Moo-tivations, Obstacles, and Opportunities:
Implementing Sustainable Agricultural Practices On Dairy Farms in New York State

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Abstract

New York State (NYS) is the third largest producer of dairy in the United States with over 4,000 dairy farms and more than 620,000 milking cows that yearly produce almost 15 billion gallons of fluid milk. While the dairy industry is an important part of NYS's economy, it is also a major contributor to the state's greenhouse gas emissions and continues to be affected by climate change. The purpose of this study was to examine what sustainable agricultural practices (SAPs) NYS dairy farmers are adopting, what their motivations are for adopting SAPs, what obstacles prevent farmers from adopting SAPs, and what opportunities are available. Semi structured interviews were conducted with 18 NYS dairy farmers and 13 regional agricultural stakeholders. An online survey was sent out via email and postcards with the questionnaire link. The most significant finding was that NYS dairy farmers are currently struggling due to low milk prices and as a result define SAPs as agricultural practices that first contribute to the economic sustainability of an operation instead of environmental sustainability. However, many respondents were still motivated to implement SAPs but the motivations and ability of farmers to implement SAPs ranged greatly depending on the circumstances of each individual operation. Farmer perception of available government support also varied depending on the type and size of the operation. If dairy farmers are expected to reduce the carbon footprint of their operations, there needs to be more financial and technical support from state and federal agencies to help implement more expensive SAPs that go beyond just helping farmers meet existing environmental regulations.

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Introduction

The primary purpose of this research is to better understand the motivations and obstacles that exist for New York State dairy farmers (hereafter farmers) in the Capital Region as well as northern and central New York State (NYS) to the implementation of sustainable agricultural practices (SAPs) on their farms.

The research questions guiding this study include:

1. How do farmers and stakeholders define SAPs?
2. What SAPs are being implemented by farmers?
3. What motivations do farmers have to implement SAPs?
4. What are the obstacle that farmers face to implementing SAPs?
5. What opportunities are available to help dairy farmers implement SAPs?

This research fills a gap in the understanding of dairy farm-based sustainable agricultural practices in NYS. In doing so, we offer a more nuanced understanding to farmers and consumers alike of the NYS dairy industry that is integral to the nationwide market. In addition to facing cycles of economic challenges, farmers will continue to be affected by the changing climate that is causing changes in precipitation patterns, temperature variations, and disruptions to ecosystems. This research will serve to fill a gap in the recent literature with a comprehensive analysis of sustainable agricultural practices in upstate New York that includes quantitative and qualitative data.

New York's Dairy Industry

With a historical foundation of dairy farms as old as the state itself, today New York has more than 4,000 dairy farms that handle about 620,000 milking cows. The 14.765 billion gallons of milk they produce in a year is valued at $2.5 billion (Trodden, et al., 2016). Liquid milk alone makes up 50% of the state's total agricultural sales (Fox et al., 2017) and dairy valued as five times more profitable than the next most profitable agricultural product in the state (USDA, 2012). While consistently ranking third or fourth in milk production nationally, the industry has changed considerably even in the last few decades. Between 2006 and 2012, NYS saw the loss of 18,000 dairy cows and 14,000 dairy farmers. Meanwhile, in those 6 years NYS dairy farmers have been able to increase their total annual milk production by almost 6,000 million more pounds (USDA, 2012). While there are fewer farmers milking cows, each cow is producing more milk. The causes of these changes may be the consolidation of small farms and proliferation of highly efficient, large, industrial style dairy farms that render small dairy farms obsolete in the face of regulation, development, and low milk prices (Gardner and Simmons, 2016). Conventional dairy in the state faces additional barriers to success such as unstable prices and an aging farm owner population (Overton, 2017).

Sustainability and the Dairy Industry

Sustainable development is defined as development that "that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Pronto, 2016, p. 26). The concept of the triple bottom line addresses three main areas that relate to the sustainability of organizations and businesses as they develop. The three main areas are society, environment, and economics. For the purpose of this study, we defined SAPs as practices

farmers can implement that both benefit the environment, and are economically feasible for farmers to implement. The societal effects of the implementation of SAPs, other than the benefits everyone experiences when land and water resources are well-managed, are beyond the scope of this research.

Climate Change and the Dairy Industry in New York

New York's dairy industry is a significant contributor to climate change. According to the Innovation Center for U.S. Dairy (2017), the average carbon footprint of the production of a gallon of milk in the United States is 10.6 pounds of carbon dioxide (CO2). This estimate takes into account the emissions produced during milk production by farms including emissions from energy use, growing practices, and purchased feed, but does not include emissions produced in the processing of milk. In order to calculate the carbon footprint of New York's dairy industry using this estimate, we converted the 14.765 billion pounds of milk in 2016 to gallons. The 1.7 billion gallons of milk produced in New York in 2016 accounted for approximately 8.3 million metric tons of CO2 emissions, which is equivalent to the annual CO2 emissions from 1.8 million passenger vehicles (US EPA, 2018).

Simultaneously, the effects of climate change are already visible in NYS through changes in temperature and precipitation patterns, which will affect dairy farmers. Since 1970, the average temperatures have increased 2° Fahrenheit in the Northeastern United States. In New York state, the number of summer days above 90° F has increased and the number of winter days below 32° F has decreased. Average temperatures are expected to continue increasing by 1.5 to 3°F during the next decade. Precipitation in the state has increased during winter months and decreased in summer and fall. Precipitation is also more likely to occur rapidly over a short

period of time and the amount of precipitation falling each year is expected to increase by five percent in the next decade (Rosenzweig et al., 2011).

NYS can also expect to experience more extreme weather events like hurricanes Irene and Sandy, which occurred in 2011 and 2012, respectively (DeGaetano et al., 2011). Hurricane Irene caused land and structural damages along the southeastern coast to upstate New York. After the initial damages caused by flooding, farmers were faced with a second wave of challenges: sediment contamination, fluxes in nutrient composition, and yeast growth. For a period after the storm, USDA advised producers in affected regions to avoid harvesting and feeding crops to livestock because of potential contamination from sewage, pathogens, heavy metals, and industrial chemicals. About half of producers with flooded crops reported health issues in their animals after feeding them post-flooded corn silage (Kung et al., 2015). Due to the number of major rivers in the capital region, crop farmers in upstate New York will also be at risk of flooding from storm surges. These surges, in addition to containing contaminants, will also increase the likelihood of saltwater intrusion, which negatively affects soil fertility and crop productivity (Rosenzweig et al., 2011).

Higher average temperatures will affect the rate of precipitation and evaporation, further affecting the water cycle and patterns of precipitation in the region. In the last 50 years, the number of downpours occurring in the state has increased. Downpours have the potential to cause significant damage to farms as they can cause flash flooding and erosion of soils. An increase in precipitation can also negatively affect farms by delaying planting of crops in the Spring and causing run off of inputs such as fertilizers or pesticides that farmers have applied to their crops. Additionally, when farmers operate heavy machinery on saturated soils, the soil structure is damaged. An increase in the moisture content of the soil that occurs during

downpours and floods also has the potential to cause more issues with leaf and root pathogens that cause further crop damage. Crops, such as corn and hay, grown for livestock, are considered low value crops that would be negatively affected by an increase in drought in NYS. Traditionally these crops have only been rain fed meaning that in a changing climate, farmers will either have to find extra capital to invest in an irrigation system, or grow other crops. While warmer temperatures will extend the growing season for feed crop farmers, these farmers will also face increased pest pressure from insects and invasive weeds that will also thrive in more favorable climatic conditions (Rosenzweig et al., 2011).

Rising temperatures due to climate change will have severe economic effects on the dairy industry. Heat stress in dairy cows can have serious repercussions in terms of milk productivity. When cows experience heat stress, they spend more time walking and standing than resting. Milk production from a cow decreases by two to three pounds for every hour a cow is not resting. When cows experience extreme heat stress, their reproductive systems can be damaged and their milk productivity can be permanently reduced. The current estimate in economic losses per cow in New York is $37 to $66 from rising temperatures and projected increases in heat stress. In order to reduce the risk of heat stress, dairy farmers will need to install cooling systems in their barns. These systems are expensive and may exacerbate the already challenging economic conditions dairy farmers face, leading to more loss of smaller dairy farms and further consolidation within the New York dairy industry (Rosenzweig et al., 2011).

The effects of climate change on the dairy industry will ultimately depend on the volume of GHG emissions released by anthropogenic activities today and in the future. Effects such as increases in average temperature and precipitation are expected to continue, general shifts in the

predictability of climate patterns will likely stress agricultural crops adapted to NYS's historical climate patterns (Rosenzweig et al., 2011).

Dairy Farm Policy Review

Many agricultural commodity policies were developed to lift the United States' economy out of the Great Depression during New Deal legislation in the 1930s (Deluca, 2017). Since then, policies have been updated periodically but the overarching doctrine persists: government must regulate commodities in order to benefit producers and consumers, and limit foreign imports. As such, current dairy policy is focused on 1) protectionist measures that create import barriers for foreign products, as well as subsidies to facilitate exports; 2) regulation of raw milk prices and; 3) direct government purchases of dairy products to stabilize those prices. Farm Bills are the primary means of federal policy for agriculture, and are revised every five years - the most recent one being the Agricultural Act of 2014. The following three programs are all federal policy mandates under the Farm Bill.

Milk Marketing Orders

After distributors in large cities became commonplace, milk producers were able to specialize in their field, but as a result, this created excess supply and prices plummeted. The first Agricultural Act of 1937 created federal milk marketing orders, which are market conditions that benefit dairy farmers and consumers. Milk marketing orders are characterized mainly by their revenue pooling and classified pricing system. Processors pay for milk according to the category of use (classes I-IV). That money is pooled and distributed equitably among producers, allowing for a fairer share of revenue. Milk marketing orders also assure farmers will be paid a

minimum price for their milk. These prices can be determined by geographic areas, and sometimes by other circumstances. Generally, milk marketing orders are price stabilizers meant to incentivize dairy farmers to keep up supply, thereby artificially driving down the price for consumers (USDA, 2017).

Federal Dairy Programs

Margin Protection Program (MPP) and Dairy Product Donation Program (DPDP)

As part of the 2014 Farm Bill, the Margin Protection Program for Dairy offers insurance to dairy farmers based on the average national dairy production margin. This margin is the difference between the US all-milk price and average feed cost; the insurance is adjusted annually to reflect the changes in the national average milk production. Therefore, if margins fall below a certain level, farmers are insured by the USDA, which sends an indemnity payment based on how wide the margin is and the level of coverage. Dairy producers pay premiums for insurance based on the selected coverage which ranges from 25% to 90%. The original version of the MPP included in the 2014 Farm Bill In addition to the MPP, farmers who fall below their margins for more than two months are eligible for the DPDP, meaning the government will purchase their products. The government purchasing continues until their margins rise above that level. Purchases are made at market prices, and are donated to groups in need (USDA, 2017). The MPP was last updated in March by the Bipartisan Budget Act of 2018 in response to its unpopularity among farmers. While the coverage amounts available to through the program did not change, the enrollment schedule, premium rates, and payment schedule were adjusted. Additionally, there is funding available to exempt certain farmers (beginning, veteran, limited resource) from the program's administrative fees (Burdine, 2018).

Environmental Quality Incentives Program (EQIP)

EQIP is a cost sharing program available through the Natural Resources Conservation Service (NRCS) of the US Department of Agriculture (USDA). EQIP was designed to provide technical and financial support to farmers for implementing soil and water conservation practices. The 1996 Farm Bill created EQIP and the program was most recently allocated funding by the 2014 Farm Bill, which designated 1.8 billion for fiscal year 2018 (National Sustainable Agriculture Coalition [NSAC], 2016b). To be eligible for EQIP, farmers and ranchers must develop a plan of operations describing their conservation objectives. If awarded funding, farmers incur the costs of the projects they want to implement and EQIP provides funding for a portion of the costs. EQIP agreements can last for one to ten years (USDA & NRCS, 2009).

Conservation Stewardship Program (CSP)

CSP is payment program available through the NRCS and USDA. The goal of the program is to "Help agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resources concerns" (USDA, 2014, p. 1). The CSP was established by the 2008 Farm Bill and was renewed in the 2014 Farm Bill with about $7 billion in funding through 2019 (NSAC, 2016a). CSP is available for private and tribal agricultural land as well as non-industrial private forest land. If awarded funding through CSP, landowners or stewards will receive annual payments for their conservation practices for five years in accordance with their conservation stewardship plan that outlines resource concerns. This program incentivizes continual improvement and maintenance

of conservation practices as payments can change based on evaluation of farmers' practices (USDA & NRCS, 2009).

NYS Dairy Programs

Dairy Acceleration Program

This initiative, introduced by Governor Cuomo, the NYS Department of Agriculture & Markets, and the NYS Department of Environmental Conservation aims to help dairy farmers remain profitable while practicing "environmentally responsible" dairy farming (Cornell College of Agriculture and Life Sciences, 2017). The program allocates funding to improve dairy business operations. Special attention is paid to farms that seek to develop or update their Comprehensive Nutrient Management Plans, use best management practices, undergo inspection, implement soil health tests and other environmental engineering projects. Small farms with less than 300 cows are prioritized (Potter, 2017).

Climate Resilient Farming Grant Program (CRF)

The Climate Resilient Farming Grant Program allocates $2.5 million to help dairy farmers reduce methane emissions through infrastructure such as manure storage facility covers or flares that burn off methane (NYS Climate Resilient Farming [CRF], 2017). In NYS, GHG emissions from agriculture (apart from agriculturally-related energy use) are estimated to be around 5.3 to 5.4 metric tons annually, where manure accounts for 15% and emissions from soils comprise just under ⅓ of the total. The Agricultural Environmental Management (AEM) Framework is used to assess potential environmental risks, and plan accordingly. While the Agricultural Non-Point Source program exists to provide funding for water quality concerns, the

CRF grant program is used as a preventive measure to actively mitigate emissions that contribute to climate change (NYS CRF, 2017). Individual farmers cannot apply for funds directly from the CRF grant program. In NYS, the Soil Conservation and Water Committee that oversees the state's 58 Soil and Water Conservation Districts (there is a district for almost every county in the state). These districts can provide technical support in natural resource management to farmers as well as general land owners and can apply for the funds through the CRF grant program on behalf of the farmers (NYS Soil & Water Conservation Committee, 2018).

Literature Review

Greenhouse Gas (GHG) Emissions and Dairy Farms

The dairy sector accounts for 4% of global anthropogenic greenhouse gas emissions (FAO, 2010). According to Thoma et al. (2013), 72% to 75% of GHG emissions released throughout to entire process of producing and processing milk from dairy cows come from dairy farms. After conducting a life cycle analysis of milk production from "cradle to farm gate" in 2008, Thoma et al. (2013) concluded that the three main sources of GHGs on dairy farms are feed, enteric methane (methane produced by cows during digestion), and manure management. This suggests that these are the three main areas dairy farmers can adjust their practices to reduce GHG emissions from their operations.

