Farm Inputs

What kinds of resources are needed to produce food in Vermont? How can Vermont farmers deal with rising production costs?

Before food production can occur, a number of critical inputs are required, from land to labor and from seed to feed. A major switchover—from human and animal based labor—to fossil fuel based inputs and fossil fuel dependency has changed the face of American agriculture. Despite major gains in productivity over the past 60 years, increases in production costs, largely driven by rising crude oil prices, have meant that average national net farm income levels in 2009 were actually 21% below 1970 levels.

The thing with farming is that it's one of the few professions where you have a multitude of uncontrollable variables. You can't ever predict the weather from year to year or even day to day, so it's high risk. Sometimes it's scary to want to invest more into land or overextend yourself.

—Windham focus group participant

Most Vermont farms today rely on out-of-state sources for equipment, seeds, feed, fuel, and fertilizer. A recent USDA report found that **"the largest four firms in the crop seed, agricultural chemical, animal health, animal genetics/breeding, and farm machinery sectors accounted for more than 50 percent of global market sales in each sector."**[1]

Chapter 3, Section 2: Farm Inputs explores changes in the production, availability, and cost of farm inputs, including land, soil, fertilizer, animal feed, seed, water, labor, and energy.

PHOTO CREDIT: UVM Special Collections

Farmer and hired man cultivating Vermont field, date unknown. Petroleum based inputs and machinery largely replaced human and animal labor during the 20th century.

THE ROLE OF INPUT COSTS

Agricultural Productivity

The *USDA Economic Research Service* (ERS) has developed a measure of *annual agricultural productivity* (or total factor productivity) that attempts to describe changes in the *efficiency* with which inputs are transformed into outputs. That is, annual agricultural productivity measures the difference between the growth of total agricultural output (reported as an index that includes livestock, dairy, fruits and vegetables, and other outputs) and the growth of all inputs (reported as an index that includes capital, labor, energy, chemicals, purchased services, and other inputs).

From 1948 to 2009, the index of total farm output increased about 170%, growing at an average annual rate of 1.63% (Tables 3.2.1 and 3.2.2, Figure 3.2.1). During this time frame, the United States became a major food producer for the world. Aggregate input use grew at an average annual rate of 0.11% and only increased 7.1% overall from 1948 to 2009. As a result, the USDA ERS reports that **farm productivity in the United States was 170% higher in 2009 than it was in 1948, and it grew at an average annual rate of 1.52% during that time frame.**[2]

Table 3.2.1: U.S. Agricultural Productivity Growth Rate, 1948-2009

Average Annual Growth Rate	Percent
Output Growth	**1.63%**
Input growth	**0.11%**
Inputs	
Labor	-2.51%
Capital	-.21%
Land	-0.52%
Materials	1.43%
Total factor productivity	**1.52%**

Source: USDA Economic Research Service, *www.ers.usda.gov/data-products/agricultural-productivity-in-the-us.aspx*.

Agricultural productivity has increased for a variety of reasons, including yearly weather fluctuations, increased mechanization and use of fossil fuels, more efficient use of energy and materials, improved quality of inputs, increased farm consolidation and specialization, the decoupling of livestock and crop production, government policies, a changing farm workforce (i.e., decreased labor), and behavior changes.

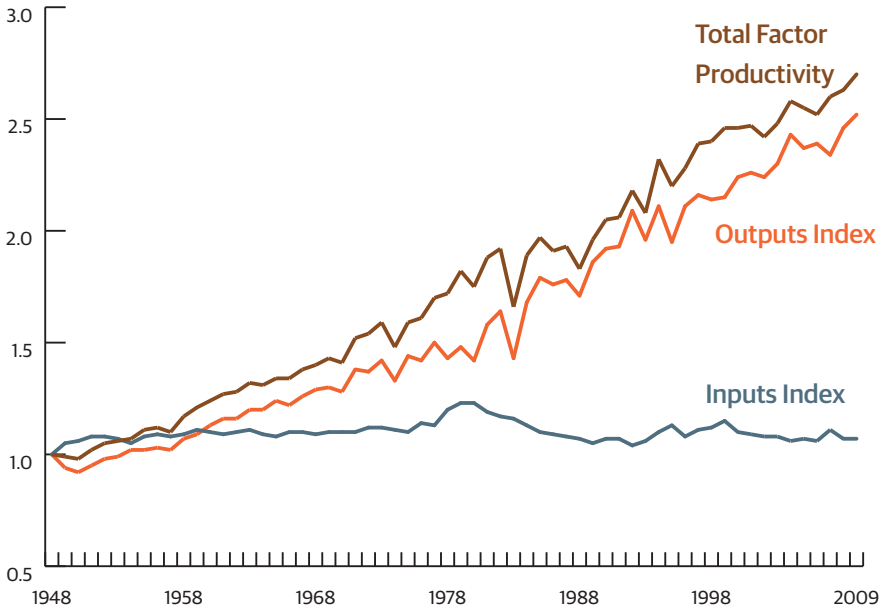
Although the index of total inputs increased slightly from 1948 to 2009, the composition of inputs changed dramatically: indices for land and labor inputs declined -2.76% and -10.73% respectively. The index of materials inputs increased 138.54% overall, including increases in energy (67.64%), chemicals (370.27%), and purchased services (101.81%). In other words, **U.S. agriculture is now much more reliant on material inputs (many of them petroleum based) purchased off the farm and less reliant on labor.**[3]

Table 3.2.2: U.S. Agricultural Productivity Average Annual Growth Rates

	Outputs	Inputs	Productivity
1948-1953	1.18%	1.30%	-0.16%
1953-1957	0.96%	0.28%	0.68%
1957-1960	4.03%	0.50%	3.53%
1960-1966	1.21%	0.05%	1.16%
1966-1969	2.24%	-0.08%	2.32%
1969-1973	2.65%	0.46%	2.19%
1973-1979	2.26%	1.64%	0.62%
1979-1981	1.53%	-1.85%	3.39%
1981-1990	0.96%	-1.22%	2.19%
1990-2000	1.84%	0.31%	1.53%
2000-2007	0.77%	0.14%	0.63%
2007-2009	1.88%	-1.80%	3.68%
1948-2009	**1.63%**	**0.11%**	**1.52%**

Source: USDA Economic Research Service, *www.ers.usda.gov/data-products/agricultural-productivity-in-the-us.aspx*.

Figure 3.2.1: Agricultural Productivity in the United States, 1948-2009



Source: USDA Economic Research Service, www.ers.usda.gov/data-products/agricultural-productivity-in-the-us.aspx.

"We as a nation have an expansive appetite for inexpensive food. To produce more, you have to turn to strategies like chemicals and pesticides."[4]

—USDA Secretary Tom Vilsack

Agricultural productivity in Vermont was 104% higher in 2004 than it was in 1960, and it grew at an average annual rate of 1.62% during that time frame (nationally, agricultural productivity was 215% higher in 2004 than it was in 1960, and it grew at an average annual rate of 1.74%). Of course, agricultural production in Vermont differs from agricultural production in the rest of the country in significant ways. Vermont's productivity gains were made on a much smaller increase in outputs and a much steeper decline in inputs compared to the national average (Table 3.2.3). Over 70% of the market value of agricultural products produced in Vermont is generated from just one commodity: dairy products. The number of dairy farms has dropped nearly 90% in the past 60 years and the number of milk cows are down by 50%, but the annual average gallons of milk produced per cow are up by over 200% from 1920s levels. Vermont's ability to produce more milk from fewer animals may help to explain the state's productivity gains. Vermont ranked 29th in the nation in agricultural productivity in 2004, and 26th in average annual productivity change (i.e., increased productivity) from 1960 to 2004.

In contrast to national trends, the index for total agricultural output in Vermont increased at an annual average of only 0.24% and grew 11% overall from 1960 to 2004 (the national average growth rate was 1.64% during that time frame). The index for total inputs decreased at an annual clip of 1.38% and 45% overall from 1960 to 2004 (the national average growth rate was –0.10% during that time frame). **The only input that had a positive annual average growth rate from 1960 to 2004 in Vermont was energy (0.48%).**

Table 3.2.3: Vermont Agricultural Productivity, 1960-2004

	Outputs	Inputs	Productivity
1960-1966	-0.41%	-3.04%	2.63%
1966-1969	-1.05%	-3.17%	2.11%
1969-1973	0.00031%	-1.70%	1.70%
1973-1979	2.06%	2.31%	-0.25%
1979-1981	1.26%	2.90%	-1.63%
1981-1990	-0.37%	-2.74%	2.37%
1990-2000	1.19%	-0.62%	1.80%
2000-2004	-1.77%	-3.71%	1.94%
1960-2004	**0.24%**	**-1.38%**	**1.62%**

Source: USDA Economic Research Service, www.ers.usda.gov/data-products/agricultural-productivity-in-the-us.aspx.

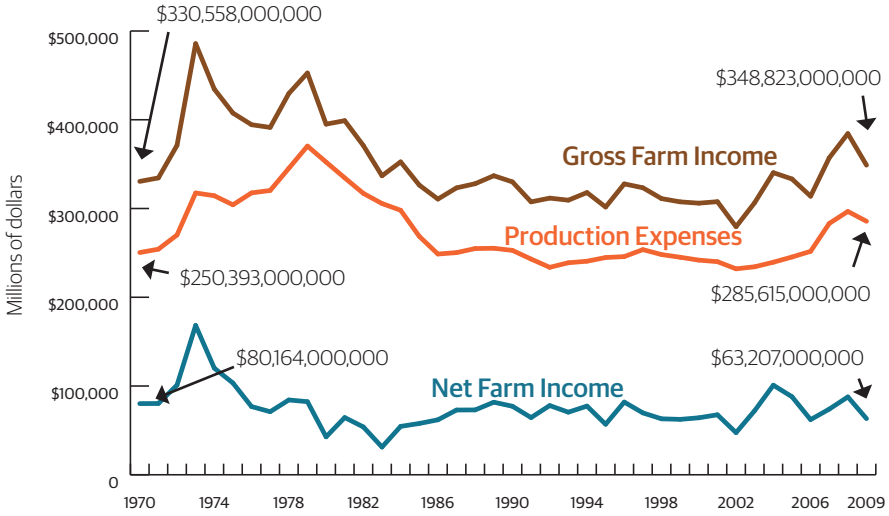
Net Farm Income

Despite tremendous gains in agricultural productivity in the United States, **aggregate gross farm income increased only 6% in real terms from 1970 to 2009, while total production costs increased 14%** (adjusted for inflation to 2010 dollars). Much of this increase in the cost of farm inputs has been attributed to rising crude oil prices.[5] **The peak year for gross and net farm income in the United States was 1973** (Figure 3.2.2). Major productivity gains occurred in the United States with relatively flat growth in the use of most inputs, but increases in the cost and use of material inputs (especially petroleum products) mean that national **net farm income levels were actually 21% below 1970 levels in 2009.** Gross farm income increased or stayed the same 19 times on a year-to-year basis from 1970 to 2009 (i.e., from 1970 to 1971, from 1971 to 1972, and so on), and the aggregate value of net farm income increased or stayed the same 20 times. However, these gains frequently did not exceed previous year-to-year losses. Table 3.2.4 shows peak-to-peak growth rates for gross farm income, production costs, and net farm income. In six of the nine peak-to-peak periods after 1973, gross farm income declined; production expenses increased or stayed the same in four out of nine periods; and net farm income decreased in six out of nine periods.

As a subsystem of the larger U.S. food system—and one that is heavily dependent on dairy production—Vermont's gross farm income, production expenses, and net farm income vary quite a bit from national averages. For example, the conventional milk market is characterized by high price volatility, and milk producers can lose money on each pound produced in some years. **Total gross farm income (-35%), production costs (-24%), and net farm income (-65%) all declined in Vermont from 1970 to 2009** (Figure 3.2.3). The peak year of net farm income in Vermont was 1972. Table 3.2.5 shows peak-to-peak growth rates for gross farm income, production costs, and net farm income in Vermont. In four of the ten peak-to-peak periods, gross farm income declined, expenses increased in five out of ten periods, and net farm income decreased in six out of ten periods.

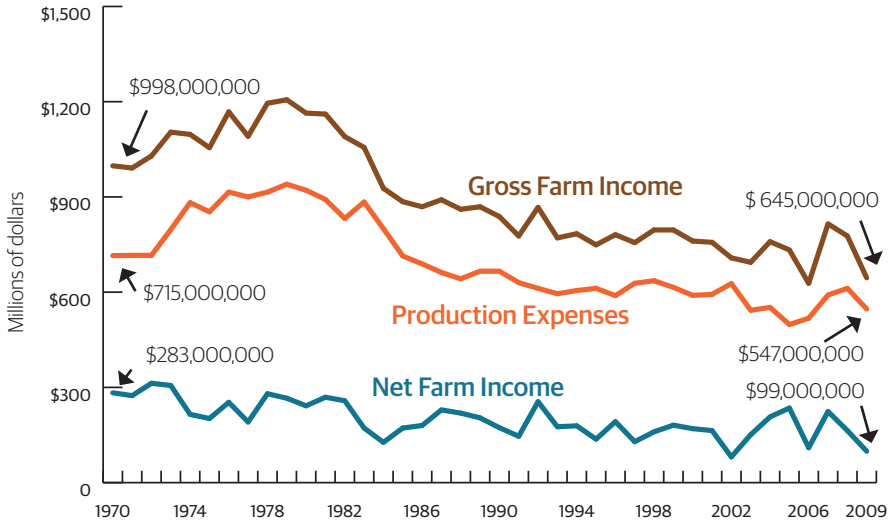
Aggregate net farm income data masks considerable variation in gains or losses among farms of various sizes. For example, 64% of small family farms in Vermont (i.e., farms with sales under $100,000) reported net *losses* from 2002 to 2007, while 81% of large, very large, and nonfamily farms reported net *gains* between 2002 and 2007.[6]

Figure 3.2.2: U.S. Aggregate Gross Farm Income, Production Expenses, and Net Farm Income, 1970-2009



Source: USDA Economic Research Service, www.ers.usda.gov/topics/farm-economy/farm-sector-income-finances.aspx.

Figure 3.2.3: Vermont Aggregate Gross Farm Income, Production Expenses, and Net Farm Income, 1970-2009



Source: USDA Economic Research Service, www.ers.usda.gov/topics/farm-economy/farm-sector-income-finances.aspx.

Table 3.2.4: Peak-to-Peak Growth Rates for U.S. Aggregate Gross Farm Income, Production Expenses, and Net Farm Income

	1970-1973	1973-1979	1979-1981	1981-1984	1984-1989	1989-1994	1994-1996	1996-2001	2001-2004	2004-2008
Gross	47%	-7%	-12%	-12%	-4%	-6%	3%	-6%	11%	13%
Expenses	27%	17%	-10%	-11%	-14%	-6%	2%	-2%	0%	24%
Net	110%	-51%	-22%	-15%	50%	-5%	6%	-17%	49%	-13%

Source: USDA Economic Research Service, www.ers.usda.gov/topics/farm-economy/farm-sector-income-finances.aspx.

Table 3.2.5: Peak-to-Peak Growth Rates for Vermont Aggregate Gross Farm Income, Production Expenses, and Net Farm Income

	1973-1976	1976-1979	1979-1987	1987-1989	1989-1992	1992-1994	1994-1996	1996-1998	1998-2004	2004-2007
Gross	5.9%	3.3%	-26.1%	-2.4%	-0.3%	-9.6%	-0.5%	1.9%	-4.6%	7.4%
Expenses	14.7%	2.8%	-29.5%	0.5%	-8.0%	-1.1%	-17.7%	8.0%	-13.2%	7.2%
Net	-17.3%	5.1%	-14.1%	-10.9%	25.1%	-29.9%	-32.1%	-16.7%	29.7%	8.0%

Source: USDA Economic Research Service, www.ers.usda.gov/topics/farm-economy/farm-sector-income-finances.aspx.

Production Costs

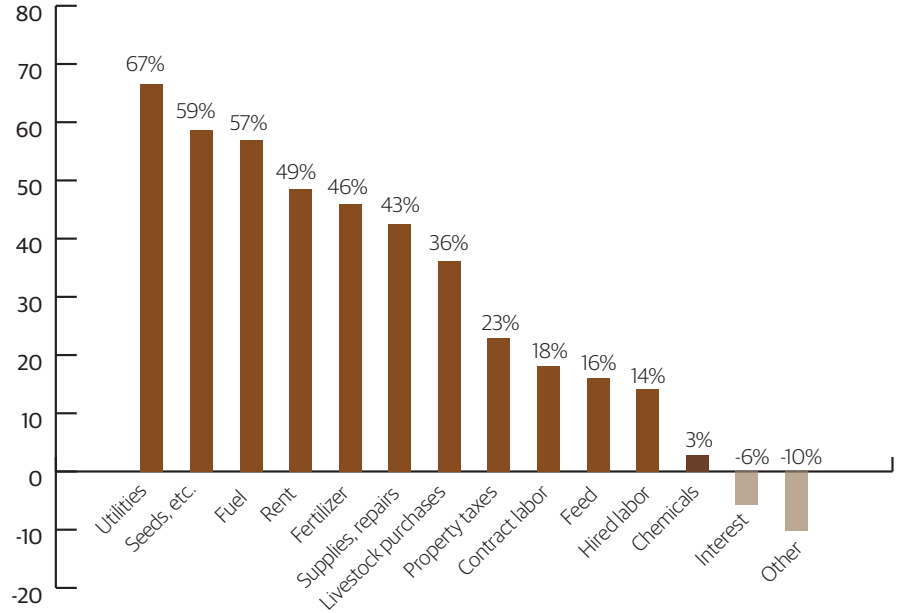
In 2007, U.S. farmers spent over $253 billion for farm inputs, up from over $194 billion in 1997 (adjusted for inflation to 2010 dollars). Average production expenses per farm increased about 54% from 1997 ($96,750) to 2007 ($148,576). The United States had 38,713 farms with expenses over $1 million in 2007.

- Animal feed constituted 20.4% of total farm production expenses, or over $51.6 billion in 2007.
- Fossil fuel–based products, including gasoline for transportation ($13.5 billion, 5.4%), chemicals ($10.6 billion, 4.2%), some portion of utility bills ($6.2 billion, 2.5%), and some portion of the fertilizer, lime, and soil conditioner category ($19.0 billion, 7.5%) made up an additional $49.4 billion in expenses.
- Hired labor ($23.0 billion, 9.1%); supplies, repairs, and maintenance ($16.7 billion, 6.6%); custom work and hauling ($4.3 billion, 1.7%); and contract labor ($4.7 billion, 1.9%) accounted for almost $48.7 billion in expenses.
- Livestock and poultry purchases added $39.9 billion (15.8%) in expenses.
- Property taxes ($6.5 billion, 2.6%); interest payments ($11.4 billion, 4.5%); rent for land, buildings, and grazing fees ($13.9 billion, 2.0%); and rent and lease expenses for machinery, equipment, and vehicles ($1.4 billion, 0.5%) cost U.S. farmers a little over $33.4 billion in 2007.
- Finally, seeds, plants, vines, and trees added over $12.3 billion (4.9%).

From 1997 to 2007 the average cost of utilities increased 67% (69% of electricity is generated by fossil fuels in the United States), while liquid fuels and fertilizers increased by 57% and 46%, respectively, for U.S. farmers (Figure 3.2.4).

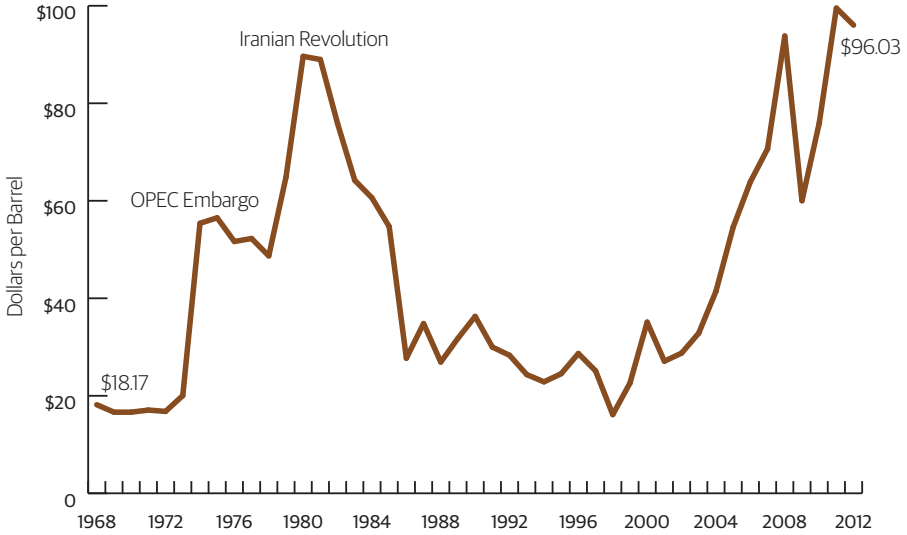
During the past 40 years, production costs for agriculture spiked to their highest levels as a result of oil crises in 1973 (the year of an OPEC oil embargo) and 1979 (the year of the Iranian revolution). After the Iranian revolution, the average price of a barrel of crude oil bottomed out at $16.14 in 1998. Since then it has increased 495% to an average of about $96.03 in 2012 (Figure 3.2.5, adjusted for inflation to 2010 dollars).

Figure 3.2.4: Percent Change in U.S. Farm Production Expenses, 1997-2007



Source: USDA Census of Agriculture, www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1_Chapter_1_US/st99_1_004_005.pdf.

Figure 3.2.5: Annual Average Imported Crude Oil Price, 1968-2012



Source: Energy Information Administration, www.eia.gov/forecasts/steo/realprices/real_prices.xls.

In 2007, Vermont farmers spent almost $578 million for farm inputs, most of which originated out of state (Figure 3.2.7). **Farms that produced milk and dairy cattle had 72% ($417 million) of total Vermont farm production expenses in 2007** and accounted for the majority of nearly every category of farm input expenses (e.g., dairy farms made 89% of feed purchases in 2007). The average Vermont production expense per farm was $82,807 in 2007, compared to an average of $75,089 in 1997. Vermont had 97 farms with expenses over $1 million in 2007.

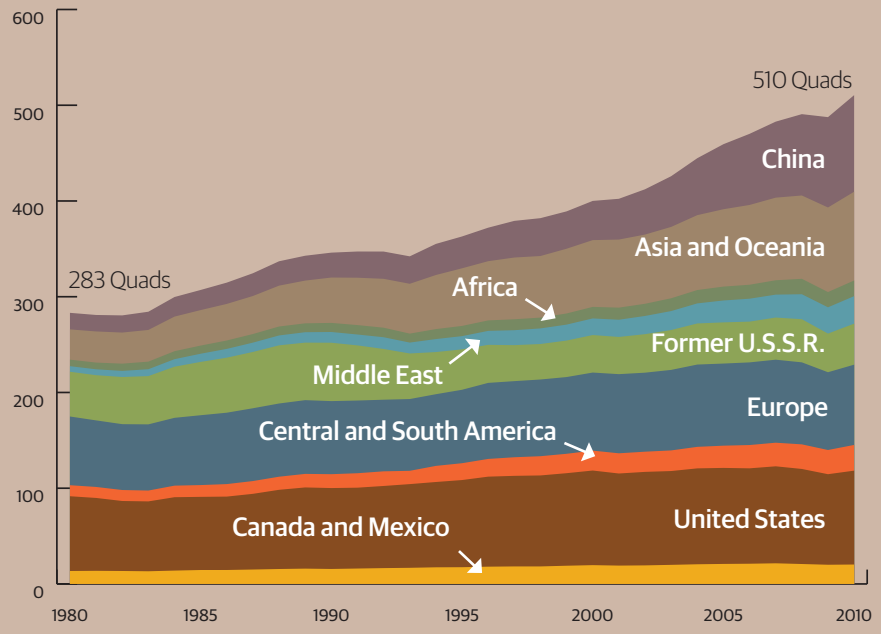
- Vermont farmers spent $151.6 million on animal feed in 2007, equal to 26.2% of total farm production expenses.
- Hired labor ($76.0 million, 13.2%), supplies, repairs, and maintenance ($68.1 million, 11.8%), custom work and hauling ($20.8 million, 3.6%), and contract labor ($5.3 million, 0.9%) accounted for over $170 million (29.4% of total) in farm expenses in 2007.
- Fossil fuel–based products, including fuel for transportation ($34.3 million, 5.9%); chemicals ($5.9 million, 1.0%); some portion of the fertilizer, lime, and soil conditioner category ($20.8 million, 3.6%); and a small portion of utility bills ($19.7 million, 3.4%) made up an additional $80 million in expenses (14.0% of total).
- Property taxes ($32.1 million, 5.6%); interest payments ($28.3, 4.9%); rent for land, buildings, and grazing fees ($11.9 million, 2.0%); and rent and lease expenses for machinery, equipment, and vehicles ($2.8 million, 0.5%) cost farmers a little over $75 million (13.0% of total) in 2007.
- Livestock and poultry purchases added $26.5 million (4.6%) in expenses.
- Finally, seeds, plants, vines, and trees cost about $9.4 million (1.6%).

