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VIEWPOINT

Coordinating a "basket of incentives" to facilitate resilience in the dairy sector

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INTRODUCTION AND OVERVIEW

The dairy farm sector has been the backbone of rural communities throughout the northeastern United States for more than 100 years. Beyond this important heritage, the region's dairy farms drive economic activity in its rural communities. However, from late 2014 through September of 2020, the farmgate price of milk has been below the cost of production for most dairy farms in the region (Farm Credit East 2020; Karszes et al. 2020). The loss of dairy farms is not only a tragedy for the multigenerational farm families, it is a loss for working landscapes, rural communities, and the economy of the Northeast region.

The intersection of the dairy farm financial crisis with the growing urgency to find solutions to the water quality and climate problems provides a unique opportunity to feed two birds out of one hand. Public and private sector collaboration can create pathways for transformation in the dairy farm sector—transformation toward farms that have financial resilience and the ability to help address these crucial environmental problems. Protecting water quality and reducing net greenhouse gas emissions are essential. Production systems that can do this while earning profits will not require ongoing public investments or subsidies to produce these necessary ecosystem services. However, creating the pathways for widespread dairy farm transformation requires significant investment now. Planting the seeds of change today will yield an ongoing stream of economic and environmental benefits into the future.

The burden of this transformation cannot be put on the farmers alone. It is in society's best interest to invest in a healthy dairy farm sector and assist interested farmers through the transformation process with coordinated funding and technical assistance. The basis for the transformation in dairy production needs to focus on rapidly improving soil health, as this provides the agronomic productivity to support the farms' bottom lines, reduce the nutrient loss that is causing water quality problems, and decrease net greenhouse gas emissions by increasing carbon (C) draw down. At the heart of the regenerative agriculture movement are farming and grazing practices that sequester C by rebuilding soil organic matter, which brings with it a host of important co-benefits, including mitigation of downstream flooding through greater water holding capacity of the soil and significant economic benefits for farmers.

The focus of this paper is not specific systems of regenerative agriculture. Instead we focus on ways to creatively combine resources, traditional and innovative, public and private, in a way that provides incentives and financing for dairy farm transformations that benefit farmers, rural communities, and the environment.

ECONOMIC AND ENVIRONMENTAL PERFORMANCE OF DAIRY

The COVID-19 pandemic has reduced the demand for milk and further depressed farmgate milk prices in 2020 on the heels of five years of low milk prices. This has caused large numbers of dairy farms in the Northeast to exit the industry. As each farm goes out of business, it leaves a hole in the region's working landscape and in rural economies. Although the increased volatility and downward pressure on milk prices (figure 1) play a large role, the long-term health of the region's dairy farm sector requires new production systems that are more resilient to lower prices and financial and environmental shocks. As seen in figure 2, net returns (i.e., profits) on US dairy farms have been mostly negative since the early 1990s (MacDonald et al. 2020). Promoting solutions that enhance farm profitability and improve environmental performance simultaneously are crucial. Significant improvements in soil health seem to hold the key to a set of win-win solutions.

As the single largest agricultural land use in the Northeast region, dairy farming has an undeniable impact on the environment, particularly the interrelated issues of soil health, water quality, and climate change. Field management practices, such as crop rotations and the type, timing, and frequency of tillage operations, have an important impact on soil structure, soil organic matter, and C content, as well as soil loss. Soil structure, organic matter, and C content not only impact the water holding capacity of the soil, which provides resilience to drought, but also improve the soil's productivity and help to minimize downstream flooding. Soil health is increasingly understood as a central component to reduce nutrient losses from farms into ground and surface water, which impact the water quality of the streams and lakes these nutrients flow into. Supporting dairy farmers' efforts to improve their soil health is an investment in the broader regional economy with tourism and recreation industries standing to benefit alongside farmers. Further, agricultural land has great potential as a C sink by removing carbon dioxide (CO_2) from the atmosphere and storing C in the soil.