Manure Disposal

Enahoro et al. (2016), addresses the faults in NYS's Pollution Discharge Elimination System (SPDES) permits program. The study found that the current practice of manure spreading is already entrenched in the economics of dairy business, but is harmful to the environment. By taking into account farm income, land use, manure and fertilizer management, and environmental quality, the researchers concluded that while farmers are dependent on selling their manure, there must be another way to deal with the large quantities of nutrients or actually reducing the nutrients. A host of scholars, including Kebreab et al. (2013) stress the importance of feeding cattle less grain-based foods (i.e. corn) because grain increases methane production during cow digestion. Feed-to-milk conversion efficiency (specifically production and use of fertilizer for crops) is the main factor affecting GHG emissions per kilogram of milk. Grass

makes a more significant contribution to GHG emission than other foraging crops, nearly as much as corn. Larger farms require more manure management and emit greater amounts of GHG; however, feed conversion rates are more efficient than small farms (Thoma et al. 2013).

Other studies delve into anaerobic digesters as a solution. Styles et al. (2015) conducted a study that analyzed the use of anaerobic digesters on dairy farms that only used slurry containing cow manure in their digesters versus farms that mixed slurry with plant material. The study found that when only slurry is used in an anaerobic digester, the farm reduces its "global warming potential," but eutrophication and acidification occur. On farms that co-digest slurry and crop material such as maize, the digesters were more effective but GHG emissions may also increase if the farm is using its own crops in the digester and begins importing feed from elsewhere. Styles et al. concludes that anaerobic digestion is a good GHG mitigation technology that dairy farms can utilize if they follow are careful about what they put in a digester (Styles et al., 2015).

Feed Transportation

Dairy operations often import feed crops from other farms due to the trend in intensification of the industry that minimizes available space where more animals are raised on less land. In one estimate, importing feed crops produced through conventional tillage agriculture practices, including pesticide, herbicide, and fertilizer application, accounted for 42% of the importing farm's energy use (Malcolm, Camargo, Isher, Richard and Karsten, 2015). In an energy and GHG analysis of three different dairy farm cropping systems in Pennsylvania, Malcolm et al. (2015) concluded that dairy operations producing feed crops can reduce their carbon footprint by 15 to 18% because they do not rely on fossil fuels to transport their feed. The

three cropping systems analyzed in this study included a dairy farm growing its own forage and importing grain, a farm growing forage and grain, and a farm growing forage, grain, and fuel for the farm. All three farms were considered to be no-till systems. The farm growing forage, grain and fuel, referred to as an NSVO system, is a trial operation at Pennsylvania State University. The NSVO system consists of a rotation of forage and grain crops every six years in addition to the cultivation of canola grain. The canola grain is used to produce vegetable oil fuel while the byproduct from the plants after fuel production is used as an additional feed source. The NSVO operation required more land than the other two operations but also employed a variety of other conservation practices, in addition to no-till, including cover cropping, green manure, manure injection and integrated pest management. The combination of these conservation practices further reduced the carbon footprint of the NSVO operation in comparison to the other two cropping systems because less inputs were importing, reducing transport and production GHG costs (Malcolm et al., 2015).

Tilling Alternatives

In looking at the major emissions from dairy farms, reducing emissions from feed and cows can be difficult. First, farmers often have limited options for producing or purchasing feed. Second, some enteric methane emissions from cows are unavoidable, if cows are consuming feed and digesting it, they will produce methane. Third, adjusting manure disposal techniques may not be feasible for many farmers due to land or economic constraints. However, implementing SAPs that promote carbon sequestration may be more affordable for farmers and at least offset some of the GHG emissions from NYS's dairy industry. One option involves switching from traditional

tilling practices to conservation or no-till agriculture which both reduces the release of carbon from soils and allows for dairy farms to sequester more carbon.

No-till agriculture refers to the cultivation of crops without systematic and frequent disruption of fields through tilling. No-till farming is considered to be a conservation farming practice because tilling negatively affects soil structure and fertility. Tilling causes break down of soil structure which affects soil's ability to absorb and hold nutrients including organic matter in the form of carbon. Carbon exposed to the air during tilling oxidizes and enters the atmosphere as CO_2. Carbon is also a crucial component in maintaining soil structure that allows for the movement of air, water, nutrients, and organisms through the soil. Soils without sufficient carbon supported structures become compacted, increasing the need for tilling before crops are planted. Freshly tilled soils are more likely to erode or be washed away during extreme weather events (Argaman and Stavi, 2014).

In addition to not releasing carbon, no-till agriculture can also promote the increase of carbon absorption of soils, which is called carbon sequestration. Soil sequestration occurs naturally in the form of photosynthesis—a kind of carbon fixation where atmospheric CO2 is broken down—and is a fundamental part of the global carbon cycle. Once fixed, carbon associates with soil minerals or is held by soil microbes after it is made available by the natural release of carbon by plants or by the decomposition of carbon-rich plants, animals, and microbes (FAO, 2017).

Despite the benefits in soil fertility and structure that result from no-till agriculture, there are other obstacles that must be overcome for no-till systems to be successful. Tilling is often used as a form of weed management on both conventional and organic crop farms. Weed management can be particularly challenging in no-till systems, especially without the use of

herbicides. In some cases, the carbon sequestered in a no-till system is negligible when considering the carbon footprint of the farm in terms of chemical inputs used to address weed pressure. Crop rotation and cover cropping are two forms of management farmers can adopt in addition to no-till agriculture to help combat weed growth. Success of no-till agriculture within agroecosystems is highly dependent on the location of the agroecosystem and climate. The feasibility of adapting no-till agriculture must be evaluated on a regional basis taking into account the crop varieties farmers want to produce (Argaman and Stavi, 2014).

Dell, Salon, Franks, Benham, and Plowden (2008) conducted a study analyzing the success of growing dairy feed crops in no-till systems. Soil from seven fields was sampled for carbon and nitrogen content after corn was harvested in the Fall. The sampled fields were located on dairy farms in central Pennsylvania. Four of the seven fields sampled were part of no-till systems. The no-till fields had been converted from conventional farming at different times, the fields tested were part of no-till operations for eight to thirteen years. Dell et al. (2008) found that the no-till fields contained 50% more carbon and nitrogen in the top five centimeters of soil in comparison to the conventional tillage fields. Below five centimeters, the soil from the no-till and conventionally tilled fields had similar nutrient contents and structure. This study demonstrated that a higher rate of carbon sequestration is possible if no-till systems are adopted when growing dairy feed. In addition to carbon sequestration, the authors noted other benefits of no-till agriculture including soil-aggregate stability (Dell et al., 2008).

Organic Certification

After 2002, farmers in the US could become certified organic by way of the 1990 Organic Food Production Act. Farms with annual profit greater than $5,000 can reach out to a

state certification organization accredited by the USDA to begin the transition process (NYSDA, 2017). There are 12 certification organizations in NYS. The standard three year process for farmland to become certified organic involves implementing organic farming methods that reduce inputs and include, but are not limited to: soil quality, weed and pest management, crop rotation and cover cropping, composting and disease control (NOFA, 2017). Many of these practices required for organic certification reduce carbon emission, promote carbon sequestration, and reduce dependence on chemical inputs like fertilizers and pesticides produced and transported by burning fossil fuels, contributing to GHG emissions. Once completed, farmers in NYS may apply to be reimbursed by the state for up to 75%, but no more than $750 of certification fees (NYSDA, 2017).

For dairy farms, once land is certified, there is an additional one year transition period for a herd (unless farmers opt to purchase an already certified organic herd). For land and for livestock such as dairy cows, farmers must submit an Organic System Plan outlining what practices they anticipate implementing. These include: feed, health care, and living conditions (Rinehart, 2016). This means farmers must use exclusively organic feeds and bedding, meet pasture grazing requirements, and use only organic mineral and vitamin supplements. Growth hormones, reproductive aids, udder treatments, and any other synthetic products are not permitted in certified organic operations (NYSDA, 2017).

Heating and Cooling

With rising global temperatures from the greenhouse effect, heating and cooling are pertinent issues to farmers. Not only does milk need to be refrigerated, but dairy cows themselves must be cooled to promote high milk production. Suadsong et al. (2008) finds that

barns equipped with evaporative cooling systems had greater milk production than uncooled cows. Ferreira et al. (2016) compared the economic losses from not cooling cows to the cost of cooling them. They calculated the number of heat stress days for each state in the US, where humidity was greater than 68%. The combined annual losses of neglecting to cool cows in the three largest dairy-producing states (California, Wisconsin, and New York) was $810 million. In NYS, the losses are equivalent to $75 per cow. Overall, these studies provide strong evidence to support that cows should be adequately cared for especially considering the extreme weather patterns from climate change. Likewise, they show that addressing the core issue of agriculture-caused emissions - feeding cows an unnatural diet - is of utmost importance.

Methods

Population and Setting

Our research focuses on dairy in the Capital Region as well as central and northern New York. We define the Capital Region as the eastern part of mid-NYS, which spans 5,199 square miles and encompasses eight counties including Albany, Rensselaer, Schenectady, and Saratoga counties. As of 2009, the total population was about 1 million residents and the average per capita income was $28,644 (Empire State Development, 2016). Farmers and policymakers both working in the Capital Region and surrounding counties are the primary stakeholders in this study. The number of farms and cows varies in each county represented in our study (Table 1).

Table 1: Counties Involved in Our Study, Dairy Farming and Milk Production (Trodden et al., 2016)

County	**Number of Dairy Farms**	**Number of Dairy Cows**	**Total Milk Marketed (Thousand lbs)**
Rensselaer	43	4,100	22,920
Saratoga	23	8,500	16,596
Fulton	12	1,600	1,600
Montgomery	219	13,800	33,969
Washington	115	22,500	30,359
Columbia	13	5,600	6,490
Ulster	4	400	407
Delaware	98	8,700	12,135
Schoharie	53	5,400	9,529
Essex	12	1,600	1,276
Clinton	93	18,100	35,918
St. Lawrence	316	34,500	69,408
Jefferson	168	28,500	60,421
Cayuga	92	35,000	93,678
Cortland	96	10,500	24,695
Chenango	158	12,300	19,310
Madison	168	20,500	33,864
Oneida	210	16,400	43,178

Survey Instrumentation, Data Collection, and Analysis

A survey was created using Qualtrics. which was distributed via email by the Cornell Cooperative Extension (CCE) of Washington and Ulster Counties. CCE of Washington County sent out a postcard containing our survey link to 149 farmers. The survey was designed to observe commonalities among dairy farmers in terms of the SAPs they use, their motivations for using those SAPs, as well as their opinions funding available to implement SAPs. We listed 15 SAPs on our survey: soil health tests, nutrient management plan, crop rotation, conserving forested land, variable speed vacuum pump, reduced till (or no-till), grass filter strips, cover cropping, integrated pest management, plate coolers, diversified livestock, solar panels or solar thermal, organic practices, rainwater capture, and anaerobic digesters (See Appendix I for definitions). These practices were chosen with the help of a stakeholder from Cornell Cooperative Extension. While the majority of these practices help to mitigate climate change by reducing on farm GHG emissions or promoting carbon sequestration, we also decided to include several general conservation practices such as rainwater capture and grass filter strips. In addition to selecting the SAPs they implement, survey respondents were asked to select their primary motivation for implementing each SAP. We included the following 8 motivations: profitability, to protect watersheds, marketing and labeling edge, to protect farm workers, to protect land/ecosystems, to protect consumer health, to maintain animal health, and to mitigate climate change. The survey included questions about farmers' ages, farm size, and whether or not they owned their farmland to indicate whether or not a relationship between the above variables and a farmer's likelihood of practicing sustainable dairy farming methods exists. Qualtrics was used to analyze and visualize the data collected through the survey. The full survey is included in Appendix IV.

Interview Instrumentation, Data Collection, and Analysis

Semi-structured interviews were also conducted to gather data (Creswell, 2007). The sample population consisted of farmers and agricultural stakeholders. We used non-probability convenience sampling methods, contacting the majority of the farmers we interviewed online when available, either through email or Farm Facebook pages. We contacted the majority of the stakeholders we interviewed through email. We also attended four conferences: the Northeast Farming Association's (NOFA) Annual Winter Conference, NOFA's Organic Dairy and Field Crop Conference, the 3rd Annual Cornell Dairy Center Of Excellence Symposium: Sustainable Dairy Systems: Food, Energy, Water, and the Northeast Dairy Producers Conference. At these events, we distributed our survey link as well as conducted in-person semi-structured interviews with farmers and stakeholders. Finally, we conducted four in person interviews with farmers during visits to their farms.

During phone interviews, all three researchers were present when possible and the phone was in speaker mode so that everyone could participate and follow the conversation. Interviews were guided by a set of pre-established questions (see Appendix II and III). Both in-person and phone interviews were recorded using QuickTime Player on a laptop or iPhone. Interview data was analyzed by coding key words and grouping similar terms into categories. The frequency of responses was analyzed through Type 1 Tabulations (Silverman, 2006). Descriptive narratives of farmers were useful for assessing individual perspectives on the dairy industry, and we analyzed these narratives thematically when farmers spoke about implementing SAPs (Creswell, 2007). The results of our analysis can be found in a quote chart on Appendix V.

Limitations

Limitations of our study included time and money constraints. We realistically were not able to contact or visit the majority of dairy farms in our study region. Many farms were inaccessible due to distance, time, and resource constraints. Another limitation is our sample size because the farmers we surveyed and interviewed do not represent all dairy farmers throughout our study region or New York. Therefore, we make sure to characterize our findings specifically to our participants, and we are careful not to generalize our findings to the greater public. Additionally, not all of our survey respondents answered every question on our survey. As a result, although we had 57 total respondents, only 31 respondents fully answered all of our questions.

Results and Discussion

Background

Farmer Demographics

Our survey consisted of 57 respondents from 12 different counties across New York State. We also conducted 18 semi-structured interviews with dairy farmers who work in 10 different counties (Figure 1).