The amount of money Vermont farmers spent on fuel and fertilizers increased 83% and 50%, respectively, from 1997 to 2007 (Figure 3.2.8). The amount spent on supplies, repairs, and maintenance increased by about 83%, but most of this increase occurred between 1997 and 2002, possibly reflecting costs associated with the ice storm of 1998, as well as increased costs to ship goods (e.g., equipment parts) as a result of rising petroleum prices. The amount of money spent on livestock and poultry (–22.1%) and animal feed (–9.3%) notably decreased, possibly reflecting the downward trend in the number of dairy cows in Vermont.

Fossil Fuel Dependency and Peak Oil

In the 200 years since the Industrial Revolution, virtually every society on the planet has become dependent on nonrenewable fossil fuels for everything from electricity and fuel to agricultural inputs and plastics. Today, when we flip on a light switch, turn an ignition, or eat a hamburger, we engage complex energy extraction systems that largely rely on nonrenewable energy. According to the *Energy Information Administration*, 85.9% of world energy consumption came from petroleum (34.2%), coal (28.7%), and natural gas (22.9%) in 2010, down from 90% in 1980. World energy consumption grew 44.5% from 1980 to 2010 (Figure 3.2.6).

Figure 3.2.6: World Energy Consumption, 1960-2010, Quadrillion BTUs



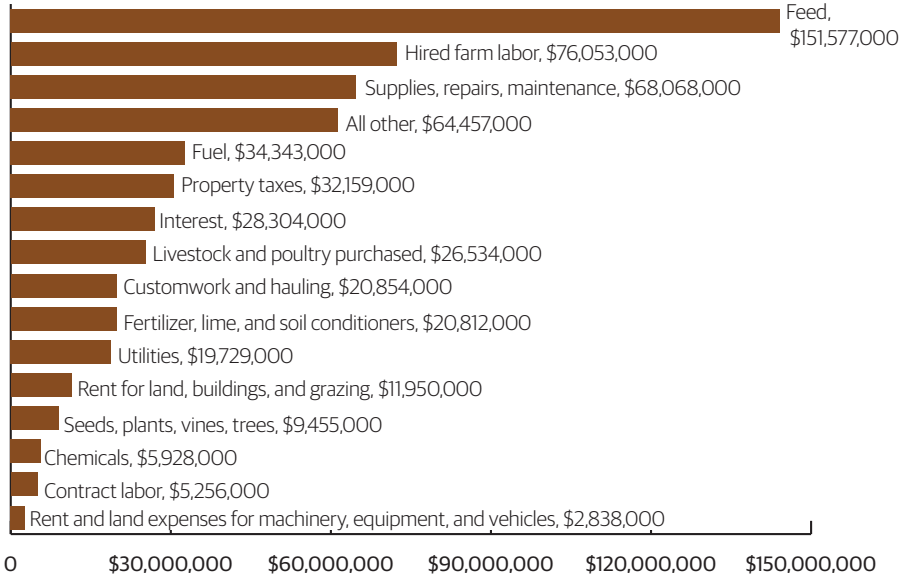
Source: Energy Information Administration, www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=44&pid=44&aid=2. A quadrillion is a 1 followed by 15 zeros.

Even though the United States is the third-largest producer of crude oil (after the Russian Federation and Saudi Arabia), domestic oil production peaked in 1970, and our country is now a net importer of oil and natural gas. The United States is now the second largest consumer of energy in the world (98 quadrillion BTUs in 2010), behind China (100 quads in 2010, up from 17 quads in 1980). A little over 83% of U.S. energy consumption came from fossil fuels in 2010, down from 89% in 1980. Vermont consumes the least total amount of energy of any state in America, but petroleum for transportation and heating made up 53.5% of *energy consumption in 2010*.

Peak oil is the point in time at which half of the oil that exists has been extracted from the earth. Peak oil is not the end of oil, but rather the end of cheap and easy-to-reach oil (i.e., peak oil means that the supply of readily available oil and oil-related products will decrease). U.S. oil discovery peaked in the 1930s, followed by a production peak 40 years later. Global oil discovery peaked in the 1960s, and global production peak is predicted to occur sometime between now and 2016.[7] **To-date, a global peak in oil production has not taken place**.[8] Efforts are underway to extract additional fossil energy from tar sands and shale rocks, but processes for extracting this energy (e.g., hydraulic fracturing) have substantial environmental consequences.

Peak oil has implications for how we live, where we live, and how our food systems function. The "Hirsch Report" describes peak oil as a classic risk management problem: If peaking is delayed, then mitigation efforts may have been premature. Alternatively, "If peaking is imminent, failure to initiate timely mitigation could be extremely damaging."[9] In either case, the Report recommends that risk management should begin well in advance of peaking. The emerging literature on peak oil is overwhelmingly apocalyptic.[10] The Hirsch Report states that "Intervention by governments will be required, because the economic and social implications of oil peaking would otherwise be chaotic."[11] Unfortunately, a *Government Accountability Office* report finds that "according to DOE [*Department of Energy*], there is no formal strategy for coordinating and prioritizing federal efforts dealing with peak oil issues, either within DOE or between DOE and other key agencies".[12] In the absence of international or national activities to address peak oil, many community-driven efforts, including the *Transition Town* movement, have emerged to attempt to build local resilience against predicted disturbances.

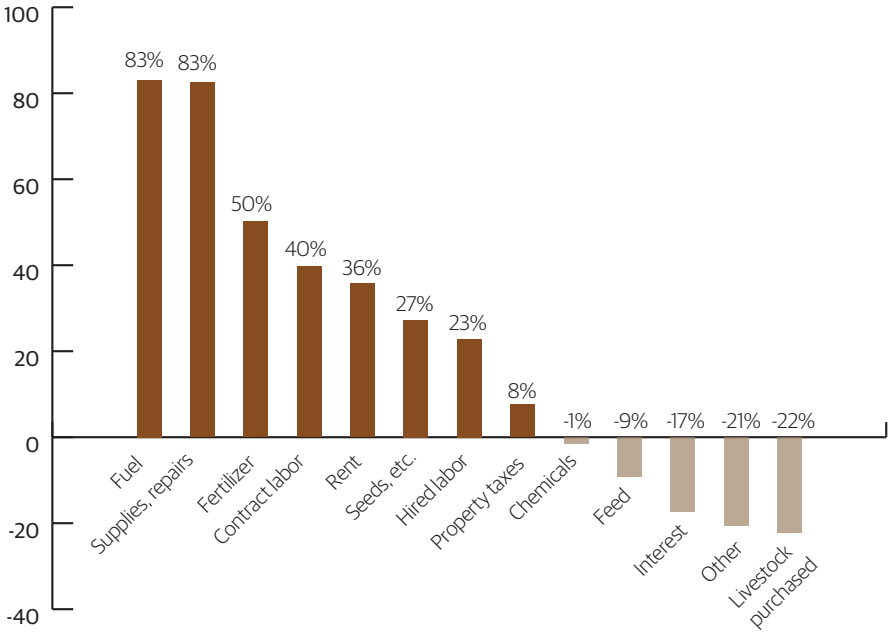
Figure 3.2.7: Vermont Farm Production Expenses, 2007



Source: USDA Census of Agriculture, *www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_State_Level/Vermont/st50_1_004_005.pdf*.

In summary, since 1948, American farmers have made more food and other agricultural products on less land and with less labor but with more petroleum-based material inputs, and most farmers have made less money in the bargain. Vermont farmers have produced slightly more milk, with fewer cows and fewer dairy farms, but the volatility of milk pricing and increased material input costs have meant that, on average, many farmers are making less now than they did in 1970. The cost of petroleum has increased dramatically since 1998, and prices for energy and petroleum-based inputs will continue to rise with the peaking of world oil production. In addition, gains in agricultural productivity have commonly been achieved at the expense of the natural environment. Environmental degradation of land, air, and water resources, and other ecosystem disturbances (e.g., climate change) have proliferated with increased petroleum use.

Figure 3.2.8: Percent Change in Vermont Farm Production Expenses, 1997 to 2007



Source: USDA Census of Agriculture, *www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_State_Level/Vermont/st50_1_004_005.pdf* and *www.agcensus.usda.gov/Publications/2002/Volume_1,_Chapter_1_State_Level/Vermont/st50_1_004_005.pdf*.

Richmond Farm Supply applying liquid fertilizer, date unknown.

Photo Credit: UVM Special Collections

Farm Assets and Debts

Farm Assets

According to the USDA, Vermont farmers had $4.1 billion in assets from land, buildings, and machinery in 2007 (Table 3.2.6). More than half of the assets are held by dairy and livestock producers, while the vast majority of crop production assets are used for growing feed and bedding.

As the number of dairy farms has decreased, the value of land and buildings held by dairy farms has decreased, from 44% of the total market value of land and buildings in 1997, to 39% in 2002, and 33% in 2007. Likewise, the estimated total market value of machinery and equipment held by dairy farms decreased from 58% in 1997 to about 50% in 2002, and 44% in 2007 (all numbers adjusted for inflation to 2010 dollars).[13]

We started out thinking we could do with just the rototiller, but the demand was there and we couldn't get the beds prepped fast enough. What we really needed was for our system to get mechanized to save our backs and farm longer. So the investment in tractors, manure spreaders, and equipment is huge. It's really stressful. People compare farms to regular businesses, but the capital above is incredible.

—Upper Valley focus group participant

As agriculture production has changed toward commodity crops, more farmers are producing fewer overall products. Farms that once grew a diversified range of products had more tools to cultivate and harvest those products. When Vermont farms stopped growing grains and started importing them from the Midwest, for example, farmers had less use for certain equipment and infrastructure, such as combines and mills. The number of combines in the state decreased from 126 in 1997 to 64 in 2007.[14] Vermont's food system now needs to rebuild some of this lost infrastructure. Small-scale producers can have difficulty accumulating assets, which can lead to other business challenges. A Bennington County focus group participant explained: "I'm trying to get insurance for our farm because we process basil made into pesto and I haven't been able to find an insurance company to insure us because we don't own our land and we don't own our equipment."

Farm Debt

One primary input cost for Vermont farmers is the debt owed for farm assets, including land and machinery. Vermont farmers spent a little over $75 million for debts in 2007, including over $32 million for property taxes (5.6% of total expenses); over $28 million for interest payments (4.9% of total expenses, Table 3.2.7); almost $12 million rent for land, buildings, and grazing fees (2.0% of total, Table 3.2.8); and over $2.8 million on rent and lease expenses for machinery, equipment, and vehicles (0.5% of total, Table 3.2.9). Over a quarter of Vermont farms had debt in 2007, with an average annual interest payment of $14,619 (up from $13,321 in 2002).

So much land in Vermont has been held in a way that basically leaves farmers borrowing against it over the years. When you borrow against your equity for 20 years, you end up in a position of high debt and low cash. The whole process has become like the snowball effect of the banking process, where you borrow too much money and get yourself into a box where the only way out essentially is to sell it all off to a buyer.

—Northeast Kingdom focus group participant

Typically, interest rates are lower for farms than other types of businesses, largely because of a connection between the lending agency and federal or state government. For instance, the *Vermont Agricultural Credit Corporation* (VACC) at VEDA is lending at a variable 4.5% rate, *Yankee Farm Credit* lends in the 5% to 6.5% range, while commercial banks lend at 6% to 7.5%, depending on the level of risk. VACC and the *USDA Farm Service Agency* typically handle the riskiest loans for those farms that can't get other forms of credit. While there is generally enough credit available to meet the demand for it, there does appear to be a gap in credit for very small projects, especially those projects without sufficient collateral.[15]

For more details on farm financing, see Chapter 4, Section 5: Financing the Food System.

Table 3.2.6: Estimated Assets from Land, Buildings, Machinery, and Equipment Used for Agricultural Production in Vermont, 2007

Type of Activity	Value of Land & Buildings	Value of Machinery & Equipment	Total	Percent of Total
Dairy cattle and milk production	$1,229,075,990	$242,511,711	$1,471,587,701	34.12%
Hay farming	$689,156,074	$86,857,840	$776,013,914	17.99%
All other crop farming	$442,738,676	$43,714,937	$486,453,613	11.28%
Beef cattle ranching and farming	$311,775,914	$40,203,678	$351,979,592	8.16%
Horse and other equine production	$244,121,128	$26,279,964	$270,401,093	6.27%
Sheep farming	$116,955,269	$9,477,769	$126,433,038	2.93%
Nursery and tree production	$107,506,986	$12,661,134	$120,168,121	2.79%
Vegetable and melon farming	$93,808,376	$11,153,170	$104,961,546	2.43%
Apple orchards	$90,174,488	$8,717,268	$98,891,756	2.29%
All other animal production	$82,509,243	$11,109,185	$93,618,427	2.17%
Chicken egg production	$62,511,027	$9,163,501	$71,674,528	1.66%
Floriculture production	$54,802,413	$10,772,630	$65,575,043	1.52%
Berry (except strawberry farming)	$39,953,914	$2,785,735	$42,739,649	0.99%
Corn farming	$31,470,582	$7,031,699	$38,502,280	0.89%
Goat farming	$28,182,487	$5,964,930	$34,147,417	0.79%
Cattle feedlots	$26,716,959	$4,294,210	$31,011,169	0.72%
Apiculture	$20,323,697	$1,633,631	$21,957,328	0.51%
Hog and pig farming	$13,002,053	$1,944,943	$14,946,996	0.35%
Other noncitrus fruit farming	$12,710,872	$1,240,358	$13,951,230	0.32%
Turkey production	$11,803,886	$1,689,324	$13,493,210	0.31%
Food crops grown under cover	$10,425,689	$1,969,521	$12,395,209	0.29%
Animal aquaculture	$9,654,359	$1,577,409	$11,231,768	0.26%
Grape vineyards	$9,224,740	$1,525,111	$10,749,845	0.25%
Other poultry production	$5,714,639	$620,128	$6,334,768	0.15%
Broilers and other meat-type chicken production	$4,389,463	$309,055	$4,698,518	0.11%
Fur-bearing animal & rabbit production	$3,896,234	$216,182	$4,112,416	0.10%
Strawberry farming	$3,011,573	$669,489	$3,681,062	0.09%
TOTAL	**$3,755,616,732**	**$546,094,511**	**$4,301,711,243**	**100.00%**

Source: USDA Census of Agriculture, *www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_State_Level/Vermont/st50_1_046_046.pdfst50_1_046_046.pdf*.

Table 3.2.7: Vermont Interest Expenses, 2007

Farms with expenses of	# of farms with debt		Average annual interest paid		Interest paid	
	2002	2007	2002	2007	2002	2007
$1 to $999	309	278	$482	$514	$171,829	$143,028
$1,000 to $4,999	604	628	$3,267	$2,878	$2,274,299	$1,807,826
$5,000 to $9,999	297	371	$8,754	$7,427	$2,996,542	$2,755,383
$10,000 to $24,999	338	397	$18,820	$15,786	$7,331,398	$6,266,920
$25,000 to $49,999	112	154	$39,988	$35,047	$5,161,874	$5,397,186
$50,000 to $99,999	39	69	$81,366	$70,859	$3,657,318	$4,889,228
$100,000 or more	19	39	$218,433	$180,619	$4,783,290	$7,044,106
TOTALS / AVERAGES	**1,718**	**1,936**	**$13,321**	**$14,619**	**$26,376,550**	**$28,303,678**

Source: USDA Census of Agriculture, Table 4, *www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_State_Level/Vermont/vtv1.pdf*. 2002 interest paid adjusted for inflation to 2007 dollars.

Table 3.2.8: Rent for Land, Buildings, and Grazing Fees

Farms with expenses of	Farms	Expenses	Average
$1 to $499	193	$50,480	$262
$500 to $999	164	$117,787	$718
$1,000 to $4,999	422	$1,047,466	$2,482
$5,000 to $9,999	206	$1,548,063	$7,515
$10,000 to $24,999	147	$2,280,027	$15,510
$25,000 to $49,999	55	$1,991,869	$36,215
$50,000 or more	43	$4,914,468	$114,290
TOTAL	**1,230**	**$11,950,161**	

Source: USDA Census of Agriculture, Table 4, *www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_State_Level/Vermont/vtv1.pdf*.

Table 3.2.9: Rent and Lease Expenses for Machinery, Equipment, and Vehicles

Farms with expenses of	Farms	Expenses	Average
$1 to $499	83	$17,878	$216
$500 to $999	38	$28,395	$748
$1,000 to $4,999	122	$340,742	$2,793
$5,000 to $9,999	50	$363,879	$7,278
$10,000 to $24,999	40	$572,110	$14,303
$25,000 to $49,999	17	$585,782	$34,458
$50,000 or more	10	$931,782	$93,178
TOTAL	**360**	**$2,838,466**	

Source: USDA Census of Agriculture, Table 4, *www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_State_Level/Vermont/vtv1.pdf*.

☼ Climate Change and Agriculture

For many decades, scientists have warned that the consequences of anthropogenic climate change could be severe across all ecosystems and social systems. And for the past two decades, the conservative movement has effectively undermined climate science and policy in the United States by 1) misrepresenting, manipulating, and suppressing research results; 2) intimidating or threatening individual scientists; 3) invoking existing (or creating) new rules or procedures; and 4) invoking an existing bias of the media (i.e., a 'dueling scientists scenario').[16] Recently, however, several federal agencies have produced reports on the predicted impacts of climate change on various ecosystems and sectors of the U.S. economy.

Two new reports from the *U.S. Department of Agriculture* (USDA) and a draft report from the *U.S. Global Change Research Program* indicate detrimental effects on most crops, livestock, and ecosystems that will vary somewhat by region.[17]

- Rising temperatures and altered precipitation patterns will affect agricultural productivity. Crop sector impacts from weather are likely to be greatest in the Midwest, and these impacts will likely expand due to damage from crop pests. Decreased yields in the major corn, soybean, and wheat supplying region of the country will, of course, have ripple effects, including impacting the cost and availability of animal feed in Vermont and the cost and availability of ingredients for marquee Vermont food processors like *King Arthur Flour*. Since the impacts of climate change are global, the availability of food products that we have been accustomed to enjoying—and that Vermont companies use as key ingredients—will diminish. For example, *cocoa production* in Ghana and the Ivory Coast is expected to decline[18] (which will impact *Ben & Jerry's*, *Lake Champlain Chocolates*, and other chocolatiers), as is *coffee production*[19] (which will impact *Green Mountain Coffee Roasters* and other coffee companies).
- Livestock production systems are vulnerable to temperature stresses. Many Vermonters are interested in expanding livestock production to reach regional markets for grass-fed and pasture-raised meat. It is unclear how temperature stresses will impact the expansion of livestock production in Vermont, but the USDA states that the negative effects of hotter summers will likely outweigh the benefits of warmer winters. Temperature stresses can be mitigated for animals raised indoors but hotter summer temperatures may require new thermal environment control systems and the cost and availability of animal feed will likely be a problem.
- Climate change will exacerbate current stresses from weeds, diseases, and insect pests on plants and animals; it will also alter pollinator life cycles, which will impact all types of crop and livestock production in Vermont.
- Ecosystem services (e.g., maintenance of soil and water quality, flood control) that food systems depend on will be damaged.
- Increased incidences of extreme weather events will impact food production around the world. Tropical Storm Irene—viewed as a harbinger of things to come—flooded 20,000 acres of farmland and impacted 463 Vermont producers when it struck in 2011.

Developing strategies to address rising material input costs—and other interrelated issues such as land access and availability, water use and pollution, import substitution, and soil health—in ways that are aligned with climate change adaptation strategies is crucial to the sustainability of Vermont's food system. The following sections describe a variety of programs for conserving land, expanding access to land (e.g., conservation easement programs, cooperative land management arrangements, and farm incubator programs), protecting soils, reducing runoff, improving forage management and storage, and increasing on-farm energy production.

GETTING TO 2020

Goals 4 through 6 of the F2P Strategic Plan address the need to reduce the cost of farm inputs, conserve agricultural land and soils, and prepare Vermont for climate change.

Goal 4: Options for farmers to reduce their production expenses will be widely disseminated and utilized.

Goal 5: Agricultural lands and soils will be available, affordable, and conserved for future generations of farmers and to meet the needs of Vermont's food system.

Goal 6: Farmers and other food system operators will improve their overall environmental stewardship to deliver a net environmental benefit to the state.

FARM INPUTS
Land

How much land is available for farming in Vermont? What programs or opportunities exist to ensure that good farmland is available to farmers?

The Council on the Future of Vermont's 2009 report, *Imagining Vermont: Values and Vision for the Future*, reflects the views of nearly 5,000 Vermonters about the future direction of the state. The highest-rated value during the Council's public engagement process was "the working landscape and its heritage," which includes the land used in agriculture and forestry that is "central to Vermonters' personal identification with and love for the state." The Council's report identified Vermont's agricultural landscape as a central element to attract tourists, new residents, and new revenue to the state.[20]

Access to land is probably the biggest thing for people who may not have a family connection but are interested in farming. How do they get the land? There are tremendous financial barriers right now.

—Windham focus group participant

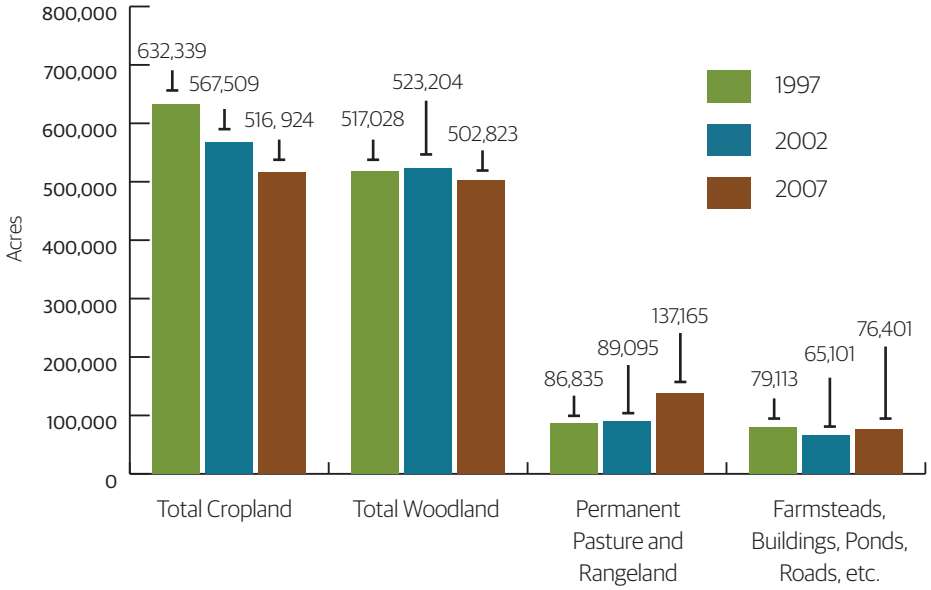
Affordable access to farmland was described by F2P stakeholders as a serious barrier for new farmers or those seeking to grow and expand. Productive farmland, especially in relatively close proximity to market areas, is often too expensive for a farmer to purchase without significant cost-sharing programs or a risky level of debt fully collateralized by the land itself. Farmland parcels for sale are often too large for the needs of an individual Vermont farmer who is seeking 3-10 acres, for example, for smaller-scale vegetable production.

CURRENT CONDITIONS

In 2007, over 1.2 million acres, or 21%, of Vermont's land was considered to be in agriculture. Land in agriculture decreased over 6% from 1997 to 2007, from 1,315,315 acres to 1,233,313 acres. Cropland made up 516,924 of agricultural acres (42% of total) in 2007, down from 632,339 acres (48% of total) in 1997. About 84% (434,000 acres) of total cropland was designated as "harvested cropland" in 2007, while the rest was pasture (48,686 acres), cover crop (29,895 acres), summer fallow (1,868 acres), or had experienced crop failure or abandonment (5,401 acres). **Crops grown for animal feed—corn for grain, corn for silage, and all forages—constituted nearly 98% of all harvested cropland acreage in 2007.** Woodland totaled 502,823 acres in 2007 (41%), down from 517,028 acres (39%) in 1997. Woodland acres may include

Distinguishing Land and Soils: Text and figures in this section provide basic information about agricultural land in Vermont. This Land section focuses on available acreage for agriculture and land access issues, whereas the Soil section focuses on soil fertility and other soil-specific issues, such as erosion control.