Financial Resilience. Fostering production systems that are good for the farm business and good for the environment is critical. Without improved dairy farm financial resilience, support and subsidies to the sector are likely to be needed perpetually, and the ability of farmers to implement conventional conservation practices will remain limited. Resiliency is defined as the ability to recover from or adjust easily to misfortune or change. Farms that can produce milk at a lower cost and have the flexibility to alter their input mix and production level to better withstand shocks to feed or milk prices will have greater resiliency and higher probability of long-term survival.

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Figure 1

Northeastern US real farmgate milk prices 45% lower than in 1979 (Farm Credit East 2020). Real price equals actual price adjusted for inflation (2019 dollars).

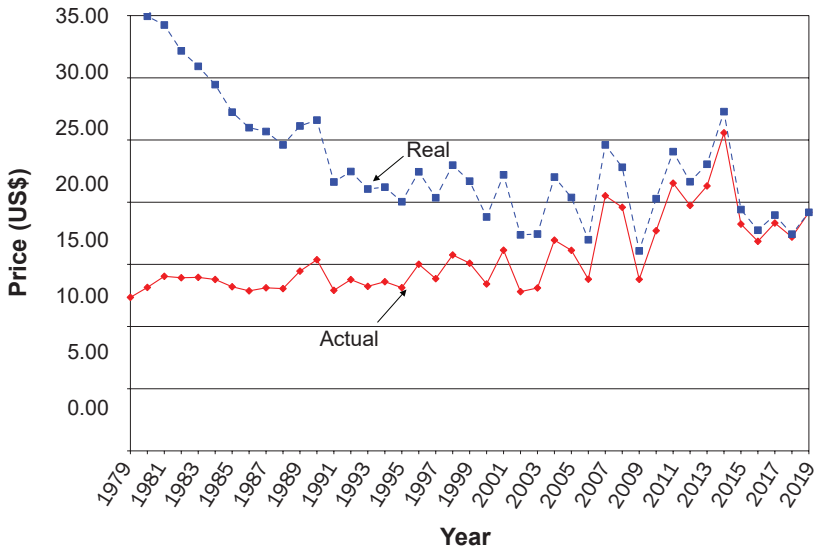
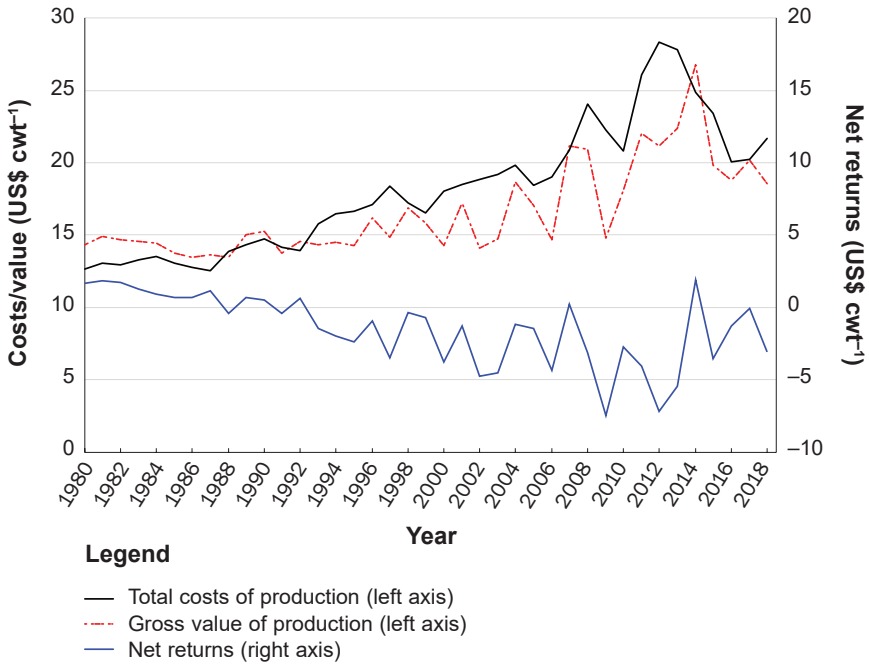


Figure 2

US dairy farm costs of production and net returns 1980 to 2018 (MacDonald et al. 2020).