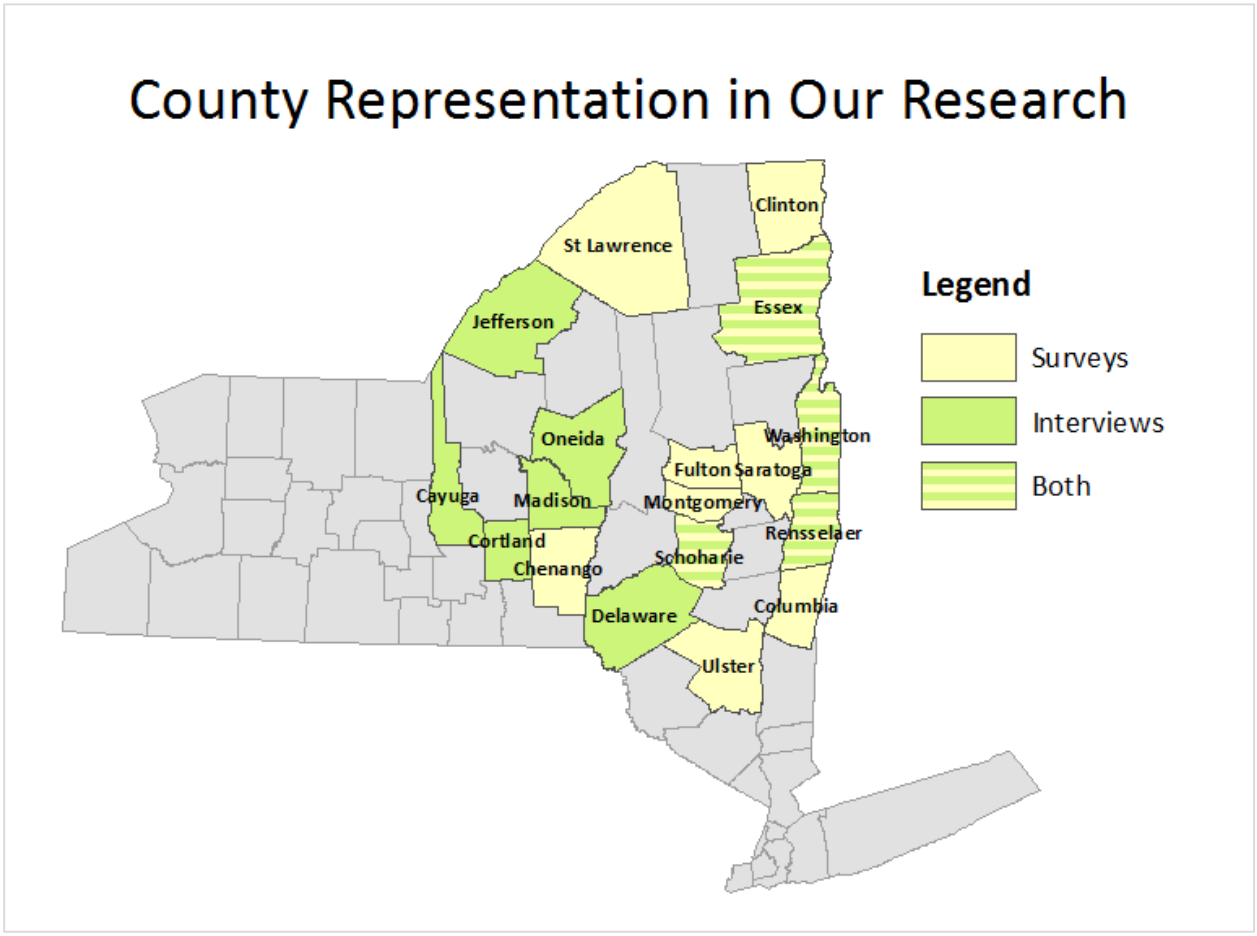


Figure 1: Research scale consists of Capital region, Northern, and Central New York counties

Our survey data represents a moderately even distribution of ages, where 59% of respondents were 40 and older (Figure #). This reflects the national skew, where 72% of dairy farmers are 45

and older (USDA, 2012). Sixty-four percent of respondents had worked on the dairy farm for more than 15 years, and 50% for more than 20 years (Figure #). Between our interviews and surveys, we found no correlation between farmer's age and their likelihood to implement SAPs. Likewise, we did not find any influence of age on what motivations or obstacles to implementing SAPs that they may or may not have experienced.

The average herd size of the farmers we surveyed milked or otherwise owned (such as dry cows) 401 cows. About a quarter of the respondents worked on dairies with less than 250 cows, milking and dry. Five respondents reported farms with 1000 cows or more. The New York State Department of Environmental Conservation defines a "Concentrated Animal Feed Operation" (CAFOs) as having 299 or more cows. A CAFO also confines animals from pasture for at least 45 days within any 12 month period (DEC, 2018). By these requirements, 29% of our respondents are considered CAFOs.

For interviews, the average number of cows was 670 and the average size of land owned, rented to or by farmers was 1061 acres. Forty seven percent of the farms we interviewed were family farms with no additional hired labor. Figure #indicates the number of milking cows owned and acres farmed by the 18 farmers we interviewed.

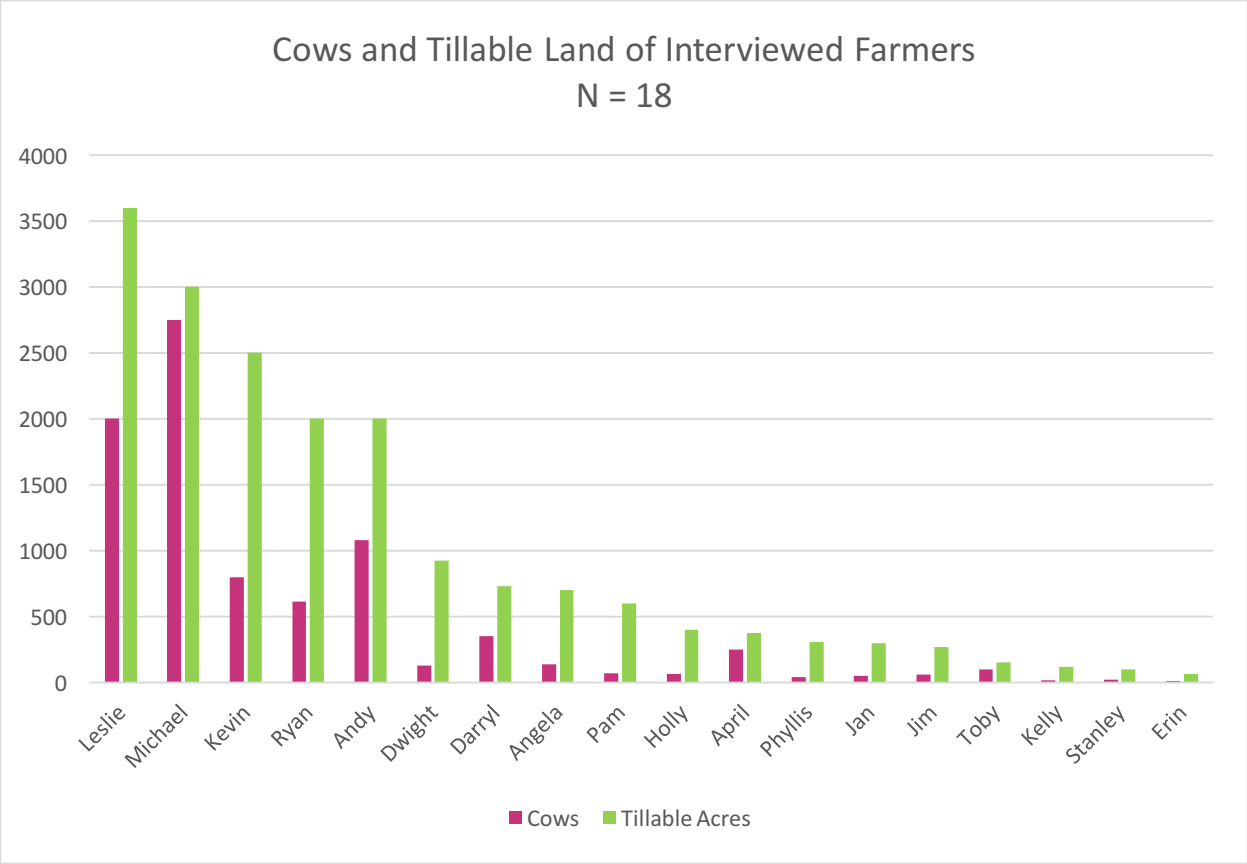


Figure 2: Cows and Tillable Land Owned by Interviews Farmers

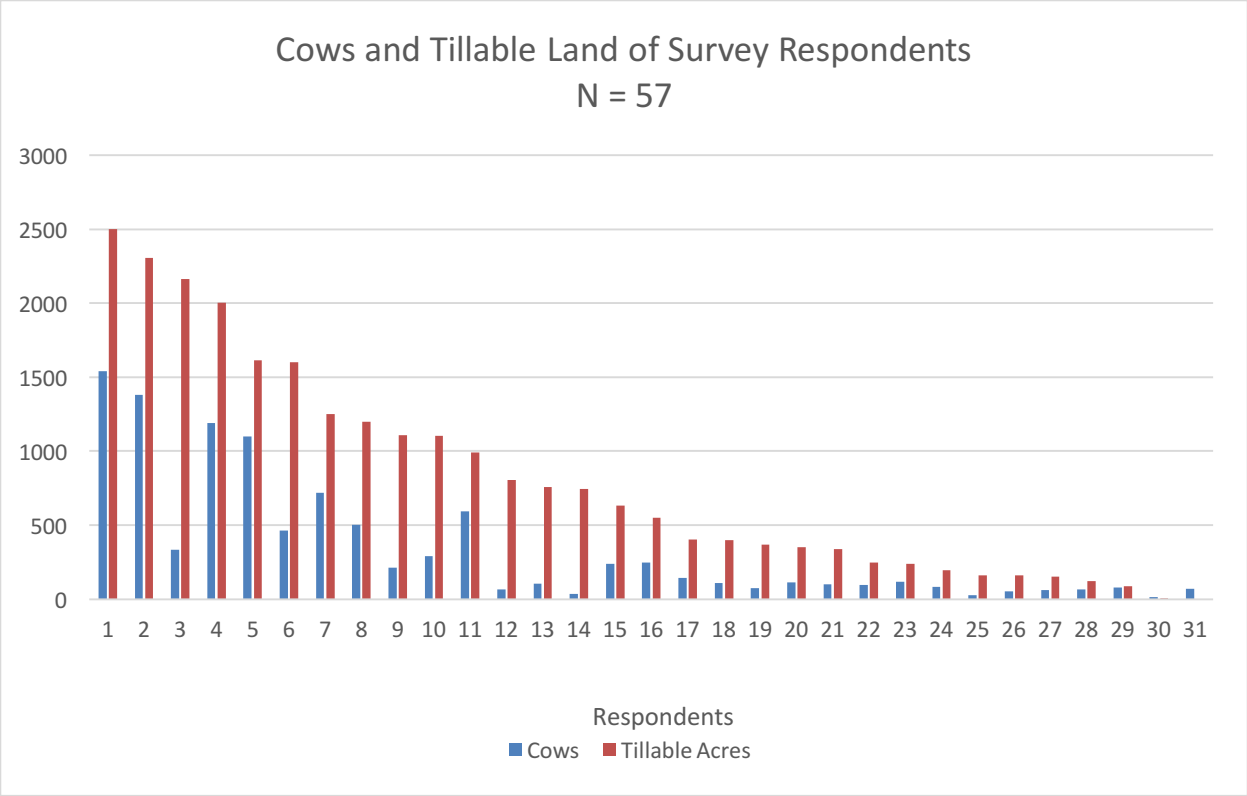


Figure 3: Cows and Tillable Land Owned by Survey Respondents

Impacts of Dairy Herd Size

Herd size can potentially be a driver or result of other factors. For example, income and herd size are related. Farmers who did not rely on dairy as their sole source of income tended to own fewer cows (Figure #). In fact, all the farmers we interviewed whose income did not solely come from dairy owned less than 250 cows. Farms that were responsible for most of a farmer's income were much bigger, with a median around 250 and an upper limit of about 500 cows. We recorded at least 4 outliers that had multiple thousands of cows.

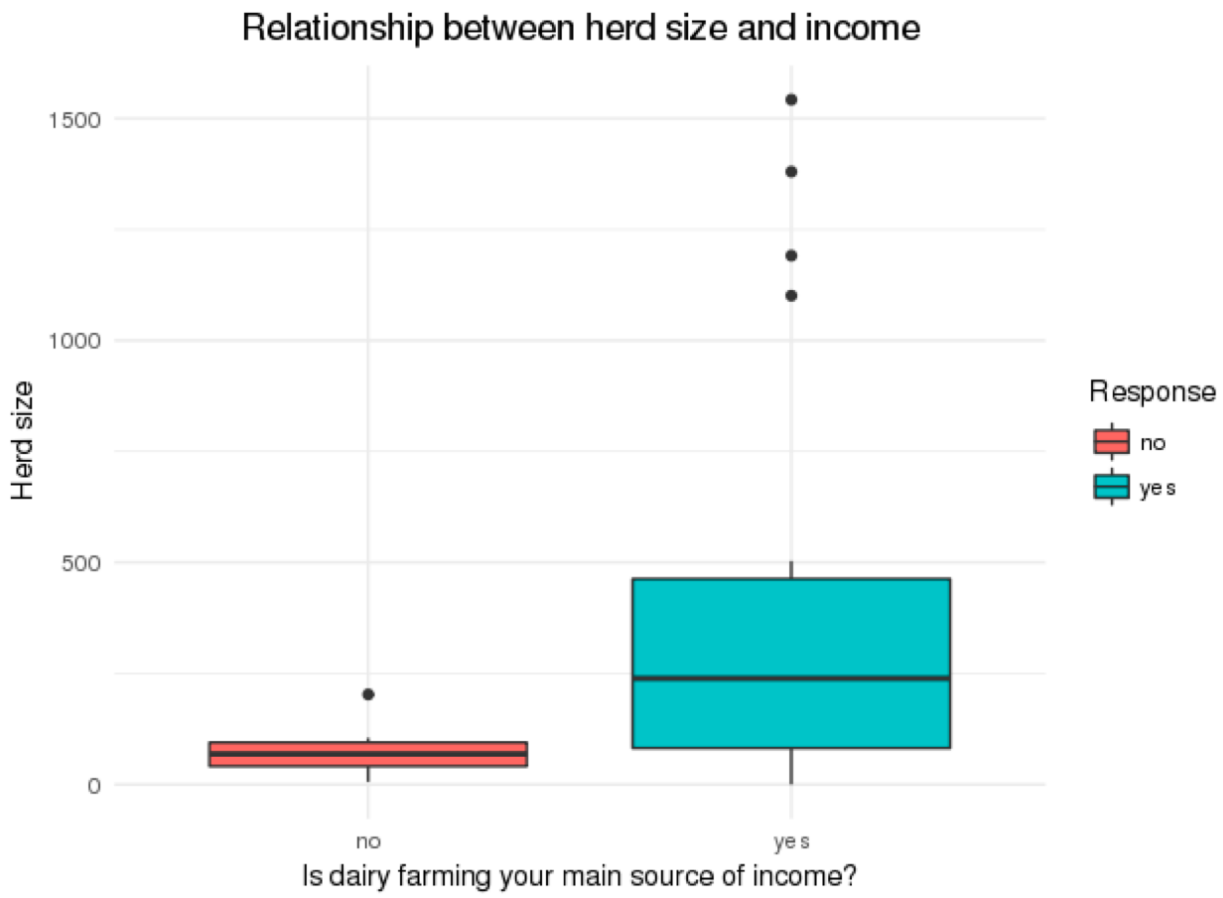


Figure 4: Boxplot illustrating the relationship between herd size and income

We spoke to several farmers who explained that as family size increases, more cows are needed to supplement the income. As Andy notes:

> When [our parents] were growing up, they were milking 65 cows or so, and each son decided to come back to the farm instead of starting their own farm or getting out of agriculture altogether. As each son came home, the farm kept getting bigger because we're not going to be able to afford mom and dad, and three other families on a hundred cow dairy.

As with age, we found no direct correlation between farmer interviewee's or survey respondent's herd size and their likelihood to implement SAPs. We did not find any influence of herd size on what motivations or obstacles to implementing SAPs that they may or may not have experienced.

Stakeholder Demographics

Table 2: indicates the stakeholders and dairy industry experts we interviewed and their employers.