Figure 3.2.9: Land in Agriculture in Vermont, 1997-2007

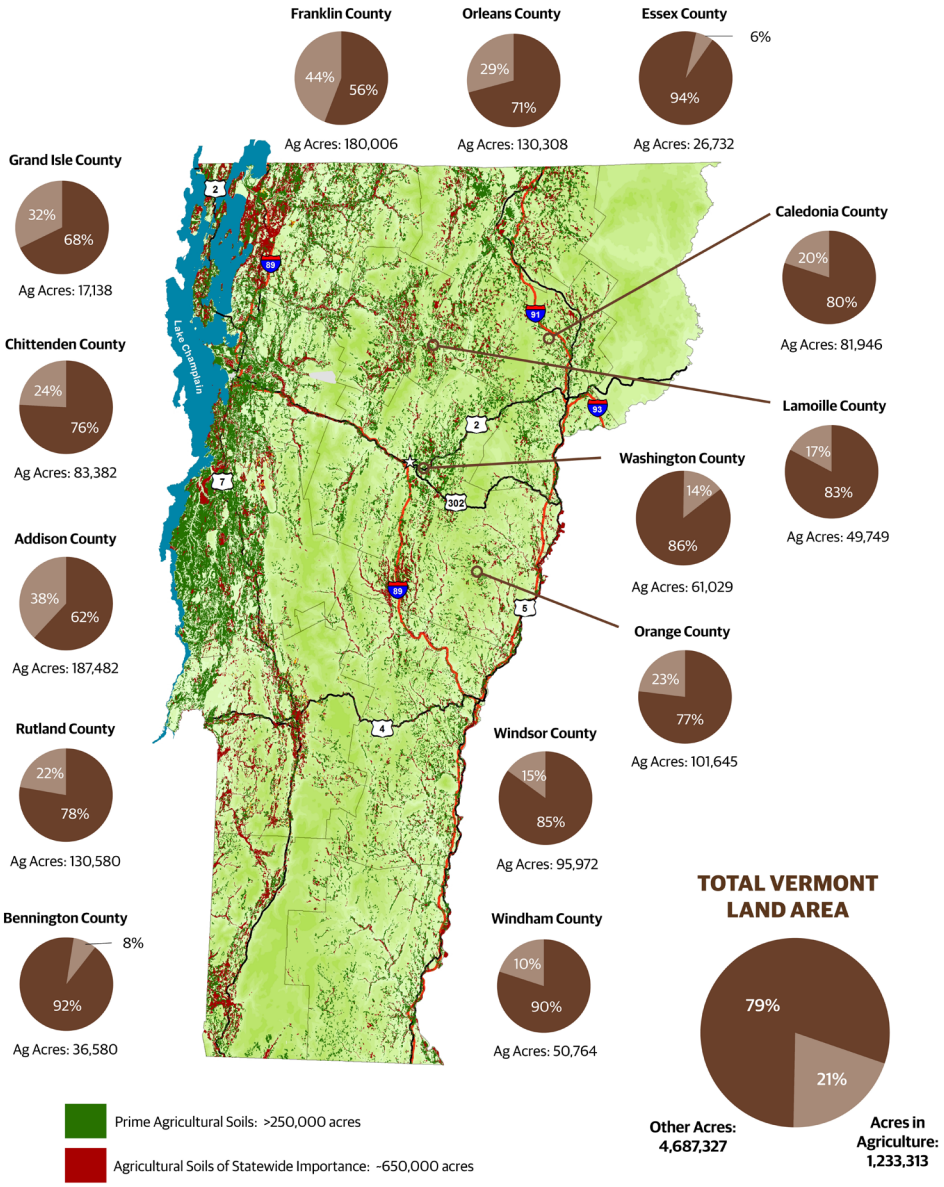


Source: USDA Census of Agriculture, *www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_State_Level/Vermont/st50_1_008_008.pdf* and *www.agcensus.usda.gov/Publications/2002/Volume_1,_Chapter_1_State_Level/Vermont/st50_1_008_008.pdf*.

maple sugaring activities. Permanent pasture or rangeland increased about 58% from 1997 to 2007, from 86,835 acres (7% of total) to 137,165 acres (11% of total). Finally, farmstead buildings, roads, ponds, and other aspects of the built environment cover 76,401 acres, or 6% of total acres in 2007 (Figure 3.2.9).[21]

Agricultural activity can be found in every county. For some counties it is a major land use, whereas for others it is a modest percentage of total land area. Certain counties dominate Vermont agriculture because of soil fertility, topography, proximity to markets, and other farm location influences. Addison, Franklin, Rutland, Orleans, and Orange counties contain 59% of the agricultural land in Vermont (Figure 3.2.10). **According to the Census of Agriculture, the average size of Vermont farms is 177 acres, but 70% of the farms are smaller than that.** Maps of agricultural soils exist, but detailed, publicly available current land use maps are lacking for most of the state. In other words, although data on aggregate land in agriculture exists at the county level, it is currently not easy to describe and graphically depict the mosaic

Figure 3.2.10: Percentage of Land in Agriculture by County



Source: Agricultural soils, Vermont Center for Geographic Information. Note: agricultural soils maps for Essex County are not available. **Agricultural soils by county: USDA Census of Agriculture,** *www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_State_Level/Vermont/vtv1.pdf*.

of land uses at the county and town levels. **Many stakeholders identified and supported the need for mapping agricultural soils, parcels, and land uses to match farmers with potentially available land.**

From 1997 to 2007, total cropland decreased by 115,415 acres, total woodland decreased by 14,205 acres, while pastureland increased by 50,330 acres. In total, land in agriculture decreased by 82,000 acres from 1997 to 2007. One recent study examined Vermont subdivision trends from 2002 through 2009.[22] It found that "most residential development appears to be occurring at low densities in rural areas rather than in compact existing centers or planned growth centers." The *National Resource Inventory* indicates that developed land increased by 47,800 acres between 1997 and 2007.[23] The *Farmland Information Center* also says that Vermont lost 41,000 acres of agricultural land to development from 1982 to 2007. Because of Vermont's small size, the loss of about 41,000 acres is nearly the lowest amount of any state. But, relative to total agricultural acreage, this loss ranks Vermont 23rd in the nation for agricultural land conversion.[24]

The largest open land in our area is an old farm with a couple that lives on it in their eighties. It is by far the most distinctive piece of property in our town. We brought in the Land Trust because a number of us in town want to see that preserved. All the couple cares about is keeping it exactly the way it is. They would prefer to have it in vegetables or some kind of crop. They know their cows aren't going to be there for milking anymore. But that's what they want—they don't want it developed."

—Northeast Kingdom focus group participant

The *Use Value Appraisal Program* (commonly known as the *Current Use Program*) and other land conservation efforts coordinated by the *Vermont Land Trust* (VLT), the *Vermont Housing and Conservation Board* (VHCB), the *Upper Valley Land Trust*, and other organizations are preserving critical farmland parcels. A variety of other programs, including cooperative land management arrangements, and farm incubator programs, provide opportunities for expanding access to farmland.

Current Use Program

Just as Vermont farms fall under a unique category for Act 250 review, they may also have a unique property tax structure. Farms that use the *Current Use Program* are taxed based on their value as productive farmlands, not their highest development value. This system reduces the financial pressure on farms to sell land for development. In exchange, farmers must use the enrolled land for the agricultural production that was the basis for the appraisal. Enrolled land that becomes developed is subject to a change in use penalty. The change in use penalty is 20% of the fair market value of a property, or, in the case of the sale of part of a property, a pro rata share of the fair market value of the entire property.[25]

According to the *Vermont Department of Taxes*, which oversees the program, currently **over 15,000 properties are enrolled in the program, totaling more than two million acres (543,354 acres of farmland and 1,704,668 acres of conserved forest lands), or one third of Vermont's total land area.**[26]

The Vermont Legislature established the *Current Use Program* in 1978. Since that time, two major changes have taken place: the inclusion of some nonprofits' conservation land and the exemption of farm buildings from property tax. With state government budget cuts, the Current Use Program has come under scrutiny. For example, it has been reviewed to understand how to cut the costs of administering the program, and even how to cut aspects of the program to raise additional property taxes for other public needs.

Stakeholder interviews and widespread public input throughout the F2P process have delivered a very clear message about current use: **The Current Use Program is critical to food system viability into the future.** Every farmer we spoke to that owned any land said that without the *Current Use Program*, he or she would go out of business.

Land Conservation Programs

According to a 2000 report from the *American Farmland Trust*, Vermont has spent more per capita on farmland conservation programs (about $42 million) than any other state in the country.[27] VHCB, VLT, UVLT, and the *Vermont Agency of Agriculture, Food and Markets* (VAAFM) are Vermont's principal organizations for

helping farmers conserve farmland. They do so by purchasing development rights, known as conservation easements, from farmland owners. Farmers and landowners may also decide to donate conservation easements. Conservation easements are legal documents that stipulate limitations on non-agricultural development activities that can be made on the conserved property (e.g., subdivisions are prohibited without permission, except for special circumstances). Farmers and land owners that contact one of these organizations go through a preapplication process with VHCB's Agricultural Advisory Committee. The preapplication process collects existing information and generates new information about the farm, including in-depth mapping of the property. This committee meets twice a year and approves a portion of applicants based on such criteria as the quality of soils at the location, the location itself, existing infrastructure, and resource management practices.

Approved farms are appraised at their fair market value *and* at what the value would be if the land were conserved. The difference between the fair market value and the conserved appraisal is what the farmer is paid. After VLT or UVLT appraises the value of the development rights of a farm, it asks VHCB (which gets funding from the state), the federal government (e.g., through the *Farm and Ranch Lands Protection Program* run by the *Natural Resources Conservation Service* and the USDA), and private sources for money to purchase the rights. From start to finish, this process can take up to two years. The conserved land is still owned by the farmer, who can do what he or she likes with the money received (e.g., pay down debts, invest in the farm). The land can be sold, but the conservation easement and its development restrictions are always attached to the land. The conserving agency has the right of first refusal (i.e., the right to match the purchase price that the landowner accepts), or some properties have an "option to purchase at agricultural value" (OPAV) when the buyer is a not a farmer or a family member. Because the agricultural value may be less than fair market value, the OPAV can act as a deterrent to selling farmland for nonagricultural uses.

The latest figures from VLT identify 513,746 total acres of conserved land (including forest land), with 848 parcels (equaling 186,778 acres) in agricultural use. The UVLT reports over 10,000 acres of conserved land on 81 farms (includes forest land).

Once viewed with skepticism and a fair amount of distrust, farmland conservation efforts are growing. One F2P Northeast Kingdom focus group participant explained:

"I conserved my farm in 1991, and the looks I got were like people thought I'd gone right off the end of the world. But to watch the progression—the people that originally told me how foolish I was—they have all dropped this perspective one by one. It's a long, long process."

Focus group participants noted that there is still confusion about how easements work, and there is a need for more technical assistance for farmers

Table 3.2.10: Vermont Farm Transfers and Sales

Farm Transfers and Sales			
Number of Farm "Transfers"		**Number of Farms Sold**	
2006	325	2006	105
2007	340	2007	54
2008	383	2008	64
2009	265	2009	66
2010	213	2010	66
Total	**1,426**	**Total**	**355**
"Transfers" are all land transfers		"Farms sold" are only "valid sales" (market value)	
Farm sold			
Average Sale Price		**Median Sale Price**	
2006	$230,442	2006	$115,601
2007	$357,018	2007	$265,918
2008	$383,444	2008	$266,548
2009	$205,967	2009	$186,750
2010	$299,211	2010	$200,000

Source: Vermont Tax Department, Property Transfer Tax System, *www.state.vt.us/tax/pdf.word.excel/statistics/2010/report123110.pdf*.

on this issue. Additionally, there is a need for more financial and technical assistance tools for farm transfers, farmland access, farmland conservation, and affordability.

Ownership has been transferred at 1,426 farms in the last five years, but only 25% were actually sold at market value (Table 3.2.10). The rest were foreclosures, sales between family members, tax sales, and sales to or from government entities or charities. There is no easy way to know which of the farms sold or transferred are still in farming, but with a couple of hundred farms on the market each year, there is a substantial opportunity to conserve farmland for future generations.

Landscape Auctions: In the summer of 2010, the *White River Partnership* organized the first-in-the-nation "landscape auction," enabling individuals to bid on land conservation efforts, from maintaining a habitat for ruffed grouse to helping to fund the purchase of development rights on a parcel of good farmland. The auction drew 150 people to bid on a variety of items offered by nine White River watershed landowners and raised $20,000. This innovative fund-raising method for land and natural resource conservation has been used in Europe for years, and could be advanced as a way for Vermonters to invest in preserving agricultural lands.

Cooperative Land Management

University of Vermont (UVM) graduate researchers recently studied embedding agriculture in residential areas closer to active markets have delivered some promising results. In the spring of 2009, a mail survey was sent to 2,100 large-lot (5 -24.99 acres) landowners in Chittenden County to assess their willingness to participate in cooperative land management.[28] Cooperative land management is the *voluntary* enrollment of a portion of one's land into a program that collectively manages portions of neighboring parcels, creating a larger "parcel" suitable for farming (e.g., sheep grazing) or another shared goal (e.g., recreational trail). Landowners retain ownership of their land, but the specifics of the actual land management agreement among all parties are unique to each situation. The actual hands-on management of the land may or may not include landowner involvement.

The survey had a 31% response rate (634 responses). When asked, "Based on the definition of cooperative land management given above, would you consider enrolling a portion of your land if such a program existed?," 289 (45.6%) respondents said "yes", 180 (28.4%) said "maybe", 109 said "no", and 47 (7.5%) indicated they were already involved in this type of activity. The "yes" parcels had about 3,789 acres of land, and the "maybe" parcels had about 2,048 acres.

They say the fields are disappearing, and I can attest to that because there were farms that we used to hay when I was 12 years old that are now 8- to 10-foot-high woody brush. It's not necessarily track housing that's going up or new development. It's just going back to woodlands, so we're losing field space through farmer attrition.

—Windham focus group participant

The research team determined that a total of about 78 ,177 acres of agricultural opportunities (open land with varying slopes and soil types) exist in Chittenden County. Of this amount, there are about 59,933 acres of prime soil occurring on all slope types and 35,057 acres of prime soil occurring on flat land. The agricultural opportunities are widely dispersed throughout the county with the majority occurring in the southwest quadrant in the towns of South Burlington, Shelburne, Charlotte and Hinesburg. Additional high quality opportunities are visible along the Winooski River corridor, which snakes its way through the town of Bolton in the east to Colchester and Burlington in the west.

Those parcels with residential structures, activity, and function have a total of 22,763 acres of agricultural opportunities and 8,268 acres of prime agricultural opportunities. Five towns have greater than 2,162 acres of agricultural opportunities located within residential parcels, Charlotte, Essex, Hinesburg, Jericho, and Shelburne. Charlotte has the most with 3,400 acres. Charlotte and Shelburne have the most prime agricultural opportunities with 1,441 acres and 1,156 acres, respectively.

The land uses on these parcels and their overall quality is currently not clear, but 5,800 acres from "yes" and "maybe" responses and upwards of 22,763 acres in total just in Chittenden County present a unique opportunity to strengthen Vermont's food system. Some businesses are already exploring this opportunity. For example, *Backyard Farm Vermont* offers to help homeowners convert their backyards into

garden plots. *Linden L.A.N.D. Group*, a landscape design/build firm, also offers micro-farm components (e.g., chicken coops, greenhouses, kitchen gardens) to their clients.

To gauge potential farmer interest, the same researchers are currently conducting a complementary "willingness to participate" survey to find out whether existing and aspiring landless farmers are willing to farm suitable parcels with one or many landowners.

Many F2P stakeholders reported the need to change existing zoning and comprehensive plans to more effectively support agricultural uses. The *American Planning Association* (APA) developed *agricultural land conservation* and *food system* policy guides to recognize the critical role of food systems and agriculture in community planning and development, but Vermont does not have an APA chapter. There are significant opportunities for towns and cities to increase agricultural land and adjust their zoning and land use regulations to strengthen local food systems. Specific issues that were raised in F2P focus groups related to land use planning included allowing multi-housing units for farm employees on farm parcels. In addition, many advocated for supporting town-owned farms to increase food security and leasing town-owned agricultural land to viable farmers.

Farm Incubator Programs

Farm incubator programs and sites were described as an excellent way to help improve access to land, especially for new or growing farmers. The *Intervale Center's Farms Program* overcomes many of the start-up barriers for new farmers: access to land, capital, equipment, and technical assistance. The program offers new farmers access to smaller parcels of leased land at reduced rates for the first year of business; shared equipment and infrastructure including tractors, implements, wash stations, cold storage,

In other meetings where we talked to young farmers, the idea of incubator farms comes up, but when you really tease it out, you always get back to the fact that people want their own land. If you go onto an incubator farm, then you don't want to be there for life. You want to be there for a period of time and then you want to be able to go somewhere else. There's got to be that somewhere else to go.

—Windham focus group participant

The Intervale Center's Farms Program

Bobby Young of Hens and Hands Farm, Intervale Center, 2009.

PHOTO CREDIT: Intervale Center

The *Farms Program*, a nationally recognized farm business incubator, has supported the growth of dozens of farms since 1990. Farms are accepted into the program after a rigorous application process that includes developing a business plan and presenting it to staff and existing *Intervale* farmers. New farmers have access to land and shared equipment at reduced rental rates in years 1 through 3. By year 5, new farms should be on firm footing and ready to transition out of the *Intervale* onto land of their own. Between 2006 and 2009, three Intervale farms successfully graduated onto their own farms in Vermont, and four new farms enrolled. The community of farmers in the *Intervale* has made the program a leader in farm business incubation for 20 years. *Intervale Consulting* was started to respond to regular interest in replicating the Farms Program model, which has proven to help farmers gain access to smaller parcels of fertile land, shared equipment to reduce start-up capital needs, and access to hands-on knowledge from mentor farmers.

Being at the Intervale with shared infrastructure and start-up guidance is a huge help. And being around other farmers who have a bunch of experience is the best.

—Bobby Young, Intervale incubator farmer

For more information, including an application packet, visit the Intervale Center's website at *www.intervale.org*

and greenhouses; and a community of experienced farmers to learn from. Many farmers have graduated from this program and gone on to operating their own farms.

The *Northeast Organic Farming Association of Vermont* (*NOFA Vermont*) has an *Apprentice & Farm Worker Program* that provides an online directory that lists farms looking for apprentices or workers and workers looking for farm work. The *University of Vermont* (e.g., *Cooperative for Real Education in Agricultural Management*), *Vermont Technical College* (e.g., *Diversified Agriculture. Agribusiness Management Technology*, and *Dairy Farm Management Technology*), *Sterling College* (e.g., *Sustainable Agriculture*), and *Green Mountain College* (e.g., *Sustainable Agriculture and Food Production*) all offer hands-on experiences and food system degree programs. F2P stakeholders expressed very strong interest in increasing the number of farm incubator sites throughout the state, especially among the Regional Food Centers.

Linking Land Seekers with Landowners

Matching farmers—farmland seekers—with farmland sellers *and* closing on the deals is a human resource–intensive process, involving professionals with expertise in real estate, legal, financial, technical, business, and even emotional matters. *Land Link* Vermont used to be a program run by the *University of Vermont Center for Sustainable Agriculture* that connected beginning and relocating farmers with farmland owners. Land Link also provided education on farm transfer, farmland tenure arrangements, and environmental stewardship through workshops and personal consultations. The program performed an important function in the food system, but stakeholders reported that it was underfunded to begin with and did not have sufficient capacity or partners to facilitate enough matches. A key insight of program participants was that having a good land seeking "dating" service, where property owners and property seekers learn more about their needs and goals, is as important as the matches. Many people who didn't make matches through the program made matches outside the program based on the knowledge they gained through *Land Link*. The *Center for Sustainable Agriculture* now has a *Land Access Program* that provides coaching and consulting to farmers looking for land and for landowners looking to make their land available. UVM's *New Farmer Project* also provides a substantial amount of information and toolkits for beginning farmers, including information on land access.

The *Vermont Land Trust's Farmland Access Program* provides a matchmaking service between potential farmers and landowners and has facilitated the sale of conserved farms to several viable farms since 2004. The Farmland Access Program provides opportunities to potential farmers by, for example, purchasing farms and reselling them at agricultural value, or using their right of first refusal or OPAV if a potential buyer of a conserved property is not going to farm the land. VLT maintains a list of people looking for farm ownership or leasing opportunities and alerts them when a farm goes on the market. Eligible applicants must have three years of farming experience, strong agricultural references, plans to develop an agricultural enterprise that would gross $100,000 per year within five years of start-up, and sufficient financial resources (or the ability to be financed) for start-up expenses.

The nascent *Vermont Farmland Access Network* (VFAN)—composed of the *Intervale*, VLT, *Rutland Area Farm & Food Link* (RAFFL), *Land for Good*, and *UVM Extension*—currently works as a referral network to offer more customized and geographically specific technical assistance to match farm seekers with farmland sellers. While *Land Link Vermont* lacked capacity to provide technical assistance across the state, the hope is that VFAN puts more "boots on the ground" in various locations that can efficiently provide assistance and publicize opportunities to landowners and farmers. Rather than focus entirely on maximizing the numbers of matches made, VFAN emphasizes that preparedness on the part of farm seekers and landowners is key to *sustaining* quality farm tenure arrangements. To this effect, VFAN provides assistance to both parties in areas such as business planning, land stewardship planning, farm transition strategies, and farmland assessment techniques to ensure that viable arrangements are developed based on informed decisions.

An online matchmaking platform was launched in May 2011 by the UVM Extension led New Farmer Project. The *Vermont Agriculture Land Access Database* enables farmers to search available listings and farm opportunities based on open acreage size, location, and type of farm tenure arrangement.

A variety of innovative matchmaking services also exist around the world. For example, *FarmLINK* in Ontario has developed a map-based website that shows the locations of farms by criteria such as acreage available for a new farmer, farming practices currently used on the land (e.g., conventional or organic), and facilities and equipment currently on the farm.

State Farms on Public Land

Publicly owned land, even conserved farmland, is used for multiple purposes, including recreation and wildlife conservation. Historically, public institutions such as correctional facilities and state hospitals hosted farms for growing their own food and providing job training and therapeutic work opportunities for inmates and patients. With the industrialization of the food system, these public farms no longer exist. Many stakeholders noted that new town farms or state farms on public land would be an excellent opportunity to employ farmers and increase local food production for local use, especially in institutional settings such as state owned building cafeterias.

For example, during the summer of 2010, Vermont inmates helped the struggling dairy industry by painting and repairing barns through a public–private partnership among the *Department of Corrections*, VAAFM, and VLT. Work crews were able to give back to other struggling members of the Vermont community while gaining skills, and to participate in community engagement that may help reduce recidivism rates. Many stakeholders noted that farms at correctional facilities and other public institutions should be reinstated for food production and job training.

Lease Arrangements

In lieu of private landownership, many farmers lease land for agricultural production. There are opportunities and challenges associated with both landownership and leasing. Landownership ensures independence and an ability to invest in a parcel of land, yet it presents numerous financial barriers and risk. Purchasing land and the pressure of a monthly mortgage can stall the ability of new farmers to get a viable business off the ground. For beginning farmers with limited capital, accumulating other farm assets to help with production takes priority, so leasing can offer an ability to build a market or develop a product niche.

I think what's needed is a little bit more education for landowners about what it means to enter into a lease arrangement on your property with a farmer. Amongst landowners in terms of agriculture, more and more land is going out of the hands of farmers. Those people who are buying just don't know why you need a fence, or why you need a fence in a certain way, or why you need fertilizer.

—Northeast Kingdom focus group participant

Leases are set up in a variety of ways: An aging farmer may lease to another farmer to keep the land in production. An established farmer may lease neighboring parcels to expand acreage, or new farmers may lease-to-own to affordably transfer property. Beginning farmers may ask their neighbors if they can grow vegetables or graze livestock on their land. Although some landowners charge monthly fees to lease a certain amount of acreage, others do it for tax reasons and are happy with barter for products in exchange for land use.

Challenges with lease arrangements were discussed in great detail during F2P focus groups—from the difficulty of being far away from livestock, to disagreements between

Land Access Project: *Land for Good*, a nonprofit based in Keene, New Hampshire, is coordinating a new initiative, the *Land Access Project* (LAP), through a 3 year USDA Beginner Farmer and Rancher Development Fund Grant. LAP is networking land access technical assistance providers in New England around 4 task forces focused on improving opportunites, policy, educational materials and processes for:

- Listing and linking landowners and prospective farmers
- Helping to transfer farms from retiring farmers to prospective farmers
- Encouraging NonFarming LandOwners (NFLOs, e.g., state government, nonprofits, municipalities) to lease or sell land to prospective farmers, and to improve the quality and sustainability of these lease arrangements;
- Investigating tenure innovations for purchasing or leasing land that will help improve affordability for farmers.

