers already familiar with them? Were they using them? If not, why not? I think this is the real nut to crack. Figuring out who or what is seen as a credible 'expert' in farmers' eyes and working through them to make the case for change. Is the one farmer who has adopted a nutrient mgmt plan willing to talk about his experiences? Maybe he could be given an incentive to help other farmers in the Coop?

My only other comments were:

Biodiversity section, pg. 7, Red point range Interpretation starts with 'Water management should be ?' Should this be 'Biodiversity management?' instead? Certainly there are water impacts if riparian zones aren't well managed, but there are other impacts of being in the red on biodiversity.

Red point ranges in general are much larger than yellow or green ranges. Did you get any push-back on this? I don't have a suggestion for how to set the ranges, just was curious ? you don't want the red zone to be so large it discourages farmers, but then again you said most in the Coop you visited were very advanced already so a finer scale is probably more useful. No suggestion, just something to think about.

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