For dairy farms to be financially resilient in the long-term, they need to be efficient and adaptable. A common attempt to increase efficiency by dairy farms has been to increase economies of scale, which allows farmers to spread their fixed costs of production, such as buildings and equipment, over more units of output. Conventional wisdom in the industry presents the key to survival as increased capital investment to both (1) expand animal housing and increase herd size, and (2) invest in technology and management to increase milk production per cow. Capital investment generally requires taking on new debt and increases the costs of debt service for the farm. Farms with high capital investment per cow need to strive for maximum milk production per cow to maintain positive cash flow, which is the famer's most immediate financial concern. The increased milk production resulting from continuous pressure to produce more puts additional downward pressure on milk prices, further exacerbating the dairy farm crisis.

As can be seen in figure 3, economies of scale are represented by a movement down and to the right on the long-run average cost (LRAC) curve; herd size and milk output are increased to reduce average total costs of production. Transformation changes the farm's cost structure resulting in a downward shift in the LRAC curve to LRAC'. This indicates that costs of production can be reduced without increasing herd size or milk output, although somewhat larger herd sizes may be necessary. Shifting the cost curve downward will help to reduce the pressure to "get big or get out" that is so prevalent in the dairy sector today.

Restructuring a dairy farm can be very difficult to do, especially given the massive daily level of effort required just to keep the farm running. Even if the outcome is a leaner and more profitable farm, the risks and costs associated with the transformation can be too great for the farmer to take on alone. This is where the "basket of incentives" concept develops traction, by facilitating the transformation through a variety of funding and financing options and adequate technical assistance. If the transformation also produces a flow of quantifiable ecosystem services, as improved soil health will do, the value of the transformation may have broad public benefits, further justifying the work needed to coordinate the basket of incentives.

FACILITATING CHANGE THROUGH A BASKET OF INCENTIVES

The basket of incentives concept represents a coordinated effort to provide interested farmers with comprehensive planning and financial resources to navigate intentional change toward improved soil health and greater financial resilience.

The goal of the basket is to motivate farmers and facilitate the transformation (i.e., help them to get over the hump) to an improved production system that provides a long-term stream of environmental benefits. The basket would contain sources of both funding and financing, including commercial lenders that have an interest in positive environmental outcomes. In addition to the obvious and traditional sources, such as federal and state conservation programs, the basket would contain novel sources of public funds, such as those dedicated to clean water and rural development.

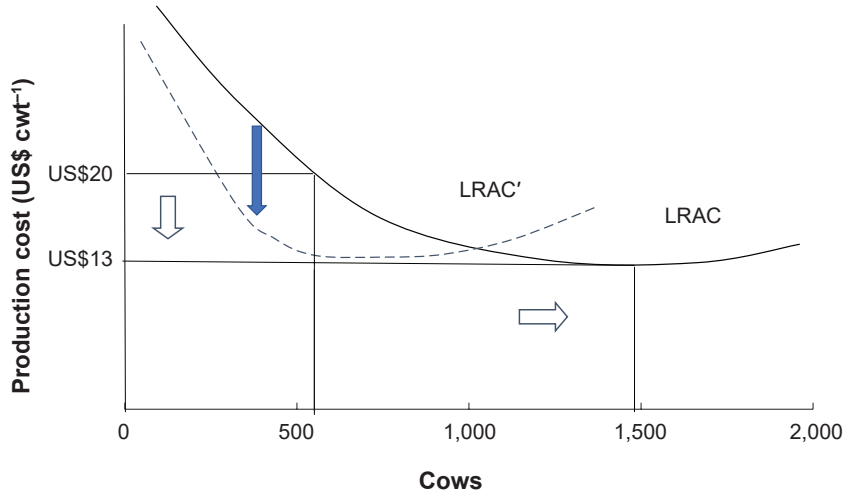
The basket would draw from both public and private sector sources, which may include processors, retailers, and other businesses in the dairy supply chain, as well as entities working in conservation finance. It would include traditional cost-share payments to farmers, payments linked to quantified environmental performance, subsidized government loans, and block grants to entities that support farms, as well as funding and finance from the private sector. Focusing more sources of public funds on improving soil health may have the effect of reducing the risk borne by potential private sector investors who are interested in financing the production of ecosystem services.