This project has the involvement of technical assistance providers, farmers and farmland owners from all 6 New England States, including several Vermont organizations. Educational materials, recommendations, and workshops will be developed in 2011 and 2012. While it is hoped that lasting partnerships and infrastructure will be developed from this initiative, nonetheless, funding for the current initiative will run out in 2013.

landlords and tenants, to difficulties in obtaining working capital because of a lack of collateral. Leasing land doesn't work for everyone. The independent nature of farming, combined with the long-term nature of land management decision making, often makes farming incompatible with temporary lease agreements.

From a tenant's perspective, one of the biggest challenges is the loss of security associated with making investments in the natural resources on a particular piece of property or in the farm's physical structures (e.g., barns or fencing). Responsibility for land management decisions and issues around permitting were described as additional headaches for both tenants and landowners alike. At times, the tenant and landlord can have different long-term goals for the property which limits opportunities for the grower. As one Central Vermont focus group participant explained, "Leasing does limit your opportunity. When the landowner doesn't sign off, you can't do anything. Or when there are preexisting situations, then you are juggling to manage other people's land management problems that are not your own."

When the relationship works (i.e., the right mix of people, a manageable arrangement, mutual benefits), leasing can offer advantages to farms of all sizes. Successful long-term lease arrangements are shifting the way we look at farms and farming, focusing less on the need to own land and more on farm profitability. One focus group participant called it a transition to "branded products": "What changes with the lease dynamic is that you have a business and not a place. I think more and more what we are looking at is branded farms that are a business—where the brand represents what consumers are buying."

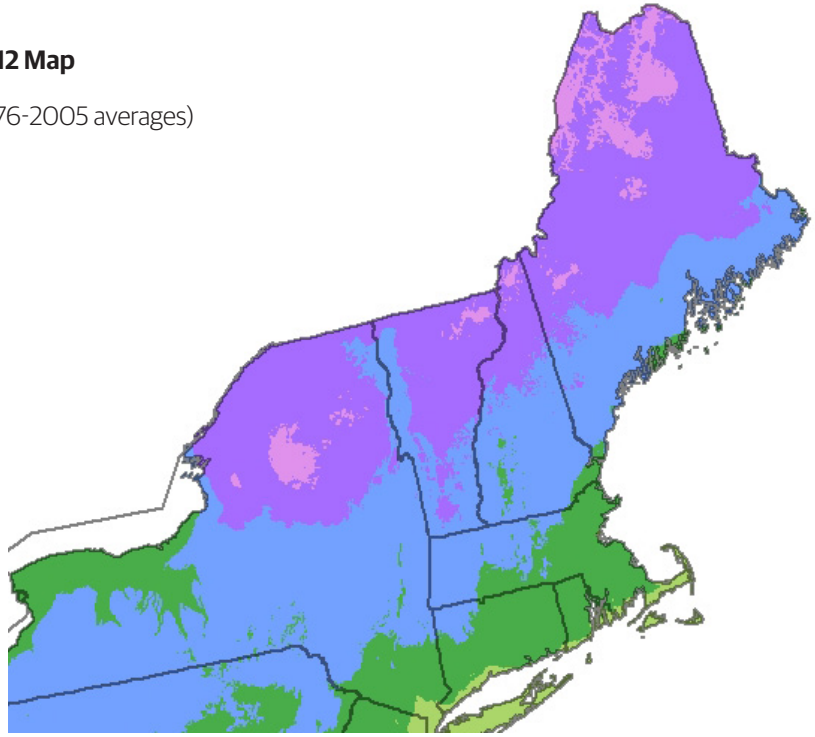
☼ Climate Change Impacts on the Landscape

Rising temperatures and altered precipitation patterns will affect agricultural productivity in all food producing regions of the world, including Vermont. Evidence already suggests that Vermont's growing season for frost-sensitive plants has increased by about two weeks over the past forty years, although there is large variability from year to year.[29] A longer growing season may present new opportunities for food production in Vermont, but gains in the length of the growing season must be counterbalanced with other changes. **Climate change has shifted plant hardiness zones northward across the United States over the past 40 years** (Figure 3.2.11). Plant hardiness zones reflect the average annual extreme minimum temperature during a period of time. The most recent plant hardiness zones map reflects averages from 1976 to 2005 and show the creep of zones 5 and 6 into more parts of New England. Some research indicates that the 2012 plant hardiness zone maps already underestimate total warming by 0.7 to 1.7 degrees.[30] According to the *USDA*, each crop

Figure 3.2.11: Changes in Plant Hardiness Zones, 1976-2005

2012 Map

(1976-2005 averages)



Average Annual Minimum Temperature

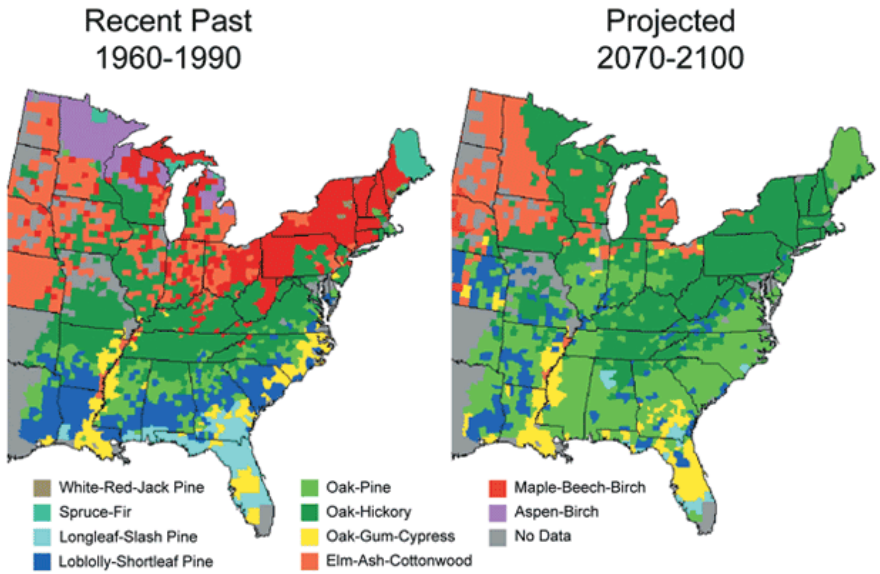
-40 to -30 F	**Zone 3**	-40 to -34.4 C
-30 to -20 F	**Zone 4**	-34.4 to -28.9 C
-20 to -10 F	**Zone 5**	-28.9 to 23.3 C
-10 to 0 F	**Zone 6**	-23.3 to 17.8 C

Source: USDA Agricultural Research Service, *http://planthardiness.ars.usda.gov/PHZMWeb/Default.aspx*.

and animal species has a "given set of temperature thresholds that define the upper and lower boundaries for growth and reproduction, along with optimum temperatures for each developmental phase."[31] For example, vegetables exposed to temperatures that are 1 to 4 degrees Celsius above optimal for biomass growth may have reduced yields, while exposure to temperatures above 5 to 7 degrees Celsius can result in total crop loss. Or, for example, increases in winter temperatures can effect the chilling requirements (i.e., a minimum period of cold temperatures that trigger blossoms) of perennial crop systems. The USDA says that perennial crops in the Northeast that have a lower than 400-hour chilling requirement should be safe for the rest of the century, but plants with prolonged cold requirements (e.g., apples) may experience reduced yields.

Warming temperatures also mean more habitable environments for insects, invasive plant species, and other pests that may impact agricultural productivity in Vermont. And most *forest cover models* show the composition of Vermont's forest species changing from maple-beech-birch to oak and hickory by 2100 (Figure 3.2.12). **The implication of these changes is that the appearance, composition, and functioning of Vermont's working landscape will be dramatically different in the years ahead. Vermont's farmers, land planners, conservationists, and other technical assistance providers will have to improve their ability to monitor, anticipate, and adapt to the variety of ecosystem changes that will make food production increasingly challenging during the 21st century.**

Figure 3.2.12: Projected Shifts in Forest Types



Source: United States Global Change Research Program, 2009, *www.globalchange.gov/images/cir/pdf/ecosystems.pdf*.

ANALYSIS

F2P stakeholders described *affordable access to farmland* as a serious barrier for new farmers or those seeking to grow and expand. Stakeholders want to know more about how to ensure smooth farm transfers to keep land in farming. Farm incubator programs and sites have been identified as a way to help new farmers overcome capital barriers and gain access to affordable leased land, shared equipment, other infrastructure, and mentors while they are in the start-up phase of their businesses. Embedding agriculture in residential areas closer to active markets has recently been studied in Vermont. Zoning ordinances, town and regional plans, and statewide planning enabling legislation should be reviewed and adapted to encourage viable local agriculture and food distribution. Ongoing conservation efforts, especially for prime agricultural farmland, are essential to the future viability of farming in the state.

Research

Land use matchmaking: The *Vermont Agriculture Land Access Database* was recently launched to enable farmers to search available listings and farm opportunities based on open acreage size, location, and type of farm tenure arrangement. An expansion of this project to include publicly available maps that identify potentially available farmland parcels and land owners, similar to *FarmLINK* in Ontario, will enable better prioritization of conservation efforts and improve access to farmland parcels. An efficient use of resources could be to examine existing town tax maps or initial points of contact like the ACT 250 database to target underutilized lands. A more long-term initiative would be to create and update a statewide land use spatial LiDAR database of agricultural land usage and an inventory of agricultural land that captures information on soil type, current land use, accessibility to roads, proximity to market areas, and so on.

Any targeted mapping effort should coincide with surveying potential stakeholders to "map" the social aspects of pioneering farm access arrangements on dormant lands. Barriers due to landowners' lack of awareness of how to pursue agricultural or conservation uses of their land may need to be overcome with education and outreach activities.

Embedding farms in residential areas: Ongoing research and outreach should be supported to link nonfarmer landowners of productive agricultural soils in suburban and urban areas with farmers seeking to lease farmland closer to markets.

Farm Transfer Needs: The needs of established farmers nearing retirement should be assessed to determine if plans are in place to transition the farm to the next generation, and what assistance or resources are necessary to ensure a smooth transition.

Natural Resource, Physical Infrastructure and Technology

Farming on public lands: Opportunities for farming on public lands, such as town farms or state farms, and parcels in close proximity to public institutions such as correctional facilities, should be explored. Processes or mechanisms for improving inter-agency coordination (e.g., between VAAFM, ANR, the *Department of Corrections*, and the *Department of Buildings and General Services*) as well as models of public-private-nonprofit partnerships need to developed.

More farm incubator sites: Incubator farm programs offer a proven means to help new and growing farmers gain access to land, shared equipment, and mentorship—all of which are critical to successful farm businesses.

Conserve a variety of high-agricultural-value parcels: Vermont's food system will only grow if land with prime agricultural soils and soils of statewide significance continues to be conserved in perpetuity and in connection with viable farmers and farm operations. VLT, UVLT, and VHCB's land conservation funding and technical assistance resources are critical to the future success of Vermont's food system. Additionally, small parcels of land tend to be more expensive, so research is needed to identify funding opportunities for small parcel conservation.

Technical Assistance and Business Planning

Creative, secure, long-term leasing arrangements: Case studies detailing innovative tenure models should be compiled to provide educational tools that help inform farmers and landowners developing farm access arrangements, as well as assist policy makers in devoting public support for increasing farmland access via these models.

Valuing agricultural land: An agricultural land value index should be developed to help landowners, farmers, and financial institutions conduct agricultural land transactions in an open and transparent manner. An agricultural land value index is essentially a way to gauge rental and per acre prices for agricultural land in different areas of the state and make these values transparent for landowners, landlords, farmers seeking land, realtors, and others.

Network Development

Farmland access support: The *Vermont Farmland Access Network* (VFAN) works as a referral network to offer customized and geographically specific technical assistance to match farm seekers with farmland sellers. VFAN is participating in the development of educational materials and curricula for the Land Access Project. But VFAN is a volunteer network—its core members currently do not have resources specifically devoted to network activities. Developing the capacity of VFAN, including building the capacity of members to deliver hands-on services in each area of the state and creating an online portal for linking landowners and farmers, is important for improving agricultural land access.

Financing

Maximize public and private investment in land conservation: Throughout the F2P process, a wide variety of creative ideas, policies, and programs to increase investment in land conservation and enable more farmers to access good, affordable agricultural land were identified. From tax incentives to tourist "tips" dedicated to preserving Vermont's working landscape, more mechanisms should be in place to ensure a more diverse pool of funds for land conservation.

Regulatory and Public Policy

Strengthen the Current Use Program: The Current Use Program has enabled Vermonters to preserve the working landscape. The state should support efforts to discourage short-term enrollments of land in the program that a landowner intends to develop, and convert paper documents to electronic files and GIS-based maps.

GETTING TO 2020

Vermont lost over 82,000 acres of land in agriculture to development and other land use changes from 1997 to 2007, a 6% decrease. Not surprisingly, many people cited affordable access to farmland as a serious barrier for new farmers or those seeking to grow and expand. **To meet the F2P goals of strengthening Vermont's food system, the rate of farmland conversion needs to decrease.** A variety of programs for conserving land and expanding access to land exist, including conservation easement programs, cooperative land management arrangements, and farm incubator programs. The following objectives and strategies identify additional opportunities to augment these programs and strengthen Vermont's food system.

Table 3.2.11: Objectives and Strategies for Improving Land Access

OBJECTIVE	STRATEGY
Research Strategies	
To help Vermont farmers, land owners, and technical assistance providers adapt to climate change.	Climate change will alter the composition of crops, forests, and land cover (i.e., Vermont's working landscape). Farmers, land owners, and technical assistance providers (including educational institutions) should begin analyzing scenarios for land composition changes in Vermont in the coming years and preparing adaptation options.
To improve access to viable and affordable agricultural land and secure tenure for farmers (ownership and leases).	Create and update a statewide land use spatial LiDAR database of agricultural land usage and an inventory of agricultural land that captures information on soil type, current land use, accessibility to roads, proximity to market areas, and so on. Call attention to publicly owned land locations conducive to food production that are adjacent to publically owned buildings. Survey owners of arable land and town representatives to determine what types of farm tenure arrangements are possible to develop with new farmers or employed farm managers.
	Support legal research on embedding new farming activity in established and developing residential areas on productive agricultural land owned by nonfarmers. This effort should be coordinated with existing farmland access programs and should be included in the Vermont Food System Atlas.
Physical Infrastructure and Technology Strategies	
To improve access to viable and affordable agricultural land and secure tenure for farmers (ownership and leases).	Establish additional farm incubator programs (providing land, technical assistance, equipment sharing) in underserved areas of the state. Develop a matchmaking database of existing farmers who want to host and mentor new farmers on a portion of their property, or mentor new farmers who operate on their own elsewhere.
	Support VLT, VHCB, and other farmland conservation partners to set aggressive targets for conserving farmland for dairy, fruit and vegetables, livestock, grains, beans, oilseed, and other crop production.
Technical Assistance and Business Planning Strategies	
To improve assistance provided to retiring farmers exploring options for farm transition to the next generation	Fortify support for the Vermont Housing and Conservation Board's Farm Viability Program to significantly increase the capacity of partnering agricultural service providers, accountants, attorneys and mediators to provide farm transfer planning assistance.
To increase information about viable and affordable agricultural lands and tenure models.	Assemble information on farmland lease options and samples for secure tenure models, customize them for Vermont application, consolidate them into a searchable database and online resource, and conduct workshops for farmers and landowners that explain leasing and lease options and provide hands-on technical support.
	Create an agricultural land value index for different types of production to make rental values transparent for landowners, investors, and farmers).
	Increase funding support for farmland access technical assistance and matchmaking programs such as Vermont Land Trust's Farmland Access Program and the Vermont Farmland Access Network

OBJECTIVE	STRATEGY
Technical Assistance and Business Planning Strategies	
To protect farmland currently in dairy production. Encourage and help facilitate contact with farmland protection organizations when dairy farmers are considering expansion, closure, transfer, or transition plans.	Encourage and help lending institutions and rental agents to provide notice to farmland conservation organizations before dairy farms are transferred or sold.
	Advertise and encourage using *USDA's Transition Incentives Program* (TIP)—a new program under the Conservation Title of the 2008 Farm Bill—to encourage retired or retiring owners or operators to transition Conservation Reserve Program land to beginning or socially disadvantaged farmers or ranchers. Coordinate outreach with USDA Farm Service Agency (FSA) county offices.
Network Development Strategies	
To improve the coordination of services provided throughout the state to assist farm seekers and land owners develop secure tenure arrangements.	Support the Vermont Farmland Access Network's effort to deliver on-site technical assistance, connect farm seekers and landowners, report on policies and innovative farm tenure and stewardship models, and build information sharing platforms that enable farmers and landowners to pursue sustainable farming arrangements.
Financing Strategies	
To establish a conservation revolving loan fund.	Establish a revolving loan fund in collaboration with the Vermont Land Trust, the Vermont Housing and Conservation Board , and other farmland conservation partners for the purpose of fee purchases of strategic farmland parcels to be conserved (i.e., conservation easements applied), resold to farmers, and/or held as leased incubator farms or for other farming activities.
To encourage more public and private investments in agricultural land that provide longer-term financial returns and flexible exit strategies, and that involve farmer lease-to-own contracts.	Benchmark models such as the *New Brunswick New Land Purchase Program*, *Equity Trust* and *Farmland LP* to identify agricultural land investment models that could work in Vermont. Create or leverage an existing intermediary that would raise private investment funds, purchase farmland, and create flexible lease-to-own contracts with farmers. Such contracts would allow farmers' lease payments to go toward building more equity each year, tie payments to annual farm performance and income, and provide exit options for farmers.
To use any and all legal and financial mechanisms to value farmland at affordable prices for farmers, based on agricultural value, farmer income, etc.	Support OPAV program on all conserved farmland parcels, and VHCB's retroactive option to purchase program.
To encourage more public and private investment in agricultural land.	Institute a tax credit program for farmland preservation for new farmers (See an example at *Nebraska Beginning Farmer Tax Credit Program*).
	Review a luxury property tax (i.e., if a property is sold at a certain percentage of median property value, a portion would be levied for a farmland purchase fund).
	Allocate some portion of tourism-related taxes to be used toward a farmland purchase fund, and promote visitor donation/"tips" marketing.
	Fully fund the property transfer tax formula that is meant to support VHCB annually as outlined in the original enabling legislation.
	Increase opportunities for investors interested in serving as land acquisition holding companies while easements and farmer purchase agreement are worked through during a conservation project negotiation.

OBJECTIVE	STRATEGY
Regulation and Public Policy Strategies	
To encourage farming on public lands.	Identify existing models for state and town farms and share these with Vermont legislators, state agencies and departments, state land managers, and municipal leaders. Endorse and encourage processes or mechanisms for improving inter-agency coordination (e.g., between VAAFM, ANR, the Department of Corrections, and the Department of Buildings and General Services) for using state lands for food system activities. Solicit RFPs that model effective public-private-nonprofit partnerships for managing food system activities on state lands.
To encourage the creation of local zoning regulations to protect the right to farm and encourage the protection and active use of prime agricultural soils.	Review and update zoning ordinances to ensure, to the greatest extent possible, that prime agricultural soils are conserved for agricultural use. Develop tools such as those developed by the *Delaware Valley Regional Planning Commission* to guide improvements to planning and zoning ordinances that support the further development of the food systems. Increase the off-site mitigation fees paid to discourage development of prime agricultural soil, and use this revenue to fund publicly supported land acquisition programs for new farmers
To maintain the Use Value Appraisal Program to keep farmland in farming.	Support efforts to discourage the short-term enrollments of land in the Program that a landowner intends to develop, and convert paper documents to electronic files and GIS-based maps. The administration and legislature should also work with interested parties to identify other steps to improve the program's effectiveness, efficiency, and sustainability over the long run.
To encourage state regulation changes to maximize the agricultural land that stays in active farming use.	Advance state policies and regulations to minimize the fragmentation of land (10-acre loophole in Act 250), and ensure the active agricultural use of prime agriculture land that is set aside as Act 250 mitigation.

FARM INPUTS

Soil

What kinds of agricultural soils does Vermont have? What can be done to reduce soil input costs and reduce soil erosion?

The *USDA Natural Resources Conservation Service reports* that there are more individual organisms in a teaspoon of soil than there are people on earth, and that this biodiversity is the key to the success of agricultural systems. Despite the importance of soil, nearly 25 million acres are lost every year,[32] and the use of fertilizers increased while the total amount of land in farms and total cropland in the United States decreased (4.4% and 8.3%, respectively, from 1987 to 2007). This section focuses on soil quality and best practices for maintaining soil fertility and minimizing soil erosion generated by agricultural activities.

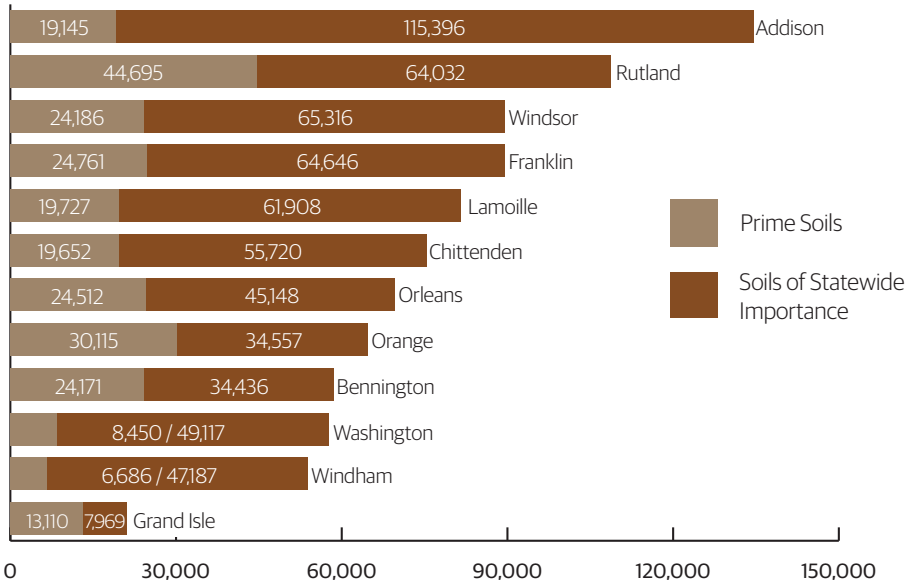
We all have that need to develop our soils and to move into a stronger resource management culture to find ways to bring all of this "waste" into our compost facilities, or we are missing out on so much.

—Bennington focus group participant

CURRENT CONDITIONS

Vermont has over 250,000 acres (21% of total acres in agriculture) of "prime" soils and almost 650,000 acres (54% of total acres in agriculture) of "farmland of statewide importance." The amount of high-quality agricultural soils varies

Figure 3.2.13: Total Acres of Good Farmland Soils by County



Source: NRCS, 2005.

considerably by county. More than a quarter of the statewide total is in Addison and Rutland counties (Figure 3.2.13).

According to Danny Peet, soil conservationist with the *Vermont Natural Resources Conservation Service* (NRCS), "I work with farmers on *Vergennes Clay* to *Hadley Loams*, and they all say it's about the soil. As far as the dairy farms on the Hadleys, they never have a poor crop year. In 2009, in a year of continual rains, you could not get on a Vergennes Clay, whereas the better soil areas had a normal harvest. This affects farmer's outlook and state of mind. You can say the same about our vegetable farmers."

What Are Prime Soils?

- Prime soils have the best combination of chemical and physical characteristics for the production of crops.
- Soil temperature and growing season are favorable.
- Soil moisture is adequate to sustain crops 7 out of 10 years.
- Water moves readily through the soil.
- Soil is neither too acid nor too alkaline.
- Soil is not frequently flooded.
- Slope is generally less than 8%.
- Soil is typically deep (greater than 40 inches to bedrock).

Soils of statewide importance are similar to prime soils, but they differ in such characteristics as slope (greater slope) and the ability of the soil to store moisture (less able to store moisture).

Vermont does not have a comprehensive soil management and monitoring program, but agricultural producers have access to technical assistance from UVM Extension, NRCS, the *Vermont Association of Conservation Districts* (VACD), and other private consultants. NRCS provides incentives for farmers to develop *Comprehensive Nutrient Management Plans* (CNMPs) to improve soil productivity and environmental protection on their farms. NRCS also offers access to cost-share programs for new equipment such as *high tunnels* to advance season extension techniques, as well as watershed protection strategies such as purchasing and planting native trees and shrubs in surface water riparian buffers. VACD, representing 14 Natural Resources Conservation Districts, also provides technical assistance and education to farmers and landowners, including the *Agricultural Resource Specialist program*, which provides technical assistance for manure management and water quality management.

Although there are good maps showing where prime agricultural soils are located, it is not known how many of these acres are actually in agriculture or available for agriculture since Vermont does not have comprehensive statewide land use maps. We don't know how many acres of "prime" and "statewide" land have already been developed or paved over; or how many parcels are too fragmented or are difficult to access. Such data can be very helpful to those seeking to identify and prioritize investments in farmland preservation. Based on stakeholder feedback, a mapping inventory of available fertile farmland is a very high priority for strengthening Vermont's food system.