Stakeholder	**Position[1] and Organization**
Peter Wright	Cornell PRO-DAIRY Program
Patrick	Cornell PRO-DAIRY Environmental Systems Program
Andy Novakovic	Professor of Agricultural Economics and Director of Land Grant Programs, Dyson School Cornell University
Sandy	Dairy Specialist, Harvest New York, Cornell Cooperative Extension
Bob Parsons	Professor and Extension Economist, Department of Community Development and Applied Economics, University of Vermont
Daphne	New York Regional Dairy Specialist, Cornell Cooperative Extension
Kyla Bedard	Education Coordinator, NOFA VT
Kim Bremmer	Founder, Ag Inspirations
Fred	New York State Soil & Water Conservation Committee
Dan McCarthy	Program Manager, Dairy Services, New York State Department of Agriculture and Markets
A. Faye Benson	South Central New York Regional Dairy & Field Crops Team, Small Dairy Support, Cortland County Cornell Cooperative Extension
Ashley Madea	Inspection Program Coordinator, Pennsylvania Certified Organic
Kristy Perano	PhD Candidate Cornell University Dept. of Bio and Environmental. Engineering

[1] For stakeholders who wished to remain anonymous, positions were not included

Definitions of Sustainability

We generally found that farmers and stakeholders viewed sustainability in terms of short and long term economic viability (heavily weighting the economic pillar within the three realms of sustainability: economic, social, environmental). Ultimately, a dairy farmer considered their operation sustainable if it is in business and making a profit and they feel a sense of security for the future. The "economic sustainability" of any given farm is of principle importance to farm owners, whereas an interest in "environmental sustainability"--defined as the long-term security of natural resources--is secondary to farmers. As UVM Extension Agent Bob Parsons put it, "if you're not economically viable, you're not sustainable" (Personal Communication, 2018). Within the realm of economic sustainability, Kim Bremmer and Parsons also described sustainability as a mindset of being willing to adopt new technologies allowing for better farm management that allows for more efficient use of resources. Additionally, using environmentally sustainable practices was mainly framed in terms of land stewardship or adaptive measures. Dairy farmers were hesitant to use the buzzword "sustainability" and no farmers mentioned climate change without having been prompted during semi-structured interviews. One farmer, Ryan, said "We try to be as good stewards as possible" (personal communication, 2018). The term 'stewardship' was mentioned otherwise by several farmers as demonstrated by Ryan. This indicates that although our respondents did not often identify the practices they implemented as sustainable agricultural practices, each farmer was implementing the practices they could afford to support the health of their land and animals.

Sustainable Agricultural Practices

On the survey, farmers listed their motivations for using a variety of different sustainable agricultural practices: soil health tests, nutrient management plans, crop rotation, reduced till or no-till, conserving forested land, applications of chemical fertilizers/pesticides, variable speed vacuum pumps, integrated pest management, grass filter strips, plate coolers, cover cropping, diversified livestock, solar panels or solar thermal, organic practices (with or without certification), and anaerobic digesters. 100% [AS4] of respondents who shared which of the above practices they use (about 53% of total survey respondents, 30/57) implement soil health tests (Figure 5). The least implemented practice was the anaerobic digester, of which only 3% (1 out of 30) of said respondents implemented.

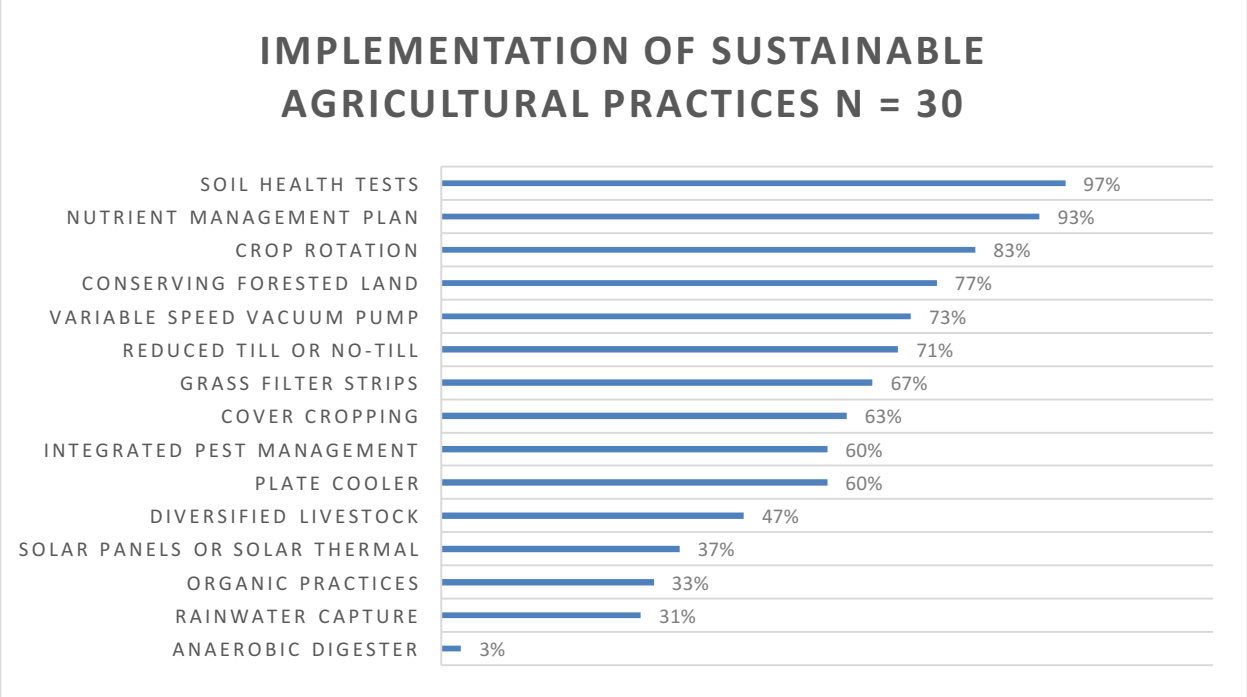


Figure 5: Sustainable Agricultural Practices Mentioned in Our Survey

Practices and motivations mentioned from the survey were reiterated in semi-structured interviews. Generally, farmers were concerned about their land and their soil in order to grow

forage for their herd. Erosion and runoff are concerns because the topsoil cannot be replaced once it's gone. As Fred, a member of the New York State Soil and Water Conservation committee notes, "The farmer's most valuable resource is their topsoil, so if we can protect that topsoil and prevent it from eroding away we should. Even though it is a very expensive [to prevent topsoil erosion], farmers really do internalize it" (Personal Communication, 2018). Cover crops, crop rotation, and conservation tillage were implemented to maintain healthy soils and good yields. One farmer named Kevin said "We use good crop rotation and strip cropping and anything else we can do to help minimize erosion, we have been big into cover crops in our area" (Personal Communication, 2018). Soil health is a prerequisite for growing healthy forage to feed herds. Soil that runs off also affects absorption of manure, where spreading on saturated lands is a violation of a farmer's Nutrient Management Plan (NMP). Registered CAFOs must abide by the DEC's NMP by completing soil tests and making detailed reports about planned manure spreading on approved lands. Farmers are tuned into weather and landscape because it guides their decisions on manure spreading. One farmer notes, "We just go where we know [manure] hasn't been spread for a while. Some fields are higher and drier than others so in the Winter or Spring when it is muddy. Those fields get covered every year" (Personal Communication, 2018).

We also discussed organic dairy farming practices (with or without certification), where farmers are either required by certification or otherwise choose not to use chemical fertilizers, pesticides, herbicides, antibiotics, GMO seeds, and other conventional farming practices. For farmers interviewed, the most important distinction between conventional and organic practices was the regulation of GMO crops. Regardless, farmers that buy or grow organic grain do so in abidance of organic certification, or simply of their own decision. If they have enough land,

farmers will generally grow their own forage and grain. However, the conventional and organic farmers we spoke to each mentioned the challenges of growing grain in New York state. Pam has managed to find a local, organic grain supplier but several of our interviewees that owned large conventional farms purchase their grain from the Midwest and have it trucked to New York, thus intensifying their carbon footprint.

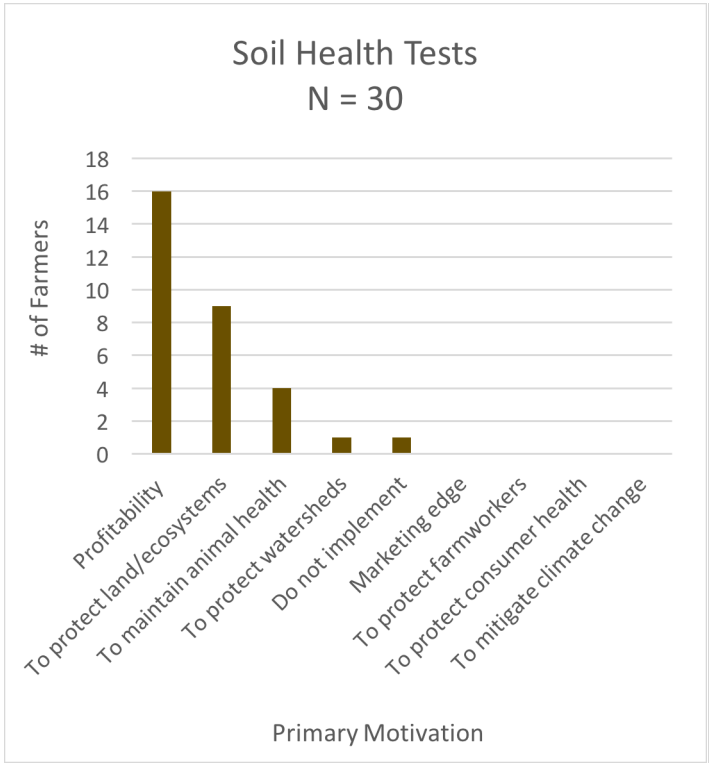
Based on our survey results and shown in Figures 6-11, many dairy farmers may implement some SAPs because it is required, such as NMPs on CAFOs, or because they have already been used by farmers for a very long time such as crop rotation and cover cropping. Other voluntary practices changes such as solar installations, rainwater capture, or anaerobic digester installations were much less popular. The following evaluations of motivations and obstacles for implementing SAPs may explain why.

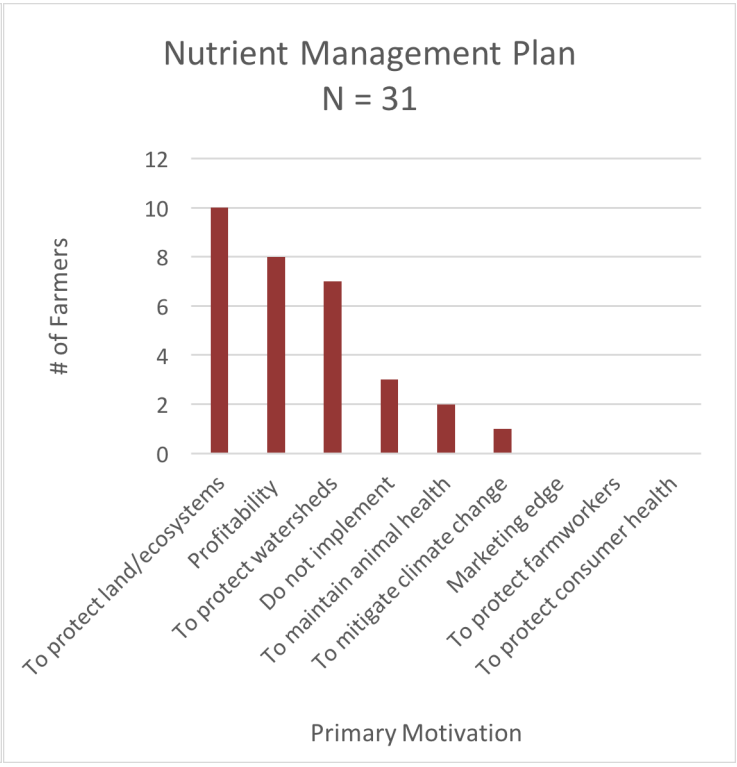
Motivations for Implementing SAPs

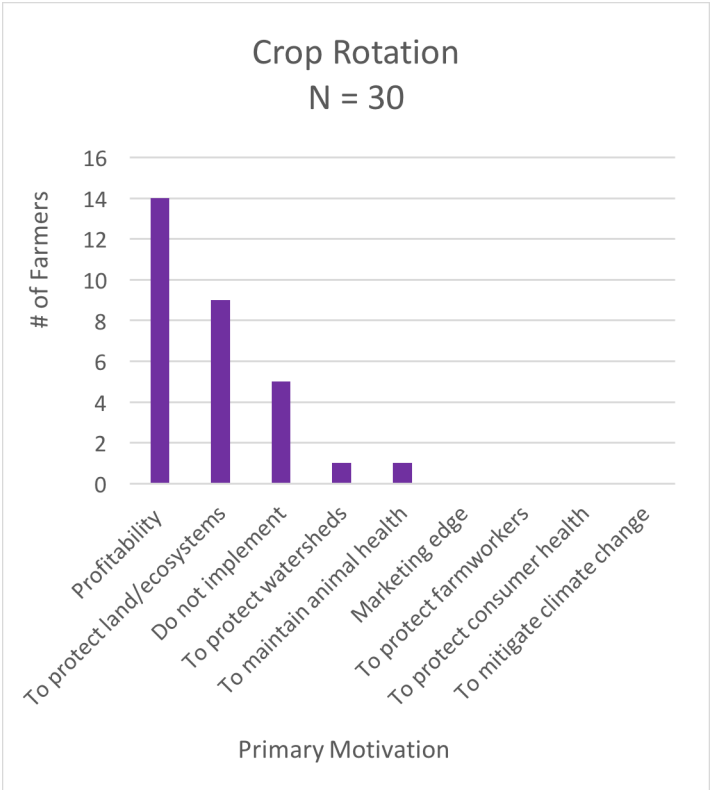
Economy

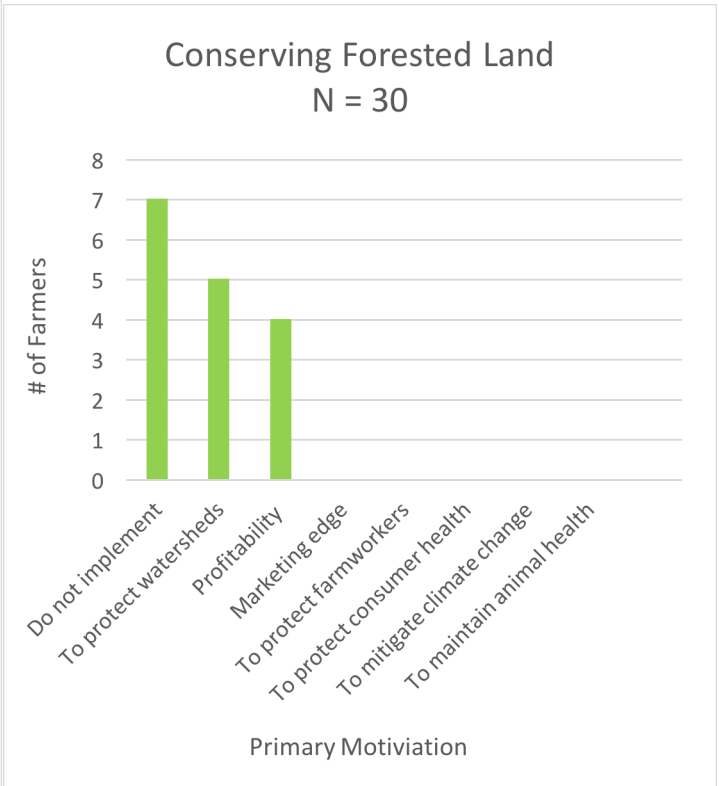
Both survey and interview respondents indicated that profitability is often a motivation for implementing sustainable practices. The survey asked farmers to select sustainable agricultural practices they implement from a list and their primary motivation for implementing each one. Figures 6 through 11 indicate respondents' motivations for implementing Nutrient Management Plans, reduced or no-till systems, soil testing, crop rotation, grass filter strips and forest conservation. These were the top six practices implemented by farmers who responded to this question on our survey.