To provide an example, this section describes some Vermont-specific sources of funding and financing that would be good candidates for inclusion in a Vermont basket of incentives, which is currently being explored with support from the Vermont Office of the USDA Natural Resources Conservation Service. States can learn from each other as the formula for the basket remains the same, even if the specific state programs vary. Figure 4 depicts the likely sources of a Vermont basket.

Any transformation that significantly improves soil health will also be producing one or more ecosystem services. Embedded in the concept of the basket is a focus on quantifiable environmental outcomes, which allow (1) farmers to be secure in their role as part of the solution, (2) society to know that it is getting something tangible for its investment, and (3) for the possibility of additional revenue streams to farmers for the ecosystem services produced. The categories of funds and financing that the basket might include are briefly described below.

Figure 3

Economies of scale versus transformation. Economies of scale usually focuses on herd size expansion to spread fixed costs. Transforming the production system involves changes in the farm's cost structure to reduce average total costs at a given herd size. LRAC is long-run average total cost per hundredweight (cwt).



The obvious starting places are the well-known and established federal and state programs that are designed to incentivize conservation activities on the farm. USDA alone spends more than US$5 billion annually on conservation programs nationwide; states generally contribute additional funds to these conservation efforts on farms. These go-to federal and state funding programs would be at the top of the basket, being most often accessed. Ideally, interest from federal and state governments to reward farmers for environmental performance, rather than paying for practices, will continue to grow. Ribaudo et al. (2014) showed that pay-for-performance conservation programs can be more than four times as cost-effective as paying for practices in the Chesapeake Bay watershed.

Other public funds that have obvious linkages to the basket are those that have water quality or rural development objectives. For example, Vermont's Clean Water State Revolving Fund could provide very low interest loans to organizations or towns that are then accessed by farms to make changes that reduce nutrient losses. Similarly, a strong argument can be made for the value of rural development block grants from USDA to be focused on bolstering the financial resilience of the dairy farm sector in dairy-dependent communities. Additionally, Vermont's Working Lands Enterprise Initiative provides technical and financial assistance to land-based businesses.

Because the basket of incentives will have a focus on quantified environmental outcomes, it is very possible that farmers could secure additional revenue streams from C and/or water quality markets. In theory, C credits can be sold from any geography. However, at current C credit prices, making C credits from agricultural land cost-effective generally requires aggregation across thousands of acres. In contrast, water quality credits can be cost-effective at the scale of a single farm, but there are very few geographies in which water quality credit trading currently exists. Vermont has several new laws, including Acts 64, 76, and 83, that provide some additional funding for environmental outcomes from agriculture and start to enable payments for ecosystem services approaches.

There are a growing number of private sector entities that are working under the banner of conservation finance. These companies look for opportunities to use their capital to produce needed environmental outcomes. They do so

Figure 4

Coordinating across relevant sources of public funds can facilitate transformation on the farm and can help to de-risk additional investment from the private sector.

by organizing the needed outreach and technical assistance, applying a quantification methodology, and arranging for third party verification. Conservation financiers either sell the quantified outcomes in a specific environmental market as credits or get reimbursed from a government agency or municipality that required those outcomes, usually with a nominal return on investment included.

The ability to reduce the risk borne by these private sector investors by using various sources of applicable public funds to facilitate changes on the farm or sweeten the deal for farmers will help to leverage more private dollars for conservation. Combining public and private investments in conservation increases the size of the pie and will result in more conservation and more cost-effective outcomes.