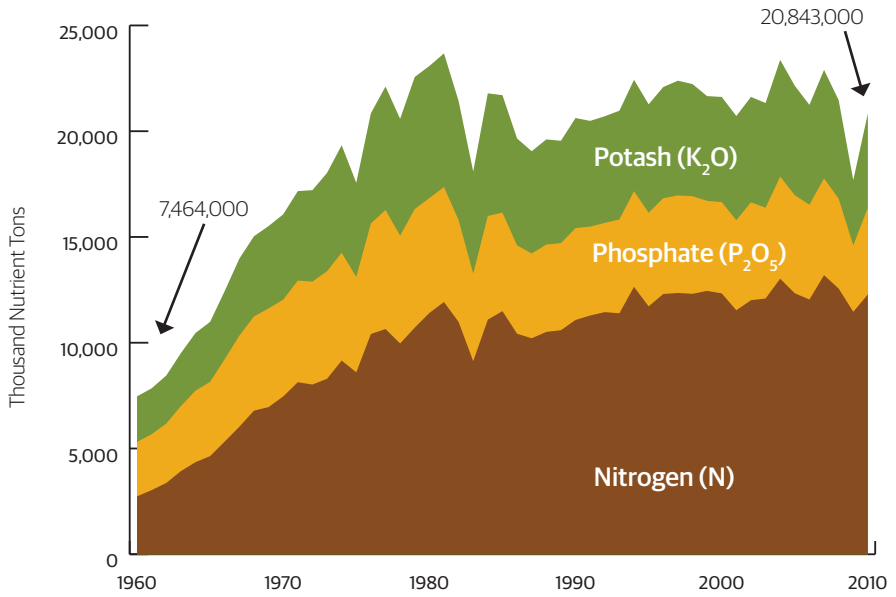
Soil Fertility

Fertilizers, Lime, and Soil Conditioners

Vermont farmers spent about $20 million on fertilizers, lime, and soil conditioners in 2007 (equal to 3.6% of total production costs), 50% more than was spent in 1997. The USDA Census of Agriculture estimates that 1,941 Vermont farms used manure as a fertilizer on 216,025 acres in 2007, while 2,346 farms used commercial fertilizer, lime, and soil conditioners on 228,040 acres.[33]

The use of inorganic (i.e., fossil fuel or mineral based) fertilizers has increased dramatically in the United States. From 1960 to 2008, total fertilizer use increased about 188%, the use of nitrogen increased 359%, the use of phosphates increased 65%, and the use of potash (i.e., potassium-based) fertilizers increased 116% (Figure 3.2.14). In 2008, nitrogen constituted 58.5% of primary nutrients given to plants, while potash and phosphates equaled 21.7% and 19.8%, respectively. The use of fertilizers increased while the total amount of land in farms and total cropland in the United States decreased (4.4% and 8.3%, respectively, from 1987 to 2007).[34] Agricultural runoff of fertilizers has been implicated in the growth of *ocean dead zones* (i.e., an abundance of these chemicals can lead to algal blooms that deprive the water of oxygen).[35]

Figure 3.2.14: Fertilizer Use in the United States, 1960-2010



Source: USDA Economic Research Service, *www.ers.usda.gov/data-products/fertilizer-use-and-price.aspx*

Corn appears to receive the most fertilizer of any crop in the United States, with over 95% of the corn planted in the country receiving nitrogen, over 80% receiving phosphate, and over 60% receiving potash in 2008. Corn for grain (5,368 acres) and silage (87,403 acres) made up 18% of total cropland in Vermont, the largest amount of any field crop after hay in 2007.

Lime is used to increase the pH of acidic soils and to increase the uptake of primary nutrients (e.g., nitrogen, phosphorus, and potassium) on acidic soils. Because lime is expensive to spread (it is heavy and can be difficult to get onto wet and steep slopes), it generally is put only on the best soils. We do not have data on this, but it is assumed that most fertilizers and soil conditioners are imported from out of state.

Many fertilizers and soil conditioners are designed to help boost nutrients for one crop year, not to build the soil's health over time. To ensure continued productivity, soils require regular testing for biological, physical, and chemical properties, and ongoing soil-building amendments to sustain nutrients and build organic matter. **Nutrients and organic matter can be provided by carefully produced and tested compost, a growing industry in Vermont that serves multiple bottom lines (e.g., waste reduction and soil building).** Compost is addressed in more detail in Chapter 3, Section 7, Nutrient Management.

☼ Climate Change Impacts on Soils

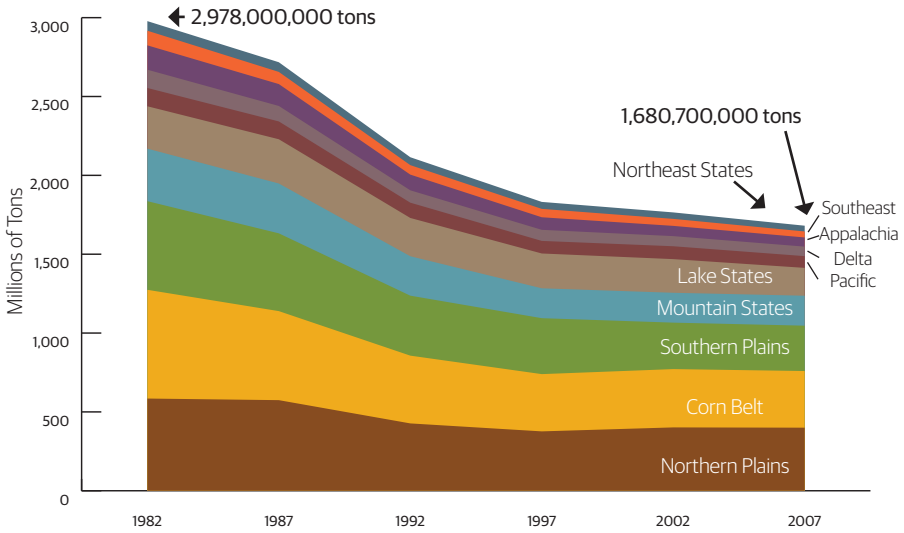
According to USDA NRCS, total soil erosion rates from wind and water decreased nearly 44% in the United States from 1982 to 2007 (Figure 3.2.15).[36] The Dust Bowl of the 1930s—caused when a major drought intersected with extensive agricultural practices that did not conserve the soil—was a major wake-up call for soil conservation practices. The United States and Europe now have the lowest cropland erosion rates in the world, but with nearly 1.7 billion tons of soil lost in 2007, we are losing soil about 90% faster than the natural replacement rate.[37]

The Great Plains and the Corn Belt accounted for over 62% (over 1 billion tons) of soil erosion in the United States in 2007, whereas Northeastern states contributed 2.2% (about 37 million tons), the least of any region in the country.

Soil erosion data specific to Vermont was unavailable. Nevertheless, soil erosion can be a serious issue in Vermont because degraded or eroded soils may limit Vermont's ability to boost local food production for local and regional consumption. Soil erosion from agricultural production can adversely affect water quality in Lake Champlain and other important water bodies and contribute to added municipal expenditures for roadside ditch dredging, road repair, and impaired waterways.

Climate change will increase incidences of extreme weather events around the world that will impact food production. **Soil erosion from rainfall, irrigation, wind, and production practices is expected to increase across the country.** Wind erosion and irrigation-induced erosion are not expected to be major factors in Vermont, but the Northeast is predicted to receive more annual rainfall and more intense rainfall during the 21st century, and rainfall-driven erosion is expected to increase.[38] In 2011, Tropical Storm Irene flooded 20,000 acres of farmland—ruining crops in the field, spoiling harvested animal feed, and drowning animals—and caused upwards of $1 billion in damage to the state of Vermont.[39] Since extreme weather

Figure 3.2.15: Soil Erosion in the United States, 1982-2007



Source: USDA Natural Resources Conservation Service, *www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/dma/?cid=stelprdb1041887*.

events are expected to increase, the USDA suggests that conservation tillage, crop residue management, cover crops, management of livestock grazing, and precision conservation practices have the potential to reduce much or all of the acceleration of soil erosion rates that might occur under a more intense rainfall regime associated with climate change.[40]

Maintaining Healthy Soils

Federal technical assistance and cost-share programs administered through the USDA are available to help support farmers to improve soil quality, retire certain environmentally sensitive lands from production, and advance watershed protection best practices.

The *Conservation Reserve Enhancement Program* (CREP) is a voluntary land retirement program administered by NRCS, the *USDA Farm Service Agency*, and VAAFM that pays landowners to take land near streams out of production for 10 or 15 years. The land is usually planted with a riparian buffer containing shrubs and trees or a filter strip made up of grasses. Vermont had 201 farms representing 2,038 acres enrolled in CREP in 2009, and farmers received an average of $104.45 per acre.[41] **A *Vermont Department of Environmental Conservation* study found that the installation of buffers and animal fencing in three watersheds in Franklin County reduced nitrogen, phosphorus, and sediment runoff by 30 to 40%.**

The *Environmental Quality Incentives Program* (EQIP) also provides payments for natural resource conservation, including the reduction of soil erosion and sedimentation, and the promotion of at-risk species habitat conservation. As of 2010, there were 419 EQUIP contracts in Vermont, equal to nearly $8.7 million and covering 48,178 acres for such conservation practices as filter strips, riparian buffers, fences, and roof runoff management.[42] The *Farm Agronomic Practices Program* also provides financial and technical assistance for soil conservation practices, such as cover cropping and crop rotation.

The *Franklin and Grand Isle Farmer's Watershed Alliance* (FWA) was established in response to adverse water quality in Missisquoi Bay of Lake Champlain caused primarily by agricultural runoff. In addition to the many services it provides to farmers to improve nutrient and environmental management, FWA received grant funding to purchase six soil aerator tools to be used by area farmers to help maximize the amount of rainfall moving vertically into the soil, minimizing horizontal water runoff and erosion. These tools are proving to be a good investment for minimizing surface runoff and soil erosion.

According to Roger Rainville, chair of the FWA board, "The FWA bought 6 machines and aerated 13,000 acres [in 2009]. Our goal was to show farmers that if you aerate your land before applying liquid manure, you can significantly reduce the potential for surface runoff. It did, and many other benefits were noticed also, such as better utilization of nitrogen. It goes in the soil and does not all volatize into the air. The aerator breaks up compaction and loosens the top 8 inches of the soil for better water absorption. Many farmers saw up to a 100% crop yield increase. The aerators are being used for a $2.00 per acre fee by farmers. There are two machines in Addison County that are administered by the Conservation District and three here in Franklin and Grand Isle and one in Orleans County that the FWA oversee. All 6 are the responsibility of FWA."

Cover Crops and Crop Rotation

Cover crops (e.g., grasses and legumes) and *crop rotation* have become popular alternatives to improve soil quality. Cover cropping refers to the use of crops to cover soil between harvests. Cover cropping has other benefits besides preventing soil erosion, including adding organic matter, suppressing weeds, and, in the case of some legumes, producing nitrogen. If the cover crop doesn't get planted soon enough in the fall, however, its benefits are not maximized. In contrast to monocropping (i.e., growing the same crop in the same place year after year), the idea of crop rotation is to sequence crops so that one crop benefits the crop that follows it. According to UVM Extension vegetable and berry specialist Vern Grubinger, "Crop rotation is one of the most effective tools for managing pests and maintaining soil fertility, but there aren't many specific recommendations for how to go about it."[43] Grubinger provides some *examples of crop rotation in Vermont*, as does the *National Sustainable Agriculture Information Service* website.

PHOTO CREDIT: Pete's Greens

Tineweeding at Pete's Greens.

Strip-Till or No-Till Cultivation

Strip-till or no-till cultivation methods can deliver dramatic benefits such as soil fertility, soil stability, and farm viability, as well as increase carbon sequestration in the soil. These methods require special tractor implements that are expensive, but can save farmers a lot of time—and money—in the field over the long run. In contrast to conventional field plowing, which disturbs all of the soil, strip-till cultivation plows about a third of the space more precisely where seeding will occur, and leaves strips of undisturbed soils between the planted rows. No-till cultivation uses equipment and GPS technology that can cut an even narrower row for planting, but many of Vermont soils are not suited for no-till methods.

Strip-Till Cultivation: Addison farmer Paul Boivin recently invested in strip-till equipment for growing corn in Vergennes Clay soils, which are heavy and easily compacted. Based on his research of strip-tilling practices used throughout the country and his experience on his own farm, Paul is confident that strip-tilling will reduce production costs and enhance soil into the future. He has already seen the benefits of this cultivation method, with dramatic reductions in the time it takes to prep the field for planting because fewer tractor passes are needed and GPS-like equipment supports more precise tilling patterns. Less tractor time ultimately means less fuel used and less soil compaction. Reduced soil disturbance preserves organic matter and stabilizes nutrients, and fertilizer is absorbed more efficiently because it is directed more carefully to the 10-inch planting row, instead of being broadcast on the field. Finally, reduced soil disturbance means less soil erosion and runoff, and greater carbon sequestration services.

Ecological Services Provided by Soil

Carbon stored in coal, oil, and natural gas for millennia is now being released into the atmosphere, altering Earth's climate. Increased attention is being paid to the possibility of reducing the amount of carbon in the atmosphere by increasing the amount of carbon stored in soils. Soils are major carbon sinks, containing more carbon than occurs in vegetation.[44] One Vermont business, *Carbon Farmers of America, LLC*, attempted to develop a market for businesses and consumers to purchase carbon credits from eligible farmers to offset their carbon footprints. Although *Carbon Farmers* ultimately

did not get off the ground, the basic idea is being pursued in various iterations across the country. For example, carbon trading programs could be modeled on water quality trading programs that exist in the *Chesapeake Bay region*, the *Ohio River Valley*, and *New York City*.

ANALYSIS

Soil health is the foundation of every food system, but there remains a lack of information about several aspects of Vermont's soils. Vermont does not have a comprehensive soil management and monitoring program or land use maps that show how many acres of "prime" and "statewide" land have already been developed or paved over. Although we could not identify soil erosion rates for Vermont, the Northeast region has the lowest erosion rates in the country, and many programs are available to curb erosion and build soil health. Vermont farmers that use fossil fuel-based fertilizers are vulnerable to price increases in petroleum based products: they spent 94% more on fertilizers, lime, and soil conditioners in 2007 than they did in 1997.

Research

Soil mapping: Mapping is needed to overlay both prime agricultural soils and soils of statewide significance with existing land use, in order to identify key parcels where different types of farming or crops would be most viable.

Conduct research on volatile and other losses of nitrogen from storage and land application techniques as a way to reduce nitrogen purchased input costs: There are data from many studies that demonstrate that spreading manure by distribution from 6-10 feet above the ground, and failure to incorporate into soli immediately results in significant nitrogen losses. In addition to contribution to ammonia emissions into the atmosphere, this is a costly management error. Data are needed using typical Vermont manure application techniques to determine the potential cost savings from modification of manure application methods.

Technical Assistance and Business Planning

Comprehensive soil management and monitoring program: According to various stakeholders, a more comprehensive soil quality management and monitoring program is needed to increase soil health and the ecological services provided by healthy soil. Monitoring systems for measuring a wide range of biological, chemical, and physical soil properties should be developed. Additional resources are needed to assist farmers with getting regular soil tests, interpreting and evaluating fertility and soil-building strategies, and creating in-depth nutrient management plans.

Farmers should be encouraged and/or incentivized to implement best practices to minimize soil erosion on a more regular basis. Cover cropping, crop rotation, and maintaining high water infiltration capacity of cropland and grazing land are common means of arresting soil erosion and maintaining soil health. Soil aerator equipment should be more regularly used to minimize storm water, nutrient, and sediment runoff and curb soil erosion. Midfield buffers made with grassy swales or waterways or native trees and shrubs to capture runoff on sloped fields are other strategies for minimizing soil erosion. Outreach by farmers to farmers about the benefits of CREP and EQUIP grants, nutrient management plans, and the implementation of best practices to increase organic matter in soils should be increased.

Additional technical assistance and demonstrations of the benefits of strip-till, zone and no-till practices should be implemented, and cost-share programs should be considered to allow farmers to lease appropriate equipment to implement these practices. According to stakeholders, producers are eager and ready to adopt these practices but do not have the financial resources to cover start-up capital expenses.

Promotion of good grazing management (incorporated with cropping, and with additional resources such as soil aeration, microbial inoculation, effective manure management, diverse seeding strategies, etc.) is low-hanging fruit. Ongoing support of the *Vermont Pasture Network's* grazing technical support will be critical to improving soil quality over time.

Locally produced compost at commercial operations and on farms is a very important long-term soil-building strategy to replace imported fertilizers.

Financing

Economic incentives to private landowners for enhancement of soil properties: Soils provide a variety of ecological services, including water purification, flood mitigation, erosion control, carbon sequestration, atmospheric regulation, and

agricultural production. Opportunities or programs for incentivizing topsoil formation or compensation for these ecological services should be investigated. These could include tax incentives, direct payment between upstream land managers and downstream services beneficiaries (e.g., municipal water quality managers), participation in carbon and nutrient credit trading schemes.

Network Development

Sharing good soils: Matchmaking services could help connect interested farmers or landowners interested in renting out a portion of their larger fields or properties to a vegetable farmer. For example, a dairy farmer could carve out a 5- to 10-acre corner of a large prime agricultural soil field and lease it to a vegetable producer, or even support diversification of the dairy farm itself (e.g., by growing vegetable crops).

Regulation and Public Policy

Revisit winter spreading ban: Some stakeholders question whether the current ban on winter manure spreading is helping or hindering soil and water quality. Suggestions have been made to change the program to a performance-based program, in which spreading is scheduled for appropriate times, based on soil condition. Winter spreading may be better for soil and water quality than spreading at other times of the year when soils are extremely wet and tractor tires can cause major disruption to soil. One stakeholder suggested looking to New York, where a winter spreading ban does not exist, but most large farms have nutrient management plans that dictate where and when manure can be spread.

GETTING TO 2020

Nationally, soil erosion decreased nearly 44% from 1982 to 2007, but soil erosion rates are still higher than natural replacement levels. The use of fertilizers (i.e., nitrogen, phosphate, and potash) has increased about 188% from 1960 to 2007 in the United States, even though the amount of land in agriculture shrank during that period. Vermont farmers spent 94% more on fertilizers, lime, and soil conditioners in 2007 than they did in 1997. To meet Goals 4 through 6 of the F2P Strategic Plan, Vermont's already substantial technical assistance network will have to expand its capacity to monitor and report on the health of Vermont's soils, while more widely sharing opportunities for preventing soil erosion and promoting soil health to Vermont's farmers (e.g., cover cropping, crop rotation, composting, and other soil building methods).

Table 3.2.12: Objectives and Strategies for Improving Soil Health

OBJECTIVE	STRATEGY
Research Strategies	
To help Vermont farmers and technical assistance providers adapt to climate change.	Climate change (i.e., increased rainfall in Vermont) may increase soil erosion. Farmers and technical assistance providers (including educational institutions) should begin analyzing scenarios for preparing, mitigating, and adapting to altered weather in order to maintain soil health and limit soil erosion.
To improve access to viable and affordable agricultural land and secure tenure for farmers (ownership and leases).	Create and update a land use statewide spatial LiDAR database of agricultural land usage and an inventory of agricultural land that captures information on soil type, current land use, accessibility to roads, proximity to market areas, etc. Call attention to publicly owned land locations conducive to food production that are adjacent to publically owned buildings.
To improve soil quality through improved pasture management.	Conduct research trials of soil building through pasture management (e.g., soil aeration, microbial inoculation, effective manure management, diverse seeding strategies).

OBJECTIVE	STRATEGY
Technical Assistance and Business Planning Strategies	
To improve water quality, soil fertility, and organic matter and reduce erosion.	Develop a more comprehensive soil monitoring program for a wide range of biological, chemical, and physical soil properties, including offering additional assistance to help farmers conduct regular soil tests and develop nutrient management plans, develop soil fertility enhancement and erosion control strategies, and comply with best practices through matching funds. This would include creating funds for ongoing crop trials for short-season corn varieties and cover crop perennials.
To increase technical assistance for best practices in soil enhancement and grazing.	Coordinate with NRCS, VACD, *Farmer's Watershed Alliance*, and other Vermont agricultural organizations to invest in skilled land managers and experienced farmers to work directly with other farmers to increase topsoil fertility and minimize soil erosion.
	Ensure the ongoing support of UVM's Pasture Network's grazing technical assistance and outreach services and events.
Financing Strategies	
To improve water quality, soil fertility, and organic matter and reduce erosion.	Leverage USDA and other funding to purchase additional equipment to share among farmers to facilitate soil aeration, no-till, strip-till and zone-till cultivation, and state-of-the-art soil quality monitoring and analysis.
To create market-based incentives to improve soil and water quality.	Investigate ways to incorporate into food sector financial transactions the high economic value of environmental services provided by stewarding healthy soils.
To provide financial incentives to farmers to implement best practices (cover cropping, crop rotation, midfield buffers, strip tillage, aeration, on-farm composting of manure, and use of composted manure on fields) and meet performance targets.	Increase outreach by farmers to farmers to communicate the benefits of CREP and EQUIP grants, nutrient management plans, and the implementation of best practices to increase organic matter in soils.
Network Development Strategies	
To increase opportunities for farmers with good soil who are interested in mentoring or renting a portion of their land to new farmers or diversified producers.	Establish a soil-sharing matchmaking program. Through farmer-to-farmer networks and outreach by agricultural organizations (VFAN, VLT, VHCB, NRCS, NOFA Vermont, etc.), identify and arrange partnerships between farmers interested in leasing a portion of their larger parcels with excellent agricultural soils and diversified producers seeking good soils.
Education Strategies	
To increase consumer awareness of the value of ecological services provided by well-managed soils.	Increase consumer awareness of carbon sequestration in soils, and make purchases of carbon sinks or credits available to consumers. Develop a consumer awareness campaign regarding nutrient trading programs such as the one operating in the Chesapeake Bay region.
Regulatory and Public Policy Strategies	
To minimize the agricultural impact on environmental resources.	Encourage legislators and VAAFM to revisit the winter manure spreading ban, review New York protocols, and maximize performance-based rules.

FARM INPUTS

Animal Feed

How much do Vermont farmers spend on animal feed? What can be done to reduce feed costs?

The way we feed the animals (e.g., milk cows, cattle, poultry, lamb, and hogs) that feed omnivores today is complex, involving a global system of production, processing, and distribution.[45] This system includes many types of feed ingredients and livestock production systems. For example, animal feed usually consists of three components: forages (e.g., hay, corn silage, haylage), concentrates (e.g., corn, soybean meal, minerals), and by-products (e.g., wheat middlings, distillers grains) that are mixed to achieve certain nutrient balances depending on the type of animal.[46] But animal feed ingredients may also consist of rendered animal protein (with restrictions based on possible prion contamination), marine by-products, and antibiotics.[47] Livestock production systems around the globe range from ruminant grazing systems where the animals spend all or the majority of their lives outside eating grasses, to mixed systems with a combination of grazing and stored forages, to "*animal feeding operations*" where the animals are confined in lots, buildings (pens), or combinations of these, and feed is brought to them.[48]

Animal feed is the largest production expense for U.S. and Vermont farmers. Total animal feed expenses in Vermont were over $151 million in 2007, equal to over 26% of total farm production expenses (Figure 3.2.6, page 144). Dairy farms accounted for 89% of feed purchases in Vermont, equal to 32% of total production expenses for dairy farmers in 2007.[49]

The majority of dairy cows, especially those in larger operations, and some other livestock in Vermont are raised in housing and many of these animals are fed stored grains and forages year round.[50] Poultry and swine are raised in a variety of combinations of confinement and outdoor conditions. **Crops grown to feed livestock (primarily cattle)—corn for grain, corn for silage, and all forages—constituted nearly 98% of all harvested cropland acreage in Vermont in 2007.** Dairy producers farmed 66% of the corn for grain acreage, 91% of corn for silage acreage, and 62% of forage-land, or 66.4% of all harvested cropland in 2007 (Table 3.2.13).[51] It is assumed that most of this corn grain, corn silage, hay, and forage is consumed by livestock in Vermont and the region. We also assume that, beyond this locally produced feed, the bulk of feed consumed by Vermont animals are imported and sold through local dealers (e.g., *Blue Seal Feeds*, *Bourdeau Brothers, Inc*, *Green Mountain Feeds*, *Morrison's Custom Feeds*, and *Poulin Grain*).