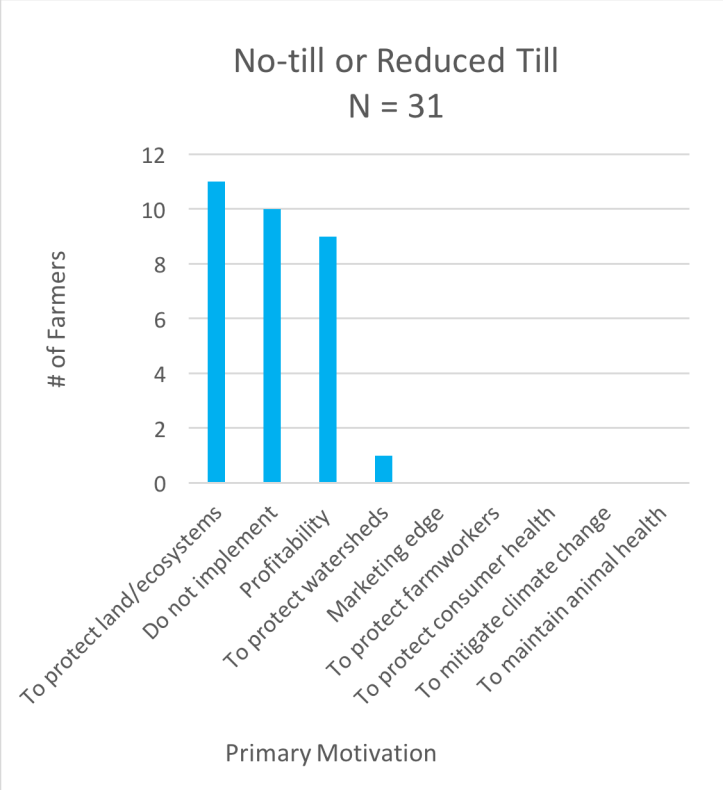
Figure 6-11: Motivations for Implementing SAPs

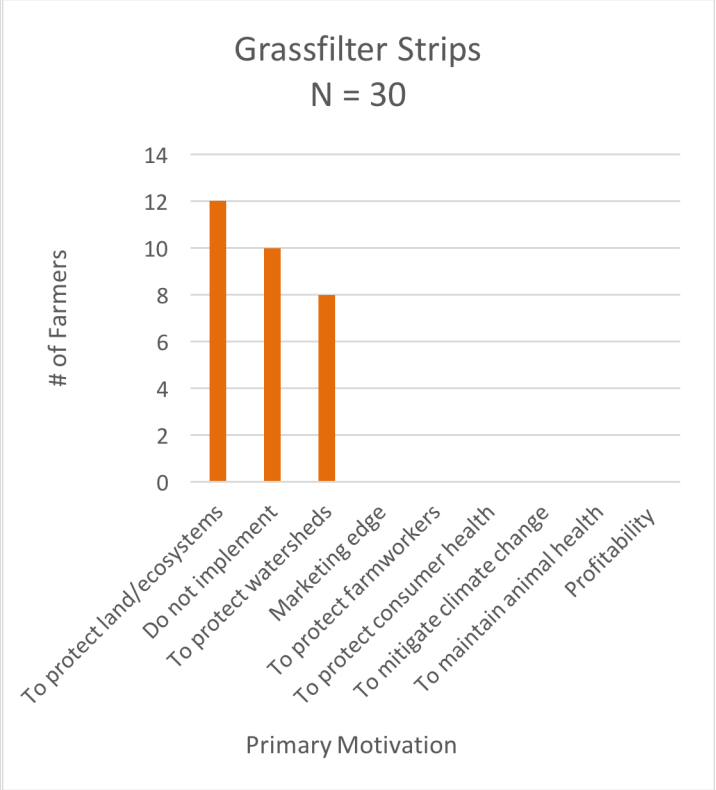












Out of the eight motivations farmers could choose on the survey, profitability was selected by at least one farmer as their primary motivation for implementing each of these practices with the exception of grass filter strips. These survey results reinforce the statements made by both farmers and stakeholders about economics being the primary factor in measuring the sustainability of a dairy operation. The most selected primary motivations included protecting watersheds, maintaining animal health, protecting land/ecosystems, and profitability. No respondents selected protecting farmworker health, marketing edge, or protecting consumer health as primary motivations for the implementing these six practices. One respondent indicated mitigating climate change as their primary motivation for establishing a Nutrient Management Plan. No other respondents selected climate change mitigation as a primary motivation for implementing any of the practices on the survey.

Interviewees who were asked about their motivations for choosing their farming methods were able to indicate more than one motivation. Two farmers, Kelly and Angela, explained that grass-fed and no till both align with their values and contributed to the economic sustainability of their operations. Kelly elaborated:

> There are no direct financial incentives [for being grass fed and no till]. It's mostly our own values of course but it's also a good marketing avenue and to distinguish ourselves in the dairy product market. We know that a lot of our customers really value that our products are 100% grass fed.

Personal

A theme that emerged in the motivations for implementing sustainable practices mentioned by interviewees included farmers recognizing their unique relationship to their land and their responsibility to care for it.

Two farmers spoke generally about their motivations for farming and highlighted how they chose difficult profession of farming because it is their passion.

> **Jim:** I am not sure exactly why besides the love of milking cows and running equipment why my son wants to keep doing the farming thing because there really isn't a lot of money in it.

> **Ryan:** In this business we don't do it because it's a job we do it because it's our passion, it has to be, you just don't keep doing this… You know you wake up every morning, go to work, put in a 14 hour day and while everyone else, your neighbors are coming home

after their 8 hour day and some of them a 5 day week…we go 7 days a week and it doesn't matter what day it is, Christmas, New Years, the job still has to be done.

While these farmers were not talking specifically about their motivations for implementing sustainable agricultural practices, their motivation for farming in the first place stems from a love of their animals and working their land. As a result, the farming methods they choose to employ are likely the methods they believe are best for their land and animals and economic sustainability of their operations.

Motivation For Implementing SAPs: Grants and Other Funding

Only 1 of the 18 farmers we interviewed alluded to implementing certain practices in order to receive government or local funding. Dwight has a 134 cow dairy with 924 acres of land and in responding to questioning about EQIP and CSP, he said, "If you go and do the practices they want you to do then they will provide some funding. Like the cover cropping and standing corn for wildlife, mowing hay field from inside out to let wildlife out" (Personal communication, 2018).

Other respondents mentioned that grant programs were helpful in implementing sustainable agricultural practices but were not motivated solely by the availability of funds. For example, Leslie said, "We have applied for EQIP funding in the past and have been awarded on quite a few occasions and it's really quite an important piece in our goals in striving to be environmentally responsible" (Personal communication, 2018). In her situation, being responsible stewards of the land is in her farm's mission statement and EQIP funding is one program that helps her farm uphold their statement. Half of the farmers we interviewed had

received funding through CSP, EQIP or another grant program and expressed similar sentiments to Leslie.

Out of 31 survey respondents, 55% had received a state or federal grant while the remaining respondents reported that they have not applied for any grant funding, but all respondents indicated that they would consider applying for the programs we mentioned in the survey. Our survey data showed that those who received funding from state and federal agencies were satisfied with their experience for achieving conservation goals.

We also visited a combined USDA and NRCS county office. The office had multiple pamphlets of information about conservation practices, which were broken up into different categories, including practices for grasslands, waterways, erosion, etc. One category, called air, energy and climate change included a list of practices farmers can implement to mitigate climate change (Figure 12).

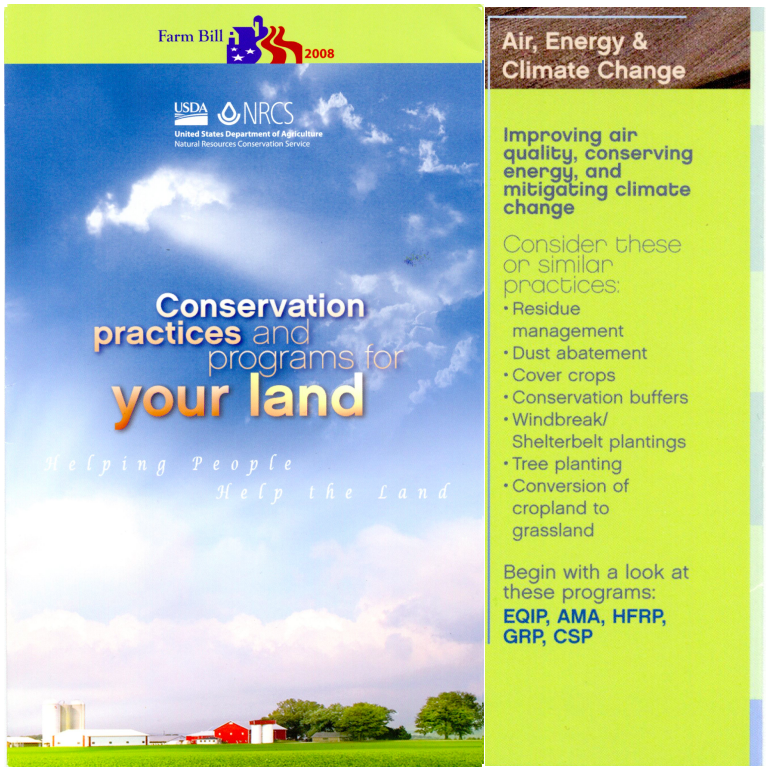


Figure 12: NRCS and USDA Pamphlet of Sustainable Agricultural Practices and Funding Sources

Each category also includes sources of funding that can help farmers implement the suggested practices. However, as was the case with our interview respondents, whether or not these sources of funding are actually helpful depends on an individual farmer's circumstances. Further, although the county office we visited had many resources and helpful staff, as indicated by the survey respondent above, not all county offices have the same resources, further affecting farmers' ability to access information and funding.

Marketing Edge

Five of the farmers we interviewed (28%) mentioned that their farming practices give them a marketing edge. Two of the farmers have organic farms and were specifically referring to the fact that organic milk is worth more per hundredweight than conventional milk. Three other farmers, all with small herds that do their own processing, mentioned that they are able to farm the way they do because they market their own products to consumers and can distinguish themselves from other dairy operations. These three farmers all mentioned how maintaining small herds and producing their own products has allowed them to maintain economically viability and thus uphold their ideal farming values. However, each farmer acknowledged that the approach they have taken is unique and requires a lot of work to become established. While small herds and processing certainly are not a solution that can be implemented by all dairy farmers, they provide a counter narrative to the idea that dairy farms must continue to grow to remain economically viable; managing small herds responsibly is possible.

Mitigating Climate Change

None of the farmers we interviewed mentioned the phrase "climate change" without being prompted. Two farmers discussed changing weather patterns after we asked, and one farmer brought up changing weather patterns when discussing the feed he grows. This farmer, Kevin, said that normally he is able to grow 80% of the forage for his cows but due to the especially wet spring last year, his forage is a much lower quality, meaning he now has the economic burden of purchasing more feed. He said weather patterns are more unpredictable, which can be challenging when making decisions for his operation. When asked about weather patterns, another farmer named Darryl said that in the 20 years he has been farming, every year has been different.

We asked Pam about her thoughts on climate change during a tour of her farm, to which she responded: "We can pretty much figure things out as we go," (personal communication, 2018) and went on to mention that consolidation of dairy farms is her major concern right now. On our farm visit with Andy, he expressed a similar sentiment: "the weather is different than it was when I was growing up...and with it comes the introduction of new pests, and maybe stuff that we've never even seen before and it's catching us off guard. Our normal planting season is X, and now it's different. So we've gotta learn with it, and work with it." Both of these farmers recognize that climate change is happening but rather than taking a mitigation approach, have opted for adaptation.

Obstacles Preventing the Implementation of SAPs

Economy

The most significant barrier that keeps New York dairy farmers from implementing sustainable agricultural practices is the struggling milk market and resulting low milk price. 61%

(11 of 18) when asked what challenges they are facing responded by immediately bringing up the low price they are receiving for their product. One farmer stated, “I’m sure you know and have heard from every dairy farmer you have talked to about the poor milk price right now.” Indeed, 100% of interviewees discussed milk prices or the milk market at some point in conversation

Some farmers went on to discuss the negative impact of the milk market and milk price on their operation and consequently on their interest and ability to explore new options, such as SAPs.

> **Andy:** Right now we’re losing probably $30,000 dollars a day (2,000 acre farm). Your crew knows, and they wonder if they’ll have jobs tomorrow. If they break something by accident they’re less likely to tell somebody. [The low milk price] just puts everybody under pressure.
>
> **Jan:** [The milk price] doesn’t give us a lot of money left over towards other stuff and that is our biggest challenge… We are pretty self-sufficient, but advancing with technology gets pricy, so we haven't upgraded too much with our equipment.

For the first farmer, the milk price becomes a pressure on operations, and for the second farmer that same pressure translates into an inability to upgrade technology such as equipment. Three farmers--Stanley and Erin each with less than 20 and Darryl who runs a CAFO--expressed a dislike but acknowledgement of the reality of a “go big or go home” sentiment in the industry due to the low milk price.

While the implementation of sustainable agricultural practices can be an asset on some farms such as for one farmer named Kelly, where it allows her to reach niche markets and in some cases stay in business as a small farm, most farmers choose not to implement SAPs such as methane digesters because they are expensive to implement and maintain, and the decision involves the risk of a new practice failing. Kevin explained:

> Right now making power in New York is not cost effective. There is no money in making renewable power to put back on the grid, so we have stopped doing that. The oldest [methane digester] engine is twelve years old and needs $100,000 worth of capital and we have decided to hold off.

Michael echoes the sentiment:

> Conservation tillage, strip cropping, no till, cover crops, all those things have been employed here and we're always trying different things. We're pretty comfortable trying stuff but we have to see the ability to see some results from it.

Farmers demonstrate that if a practice is not evidently cost effective and reliable, they are unlikely to choose to implement that practice. For the first farmer mentioned, their methane digester was not cost effective to run and maintain. The second farmer expressed interest in standard and progressive sustainability practices, yet also acknowledges that if a practice is not cost effective they will not implement it.