In addition to private sector investors, there are many companies in the dairy supply chain that are investing dollars to help improve environmental outcomes and the financial bottom line on the farms from which they source their milk. Danone North America and Ben & Jerry's are good examples; they want to contribute to important solutions and ensure the longevity of their supplying farms. Because it makes their dollars go further, being part of a coordinated effort, such as the basket of incentives, may increase the willingness of more companies in the dairy supply chain to invest in transformative change on farms. This will save companies from having to figure it out on their own and allow them to not bear all the associated risks.

TYPES OF TRANSFORMATIVE CHANGE FOR DAIRY FARMS

It is important to recognize that facilitating transformative change in the dairy farm sector will require highly skilled and effective technical assistance to work closely with interested farmers. This should include assistance on crop and livestock production (including agri-environmental performance), as well as farm financial and business planning. Ideally, experts would work with farmers as coordinated teams to ensure comprehensive assessments and plans. This assistance will be essential to successfully help interested farmers assess their current situation and their options for the future.

There are several options for transformative change on the farm to maximize soil health. The five principles for improving soil health include (1) keeping the soil covered, (2) minimizing soil disturbance, (3) keeping living roots in the ground all year, (4) increasing plant and microbial diversity, and (5) integrating livestock into cropping systems. Although these principles can be achieved in many different ways, we will describe two relevant categories of change as examples. These include cropland management and low-input dairy grazing systems.

Cropland Management for "All In" Soil Health. This is multiple, stacked practices that work together to achieve at least the first four soil health principles (and all five for dairy farms). It can include various combinations of cover cropping, no-till, soil-enhancing crop rotations, soil amendments, and even biological enhancements. A small but growing number of farmers throughout the Midwest and Mid-South are sharing very impressive results from the innovative cropping systems they are using.

For example, Rick Clark, who farms 2,833 ha (7,000 ac) in Indiana, uses diverse cover crops in an all no-till system with soil-enhancing crop rotations to grow corn (*Zea mays* L.), beans (*Glycine max* [L.] Merr.), wheat (*Triticum aestivum* L.), peas (*Pisum sativum* L.), hay, and other crops. Although he is not a dairy farmer, he produces feed for a large dairy nearby. Producing forages for the dairy allows Clark greater flexibility in crop rotations and provides access to manure for his land, both of which help him to further boost soil health. Compared to 2011, when Clark farmed in a more conventional manner, he calculates that he is now using 50% of his previous fuel and synthetic nitrogen (N) use, and zero monoammonium phosphate, potash, and lime. He estimates that he is saving over US$222 ha^{-1} (US$90 ac^{-1}) without any reduction in yield.

Making this type of transformative change requires thorough planning and access to some different equipment. A key piece of equipment for Clark is a 18 m (60 ft) wide roller-crimper that he uses to terminate growing cover crops in the spring. In his system, he plants corn and soybeans directly into green and growing cover crops and then uses the roller-crimper to terminate the cover crop. The corn and soybeans grow up through the crimped cover, which creates an armor on the soil and suppresses weeds. His cover crops are often a cocktail of eight or more species to improve diversity.

Although a much smaller roller-crimper would suffice on most farms, the basket of incentives could help other farmers acquire the equipment that they need to get started on an "all in" approach to soil health through changes to their cropland management. According to Clark, all tillage equipment can be sold from the farm, which can often offset the cost of any additional equipment needed.

Clark strives to create a systematic approach to regenerative farming that reduces costs and maintains crop yields. Adaptations of this and similar systems for the Northeast exist and are being improved upon by farmers every year. The basket of incentives could facilitate Northeastern farmers to acquire the equipment and the technical assistance that they need to get started on these types of a transformations of their cropland management.

Low Input Dairy Grazing Systems. Low-input dairy grazing systems have great potential to be financially and environmentally resilient. This system is a modification of the New Zealand dairy grazing system, but designed to work in the northern United States. The focus of this system is maximizing the percentage of nutrients in the herd's ration that come from grazed pasture forage at a scale that generates adequate revenue. There are three important metrics that make this system work: (1) low feed costs per unit of milk produced, (2) high milk sold per full-time equivalent worker, and (3) low total assets (and debt) per cow.