A growing number of Vermont farmers also raise their livestock outside on grasses for much of the year and then winter their animals on stored forages.[52] Vermont's winters are a limiting factor for year-round grazing, but the length of Vermont's winters are changing: in the past forty years, climate change has extended the growing season for frost-sensitive plants by two weeks and three to four weeks for frost-hardy plants.[53] The *U.S. Global Change Research Program* predicts reduced snowpack and a longer

growing season in New England in the years ahead. This is a factor that deserves serious consideration in strategies for livestock production into the future.

Table 3.2.13: Vermont Cropland Harvested for Animal Feed, 2007

Crops Harvested	Acres	Percentage of Harvested Cropland
Corn for Grain	5,368	52.3%
Corn for Grain on Dairy Farms	3,554	29.2%
Corn for Silage	87,403	6.5%
Corn for Silage on Dairy Farms	79,226	3.8%
Forage-land	330,984	3.2%
Forage-land on Dairy Farms	204,992	2.6%
Total Feed Crops Harvested	**423,755**	**97.8%**
Sub-total Dairy Farms	287,772	66.4%

Source: 2007 Census of Agriculture, Table 62, *www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_State_Level/Vermont/vtv1.pdf*.

Over the past several years, commodity prices, including those for animal feed, have increased dramatically.[54] Although many of the trends impacting the cost of feed are out of the hands of Vermont farmers, there are opportunities for reducing feed costs, including the production of high quality forage in Vermont, production of cereal grains locally, and improved management of stored forages to avoid losses from spoilage.

CURRENT CONDITIONS

From 2006 to 2008 commodity food prices (including animal feed prices) rose by more than 60%.[55] Since the Census of Agriculture takes place every five years (i.e., 1997, 2002, 2007) it does not capture this three-year window. However, the total amount spent by Vermont farmers on animal feed increased 15% from 2002 to 2007 (from $132 million to $152 million, adjusted for inflation to 2010 dollars) even though the number of dairy cows in Vermont decreased by 9% during that period. One indicator of animal feed costs—the benchmark Central Illinois price for a bushel of corn—increased 124% from 2006 to 2008 (adjusted for inflation to 2010 dollars).[56]

The *Economic Research Service* of the USDA reports that the index of average commodity prices closely parallels the prices of four major crops (wheat, corn, rice, and soybeans).[57] Recent increases in commodity prices and retail prices reflect a variety of short-term and long-term factors impacting these four major crops, including:

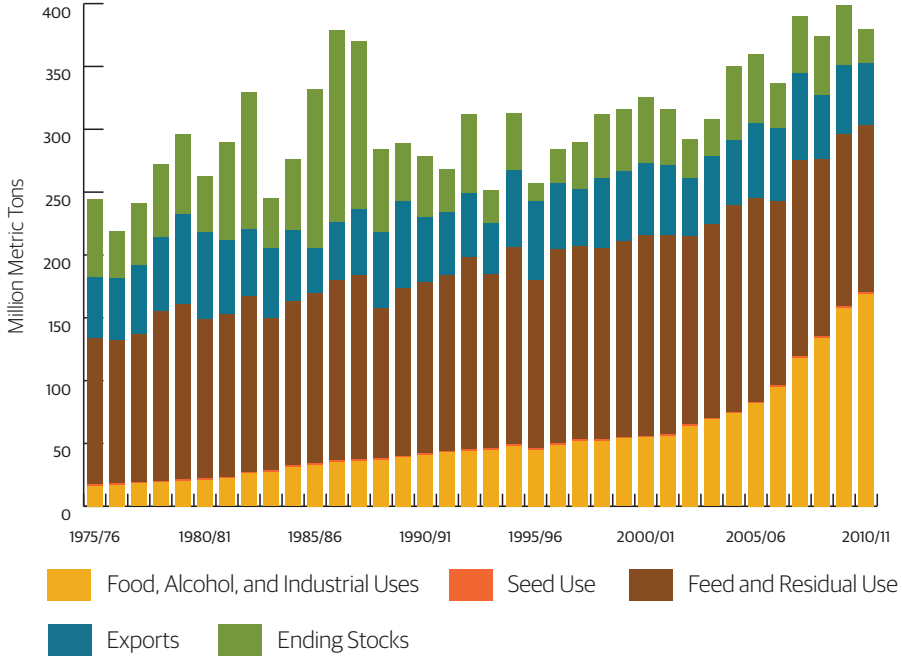
- **Rising fossil fuel prices:** from 1968 to March 2011 the price of a barrel of imported oil increased 469% (adjusted for inflation to 2010 dollars). From 1998—the year of the lowest price for a barrel of oil in the past 43 years—to 2011 the price of a barrel of imported oil has increased about 541%.[58] About 87% of world energy consumption comes from oil, coal, and natural gas.[59] Food system activities consume a lot of energy, "from the manufacture and application of agricultural inputs, such as fertilizers and irrigation, through crop and livestock production, processing, and packaging; distribution services, such as shipping and cold storage; the running of refrigeration, preparation, and disposal equipment in food retailing and food service establishments; and in home kitchens,"[60] so rising fossil fuel prices have broad food system impacts. For example, corn and soybeans are the two largest crops planted and harvested in the United States, and corn and soybeans are commonly used in the feed ration for dairy cows and other livestock. Corn appears to receive the most fertilizer of any crop in the United States, with over 95% of the corn planted in the country receiving nitrogen, over 80% receiving phosphate, and over 60% receiving potash in 2008.[61] Natural gas, a nonrenewable fossil fuel, is used as a feedstock to make ammonia that, in turn, is used as a fertilizer or as a feedstock to make synthetic nitrogen fertilizers. As natural gas prices increase, the price of nitrogen fertilizer increases, and consequently the price of animal feed increases.[62]
- **Economic growth and population growth in developing countries (e.g., China) has increased demand for energy:** The Gross Domestic Product growth rates in the developing world, including China, have been much higher than in the developed world for the past 30 years.[63] From 1980 to 2008 China's energy consumption increased 80%, while energy consumption in India increased 209%. In comparison, Europe's energy consumption increased 16% during that time period, while consumption in the United States increased by 22%. China is the now the number two

energy consumer in the world behind the United States (the United States and China alone consume more energy than most continents).[64]

- **Economic growth in developing countries has increased demand for meat:** Historically, as per capita incomes have increased in developing countries, diets have diversified to include more meat, dairy products, and vegetable oils, which has consequently increased demand for grain and protein feeds.[65]
- **Agricultural production of four major commodities—corn, wheat, rice, and soybeans—has slowed:** From 1970 to 1990, global production of aggregate grains and oilseeds increased by an average of 2.2% per year. Since 1990 the growth rate has decreased to about 1.3% per year, and USDA estimates that it will decline even more in the next 10 years. Global aggregate yield growth for grains and oilseeds averaged 2.0% per year from 1970 to 1990, but declined to 1.1% per year from 1990 to 2007, and the USDA estimates yield growth will continue to decline for the next 10 years.[66]
- **Adverse weather has impacted production yields:** Multiyear droughts in major grain producing countries such as Ukraine, Russia, and Australia have impacted production yields.[67]
- **Policy responses have been enacted to reduce exports:** Some countries eliminated export subsidies and taxes, while other banned the export of certain commodities (e.g., Ukraine banned wheat exports). These policies had the effect of raising global demand for food commodities while prices were already rising.[68]
- **Increased corn-based ethanol production:** Since 2003, federal support policies and the replacement of methyl tertiary butyl ether with ethanol have increased the amount of corn used for biofuel production.[69]

Figure 3.2.16 depicts several of these trends for U.S. feed grain production.[70] For example, the average annual growth rate in the *total supply* (including beginning stocks, domestic production, and imports) of feed grain production was 3.4% from 1975-76 to 1989-90. Between 1990-1991 and 2007-2008 the average annual growth rate was 2.3%. The average annual growth rate of U.S. feed grain *production* was 5.3%

Figure 3.2.16: U.S. Feed Grain Production (Corn, Sorghum, Barley, and Oats)



Source: Economic Research Service, Feed Grains Database, *www.ers.usda.gov/Data/FeedGrains/*.

from 1975-1976 to 1989-1990. Between 1990-1991 and 2007-2008 it was 4.4%. Between 1975-1976 and 1989-1990 the U.S. maintained an average of 72 million metric tons of beginning stocks per year, while from 1990-1991 to 2007-2008 that number shrank to an annual average of 42 million metric tons. Imports made up a small percentage of the total supply of U.S. feed grain, while exports stayed relatively constant from 1975 to August 2011. From 1975-1976 to 2010-2011, food, alcohol, and industrial uses of feed grains increased 929% and this is largely attributable to increased ethanol production. The total amount of grain used for feed has increased from 1975-1976 to 2010-2011, but it makes up a smaller percentage of the pie: in 1975-1976 grain used as feed equaled 63% of total feed grain uses. In 2010-2011 it was down to about 38% of total feed grain uses.

☼ Climate Change Impacts on Animal Feed Production

The USDA suggests livestock production can be impacted by climate change in four primary ways: 1) change in feed-grain production, availability, and price; 2) change in pastures and forage crop production and quality; 3) animal health, growth, and reproduction; and 4) disease and pest distributions.[71] The Midwest is the major producer of corn (Figure 3.2.17) and soybeans (Figure 3.2.18) for animal feed in the United States. The USDA cites research indicating that yields of both corn and soybean are depressed during warmer years.[72] According to the *U.S. Global Change Research Program*, the Midwest and northern Great Plains have experienced increases of more than 7 degrees in average winter temperatures during the past 30 years, **average U.S. temperatures are projected to increase by 4 to 11 degrees by the end of the century depending on the emissions scenario, and the Midwest and Great Plains are predicted to experience the biggest temperature increases from 1961-1979 baseline temperatures (Figure 3.2.19)**.[73] Pest problems can exacerbate adverse weather since global warming facilitates the northward spread of pests and invasive species, warmer winter temperatures allow pests to survive, and longer grower seasons can allow pests to multiply. In short, crop sector impacts are likely to be the greatest in the Midwest.[74] Decreased yields in the major corn and soybean supplying region of the country will, of course, have ripple effects, including impacting the cost and availability of animal feed in Vermont.

Livestock production systems are vulnerable to temperature stresses. Temperature stresses can be mitigated for animals raised indoors but hotter summer temperatures may require new thermal environment control systems and the cost and availability of animal feed will likely be a problem in the years ahead. Many Vermonters are interested in expanding grass-fed livestock production to reach regional markets for grass-fed and pasture-raised meat. It is unclear how temperature stresses will impact the expansion of livestock production in Vermont, but the USDA states that the negative effects of hotter summers will likely outweigh the benefits of warmer winters.[75] More rain in the Northeast and a longer growing season may lead to an expansion of forage production in Vermont, but increased concentrations of carbon dioxide in the atmosphere effect plant nitrogen and protein content, impacting the quality of the forage. Adaptation strategies include altering stocking rates, varying the season of grazing, shifting the type of livestock that graze in Vermont, maintaining soil health, and the development of forage monitoring programs.[76]

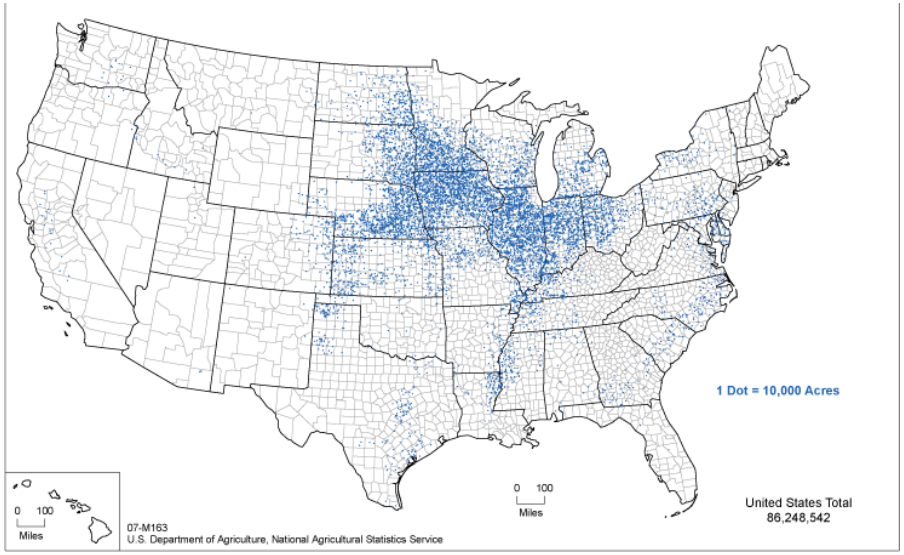
Taken together, slower growth in production, increased global demand, increased energy consumption and higher fossil fuel prices, increased ethanol production, climate change and adverse weather events, and other factors have recently tightened the world's supply of food commodities (including animal feed ingredients), leading to higher prices and lower stocks of grains. Animal feed purchases in Vermont take place in the context of these short- and long-term domestic and international trends that are increasing the prices of food commodities. Dairy farms make the majority of animal feed purchases in Vermont and, when high feed costs intersect with low milk prices, the consequences can be disastrous.

Low Milk Prices and High Feed Prices

In the first decade of the 21st century, the annual average all-milk prices received by Vermont dairy farmers have been well below historical averages. In 2000, 2002-2003, 2005-2006, and 2008-2010, the price per hundredweight of milk was below $20 (adjusted for inflation to 2010 dollars using the fresh processed milk producer price index). In 2009, milk prices dropped to the lowest price on record: $15.60 per hundredweight.[77] These historically low milk prices intersected with historically high feed prices, making it difficult for many Vermont dairy farmers to stay in business—from 2007 to August 2011 the number of dairy farms in Vermont decreased by 150.[78]

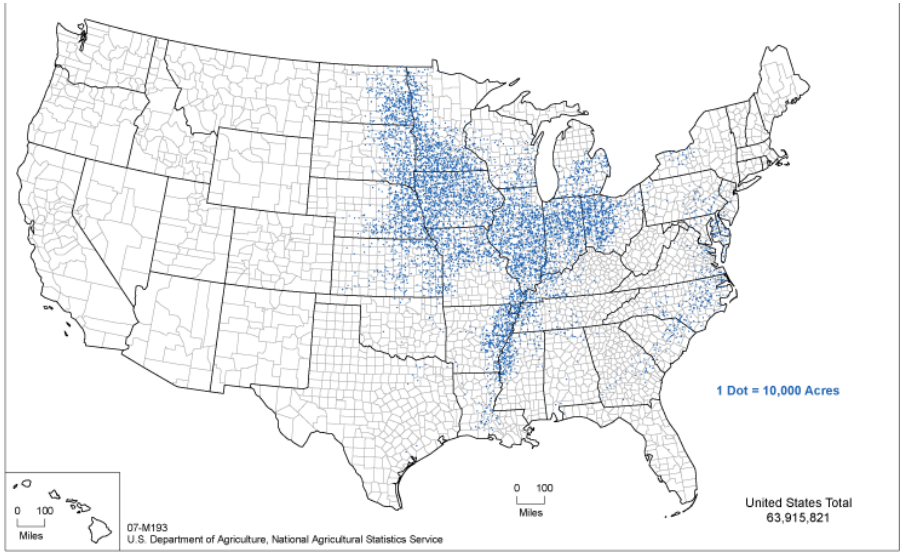
Vermont has small and midsize locally owned grain companies, as well as several companies that operate on the regional, national, and international scales. Typically, farmers have 30 days to pay for the grain they receive before they incur interest payments, most often in the range of 1.5% per month. Farmers can choose to pay grain bills early to receive discounts of up to 2% of the bill total. Prices for set amounts of grain to be delivered over an extended period of several months can be locked in by farmers to remove fluctuations in price.

Figure 3.2.17: Lower 48 Corn for Grain Production, 2007



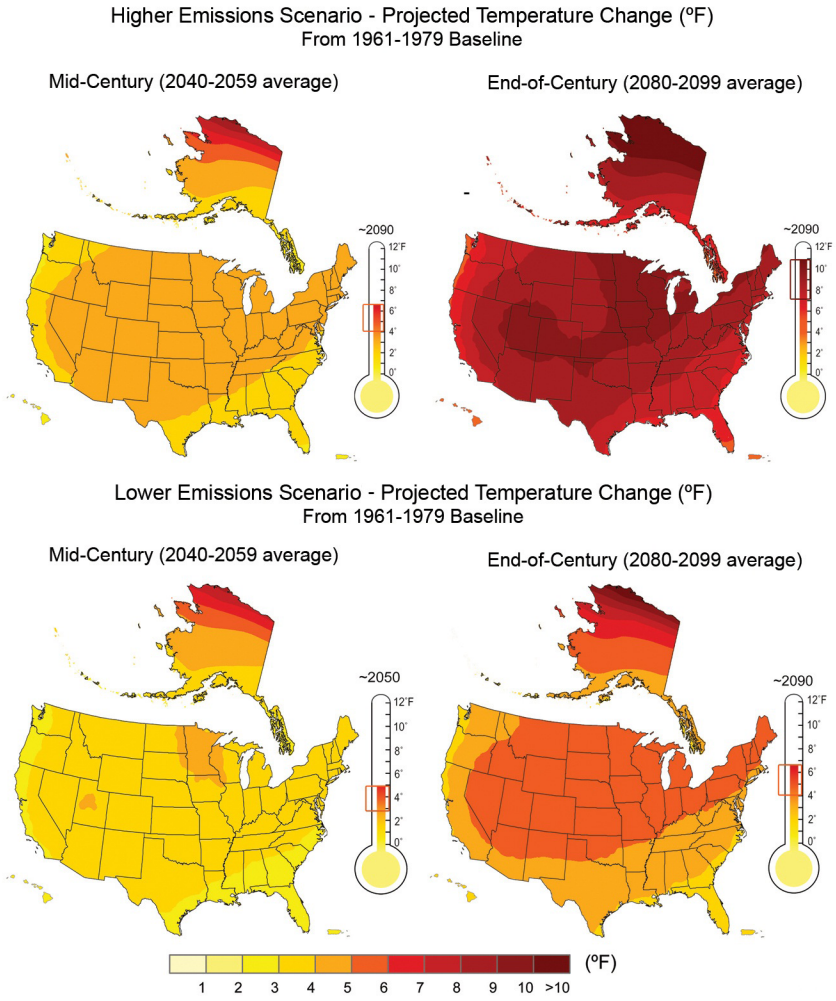
Source: USDA 2007 Census of Agriculture, www.agcensus.usda.gov/Publications/2007/Online_Highlights/Ag_Atlas_Maps/Crops_and_Plants/Field_Crops_Harvested/07-M163.php.

Figure 3.2.18: Lower 48 Soybean Production, 2007



Source: USDA 2007 Census of Agriculture, www.agcensus.usda.gov/Publications/2007/Online_Highlights/Ag_Atlas_Maps/Crops_and_Plants/Field_Crops_Harvested/07-M193.php.

Figure 3.2.19: Emissions Scenarios for the United States



Source: U.S. Global Change Research Program, www.globalchange.gov/images/cir/pdf/National.pdf. These maps are "based on projections of future temperature by 16 of the Coupled Model Intercomparison Project Three (CMIP3) climate models using two emissions scenarios from the Intergovernmental Panel on Climate Change (IPCC), Special Report on Emission Scenarios (SRES). The "lower" scenario here is B1, while the "higher" is A2. The brackets on the thermometers represent the likely range of model projections, though lower or higher outcomes are possible...These maps, and others in this report, show projections at national, regional, and sub-regional scales, using well-established techniques."

Historically, the receivables carried by grain companies as they await payment from farmers have taken predictable swings. In the spring, when farmers are incurring the expenses of seed, fertilizer, fuel, and labor to plant crops and get off the first cutting of grass, feed payments often fall behind. Likewise, when property taxes are due in the fall, some farms have difficulty paying the entire grain bill. Local grain suppliers are able to address these shortfalls through the collection of interest payments and the maintenance of lines of credit from local banks and commercial lending institutions, ensuring their ability to pay their suppliers of commodity grain ingredients from the Midwest and elsewhere.

When farmers experience difficulty paying their grain bills over the course of several months, account balances can escalate as a result of interest charges and, in some cases, late payment fees. In February 2009, in the wake of the lowest milk prices in history, at least one grain company saw the average age of its account balances (i.e., money owed to it by farmers) explode from approximately 30 days to over 65 days in a one-month period. In other words, the grain supplier received almost no income from grain sales made the previous month. By the fall of 2010, following a year and half of low milk prices, some grain suppliers were facing average ages of receivables nearing 90 days.

Jim Bushey, of *Bourdeau Brothers, Inc.*, commented on the financial relationship between farms and his feed vending business: "At the end of 2008, we had a historic ledger balance of zero for receivables, what farmers owed to us. At the end of 2009, our receivables were the highest they'd ever been in the history of the company. It's amazing what one year can do in the dairy industry."

The presence of aged accounts is detrimental to grain companies. Financial regulatory procedures followed by banks and other lending institutions require accounts over 90 days to be considered "bad debt" and not collectable. Most farms do pay down their aged accounts when milk prices recover, but in the interim the credit ratings of the supplier companies are eroded, decreasing access to the credit needed to purchase commodity grain.

If a farm declares bankruptcy or sells its assets, the grain supplier is considered an unsecured lender and can face significant losses. With the increase in farm size a single account can affect the overall financial health of a grain company. Concern about unsecured debt has led many grain companies to require "cash only" payments from some of their clients. Understandably, this increases stress for both the producer and the feed dealer.

Bushey says his company has expanded to include a wider variety of feeds to serve goats, sheep, poultry, dogs, and horses, but dairy farmers continue to be their core customers. Currently, *Bourdeau Brothers* has about 75,000 acres under contract for nutrient management planning out of its Middlebury location. Bushey reports that many farmers who have chosen to grow their own feed crops have seen an improvement in the health and productivity of their herds, and he also sees livestock production as a diversification opportunity for dairy farmers.