Regional Conditions

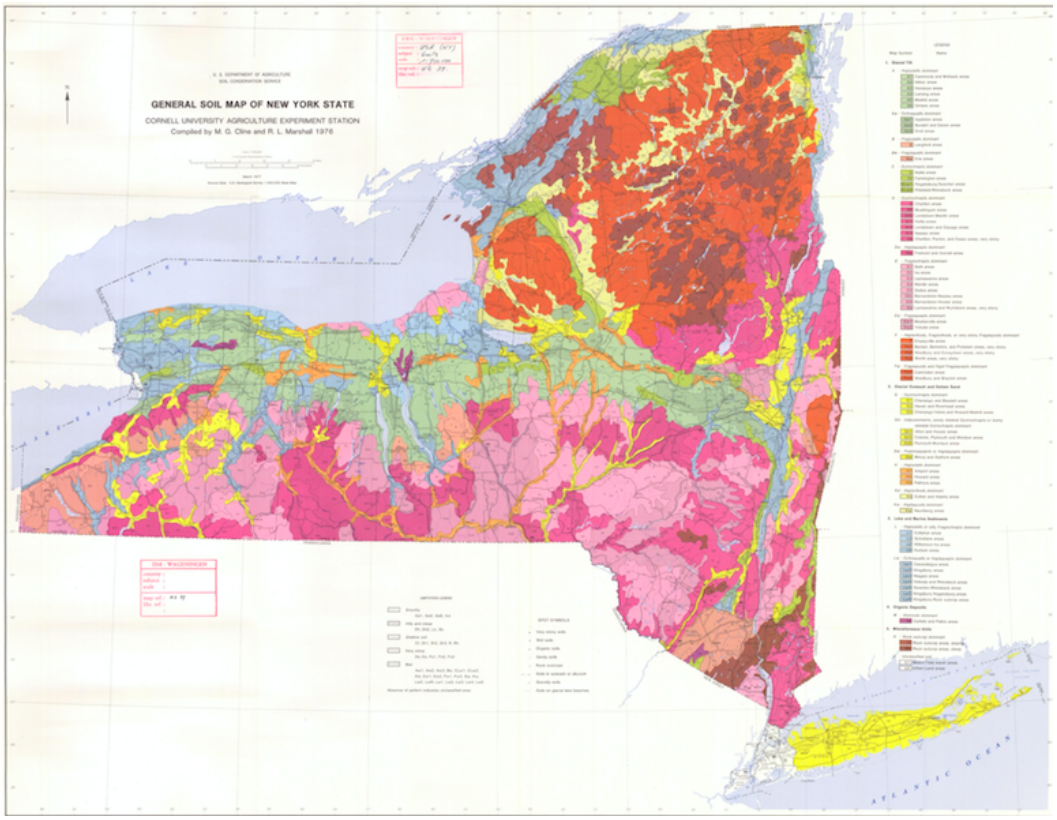


Figure 13: Soil Survey of New York State (1976)

New York State is a part of a geologically diverse region resulting in variable topography and soil types on farms of any size in the region (Figure 13). Four of the farmers we interviewed--Leslie, Andy, Toby, and Erin--explained how they must consider their soil on a field-by-field basis (Personal communication, 2018). SAPs such as grass filter strips, cover cropping, diversified livestock, and some organic practices require a certain quantity and/or quality of land. Within New York, a lack of land or lack of suitable land has become an obstacle to implementing sustainability practices. In interview, Michael explained how their land is not suitable for growing crops for feed:

> We raise most of our forage. We do buy some surrounding neighbors. We buy all of our grains. Why is that? We need the land base for forage, and the land base here is more

> suited to forage than it is to grow crops. So we actually buy it from the Midwest and have it trucked in here cheaper than we can grow it ourselves.

And another farmer, Erin, highlighted the specific limitation of available land in the Adirondack region:

> We end up purchasing our own hay, we don't have the equipment to cut our own hay. Nor do we have the land base. We're in the Adirondacks, we're in an area that's not prime agricultural land. There aren't great soils or lush grasses, and it's pretty hilly and steep so there's not a lot of tillable land. And basically we need all of our available land for pasturing.

Margot milks less than 15 cows, while Michael milks almost 2,700. Regardless, both are experiencing space and soil quality issues keeping them from growing feed. Organic certification requires cows to be on pasture for at least 120 days in a year (USDA, 2011). For larger dairies, including CAFOs (more than 299 cows), the ability to put their cows on pasture or otherwise grow forage is even more significantly limited by the amount and kind of land available. One certified organic dairy farmer, Pam, described how there it is expected that on organic farms that cows cannot be packed together, they must be able to roam within a paddock without topographic or hydrological barriers, and there must be enough forage available for proper cow nutrition. (Personal communication, 2018)

As expected, herd size can be a limiting factor for grazing opportunities (Figure #). As farm size increases, less of a cow's diet can be attributed to pasture ($p=0.02$, r-squared = 0.2). Growing forage becomes less cost effective on larger farms where the price of importing

concentrated feed is less expensive than using significant acreage to grow forage said Peter Wright, a Cornell PRO-DAIRY affiliate. Most of New York state is not suitable for large dairy operations looking to implement sustainable agricultural practices such as certified organic practices like grazing.

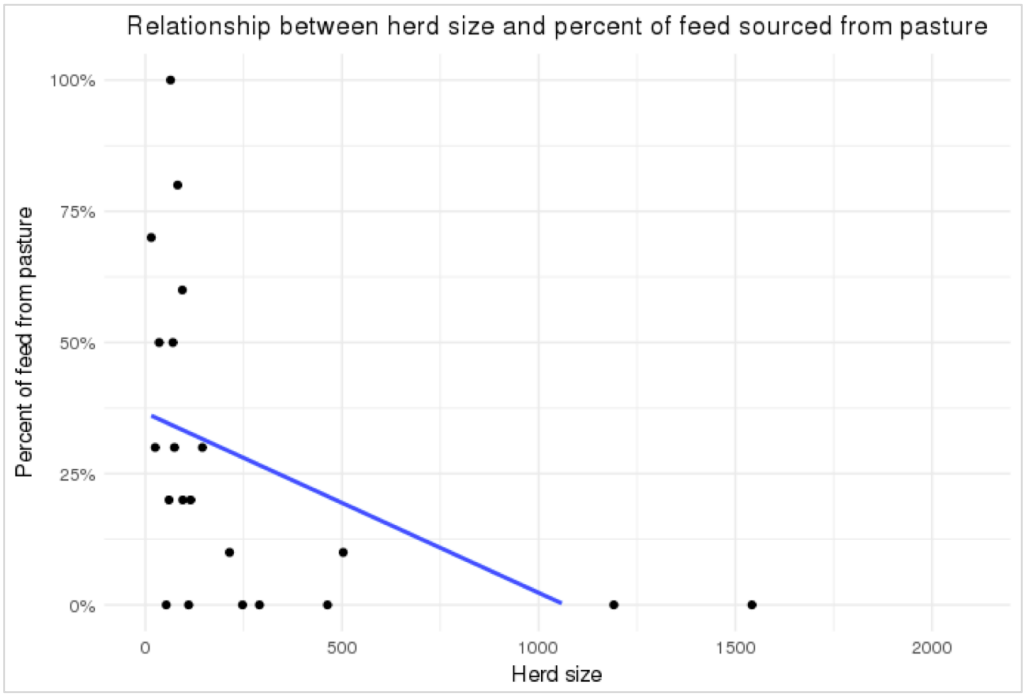


Figure 7: Relationship between herd size and percent of feed sourced from pasture

Administrative and Manual Labor

In order to implement sustainable practices and maintain them, farms must have reliable labor. Where the majority of New York dairy farms are family owned businesses (DiNapoli, 2010), the administrative side of is fulfilled by and passed on among family members. Farms may also be bought and sold by new and existing farmers. An indirect obstacle that prevents the implementation and maintenance of SAPs on dairy farms is a lack of replacement administrative labor. Farmers explain why it is hard for people to get into dairy farming:

Phyllis: When kids go to college for dairy these days, they are taught, 'If you want to go back to your family's dairy farm, you need to be prepared to add hundreds or thousands of cows to it.'

Angela: It is really hard for young people to get started in farming, especially because the amount of infrastructure, and land, and resources that you need.

The above farmers explain how being a dairy farmer is an increasingly demanding profession, and imply that making a commitment to being a dairy farmer may be increasingly beyond the interest of people who would otherwise be interested in the industry.

52% (22 of 42) of farmers surveyed and that chose to give their age where over the age of 50. There are currently not enough young dairy farmers to fill in the turnover rate in the industry. Three farmers--Phyllis, Ryan, and Darryl--made a point of expressing concern over aging population and the lack of young family members returning to the industry to continue the family business (Personal communication, 2018). Even where young people may be interested in dairy farming, two farmers named Ryan and Stanley worried that there will not be enough farms for them to work at (personal communication, 2018). Ryan said:

> We have some very talented young people in this business and industry [but] if their families decide to close the door [on their dairy farm] where do they go? We lose some valuable young people who can bring a lot to this business.

When a farm closes it's doors due because there is no administrative replacement when a farmer retires, that is one less farm willing to implement sustainable practices. Other implications of a

lack of administrative labor include the trend towards larger, consolidated dairy farms (DiNapoli, 2010) that use more technology to administer operations, lowering a need for human labor.

The other essential labor need on farms is for manual labor, especially on farms where there are more cows than a single family can tend to (depending on how large the family is). NYS reflects nationwide estimates that find that 51% of dairy labor is done by immigrants (Fox et al, 2017). Three farmers reflected on their labor situations in different ways:

> **Leslie:** Another big concern for us is labor, you know we hope someday we will get some comprehensive immigration reform so that we can try to work through labor that shares our values and is willing to work with us and do the job. we are concerned about having a reliable source of labor in the future.

> **Kevin:** We also are struggling with finding good quality people that want to work, so labor is a big challenge.

> **Jim:** We do have a little bit of outside labor but that is one of the things that is kinda hard to afford--good hired labor--so we try to do most the work ourselves.

The implications from these farmers is that the available immigrant labor force is an issue because of policy barriers, lack of training, and expense. Sandy of Harvest NY mentioned how the issues of labor and farm consolidation are intertwined. As farms become larger, farmers have been forced to hire and manage labor. The complications of immigrant labor in the New York dairy industry are beyond the scope of this research (suggested reading: Fox et al, 2017), but,

like administrative labor, having good, reliable manual labor may be a precedent to being able to implement sustainable agricultural practices.

Policy Climate

When asked a variety of questions about the political climate of the dairy industry such as "How do you feel about current government policies related to the dairy industry?" and "How do o you feel that government dairy policy could better support farmers?" The overwhelming sentiment held by dairy farmers that we interviewed is that federal and state policy with regards to the dairy industry is ineffective and lacking. To demonstrate their strong opinions: One farmer named Darryl thought policy was so ineffective that they said, "I think the more the government stays out of it the better" (personal communication, 2018) and another named Phyllis explained how lacking they felt policy was, "We literally have to take the bull by the horns and do something ourselves in order to survive." (Personal communication, 2018). Farmers had a wide range of responses:

Farmer's responses to current dairy policy
● Labelling regulation allows for the conflation of the dairy milk market with the non-dairy milk alternatives market (soy, almond, hemp, etc.) ● FSMA regulations are complicated; Some FDA inspectors do not know how to enforce ● Some organic certifiers are less strict than others ● Policymakers are not well-informed about the dairy industry ● Policy puts no limits on the milk market

While these critiques do not directly address the influence of policy on the implementation of sustainable agricultural practices on dairy farms, inferences can be made. If larger dairies are able to pay for a less strict organic certifier, they are less likely to implement

the specific sustainability practices associated with organic dairy farming such as allowing access to certified organic pasture for the entire grazing season or a minimum of at least 120 days per year (USDA). It likewise makes being an organic small dairy farmer more difficult because of increased competition, especially if a small dairy chooses to follow organic practices closely. In general, where implementing sustainable agricultural practices becomes more difficult because of complicated or ambiguous standards, inspections, or other policy, those practices are less likely to be considered.

A market leaning towards neoliberal policy that favors productive conventional farms of larger sizes has a similar effect on the implementation of sustainable agricultural practices in the dairy industry. The consensus among farmers was that the industry needs more and better policy.

Grants and Other Funding

Important to the implementation of sustainable agricultural practices on dairy farms is the availability for grants or other funding resources that give incentives, and support farmers in the process of implementing said practices. As with policy, farmers felt a similar need for more and better grants and other funding resources. Farmers that we interviewed explained why they felt funding was lacking in quantity and/or quality:

Farmer responses to the availability of grants and other funding resources (change)
● Does not cover the total immediate and/or long term expense of some projects ● Funding goes to selective projects that may not work for everyone ● Requirements that must be met in order to receive funding is limiting/burdensome ● The bureaucratic process is expensive and lengthy

Wright commented that funding sources have been "way oversubscribed" putting farmers in a difficult situation where, if they need funding to be compliant with federal and state regulations but do not receive funding, they must decide to risk waiting for funding or to pay out of pocket (Personal communication, 2018). One farmer, April, expressed this dilemma in terms of liability, "We have been working with EQIP and NRCS for four years trying to get a manure pit improvement...it is like making a deal with the devil with absolutely zero common sense, yet the regulations and liability we are at risk for is huge, too much not to do the dance." Based on our interview responses, whether or not federal and state grants were useful in implementing sustainable agricultural practices such as grass filter strips and manure storage greatly depended on each farmer's individual circumstances.

While the majority of survey respondents who received grants reported their satisfaction with the assistance they received, one farmer who received funds through EQIP described their discontent with the availability of funding.

> We feel there should be more funding for simple practices like grassed waterways, rock chutes, cover cropping. We are very aware of Climate Change and conservation and sustainability, but financially cannot afford to implement some of the measures that would make us more sustainable from an environmental perspective. Dairy farms are going out of business at a very rapid pace at this time, and once the general community and consumer realizes what they have lost, it will be too late. Dairy Farms in the NE are well-suited to the climate and soils here, and once they are gone will be hard to replace.

For New York dairy farms, the implementation of new practices may require a significant investment. This investment may come in the form of direct payments, loans, credit, or grants or other funding resources. Where sustainable agricultural practices may not currently or

immediately be cost effective, it is essential that resources are available to farmers if it is assumed such practices should be implemented.

Two farmers acknowledged personal barriers to implementing sustainable agricultural practices. One farmer named Jim was hesitant towards grants and other funding resources because he wished to accomplish things on his own with a "pull yourself up from your bootstraps" attitude (personal communication, 2018). Farmer Pam built on that sentiment when saying, "Farmers do the same thing every day because you've always done it that way and you hope that it will eventually work the way you want it to." (personal communication, 2018). This indicates that farmer attitudes can be an obstacle to implementing sustainable agricultural practices. More resources need to be provided to farmers that demonstrate the benefits of sustainable agricultural practices and indicate how climate change will make practices that have been used in the past ineffective.

Conclusion

Dairy farmers have a real passion and dedication for their work. In the midst of low milk prices, the main barrier to implementing SAPs is economic feasibility. Farmers are concerned with the short-term survival of their business and make decisions along those lines. The farmers we surveyed and interviewed more frequently engaged in short-term, day-by-day adaptations. For example, farmers would generally be more inclined to making low-cost adaptive measures such as incorporating cover crops to reduce erosion. Mitigation measures that require higher upfront costs, and slower return rates were less likely to be implemented. For instance, only one farmer were surveyed had an anaerobic digester and solar panels were relatively low on the list of implemented practices.

Despite economic barriers, some SAPs were very beneficial to the financial viability of farms. Generally, limited usage of fertilizers, pesticides, and herbicides were cost effective because farmers did not need to pay for chemicals. Soil health is arguably a farmer's main concern because it is the basis of healthy forage, which feeds cows and impacts milk production. SAPs such as cover cropping, crop rotation, and conservation tillage that benefit overall soil health (in terms of reduced erosion, reduced compaction, balanced nutrient composition, etc.) were popular among farmers. Transitioning or adding organic farms were also made along economic reasoning. Despite a lengthy and expensive transition that lasts three years, some farmers were willing to make that change since the selling price of organic milk is twice the rate of conventional.