Creating this type of dairy farm generally requires significant changes to the farm's infrastructure. To achieve the labor efficiency of greater than 0.5 million kg (1 million lb) of milk per worker will require an efficient milking system. A high throughput milking parlor that can allow each person to milk at least 100 cows per hour is preferable to keep each milking to

under two hours. Building such a milking system is likely to cost several hundred thousand dollars. Assuming that herd average for a full-on grazing farm may be in the area of 6,350 kg cow^{-1} y^{-1} (14,000 lb cow^{-1} yr^{-1}), at least 75 cows per worker will be necessary; increasing the herd size will require additional investment. The milking parlor and cows could qualify for low-interest loans or grants from rural development or environmental agencies. Fencing, water system, and cattle lanes will also be necessary investments; these may be able to be funded through existing USDA and state cost-share programs.

The value of depreciable assets, such as machinery and buildings, as a percentage of total farm assets should be much lower for this type of farm than for a conventional dairy farm. This type of farm maximizes the value of the money-making assets, such as cows and land, relative to the value of machinery and buildings needed on the farm. This change in asset structure and production system shifts the ATC curve downward to ATC', as depicted in figure 1 above.

The environmental benefits from this type of larger herd, low-input dairy grazing system are many. By having all land in permanent vegetative cover, soil is held in place which reduces erosion and nutrient transport to surface water, as well as sequestering C in the soil and providing wildlife habitat. By maximizing nutrient intake from grazed pasture forage with minimal grain supplementation, the farm will be closer to a mass nutrient balance, which reduces the risk of nutrient pollution to surface and ground water.

The type of funding and financing sources that a farm needs from the basket will be determined by the type of transformation a farmer is interested in making. For example, changing cropland management may only need a performance-based environmental payment from government or from markets. But it may also require investment in a no-till planter, a roller-crimper, or other equipment, which may be able to be funded or financed through existing federal and/or state programs. However, to transform the farm into a low-input dairy grazing operation will likely require investments in farm infrastructure and more cows, which may additionally require debt restructuring, new loans, as well as government cost-share and payments for environmental performance. Recognizing that one size does not fit all, the basket should create a "one-stop shop" to provide options and facilitate change.

SUMMARY AND RECOMMENDATIONS

The Northeast dairy farm sector is experiencing unprecedented upheaval. Not only are there pressures on farmers to address environmental conditions, farmers are fighting just to stay afloat. Currently, there are funds available through federal and state conservation programs, but these are mostly for tweaks not for transformations. Although these tweaks are positive changes, they are not likely to save the farm nor are they likely to deliver the magnitude of environmental gains that are needed from agriculture. Facilitating transformative change can be a big job, and for these instances, no single source of funding or financing is likely to be sufficient.

To create the basket of incentives, agricultural and environmental leaders will need to come together with farmers and funders and think broadly about goals and intentions. These baskets of incentives will likely need to be state-specific to be tailored to the context and take advantage of state funding sources. However, once up and running in one state, other states could build from the same mold. Neighboring states may be inclined to coordinate resources and technical assistance.

There are several key steps to coordinating a basket of incentives for soil health for any state. First, identify and quantify available funds from all federal, state, and municipal sources, as well as catalogue the options that each can be used for. Second, asses all regulatory drivers that impact environmental outcomes from agriculture and determine if and how they translate into effective demand for specific environmental outcomes. Third, use the results of the previous two steps in communication with potential private sector funding sources, including conservation financiers as well as companies in the dairy supply chain. Fourth, facilitate coordination of technical assistance teams to work closely with interested farmers.

With the support of USDA Natural Resources Conservation Service through a Conservation Innovation Grant, these four initial steps are currently being taken toward creating a Vermont basket of incentives. The information and outputs produced from this project will be made available to any interested parties by request to the authors.

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