ANALYSIS

Feed for dairy cows and other livestock is the single largest production expense for Vermont farmers and crops grown for animal feed represent the largest category of crop production in the state. Animal feed purchases in Vermont take place in the context of short- and long-term domestic and international trends that are increasing the prices of food commodities. Vermont farmers have very little control over these trends. For example, when high feed prices intersect with low milk prices, as they have in recent years, the impacts ripple through Vermont's food system, affecting dairy farmers and the support organizations (e.g., feed dealers) that depend on the success of Vermont's dairy industry. **However, Vermont farmers *can* manage the production and storage of *high quality forage* and *grains* in order to minimize feed expenses.**

Increased Local and Regional Grain Production: For example, although the 20-year trend in the total inventory of Vermont livestock and cropland devoted to growing animal feed is down (Table 3.2.14), **many of the livestock producers, distributors, and retail outlets interviewed during the Farm to Plate process identified a strong and growing local and regional demand for Vermont produced meat.** Local and regional markets for Vermont produced meat may provide an important option for diversification on dairy farms because dairy farmland, equipment, and buildings are more easily adapted to other forms of animal-based production. In particular, consumer interest in source-verified, organic and/or grass-fed meat

produced using specific standards can create a significant advantage for Vermont livestock farms.[79] *NOFA Vermont* reports that as of December 31, 2010 Vermont had 77 organic livestock producers.[80]

Additionally, demand for organic milk continues to grow: From 1997 to 2010, the number of certified organic dairy farms in Vermont increased 480%, from 35 farms to 203 farms.[81] The USDA Agricultural Marketing Service indicates that organic milk production grew over 70% from 2006 to 2010, while total fluid milk production decreased 1% during the same time period. From 2006 to 2010 organic milk production increased from 1.9% of total fluid milk products to 3.3%. Except for a dip in 2009, organic milk sales grew by over 10% per year from 2006 to 2010.[82] According to the *Northeast Organic Dairy Producers Alliance* (NODPA), the price gap between organic milk and conventional milk has been over $2 since October 2008, but half gallon prices of organic milk have steadily come down from 2008 to 2010. The NODPA views the closing of this gap as a good thing, because it will attract price conscious consumers to organic milk.[83]

A market research study conducted for the *Vermont Agency of Agriculture, Food, and Markets* found that there is a regional market for domestic fair trade milk (i.e., organic and/or free of artificial growth hormones), especially among two segments of the population they dub "Social Stewards" (e.g., 2 person households in rural or suburban areas that value local products) and "Idealists" (e.g., young urbanites that aren't brand loyal but tend to buy organic, hormone-free milk). About two-thirds of Social Stewards and half of the Idealists surveyed in New England and New York would buy fair trade milk every time they shop for milk and would pay more to do so.[84]

The *USDA Economic Research Service* reports that a scarcity of organic feed grains (e.g., organic corn and soybeans) has limited production of organic meat and milk. Recent trends that increased the prices of feed commodities (e.g., conventional corn and soybeans) have dissuaded farmers potentially interested in organic production from switching over.[85] However, a recent study in Minnesota compared 18-years of data from experimental trials of organic corn and soybean production to conventional production. The researchers found that lower average production costs and the availability of substantial price premiums for organically grown corn and soybeans resulted in higher net returns for the organic production method.[86] *NOFA Vermont*

Table 3.2.14: Vermont Livestock Inventory, Feed Production, and Feed Purchases, 1987-2007

	1987	1992	1997	2002	2007
Vermont Livestock Inventory					
Hogs & Pigs	5,133	3,738	3,477	2,019	2,701
Other hogs and pigs	4,084	2,768	2,718	1,590	2,186
Sheep	20,456	17,145	16,589	14,743	13,925
Ewes 1 yr old or older	12,824	10,880	11,099	9,189	9,162
Goats	971	1,548	3,892	4,133	6,593
Raised for meat	--	--	1,281	940	1,813
Poultry	442,902	187,390	279,470	280,671	301,274
Broilers	4,449	5,990	16,233	20,753	42,485
Turkeys	2,495	1,211	4,570	1,909	5,748
Cattle and Calves	320,189	310,518	304,639	283,619	264,823
Beef cows	9,805	11,812	12,871	11,276	10,002
Milk cows	178,967	168,473	162,868	150,626	139,719
Total Livestock	**788,680**	**520,339**	**608,067**	**585,185**	**589,316**
Vermont Feed Production - Selected Crops (acres)					
Corn for Grain	11,191	7,567	8,233	5,130	5,368
Corn for Silage	70,258	86,024	95,713	91,312	87,403
Hay or Forage	432,881	408,552	385,562	350,261	330,984
Total Feed Production	**514,330**	**502,143**	**489,508**	**446,703**	**423,755**
Total Feed Expenses	**$171,447,000**	**$168,617,000**	**$167,032,000**	**$131,746,000**	**$151,577,000**

Source: USDA Census of Agriculture, multiple years, *www.agcensus.usda.gov*. Notes: 1987 and 1992 poultry inventory does not include ducks, geese, and other poultry. The number of goats raised for meat were not disclosed in 1987 and 1992. The inventory of pullets was suppressed in 1992. 1997 poultry inventory does not include pullets or "other" poultry types. 2002 poultry inventory suppresses quail data. 2007 poultry inventory suppresses quail and pheasant data.

reports that 1,377 acres of feed grains are currently certified organic.[87] **As one way to reduce their dependency on imported animal feed and pursue local and regional premiums for organic meat, milk, or grains, Vermont dairy and livestock farmers could investigate and expand organic grain production.**

Increased Local Grazing: Encouraging *grazing* on well managed pasture could also reduce feed costs for Vermont's small and medium dairy and livestock farms while opening up new opportunities for premiums on grass-fed meat and milk.[88] Vermont was a leader in the development of *rotational grazing*, which refers to rotating animals from pasture to pasture to maximize the nutritional value of pasture forage plants for livestock, in the 1980s. The *Vermont Pasture Network* (VPN) and the *Vermont Grass Farmers' Association* (VGFA) provide technical assistance, educational events, and networking opportunities for farmers raising or interested in raising livestock on grasses for meat, milk, and other products (the *new pasture rule* requires a minimum of 120 days grazing for organic dairy cows). Jennifer Colby, outreach coordinator for the VPN, sees opportunities for dairy and livestock farmers to reduce their input costs through improved pasture management. Colby believes that well-managed grass farming supports healthy animal herds (e.g., veterinary bills decrease for pasture raised animals), reduces costs, improves soil quality, reduces erosion, sequesters carbon in soils,[89] improves the farmer's quality of life (e.g.,farmers can get a higher value for milk and meat from grass raised animals), and promotes tourism (e.g., Vermont's rolling green fields are a major feature of the state's landscape). *NOFA Vermont* reports that 23,562 acres of pasture, 51,778 acres of hay land, and 1,294 acres of silage were certified organic at the end of 2010.[90]

Improved Forage Management: Finally, the majority of dairy animals and livestock in Vermont are raised in housing and many of these animals are fed stored grains and forages year round. Many Vermont farms grow conventional corn and forage for animal feed, and a growing number are producing organic corn and forage, but Vermont farms also lose a significant portion of their stored feed due to unnecessary spoilage. **Management of stored forages to avoid losses (e.g., poorly managed silage in bunks, deterioration of baled hay left in fields, spoilage resulting in mycotoxins[91]) offers major opportunities for preservation of feed, reduced cost of feed production, and better quality of feed for animals, thus reducing the cost to produce milk and meat.**

Maple Wind Farm

At *Maple Wind Farm* in Huntington, the beef cattle "harvest their own feed," as farmer Bruce Hennessey likes to say. They're grass-fed cattle, meaning that for six and sometimes seven months of the year they eat grass on pasture, using their own energy to walk around and fatten themselves.

Grazing cattle on a cloudy day.

PHOTO CREDIT: Maple Wind Farm

Bruce, who runs Maple Wind Farm with his wife, Beth Whiting, says putting his 100% grass-fed cows on pasture costs "a tiny fraction" of what it would if he harvested or bought his own hay during the grazing season. (He does have to make hay to feed his cattle through the depths of winter.)

To be sure, other costs are associated with grass farming that can cancel out these input savings. For instance, it takes twice as long to finish a beef steer on grass as on grain, so Bruce and Beth must keep their beeves through two winters.

And the farm does have to purchase supplemental grain for its pastured pigs and poultry, as these animals require some grain in their diet. Right now it's difficult to find Vermont-sourced grain, but Bruce wonders if Vermont dairy farms that are forced to go out of business could switch to growing corn and soy for the state's livestock and poultry farmers.

"One thing I hope the Farm to Plate process can encourage is the development of a local grain supply for livestock," Bruce says. "Maybe then we can be local and organic, and have truly local chickens and pigs that aren't fed on Midwestern grain."

Research

Conduct and consolidate research on local grain and forage production: Colby indicates the need for additional research on pasture management, including exploring soil amendments for pastures, reducing pasture compaction, ways to enhance microbial activity in pasture soils, herd management techniques, and milk quality

analysis. In addition, better implementation of information that is already in hand on pasture management is needed. The *Vermont Feed Dealers and Manufacturers Association* conducted a series of stakeholder meetings for the dairy industry in 2009 which clearly identified the need for in-state research on forage crop varieties, as well as improved harvesting and storage techniques. Storage losses in bunker silos are often significant, and those are direct unrecoverable costs that can be substantially avoided.

In response to the rising financial and environmental cost of petroleum fuels, a handful of farmers in Vermont are also **growing oilseed crops** (e.g., sunflower, canola, and soybean). The oil from these crops can be extracted as food-grade oil or converted into biodiesel, a low-emission diesel fuel replacement suitable for farm equipment, heating, and transportation. After extracting the oil, the remaining fiber is a nutrient rich meal that can be used as a livestock feed and/or a soil amendment. Of the three main oilseed crops grown in Vermont, soybean meal is considered the most desirable for livestock feeding in terms of protein content and amino acid profile. Soybean meal contains several factors that reduce its digestibility to poultry and swine, however. Relative to soybean meal, canola and sunflower meal have higher amounts of rumen-degradable protein, which can limit the amount fed per day to dairy cows. Canola also cannot be fed in large amounts (maximum 3% of diet by weight) to brown egg–laying chickens. The key determinants of a livestock meal's value to feed dealers and farmers are quality and consistency. Further refinement and standardization of batch-processing techniques are needed, and additional, regular testing of the farm-pressed meal is recommended to establish quality and consistency.[92]

Technical Assistance and Business Planning

Ensure comprehensive statewide technical assistance for animal feed production and storage: Assistance for efficient production of conventional and organic annual and perennial crops, proper harvesting and storage techniques, appropriate use of soil nutrients, and ration balancing is essential to reduce the cost of feed inputs for dairy and livestock producers. *UVM Extension* provides research and outreach for growing and storing high quality *hay and haylage*, and *corn silage and grain*, as do many Extension offices across the country.[93] But reduced staffing at *UVM Extension* has limited this traditional source of information. Access to highly trained expertise for animal feeding and management is also available through private businesses. Most feed companies provide services such as forage crop selection, management, and testing, ration balancing, record keeping, continuing education seminars, and technical assistance for herd health and management.

PHOTO CREDIT: James Simard

Farrell Farm hay bales, Norwich.

Under a variety of scenarios (e.g. if the number of livestock producers with small numbers of animals increases; if the number of farmers raising poultry, hogs, sheep, and goats increases; if the number of organic producers increases) access to basic information on animal nutrition and opportunities to reduce feed costs will be in strong demand. More technical assistance providers are needed on the ground, conducting farm visits and providing educational events for existing and new farmers in order to reduce feed costs. For example, Colby estimates that fewer than ten people from VPN, UVM, *NOFA Vermont*, and Vermont NRCS are providing technical assistance to farmers interested in the science and skill of grazing. **Strengthening linkages between private businesses and grant and publically funded efforts such as NRCS, VPN and UVM could increase the quantity and quality of resources available to farmers to reduce expenses and increase profitability.**

For example, as the demand for locally grown meat has increased, some farmers are able to realize more profit by shipping animals to slaughter in the spring and summer. Several producers interviewed for the F2P Strategic Plan stated that farmers who can ensure the delivery of a predetermined number of animals year-round that are slaughtered in a consistently similar way are able to access slaughter spots to meet their needs. Producers who deliver only a small number of animals sporadically experience the greatest difficulty accessing slaughter spots. Assisting farmers with winter animal management strategies so they can profitably finish animals year-round would increase their ability to secure slaughter spots. VPN is now working with VAAFM, meat processors, and wholesale partners as part of a Meat Advisory Panel to increase understanding of these issues and improve producer-processor relationships. Four

workshops are planned for 2011-2012 that will focus on issues such as: understanding cut sheets, working with processors, producing consistent grass-based product throughout the whole year, finishing animals properly, and building a regional market.

GETTING TO 2020

Opportunities to reduce Vermont's number one farm input expense include increasing organic grain production (including oilseed crops), increasing pasture grazing, and improving management of stored feed to reduce losses. Strengthening linkages between private businesses, educational institutions, state, and federal technical assistance providers can increase the quantity and quality of resources available to farmers to reduce expenses and increase profitability. The following objectives and strategies attempt to address opportunities for reducing feed costs while building resilience for farmers and farm support establishments vulnerable to rising feed costs.

Table 3.2.15: Objectives and Strategies for Reducing Feed Costs

OBJECTIVE	STRATEGY
Research Strategies	
To help Vermont farmers and technical assistance providers adapt to climate change.	Climate change has significicant implications for long-term animal feed availability and price. Farmers and technical assistance providers (including educational institutions) should begin analyzing scenarios for increasing feed and forage production in Vermont and the region in order to prepare for, mitigate against, and adapt to these changes.
To conduct and consolidate research on local grain and forage production.	Conduct, compile, and disseminate additional research on conventional and organic forage and grain management, including information on soil fertility and amendments, reducing soil compaction, ways to enhance microbial activity in soils, harvest timing, management of stored feed to avoid losses, herd management techniques, and milk quality analysis.
To establish systematic processes for testing, refining, and recording results of on-farm meal production to establish consistent quality standards.	Farm-scale oilseed crop processors seeking to sell their meal must establish a standard process that consistently creates a high-quality product. Regular testing of meal batch samples is recommended until a process is established, as well as an in situ amino acid test to establish the protein characteristics of the meal.
Technical Assistance and Business Planning Strategies	
To ensure comprehensive statewide technical assistance for animal feed production and storage.	Assess the variety and availability of animal feed management services offered statewide. Increase coordination between feed dealers, UVM Extension, NOFA Vermont, and other service providers, as well as local and regional animal feed producers.

FARM INPUTS

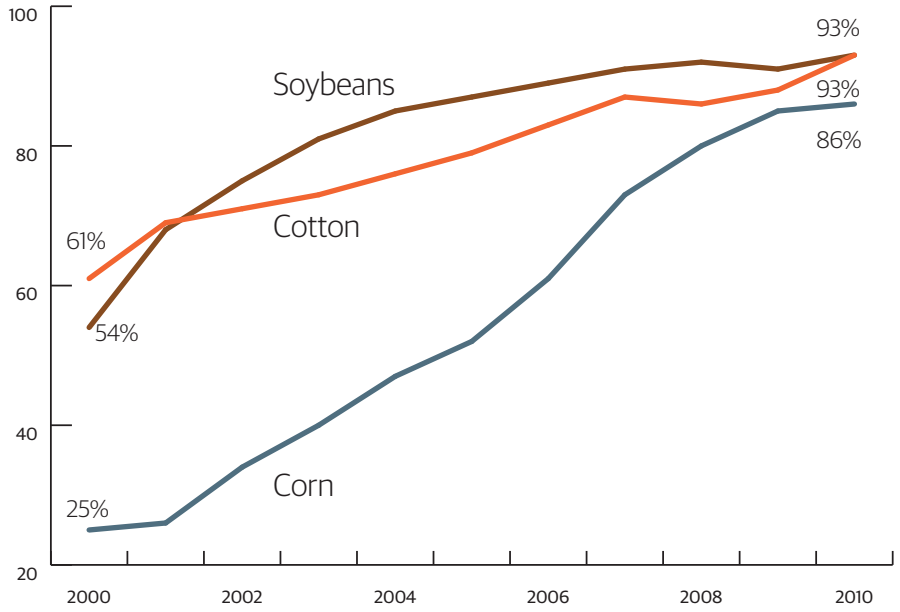
Seeds

How much do Vermont farmers spend on seeds? What can be done to reduce seed costs and promote seed sovereignty?

It is commonly said that whoever controls seeds controls the food system. In the past 40 years, the structure of the global commercial seed industry has changed from mostly small, family-owned firms to corporate consolidation and market domination. Consolidation in the commercial seed industry has led to declining rates of seed saving and replanting, a shift in public and private research toward profitable proprietary crops and varieties, and a decrease in seed diversity.[94] A recent article in *The Atlantic* reports that "In 2004, half of global seed sales were controlled by 10 companies. Today, those companies control nearly three-quarters of sales. This concentration has led to higher prices and shrinking choice for consumers."[95]

The major seed companies (e.g., *Monsanto*, *Dupont*, *Syngenta*, *Limagrain*, *BASF*) have manufactured and advocated for genetically engineered crops (GE)—for example, seeds modified to be herbicide resistant or to repel insects—as a way of feeding the world's growing population. Considerable controversy (e.g., trade disagreements between the United States and the European Union) and opposition (e.g., *Millions Against Monsanto*) has been generated by the development and use of GE crops throughout the world.[96]

Figure 3.2.20: GE Crop Trends in the United States, 2000-2010



Source: USDA Economic Research Service, *www.ers.usda.gov/Data/BiotechCrops*.

However, the USDA says that "U.S. farmers have adopted genetically engineered crops widely since their introduction in 1996, notwithstanding uncertainty about consumer acceptance and economic and environmental impacts."[97] **The percentage of GE corn planted in the United States grew from 25% in 2000 to 86% in 2010, the percentage of GE soybeans planted increased from 54% to 93%, and GE cotton increased from 61% to 93%** (Figure 3.2.20).

One recent analysis of seed expenses found that the price of GE corn and soybean seeds was higher than both organic and conventional seeds (e.g., saved seeds). For example, "In the 25 years from 1975 through 2000, soybean seed prices rose a modest 63%. Over the next ten years, as GE soybeans came to dominate the market, the price rose an additional 230%." The "all corn" price of seed increased 494% from 1975 to 2009, from $36.50 per unit (i.e., 80,000 seeds) to $217.00 per unit. In 2001, when the USDA starting reporting on the cost of GE seeds, the cost of conventional corn seeds was $85.30 per unit compared to $110.00 per unit of GE seeds. By 2009, conventional seed prices had increased about 63% to $139.00 per unit, while GE corn seed prices increased 114% to $235.00 per unit.[98]

CURRENT CONDITIONS

Vermont farmers spent about $9.4 million on seeds, plants, vines, and trees in 2007 (about 1.6% of total expenses), up 27% from $7.4 million in 1997. Most seed, whether GE, conventional, or organic, is purchased from local vendors, but the seed itself is produced out-of-state. The Census of Agriculture provides estimates of seed, plant, vine, and tree purchases by farming type, but it is not clear what percentage of this total was for seeds (Table 3.2.16).

Dairy farms made the majority of seed, plant, vine, and tree purchases in 2007. Crops grown for animal feed—corn for grain, corn for silage, and all forages—constituted nearly 98% of all harvested cropland acreage in 2007, and dairy producers farmed 66% of all harvested cropland. It is assumed that most purchases by dairy farmers in this category were seeds for corn and different forages (e.g., alfalfa). Since most GE crops are used to feed livestock,[99] it is assumed that a significant portion of Vermont's animal feed crops are genetically modified. Likewise, it is assumed that some portion of seed, plant, vine, and tree purchases by oilseed and grain farmers are GE. The USDA recently authorized commercial cultivation of GE alfalfa,[100] but it is not clear if any has been planted in Vermont to-date. Over 76,000 acres of pasture, hayland, and feed grains (18% of harvested cropland devoted to animal feed) were also certified organic by the *NOFA Vermont* in 2010.

Table 3.2.16: Vermont Seeds, Plants, Vines, and Trees Expenses

Selected Seed Purchasers	Production Expense	Percentage
Dairy Cattle and Milk Production	$4,944,000	52.3%
Greenhouse, Nursery, Floriculture	$2,762,000	29.2%
Vegetable and Melon Farming	$613,000	6.5%
Oilseed and Grain Farming	$358,000	3.8%
Hay and All Other Farming	$305,000	3.2%
Fruit and Tree Nut Farming	$244,000	2.6%

Source: USDA Census of Agriculture, Table 62, *www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_State_Level/Vermont/vtv1.pdf*.

Greenhouses and nurseries are the second biggest purchasers of seeds, plants, vines, and trees, but the percentage of these expenses for food-producing seeds is unclear.

According to *NOFA Vermont*, 142 vegetable farms in Vermont were certified organic in 2010 (equal to over 56% of vegetable farms identified in the 2007 Census of Agriculture). *High Mowing Organic Seeds* in Wolcott has put Vermont on the map for organic vegetable seed production (*Solstice Seeds* in Hartland also produces organic seeds). **Tom Stearns, president of *High Mowing*, indicates that his company already sells more that enough seed for all of Vermont's vegetable production needs, but only about one-third ofthose seeds are grown in Vermont.** *High Mowing* works with partners around the United States to grow seeds that do not grow well in Vermont. Stearns explains "I don't think that we really want to give up lettuce or spinach growing just because we can't grow the seed here."

GE Controversy

The use of GE seeds and crops has generated controversy in Vermont's food system, pitting, for example, *NOFA Vermont*, *Rural Vermont*, and *Vermont Businesses for Social Responsibility* against the *Vermont Farm Bureau* and the *Vermont Grocers' Association* over GE labeling policy. The GE controversy involves a wide range of issues, including

PHOTO CREDIT: High Mowing Organic Seeds

High Mowing Organic Seeds

Planting seeds at High Mowing Seeds, 2009.

A healthy food system begins with seeds. But a healthy Vermont food system requires seeds that are well adapted to Vermont. If farmers and growers sow varieties that don't thrive in local soils and micro-climates, local agriculture doesn't thrive. This is why *High Mowing Organic Seeds* is one of the most unique and valuable food businesses in the state. By making part of its mission the development of seeds that are known to work here, *High Mowing* fills a niche that out-of-state seeds companies—which tend to be more interested in bigger markets—probably will never fill.

"No seed company in the world particularly cares about Vermont growers or farms," says Tom Stearns, president and founder of *High Mowing Organic Seeds*. "No one is selecting breeds or varieties that will grow here."

Tom and many of his staff of 35 are doing just that, on the company's land in and around Wolcott and Hardwick, and through partnerships with seed producers in other regions. Although *High Mowing* is Vermont's largest seed company, smaller-scale producers—such as Sylvia Davatz of Hartland, who publishes the *Solstice Seed Catalogue*—are also researching on behalf of Vermont growers.

High Mowing sells primarily to small farmers, both in Vermont and around the country. Tom estimates that all the seed sold by *High Mowing* last year could plant between 8,000 and 10,000 acres of vegetables, flowers, and herbs. (Vermont currently has 3,000 acres in vegetable production.)

Yet only about one third of the company's seeds are grown in Vermont; the state just isn't suited to producing seeds of certain vegetables, such as spinach and lettuce. The rest of *High Mowing's* seeds are grown by the company's 40-odd partners—farms around the United States and the world that are better suited to producing certain seed crops.

So even though *High Mowing* is helping Vermont agriculture become more independent, it still relies on interdependence. "Everything grows better in other places," Stearns says—then quickly adds, "But there's no better place to live."

the ability of farmers to choose how they want to farm; "coexistence" between GE, conventional, and organic systems; consumer choice and "truth-in-labeling;" seed and crop contamination and compensation; and claims and counterclaims about the costs and benefits of GE seeds.

The majority of Vermonters hold consistent views on GE seeds and food products. In *2000*, *2002*, and *2004*, the *Vermonter Poll* conducted by the *Center for Rural Studies* at the *University of Vermont* asked Vermonters for their opinions on GE seeds and food products. Survey results from all three years indicate that the majority of Vermonters are:

- concerned about GE food products
- support labeling of GE seeds
- would stop buying products if they were labeled as containing GE organisms
- would pay more for food guaranteed to be free of GE organisms.

Vermont became the first state in the country to require labeling on GE seed with the passage of the Farmers' Right to Know GMO Seed Labeling Act in 2004. In 2013, the Vermont House Agriculture Committee passed *H.112*, a bill that would require labeling of GE food products sold in Vermont. Bill language states "Because both the FDA and the U.S. Congress have failed to require the labeling of food produced with genetic engineering, the State should exercise its authority to require food produced with genetic engineering to be labeled as such in order to serve the legitimate interests of the State to prevent inadvertent consumer deception, promote food safety, respect religious beliefs, protect the environment, and promote economic development."[101] The bill does provide exemptions, including for animals that were fed or injected with something produced by GE. As of March 13, 2013 the bill had not been taken up by the rest of the House or Senate.

Some organizations have joined lawsuits against GE food products. For example, *High Mowing Organic Seeds* was part of a coalition of organizations that filed a lawsuit in a federal court against the USDA's decision to deregulate "Roundup Ready" sugar beets. A federal district judge did issue an injunction ordering the destruction of GE sugar beets already planted, but an appeals court overturned the injunction in late February 2011. In late March 2011, *NOFA Vermont* joined a new multi-organization lawsuit challenging Monsanto's patents on GE crops.[102]

Rural Vermont obtained grant funding in 2008 to organize mediated, confidential "tough talks" between farmers on GE issues. This process did not conclude with a final product or summary.

In March 2013, *Whole Foods Market* announced that it would require labelling of all GE food sold in its stores by 2018. As the first major retailer to require such labelling, *Whole Foods* said they did so in response to consumer demand, including the fact that some manufacturers that have already voluntarily labeled their products as GE-free have seen sales increase.[103]

☼ Climate Change Impacts on Seed Production

The USDA indicates that many parts of the United States should be investigating the development of drought-tolerant perennial and annual crops. Drought is not expected to be a major concern in Vermont, although parts of eastern Vermont have been abnormally dry in recent years (see Figure 3.2.22, page 190). *High Mowing Organic Seeds* is already investigating seed varieties that could grow under warming conditions, but all organic and conventional growers, gardeners, and seed suppliers should start exploring options for varieties that can work in the years ahead—including crops that have historically not been grown in Vermont.

The USDA has also indicated that glyphosate (i.e., RoundUp)—the most commonly used herbicide in the U.S. loses its efficacy under increased carbon dioxide levels.[104]

ANALYSIS

Seeds, plants, vines, and trees make a relatively small percentage of production expenses for Vermont farmers. However, 1) dairy producers account for the majority of purchases in this category; 2) two of the major crops used as animal feed—corn and soybeans—are mostly GE, and a third—alfalfa—recently received USDA approval for GE cultivation; and 3) GE seed prices have increased substantially over the past 10 years. Additionally, the emergence of glyphosate- or Roundup-resistant weeds and

PHOTO CREDIT: High Mowing Organic Seeds

Cucumber seeds at High Mowing Seeds, 2009.

"*superbugs*" are increasingly undermining the weed and pest control benefits farmers have received from GE crops.[105]

Seed sovereignty as a value and practice should be advanced to maximize a diversity of food options in Vermont and the region, avoid corporate monopolization of seeds, and explore new economic opportunities. For example, conventional (e.g., saved) and organic seeds cost less than GE seeds,[106] and although non-GE food products rank seventh in total natural food sales in the United States (e.g., behind such categories as "organic" and "gluten-free"), **they were the fastest-growing category in 2010, with over $450 million in verified sales.**[107]

Vermont farmers should explore opportunities to reduce seed expenses and tap into the natural food market by 1) by boosting local and regional production of conventional and organic seeds, particularly seeds for animal feed crops, and 2) saving and breeding conventional and organic seeds.