Finally, farmers implemented SAPs regardless of economic burdens. The farmers that did implement SAPs despite economic barriers were pleased with the outcomes, and continue to

practice certain measures. Some farmers were committed to a small-scale, family farm lifestyle that was not heavily industrialized. Self-processing and creating value-added products such as cheese, yogurt, and butter were the main means that smaller farms stayed afloat and could compete with larger scale farms. One stakeholder mentioned the future of the dairy industry may revert back to small scale farming particularly in the Northeast region because of resource and land constraints. Because the economy of the dairy industry has been so low, farmers are in need of federal support if they are ever going to implement SAPs. If state and federal agencies are dedicated toward reducing the carbon footprint of the dairy industry, there needs to be support in the form of funding, benefits, and education otherwise it will likely not happen by itself.

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Appendix I: Glossary of Sustainable Agricultural Practices

Anaerobic Digester: Manure disposal method where microorganisms break down biodegradable materials in the absence of oxygen.

Conserving Forested Land: On farms, strategically leaving some forest can provide many benefits to farmers as well as the surrounding community. Forests can provide many environmental benefits including maintaining soil health, sequestering carbon, improving water quality, supporting wildlife as well as providing farmers with another source of income in the form of timber (USDA, 2018).

Cover Cropping: A time-tested conservation method based on the planting of certain species of usually low-maintenance vegetation on off-season fields with bare soil to prevent runoff and erosion and promote soil health. Cover crops are usually removed before prior to seeding and as soon as regular vegetation must be seeded.

Crop Rotation: Rotating crops refers to the practice of planting crops with different nutrient needs in succession in the same area. Crop rotation provides several ecological benefits including supporting soil health, preventing erosion, and deterring pests (Hammonds, 2017).

Diversified Livestock: having several species of livestock on an operation. This is beneficial for grazing because different animals have preferences for different forage. This results in an increase in total animal production and a decrease in chemical pesticide and fertilizer usage.

Grass Filter Strips: Areas of vegetation along waterways and drainageways that slows water flows and filters out water contaminants from farmland such as sediment, chemicals, and nutrients. Grass filter strips stabilize soil, prevent erosion and gully formation, and creates habitat for animals.

Integrated Pest Management: The evaluation of a pest issues such as insects, weeds, or disease to determine the most cost effective and low impact solution. Special care is taken to prevent chemical leaching, runoff, and drift. Limited chemical use and spot treatment is used to prevent over-treatment.

Nutrient Management Plan (NMP): According to the NY Agricultural Environmental Management Framework, a NMP is "a conservation plan unique to animal feeding operations, designed to evaluate all aspects of farm production and offer conservation practices that help achieve production and natural resource conservation goals" (NYS Soil & Water, 2018). Farms with a Concentrated Animal Feeding Operation (CAFO) Permit can own more than 299 cows and are required to have a NMP. NMP's mainly outline how farmers should responsibly store

and/or spread manure and monitor farm runoff. Smaller farms interested in state cost sharing programs available to help with manure management must also have a NMP (NYS Soil & Water, 2018).

Organic Practices (with or without certification): This is a type of farming that is used to promote the biological health of a farm through natural processes. It attempts to maintain ecological balance and conserve biodiversity. These farm systems contribute to soil health, crop and livestock nutrition, pest management, and biological diversity while keeping in mind the production goals. Practices such as using organic seeds, employing crop rotation, and prevention tactics for pest control may be used with or without USDA certification in order to benefit the farm.

Plate Coolers: A compressor alternative that allows the cooling of hot raw milk by way of heat exchange with cool water. Plate coolers run on less energy than compressors.

Rainwater Capture: Collecting rainwater in a bucket, well, or reservoir for later use on-site as opposed to letting it run off. On farms, water may be used for crop and livestock irrigation, cleaning equipment, long-term storage, or for groundwater recharge.

Reduced Till or No-till: Also known as conservation tilling. The limited use or exclusion of tilling that disturbs the soil surface in order to promote crop seed growth and kill existing weed coverage. Reduced or no till practices reduce or eliminate the oxidation of carbon sequestered in soil (creating CO2) and promote overall soil health by preserving soil aggregates.

Soil Health Tests: Soil health tested are conducted by farmers to measure their soil's capacity to support plants while "maintaining or enhancing water and air quality" (USDA, NRCS & Soil Quality Institute, 2001, p.3). Farmers can assess the health of their soils through evaluating physical, chemical, and biological indicators that include assessing microbial activity, crop growth and root depth, water holding capacity, pH, electrical conductivity, etc. The NRCS part of the USDA provides comprehensive lists of soil indicators to monitor and different means of evaluating them (USDA, NRCS & Soil Quality Institute, 2001).

Solar Panels or Solar Thermal: Photovoltaic solar cells harness power from the sun that can supply electricity. For solar thermal, solar energy is used to generate thermal energy.

Variable Speed Vacuum Pump: A type of pump used in a milking system that adjusts its speed based on the speed of milk flow from a cow (Bunge, 2009). This saves electricity as the pump is not constantly running at one high speed.

Appendix II: Farmer Semi-Structured Interview Questions

1. Can you tell us about your farm and the practices you use? How many acres do you farm?
2. Why do you use the practices you use?
3. What are the challenges (economic, environmental, etc.) facing the dairy industry right now and how are they affecting your operation?
4. How do you feel about current government policies in relation to dairy industry? How do you think state/federal policies could be changed to better support dairy farmers?
5. Have you heard of the Environmental Quality Incentives Program (EQIP) or the Conservation Stewardship Program (CSP) available through the NRCS (Natural Resource Conservation Service, which is a USDA program)? Have you heard of the Climate Resilient Farming (CPF) grant program in New York State?

    If so, have you applied for/received funds? What did you use the funds for?

    If not, would you consider apply for funds? Do you think this program is adequate to help support your operation?

Appendix III: Stakeholder Semi-Structured Interview Questions

1. Can you tell us about your work in relation to dairy farming in Upstate New York?
2. What are the challenges (economic, environmental, etc.) facing the dairy industry right now and how are they affecting your work?
3. What practices do you associate with sustainable dairy farming?
    a. In your experience, how do farmers perceive these practices? Are tffeedhey willing to adopt them?
4. How do you feel about current government policies in relation to dairy industry? How do you think state/federal policies could be changed to better support dairy farmers?
5. Have you heard of the Climate Resilient Farming (CPF) grant program in New York State?
    a. If so, do you think it is an effective initiative that farmers can take advantage of? Why or why not?
    b. Not specifically CPF but any grants/ loan programs that farmers take advantage of?

Appendix IV: Farmer Survey

Dairy Farming Practices in New York State

1. INTRODUCTION As a dairy farmer in New York State, we are inviting you to participate in a research study on current practices on dairy farms and farmers' adoption of sustainability initiatives. Participating in this study involves responding to a 22-question survey, which will take approximately 5 minutes to complete. Please read this document and ask any questions you may have before agreeing to participate. The study is being conducted by Dr. Andrew J. Schneller, Visiting Assistant Professor of Environmental Studies, and students Alyssa Bueno, Ian Daly, and Tracey Wingate from Skidmore College.

2. DURATION The survey is expected to take approximately 5 minutes.

3. PROCEDURES Your participation in this study is expected to include the following: Surveys may be taken in person via paper-and-pencil or taken online. You will be asked 23 questions related to your farm, practices, and personal opinions on dairy. Upon completion of the survey, you will be asked if you would like to take part in a semi-structured interview at a later date. This will give you the opportunity to further expand upon your survey responses and provide any additional information you feel is relevant. If you would like to volunteer to participate in a 30-minute interview, you will be asked to provide your email address or phone number so that we may get in touch with you to schedule the interview.

4. RISKS/BENEFITS **We do not anticipate any risks from participating in this research.** The benefits of participation in this research effort are: helping to create a better understanding dairy farming practices in the capital region and sustainability initiatives implemented by farmers.

5. CONFIDENTIALITY All of the records of this study will be kept private. The only individuals who have access to these data files are Professor Schneller and his Skidmore College research assistants. We will keep a key of names and ID#s during data collection that will be stored in a locked cabinet in Professor Schneller's locked private office at Skidmore College in New York. This key is only used during data collection to insure that all assessment instruments are accurately coded. All copies of the key, both paper and electronic will be destroyed (shredded and/or deleted) from all paper and electronic sources at the conclusion of data collection.

6. COMPENSATION There will be no compensation for participating in the survey.

7. VOLUNTARY NATURE OF THE STUDY Your decision whether or not to participate is entirely voluntary. You may refuse to participate before the study begins, discontinue at any time, or skip any questions on the survey that make you feel uncomfortable, with no penalty to

you and no effect your current or future relations with Skidmore College or any of its representatives.

8. CONTACTS AND QUESTIONS The researcher conducting this study is Andrew J. Schneller, PhD. If you have questions, you may contact the researcher at (518) 580-8192, or email aschnell@skidmore.edu. If you have questions or concerns regarding this study and would like to speak with someone other than the researchers, you may contact Mary Hoehn, Institutional Review Board Chair, Skidmore College, 815 N. Broadway, Saratoga Springs, NY 12866, phone 518-580-8052, e-mail mhoehn@skidmore.edu or Dr. Robert Turner, Environmental Studies Program Director, Skidmore College, 815 N. Broadway, Saratoga Springs, NY 12866, phone, 518-580-5251, email bturner@skidmore.edu. 9. STATEMENT OF CONSENT You may print a copy of this form to keep for your records. The procedures of this study have been explained to me and my questions have been addressed. The information that I provide is confidential, unless I have consented for the researchers to use my name in future publications, and will be used for research purposes only. I understand that my participation is voluntary, and that I may withdraw anytime without penalty. If I have any concerns about my experience in this study (e.g., that I was treated unfairly or felt threatened), I may contact the Chair of the Institutional Review Board or the Chair of the sponsoring department of this research regarding my concerns. The data for this study will be collected using the website Qualtrics. The researcher has taken all reasonable measures to protect your identity and responses. For example, the data is SSL encrypted, it is stored on a password protected database, and IP addresses are not collected. These measures provide the very high level of security that is used by financial institutions, and it is very unlikely that your data could be accessed by anyone. However, data collected on the Internet is not 100% secure. Therefore, we also suggest that you clear the computer's cache and browser history to protect your privacy after completing the survey. The researchers will not make or keep a list linking your personal information to your data. In publication, presentations, and dataset, we will not include any information that will make it possible to identify a participant. Clicking "Agree" indicates you are 18 years or older and you consent to participate in this survey.

Q2 I consent to participate in this study, and understand that I can end my participation at any time.

- ○ Yes
- ○ No

Q3 In which New York State county is your farm located?

_____

Q4 Please select your age range

- ○ 18-29
- ○ 30-39
- ○ 40-49
- ○ 50-59
- ○ 60-69
- ○ 70 and older

Q5 Approximately how many acres does this operation

- ☐ Own _____
- ☐ Rent or lease from others _____
- ☐ Rent to others _____

Q6 For how many years have you been working on this farm?

- ○ 0-5 years
- ○ 6-10 years
- ○ 11-15 years
- ○ 16-20 years
- ○ More than 20 years

Q39 Is dairy farming your main source of income? If not, approximately what percentage of your income comes from the farm?

- ○ The farm is my primary income source
- ○ The farm is not my primary income source. The farm makes up the following percentage of my income: (2) _____

End of Block: Personal

Start of Block: Farm info

Q7 Approximately how many total tillable acres (owned and rented) does this operation utilize?

_____

Q8 How many cows (both milking and dry) do you have on your farm?

_____

Q9 For how many years has this farm been producing milk?

_____

Q10 During the grazing season, what percent of your milk cows' daily diet comes from pasture?

_____

Q11 What percent of the cow feed is purchased?

_____

Q12 How many pounds of milk does this farm produce annually?

_____

Q13 Is this farm Certified Organic?

- ○ Yes
- ○ No (skip to question 15)
- ○ Certified transitional
- ○ Other certification (please specify) _____

Q14 For how many years has this farm been Certified Organic?

_____

Q15 Which of the following practices do you implement on your farm and what is your primary

	Profitability	To protect watersheds	Marketing and labeling edge	To protect farm workers	To protect land/ ecosystems	To protect consumer health	To maintain animal health	To mitigate climate change	Do not implemer
ver opping									
op rotation									
nserving ested d									
duced till no-till									
il health sts									
plications chemical tilizers d/or sticides									
ganic actices									
egrated st anagement									
versified estock									
aerobic gestion									
lar panels solar ermal									
ite cooler									
riable eed cuum pump									
trient anagement an									
in water oture									
ass filter ips									
her (please ecify):									

Q17 Have you applied to any of the following conservation programs? If not, have you applied for or received funds from another program?

- [ ] Climate Resilient Farming Grant (CRF)
- [ ] Environmental Quality Incentives Program (EQIP)
- [ ] Conservation Stewardship Program (CSP)
- [ ] USDA Rural Economic Development Loan
- [ ] Other (Please specify)_____
- [ ] No (skip to question 20)

Q18 What conservation programs have you used and what changes did they allow you to make?

_____

_____

_____

_____

_____

Q19 Respond to the following statement. "These programs helped me to accomplish my conservation goals."

	Strongly Agree	Disagree	Neutral	Agree	Strongly Agree
	○	○	○	○	○

Q20 Would you consider applying for funds from any of these programs?

- ○ Yes
- ○ No

Q21 Are you willing to participate in a brief 20-minute follow-up telephone interview?

- ○ Yes
- ○ No

Q22 If you answered YES to a telephone interview, please provide your name, phone number, and email address below so that we may get in touch with you to schedule the interview.

_____

_____

_____

_____

_____

Appendix V: Thematic Quote Chart

Soil Health

Mainly to try to improve soil health and retain our soil in the fields, keep it from erosion, keep the soil and the nutrients in the field rather than having it wash off into the lake.

Unfortunately as things get more and more complicated, the results are out here for example soil health. We're trying to get a handle of soil health. As environmentalists, we're thinking about how to measure nitrogen and phosphorus appropriately so that you don't drive farms and other business because you're looking at the third decimal to the right instead of the whole picture. It'll change in a matter of 2 hours so it's important to know that once you get to be a regulator and you're regulating me who's been here for 40 years and I've had a couple of things about that. The programs on the policy issue, I've been on some state committees grappling with this. You'd like to think that you'll get the best bang for your buck for your taxpayer dollar. So you wanna go where you can do the most good. So you have to be thinking about that in terms of how will that look in the bigger picture. The Clean Water Act's been here since 1972 and so if the folks are now just getting around to doing something serious about it, you have to think about how committed are they to that?

As with the soil health thing, I don't want a mandate tomorrow that everybody has to plant cover crops. But let's promote it. Let's look at areas that are highly erodible. Let's look at areas that have high nitrogen leaching. Because there are spots where it's probably not a huge deal. Could it be a little better? Yes. But we all know there's not an infinite

Cover Cropping/ Crop Rotation

Anyplace we chop corn, if the corn is chopped for silage we use a cover crop, just as soon as we can get on it after we chop. Normally it's winter rye or winter wheat, we have used oats as well but most of the time it's a rye and we don't harvest that in the spring, we go back in and chemically treat and then plant into that sod.

So environmental conservation is very important to us, we work very closely with our CAFO planner and our agronomist who works for our planner and we really try to do a lot of the best management type stuff for our land. We do cover cropping with some small grains, we try to do as much no till as we can, we certainly have a very good crop rotation program.

We try to do as much reduced till, no till or strip till as much as possible. We don't moldboard plow, we don't do any conventional tillage. We use good crop rotation and strip cropping and anything else we can do to help minimize erosion, we have been big into cover crops in our area. We have dealing with cover crops and no till since early 2000. – John

People think we're crazy. So I started - it's called 'planting green' so I plant all of my corn into a green cover crop, which is rye or a cover crop. So my goal, the conventional wisdom and a big problem that our industry has done is brown dirt. Now that being said, we produce a lot of crops, the cornbelt, but we all know that the topsoil is disappearing, nitrogen is leaching, phosphorus is moving. So this concept has been hard to integrate because some of these places have moved to,

Conservation Tillage

Of course Aaron knows our philosophy here, a lot of the things you mentioned conservation tillage, strip cropping, no till cover crops, all those things have been employed here and we're always trying different things and Aaron's always trying to get us to do something different. We're pretty comfortable trying stuff but we have to see the ability to see some results from it.

We try to be as good stewards as possible, we use a lot of manure that we produce here on the farm as a fertilizer base, we practice some no till, and the rest is basically minimum till, we haven't used mowboard plow on the farm for probably 15 years.

No, we don't use no till, people around us to but we just haven't gotten into that with our equipment, our equipment just isn't set up for that and we do crop rotation so we do corn on a field for two years and then it will be hay for two years.

No till, last year is the first year we did that and we are doing some again this year, not real sure on the whole no till practices because all that ground gets sprayed with an herbicide before we plant and then it gets sprayed again after we plant the corn.

And that's why with our practices, almost everything comes from the same… morally I wanna do it, and then the simple economics of it work out. Tillage equipment alone, I haven't exactly done the numbers and I will someday but the amount of diesel fuel, wear and tear on equipment. So if I'm buying all these parts that are

amount of money. So let's take that money and give it to priority watersheds.

So one of the things you didn't mention is soil health is compaction. And of course you get big, heavy equipment because you need to go fast when you have that many acres covered because we have the same number of days as a small farm. Compaction gets to be a serious issue especially when you have to get stuff done quickly because environmentally you can't spread a day before a big storm and you don't wanna spread after a big storm because it's wet and it wouldn't hold up your equipment. So we have what's called a dragline and these pumps that you saw all gutted out pump at 2,000 - 6,000 gallons a minute to as much as 3 miles away by a flexible line that we reel out. And so what we do is just paint a field.

We take soil samples regularly and use crop rotation, I think right now, we have room for improvement with some things and we are really limited by our land because we don't have a lot of tillable land so I think we could have a longer crop rotation and so this year we are going to be moving towards, instead of a two year rotation where a field that's in strips is corn for grain and then rye grass and clover and basically every year they switch, we are going to leave the rye grass and clover, grow less corn and take some of the ground that was in corn and do annual forages like sorghum, sudan grass and triticale and hopefully slowly move away from corn because its, I wouldn't say its difficult to grow organically but I think that the sorghum, sudan grass and triticale is actually better for the soil. You don't have as much exposed soil, it has more root structure, you're maximizing your seasons and you don't have to do any cultivation. So moving less away from cultivated row crops and more towards 'it's just big farms, and they gotta turn the dirt over.' I call it prescription. A corn plant needs 200 lbs of nitrogen. You plow the ground. You put 50 on it when you plant it, you put 75 on when it's this big, and you put the other amount on when it's this big. Well mother nature says, I don't care when you put that on. 2 inches of rain comes and where's it go? And when you start talking about the millions of acres, that's why we have the issues we have in certain areas. So I've started - and it's a big thing now, but percentage wise it's still a small group of people doing it... But I'm just using that cover crop to hold my nutrients as opposed to being on brown dirt, which we all know what happens. It has a high likelihood of not being where it needs to be at the correct time. So the neighbors love it because there's always something green. And I plant into that, and then that corn plant. It's basically 8th grade earth science, which is what frustrated me when I was sitting there. I was like, "Oh my god all this technology, and my Cornell degree. I'm sitting here looking at the carbon cycle, this is so simple. Don't overthink the process". So it's super exciting and as we move ahead it's soil health, and nutrient retention, and ability to control it way better than we have in the past. So that's one of the coolest things we're doing here from and environmental standpoint, is using that to now manage the resource that I have more effectively and it's just… so the economics side of it is, I don't have to run all of that stupid tillage equipment that makes brown dirt. You talk about big iron, and tractors, and diesel fuel, and ugh fixing that is tough. Don't have to do that anymore.

Cover crops, we used to do a little cover crops. When you have year like being made in a factory, the carbon footprint, if you take what that practice alone does, and if I can honestly say that I'm doing that, I feel good about. I'm doing better than I was yesterday.

We are a completely grass fed herd. We do some no till if we have to resteep stuff but beyond that we have try not to till, we may occasionally but we try not to.

high production, high energy, annual forages as far as what our annuals are and then keeping as much of the farm in perennial pasture and hay ground as we can and hopefully getting more, better ground that is workable that we can have those longer rotations.

we had last year you can get rye like this tall and what do you do with that… So we do not cover crop at this point…But in the spring you have got to get rid of this cover, so am I going to get the mowboard plows out? No, I'm going to use chemicals and kill it, which is $14 an acre to get it done plus the cost of, round up...probably about $14 (aaron), so you're talking about $30 an acre and you're using more chemicals again, more weed killer to kill that cover crop but you know I was reading in the farm journal last week about this guy who uses cover crops for years, and his soil just gets better and better and better so we may end up using cover crops in the future

Antibiotics

Health wise, the cows are really healthy. All the money we spend on expensive treatments we really didn't need. Our cows only average in the summertime 50lbs and in the wintertime 35-40lbs, they're not pushed. Our neighbour has cows close to 100lbs. Our cows don't get more than 10lb of grain a day, but they're happy and they're healthy. We lost a couple cows, we did put a couple cows on penicillin and had to get rid of them. We haven't had Pneumonia in 2 years. Eventually the group gets hardier. Our only issues has been calving (but things have improved). When there is too much fermentation in their feed their stomach can twist (calfs, talking about on conventional farms). That's another thing I like about the family farm. You know the animals, it's not a number, so I think you care a little bit more, not to knock other farms. When you're out there with a computer and you never actually see the individual animals it's a little different.

But I personally believe in organic vegetable farming and practices like that, but organic dairy farming is a completely different ball game. And I personally feel like honestly an inhumane practice and the reason that I feel that way is because you're not supposed to use any kind of antibiotics or a lot of different types of medicines to treat your cows. And if you do use those medicines, that cow is supposed to leave your herd, which means that she's gonna go on the beef truck and be sold for beef. And my philosophy is that if my child is sick, I'm going to give them antibiotics. I'm not going to give them antibiotics everyday but if they have strep throat, I'm going to get a prescription for antibiotics and give that to them. And I feel the same way about

Chemicals, GMOs

We are a conventional farm, so we do use pesticides and stuff like that, we do do GMO corn because we believe that, uh I'm trying to put it the best way, you do get more bang for your buck, GMO corn has allowed us to use less pesticides and we get a better crop every year so we are not planting as much corn because we can use our corn for grain but we probably only use half our corn for grain and then we buy the rest...we do use pastures and we do rotate them, our cows do go out to pasture so we don't overgraze our fields, we do feed a lot of hay all year round so we don't have our fields over grazed

There comes a cost with using GMO-free crops. And I would have another 16-18 dollars and acre on my GMO crops because I didn't control the bugs, the weeds, and some of those things… It's the disease resistance, some of the GMOs are for drought-tolerance now they can grow on a miniscule amount of water. So that's the way I look at it. If it means I don't have to use the pesticides and herbicides.

So there's a huge debate now about GMOs. We use them here. I often say to groups if you believe in evolution, isn't that GMO? Fish, amphibians, reptiles, and some other ones in there then mammals finally. But somehow those genes crossed over. Now there's not too much evidence of that but that's what the theory is. But when you think about that, that's GMO.

The corn is sprayed with an herbicide when we plant, the ground is sprayed with an herbicide ot try to keep the weeds from growing. No till, last year is the first year we did that and we are doing some again this year, not real

Purchasing Feed

We've been buying organic grain out of VT and we're going to continue doing that. Down the road I may change my mind. I don't think we'll go back to corn silage. We don't have the corn equipment anymore, so we'd be looking at $30-50,000 on equipment and it doesn't last for more than 10 years.

It's really the last year or so has hurt. I can tell just by frequency by which they order their feed, the amount of protein they're willing to pay for, how quickly they do pay for it or not pay for it. I got a lot of guys that are struggling. One guy cancelled his cable the other day because he didn't want to pay the $18 or something, like he had to cut that much out. And depending on which milk company they're with, some of them have been cut $10, some of them have been cut 6 or 8 dollars. Some of them have been put on quotas where they're only allowed to produce a certain amount. If they go over that, they're going to be paid conventional milk price for that extra milk. With the high input costs of organic feed and organic hay, it's really causing them to struggle.

We grow most of our forage. Last year our forage was 60% of what the cows ate. We still brought in 40% of what the cows ate. This year, the growing season made poor quality forage, the fiber is not as digestible, it is just not as good. Every pound of feed the cow just cant get as much out of it so we are currently at a 53% forage diet so we have to buy in the balance of it. Feed and labor are our two biggest expenses regardless of what we grow here.

my cows. If they have a treatable illness where I can give them one round of antibiotics and they can never be sick again and live another 10 years, that's important to me... And to me, the life of the animal is such an important part of what we do. I can't imagine no using medicines to help save an animal's life.

I went to an organic farm and all the others I've been to sense, well theres obviously variation but the first one I went on I asked them about that and I looked at the cows and they dont get sick. I was like oh huh which would I rather do: have sick animals that I can treat because I'm allowed or have cows that dont get sick because I have prevented it and they are healthier in the first place and that is what won me over. In the three years that I have been farming, we have never had a DA, we dont get katotic cows, especialy the metabolic things, yes you are going to get some milk cleaver because a cow is a cow but you can treat all that, theres some new research too about treating mastitis with antibiotics, and its gets better in a week if you treat it and 7 days if you dont kind of thing, it really hasnt been an issue on our farm in cows.

So we have 2000 animals. We don't use a lot of medicine. On a daily basis, there is next to no medication given unless needed. Things like that, that's calcium. When a cow first has a baby, it's basically electrolytes. A lot of these things are preventative things but as far as penicillin, and tetracycline, it's very minimal - the goal is none, we don't wanna do it. Who the heck wants to give shots?

sure on the whole no till practices because all that ground gets sprayed with an herbicide before we plant and then it gets sprayed again after we plant the corn. The fertilizer that we use is not considered organic but it is nearly organic. It is considered food grade ingredients so it is something that we could feed the cows and it is not considered a chemical. Some of the salesman that come around says you could actually drink it yourself and it wont hurt ya, of course you cant drink a lot...The hay ground doesnt get any chemicals on it at all, it does get some of the liquid fertilizer we use, 3 gallons to an acres, so its not a lot but it does help the plant stay healthy.

Organic

My parents moved out here in ‘88 and had a flock of about 200 ewes. They hayed the land, there was no chemicals used. It was very easy when my dad decided to start growing his own grain and making his own feed. Which is technically organic even though he wasn’t certified. And then he just started to see more of a demand, sold the sheep, started buying more grain. Yeah, and that’s where organic kind of comes from, is that people who have already been farming organically before organic was a regulated word. Those are the people that are actually trying to protect the integrity of organic, not just trying to do it as a source of marketing or more money. They are the one who are more apt to follow the rules. And he grew more, and he bought more. And he kind of just went from there. So to become certified he just went to do the paperwork and pay the fees, and it was really easy because he has never put anything on the land here.

There’s a whole bunch of reasons we are organic in the first place, and that dictates a lot of the reasons we do what we do, especially herd health wise. I used to have a job doing herd health on conventional farms and so the practices I used to use to treat farms definitely varied from the rules basically, which I think there is a reason behind all those rules. – Annie

It's what is healthiest for the cows, whats cost effective, less labor intensive, and like I said economical and what’s best for the cows so it’s kind of a balancing act of what’s best for them best for us, and what’s best for our checkbook as a business.

I’m not your typical organic tree hugger

Nutrient Management

Yeah we don’t have anything formal, we try to pick the fields we feel need the nutrients and also fields that are solid enough that we can get on so there aren’t going to be ruts in the dirt and stuff like that. We have our land base per cow...we have a lot more land than we need for the number of cows we are milking so we have a hard time covering each year with manure so we kinda just go where we know it hasn’t been spread for a while and if we can, some fields are higher and drier than others so in the winter or spring when it is muddy, those fields get covered every year. That is one benefit of being a small farm, we don’t have to do all the paperwork regulations that some of these bigger farms, farms that fall under CAFO, they have a lot more things, paperwork, they have to do, keep records that we don’t have to keep.

Not really, because we grow more corn than what we really need we have plenty of places to spread our manure, we do spread manure during the winter, we don’t have a pit but what I do do is make sure when I am spreading manure in the winter that im spreading on, we have quite a few pretty level fields, so I try to make sure when I am spreading in the winter that I spread on a nice level field so that nutrients don’t end up in the hudson river. Plus if I am spreading on that combine ground than there that nice cover that I have got of stalks that is helping to keep that manure there as well. We try to be careful about our barnyard, my son works at capital tractor but he ocmes and helps in the morning and he is very good about keeping the barnyard clean so this water going thru the barnyard doesnt pick up manure and end up you know

but I can see a lot of the same things I just didn't like. We were already grazing our cows. I didn't like to spray herbicides as much. I thought it was killing too much. So that's why we looked into it, and it just worked for us. We wanted to stay small.

where. We also have a drain up in here which doesnt work very well. It runs underneath this concrete, runs up in between these two barns and that is supposed to catch all that water coming off from the eaves of these two barns and take it underneath over to the brook but it is a good thought but you have to keep that top perfectly clean. Now there is rock, the tile is underneath and then there is rock that comes all the way up to the surface. You got to keep that surface very clean to get that water to run down thru the rock and into the tile and out into the brook but that was the original plan but its worked so so.

We certainly try to do as much as we can with our own manure, we do a lot of manure sampling and soil sampling you know its all about balancing the nutrients for crop removal for us, so when we sit down with our CAFO planner every year you know we look at what the crop plan is, what the planned group is for each field, and what the crop removal plan will be and what the existing soil conditions are so you know what nutrients are already there and what nutrients we may need to add in order to support to grow the crop we intend to grow there for the year so we try to do as much of that as we can with manure but we will supplement when necessary especially when we only need a certain nutrient. Like if we only need nitrogen or whatever rather than applying manure and overloading phosphorus, we might purchase, so Caravail does all of our spray and fertilizing, they are out of Salem, and so will on occasion when necessary use commercial fertilizer.

We operate about 2500 acres of land and we also operate an anaerobic digester where we mix manure and milk processing byproducts together,

heat it to 100 degrees to make methane to produce power.

It's crazy to know the detail, and to know that we have a lot of technology that helps us, know where to apply manure. It's not just applying manure to an entire field. It's applying manure only to this part of the field. Where we're gonna add extra fertilizer to this part and not this part because it's not needed because it's lower in phosphorus only in this section for whatever reason that the rest of it. And there's so many cool things going on, and it's just even for me growing up on a farm, and seeing the difference between 1985 or 1990 to where we are today.