Technical Assistance and Business Planning

Increase local and regional non-GE animal feed production: *High Mowing Organic Seeds* and its regional partners produce enough organic vegetable seeds for all of Vermont's current vegetable production, but is unlikely to produce corn, soybean, or alfalfa seeds for animal feed. The *USDA Economic Research Service* reports that a scarcity of organic feed grains (e.g., organic corn and soybeans) has limited production of organic meat and milk.[108] Many Vermont organic dairy and livestock farmers raise their animals on pasture for part of the year and purchase grains from feed dealers such as *Lakeview Organic Grain* (New York) or *Blue River Hybrids* (Iowa) for the winter. The VAAFM, *UVM Extension*, *NOFA Vermont*, private feed companies, and other organizations should explore opportunities for expanding conventional (non-GE) and organic animal grain production in Vermont. A recent study in Minnesota compared 18-years of data from experimental trials of organic corn and soybean production to conventional production. The researchers found that lower average production costs and the availability of substantial price premiums for organically grown corn and soybeans resulted in higher net returns for the organic production method.[109]

Increase opportunities to establish local and regional seed saving and production: Community groups (e.g., *Post Oil Solutions*) and other food system organizations (e.g., *Northern Grain Growers Association*) in Vermont have sponsored seed saving workshops. However, Vermont farmers, seed producers, VAAFM, and other food system organizations must cooperate with regional seed companies and seed saving organizations since other parts of the country are more suitable for growing certain kinds of seeds. To reduce seed expenses and increase conventional and organic seed production, food system stakeholders in Vermont should take a network approach to production and infrastructure development. For example, to meet the needs of growing consumer demand for local grains, grain milling companies, bakeries, and other end users should consider investing in seed production, saving, drying, storage, and milling infrastructure in order to support local grain growing.

Regulation and Public Policy

Support development of classical breeding programs: *NOFA Vermont* and the *National Organic Coalition* are encouraging the 2012 Farm Bill to include the reestablishment of public sector *classical breeding* programs to fill the void left by the demise of public breeding programs that once existed at local and state institutions, including UVM. The development of new and improved varieties suited to local needs and conditions can be very expensive. If included, this proposal calls for the development of an "Institute for Seeds and Breeds for the 21st Century," run by the USDA. The Institute would focus on public plant and animal breeding and cultivar development to meet regional climate change needs, germplasm conservation, farmer/breeder training, and improved public access and utilization. The Institution would also award competitive grants to public and private universities, nonprofit organizations, and farmer associations, to ensure availability of locally and regionally adapted public cultivar options and animal breeds for farmers of each region of the country.

GETTING TO 2020

Vermont farmers can explore reducing seed costs and capturing more of the fast-growing non-GMO segment of the natural foods category by producing, storing, distributing and/or purchasing conventional (non-GE) and organic seeds, particularly seeds for animal feed.

Table 3.2.17: Objectives and Strategies for Building Seed Security in Vermont

OBJECTIVE	STRATEGY
Research Strategies	
To help Vermont farmers and technical assistance providers adapt to climate change.	Climate change means that farmers and technical assistance providers (including educational institutions) should begin exploring different crops and different crop varieties that will thrive in a warmer environment.
Technical Assistance and Business Planning Strategies	
Evaluate need for farmer-to-farmer mediation and communication on GE issues.	*Rural Vermont*, GE "tough talk" participants, and VAAFM should evaluate the process, publish their findings, and investigate the need for ongoing farmer-to farmer mediation.
Increase local and regional non-GE animal grain production.	The VAAFM, UVM Extension, NOFA Vermont, private feed companies, and other organizations should explore opportunities for expanding conventional (non-GE) and organic animal grain production in Vermont.
Increase opportunities to establish local and regional seed saving and production.	Cooperate with regional seed companies and seed saving organizations to provide seed saving workshops and collaborative production, collection, and storage.
Regulation and Public Policy Strategies	
Support development of classical breeding programs.	Encourage the Vermont federal delegation to support the inclusion of the Institute for Seeds and Breeds for the 21st Century in the 2012 Farm Bill.

FARM INPUTS

Water

How are food system activities affecting Vermont's water bodies? What is being done to reduce water pollution caused by food system activities?

Agricultural activities account for 80% of freshwater consumption in the United States.[110] Several agricultural areas across the country face major water issues, from depletion of the Ogallala aquifer in the Midwest, to droughts and multiple competing uses in the desert Southwest and California. In contrast, Vermont's relative abundance of freshwater is a vital asset of our local food system. It is important that food production and processing activities, especially dairy production and processing, animal feed production, and livestock production, slaughtering, and processing facilities, adopt best practices to protect water quality.

CURRENT CONDITIONS

Water Use

According to the *U.S. Geological Survey* (USGS), Vermont has 22,680 miles of streams and rivers and 820 lakes or ponds covering about 555 square miles. The USGS calculates that approximately 440 million gallons of water were withdrawn every day in Vermont in 2005. About 88% of water withdrawals came from surface water sources, while 12% were from groundwater sources. The cooling of the Entergy Vermont Yankee nuclear reactor accounts for about 78% (340 million gallons per day) of daily water withdrawals. If Entergy Vermont Yankee were excluded from the USGS analysis, water withdrawals would be about 100 million gallons per day. **Water for livestock (including dairy animals) made up about 1% (4.2 million gallons per day) of total daily withdrawals. About 74% of these withdrawals were from groundwater sources, and 16% came from surface water sources. Water withdrawals for irrigation (e.g., for growing crops or pasture as well as irrigation for golf courses) were estimated at 1.9 million gallons per day.** The USGS estimates that freshwater extraction will increase from 440 million gallons a day to 450 million gallons a day by 2020, but this estimate does not account for the possible shutdown of *Entergy Vermont Yankee*.[111]

In June 2008, the Vermont Legislature adopted *Act 199*, which declared Vermont's groundwater a public trust and set up a permitting process for large water withdrawals. The Act requires that anyone withdrawing more than 200,000 gallons of water per day on a single tract of land or place of business must file a report with the *Agency of Natural Resources* (ANR). The Act also stipulates that anyone withdrawing more than 57,600 gallons of water per day must get a permit from ANR. The Act provides permitting and reporting exemptions for farming and dairy processing.

Water Use and Food Processing: The USGS provides a median value of 469 gallons of water used per employee per day for food processing facilities in the United States, the third highest value for water use at industrial facilities after petroleum refining and paper-making. We estimate that Vermont has at least 456 food processing establishments with at least 4,346 employees. Applying this median value to our estimate of food processing employees, we arrive at a value of a little over 2 million gallons of water used per day by food processing facilities in Vermont.

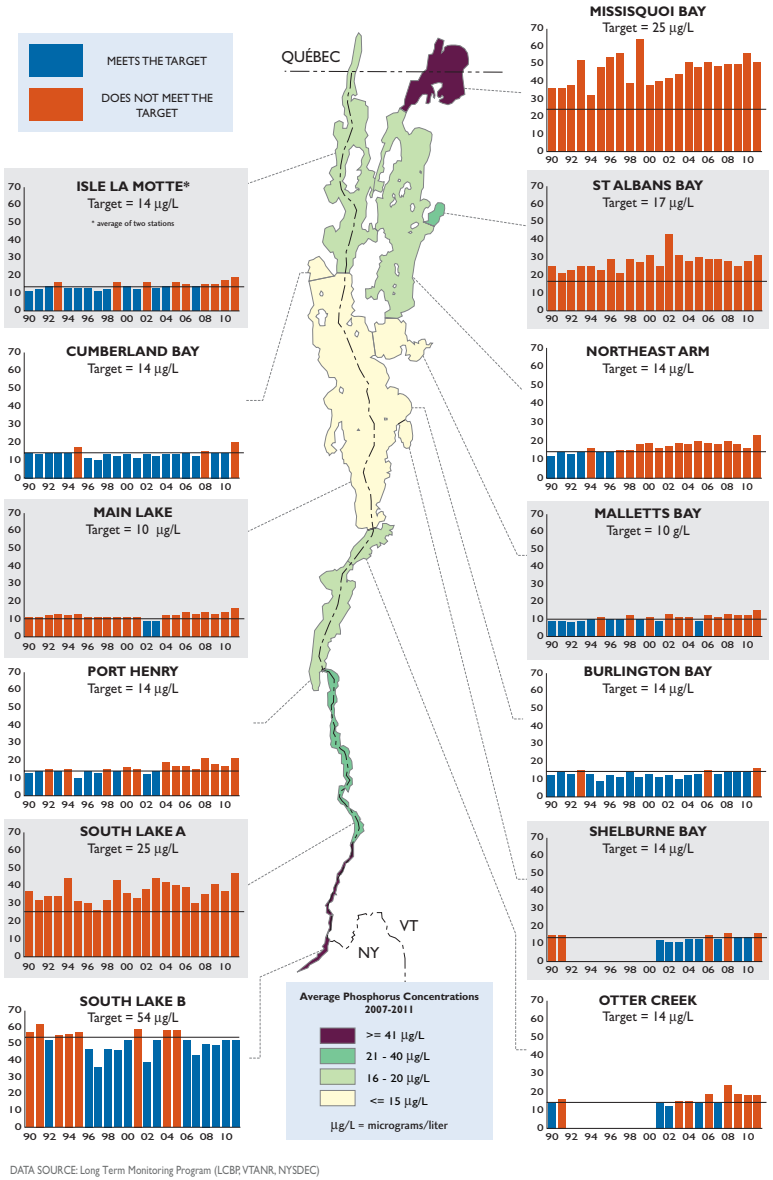
Water Pollution

According to the *USGS*, widespread application of artificial nutrients—nitrate, ammonia, total nitrogen, orthophosphate, and total phosphorus—and livestock manure has polluted more than 90% of 190 sampled streams draining agriculture and urban watersheds in the United States. High levels of phosphorus or nitrogen can lead to algal blooms and accelerated plant growth that depletes available oxygen, squeezes out fish and other aquatic species, and can pose a risk to human health (the *dead zone* in the Gulf of Mexico, which can cover between 6,000 to 7,000 square miles, is the poster child for excess nutrient runoff).[112]

The *Lake Champlain Basin Program* (LCBP), a multi-agency, multi-state (and Quebec) effort to protect Lake Champlain, monitors pollution levels from wastewater treatment plants and nonpoint sources. The LCBP reports that the 96 wastewater treatment facilities (60 of which are in Vermont) in the Lake Champlain Basin account for 10% of the phosphorus entering the lake. The remaining 90% is generated from nonpoint sources: Urban and suburban development (e.g., increased impervious surfaces, pet waste, and over-fertilizing of lawns and gardens) accounts for 46% of total nonpoint phosphorus pollution. Agricultural activities (e.g., soil erosion, manure and fertilizer runoff, livestock access to waterways) account for 38% of total nonpoint phosphorus pollution, while forestry activities (e.g., harvesting and road construction) are estimated to add 15%.[113]

LCBP has measured considerable variation in phosphorus levels and pollution sources in various sections of the lake. For example, northern sections (Missisquoi Bay, St. Albans Bay) and southern sections of Lake Champlain were eutrophic (i.e., excessive

Figure 3.2.21: Lake Champlain Phosphorus Concentrations by Lake Segment



Source: Lake Champlain Basin Program, State of the Lake and Ecosystem Indicators Report, 2012, *www.lcbp.org/PDFs/SOL2012-web.pdf*.

algae growth and low water visibility) and exceeded water quality criteria every year from 1990 to 2003. Most of the rest of the lake was mesotrophic (i.e., moderate algae growth and water visibility), while only Mallets Bay was considered oligotrophic (i.e., low algae growth and high water visibility) from 1990 to 2003. According to LCBP, agricultural activities are responsible for a majority of phosphorus runoff into Missisquoi Bay, a portion of the southern lake, and around Isle La Motte, while the urban and suburban landscape is responsible for most phosphorus runoff for every other section of the lake (Figure 3.2.21).[114] A recent *study* of the Missisquoi Bay Basin found that pasture or fields planted in permanent corn, corn-hay rotations, and permanent hay were predominantly responsible for phosphorus loading in "Critical Source Areas" flowing into the lake.[115]

A wide variety of other toxins, including mercury, polychlorinated biphenyls, road salt, pesticides, pharmaceutical products, and fire retardants, are also found in Lake Champlain. **Vermont farmers spent $5.9 million on chemicals in 2007, up from $5.7 million in 1997.** The 2007 Census of Agriculture estimates that

- 521 farms treated 37,597 acres with chemicals for insects;
- 871 farms treated 86,442 acres for weeds, grass, or brush;
- 26 farms treated 1,819 acres for nematodes;
- 219 farms treated 4,096 acres with chemicals for diseases in crops and orchards; and
- 79 farms used chemicals on 2,042 acres of crops to control growth, thin fruit, ripen fruit, or defoliate.[116]

Other pathogens, including fecal coliform from animal waste, are found in the lake and sometimes cause beach closures.

LCBP's management plan, *Opportunities for Action*, sets the stage for basin-wide goals, objectives, and strategies for protecting Lake Champlain. LCBP has identified four priority goals for addressing the health of Lake Champlain:

1. Reduce phosphorus inputs to Lake Champlain to promote a healthy and diverse ecosystem and provide for sustainable human use and enjoyment of the lake.
2. Reduce toxic contamination to protect public health and the Lake Champlain ecosystem.
3. Minimize the risks to humans from water-related health hazards in the Lake Champlain Basin.
4. Control the introduction, spread, and impact of nonnative nuisance species to preserve the integrity of the Lake Champlain ecosystem.

Nonagricultural activities are the largest source of phosphorus inputs to Lake Champlain. But, as noted earlier, several sections of Lake Champlain are eutrophic, and agricultural runoff in these sections has been identified as the major source of phosphorus inputs. The Clean Water Act requires that states develop a *Total Maximum Daily Load* (TMDL) plan for water bodies not meeting federal standards. The *Ecosystem Restoration Program*, formerly the Center for Clean and Clear, is ANR's program for addressing TMDL and other water issues. Over $100 million in state and federal funds was allocated for the Center for Clean and Clear's activities. The *Ecosystem Restoration Program* has developed a *website* that depicts various projects underway to manage Vermont's waterways, but the *agriculture projects* section of the website was incomplete as of August 2012.

VAAFM does organize and implement *at least ten programs* to reduce food system pollution:

- *Accepted Agricultural Practices* set baseline practices that all farms in Vermont must comply with (e.g., setbacks around surface water and wells, manure management). VAAFM reports that the majority of complaints received are related to manure, although the number of violations identified by on-farm investigations has remained pretty low (about 20 a year), while the number of investigations has increased.
- The *Best Management Practices Program* provides farmers with technical assistance, including engineering assistance, for constructing manure storage facilities, fencing, and leachate treatment systems. The USDA Natural Resources Conservation Service's *Environmental Quality Incentives Program* (EQIP) provides federal funding for Best Management Practices infrastructure.

- The *Conservation Reserve Enhancement Program* (CREP) provides funding and technical assistance to encourage farmers to install conservation buffers around streambanks.
- The *Alternative Manure Management Program*, a joint effort of VAAFM and the NRCS office, provides funding and technical assistance for anaerobic digester projects. Vermont ranks fourth in the nation for installed digesters.
- The *Large Farm Operation Program* (LFO) requires farms with more than 700 dairy cows, 1,000 beef cattle or cow/calf pairs, 1,000 youngstock or heifers, 500 horses, 55,000 turkeys, or 82,000 laying hens to have structures in place for manure management and nutrient management plans for dealing with this manure. Each LFO must receive a permit from VAAFM, and LFO regulations are stronger than Medium Farm Operation regulations. To date, VAAFM staff has visited all 16 LFOs in the state for compliance.
- The *Medium Farm Operation Program* (MFO) requires farms with 200-699 mature dairy cows, 300-999 cattle or cow/calf pairs, 300-999 youngstock or heifers, 150-499 horses, 16,500-54,999 turkeys, and 25,000-81,999 laying hens to have structures in place for manure management and nutrient management plans for dealing with this manure. At least 185 farms in Vermont qualify as MFOs, and very few notices of alleged violations and corrective action letters have been issued to date.
- The *Nutrient Management Grant Incentive Program* provides financial and technical assistance for nutrient management plan development and implementation (up to $14,000). All MFOs and LFOs are required to have a nutrient management plan. VAAFM has provided at least 249 grants so far, covering more than 134,000 acres statewide.
- The *Farm Agronomic Practices Program* provides financial and technical assistance for soil conservation practices, such as cover cropping and crop rotation.
- The *Vermont Agricultural Buffer Program* takes CREP one step further to allow for harvestable grasses to be used as buffers around croplands.
- The Pesticide and Groundwater Monitoring Program takes samples from wells on farms and tests for contamination from pesticides. VAAFM reports that elevated nitrate levels at wells sampled are decreasing statewide.

In addition, the Vermont NRCS office provides a wide range of technical assistance, education, and financing programs for manure management and soil conservation activities. The *Vermont Association of Conservation Districts*, representing 14 Natural Resources Conservation Districts, also provides technical assistance and education to farmers and landowners, including the *Agricultural Resource Specialist program*, which provides technical assistance for manure management and water quality management.

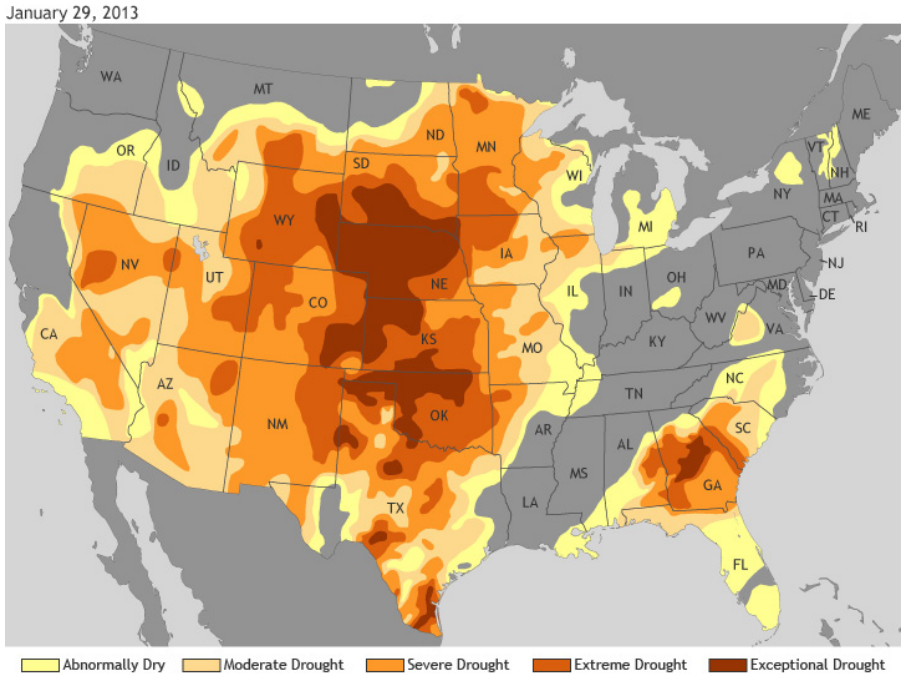
Vermont has at least one nonprofit organization that works with dairy farmers to address environmental issues. The *Franklin and Grand Isle Farmer's Watershed Alliance* was established to support farmers in improving farm practices to minimize runoff from farm fields adjacent to the Missisquoi watershed. The organization provides farm assessments to develop water quality protection plans.

☼ Climate Change Impacts on Precipitation

Many parts of the country are currently experiencing long-term (i.e., greater than 6 months) *extreme*, *severe*, and *exceptional* droughts (Figure 3.2.22).[117] While Vermont consumers will likely be impacted by the decreased availability and increased costs of food from regions of the United States impacted by water shortages (i.e., fruit and vegetable production in from California), Vermont is likely to experience *more* precipitation in the years ahead. The *U.S. Global Change Research Program* predicts that climate change in the Northeast will lead to the following:

- Increased heavy precipitation
- Less winter precipitation falling as snow and more as rain
- Reduced snowpack
- Earlier breakup of winter ice on lakes and rivers
- Earlier spring snowmelt resulting in earlier peak river flows.[118]

Figure 3.2.22: Continental U.S. Drought Monitor, January 2013



Source: ClimateWatch Magazine, January 29, 2013, *http://www.climatewatch.noaa.gov/article/2013/drought-impacts-continue-to-pile-up*.

In 2011, Tropical Storm Irene flooded 20,000 acres of farmland—ruining crops in the field, spoiling harvested animal feed, and drowning animals—and caused upwards of $1 billion in damage to the state of Vermont. The cumulative effect of an increase in extreme weather events such as Tropical Storm Irene can rapidly strain the resources of a small state like Vermont, while erratic weather and increased rainfall intensity can lead to unpredictable harvests from year-to-year.

ANALYSIS

Food system activities withdraw a relatively small percentage of Vermont's freshwater supply (even if *Entergy Vermont Yankee* is excluded), but they are estimated to contribute 38% of nonpoint source phosphorus to Lake Champlain. Although the magnitude of other chemicals from agricultural runoff (e.g., pesticides) reaching water bodies is not known, it is expected that agricultural runoff and urban runoff may contribute significant amounts of toxic chemicals. Mutually agreed upon goals for improving the health of Lake Champlain have been established by LCBP and the *Ecosystem Restoration Program*. Over $100 million has been invested in Lake Champlain cleanup over the past decade, and a number of programs and organizations exist to manage nutrient flows, conserve soils, and protect waterways. However, the *Environmental Protection Agency* recently disapproved Vermont's 2002 water quality plan on the grounds that its levels for phosphorus reduction do not satisfy the Clean Water Act.[119] The *Vermont Agency of Natural Resources* had prepared a revised implementation plan for phosphorus TMDL in 2010 that included many priority strategies (with estimated costs),[120] and the EPA has pledged to work with regional stakeholders to develop a new TMDL for phosphorus. Climate change is likely to exacerbate erosion and runoff into Lake Champlain unless careful mitigation efforts are put in place.

Technical Assistance and Business Planning

A growing number of farmers are using technical assistance and cost-share programs offered by the *Ecosystem Restoration Program*, NRCS, *Natural Resource Conservation Districts*, the *Farmer's Watershed Alliance*, and others. The 2010 update of Vermont's implementation plan for phosphorus TMDL recommended increasing the number of VAAFM and *UVM Extension* specialists, Agricultural Resource Specialists, and other personnel (engineers, soil scientists) available for on-farm technical assistance, education, and support at a cost of $500,000 annually.

Economic development and food system support organizations should investigate opportunities to advance the development of new enterprises that make products or provide services in support of agricultural best practices—for example, the production of burlap-wrapped compost products for lining riparian buffers with tree stakes, or the

expansion of *Intervale's Conservation Nursery*, which markets native trees and shrubs for riparian restoration especially adjacent to farm fields.

Financing

The 2010 update of Vermont's implementation plan for phosphorus TMDL recommended providing financial incentives to achieve a minimum width (10 feet) of buffer zone along intermittent streams and ditches that pass through annual cropland and for installing fencing (temporary and permanent), watering systems, and stream crossings to improve the management of animals in and around streams and rivers (at a total cost of $700,000 annually).

Research has shown that every dollar invested in watershed protection saves tens to hundreds of dollars in water treatment costs.[121] A water quality trading program, in which water quality implementation projects on non-point source farmland are funded by issuing tradable permits to point source polluters that have an allotted cap to fulfill (i.e., through reductions or credits), could be piloted in Vermont. Alternatively, a "Payment for Ecosystem Services" program (PES), where state government, federal government, or other sources pay farmers for the net environmental benefits they can provide to water quality (i.e., by avoiding externalized clean-up costs) by implementing soil enhancement and erosion control best practices could also be piloted in Vermont. Water quality trading programs and PES programs have been initiated in Chesapeake Bay, New York City, and the Ohio River Valley, and Vermont may be well positioned to advance a similar initiative.[122]

GETTING TO 2020

The health of Lake Champlain is a major concern and Vermont's food system organizations need to do their part to reduce water pollution. The EPA's recent disapproval of Vermont's 2002 water quality plan on the grounds that its levels for phosphorus reduction do not satisfy the Clean Water Act opens the door to improvements in technical assistance programs, financing strategies, and regulations. The *Vermont Agency of Natural Resources* has already prepared a revised implementation plan for phosphorus TMDL that includes recommendations for expansions of technical assistance programs, new positions at VAAFM and *UVM Extension*, as well as financial incentives.

Table 3.2.18: Objectives and Strategies for Mitigating Food System Based Water Pollution

OBJECTIVE	STRATEGY
Research Strategies	
To help Vermont farmers and technical assistance providers adapt to climate change.	Climate change means increased precipitation and extreme weather events in Vermont. Increased precipitation can lead to increased soil erosion, while unpredictable weather can impact crop and livestock production. Farmers and technical assistance providers (including educational institutions) should begin exploring the adoption of *fluvial erosion hazard areas*, buffers, and so on.
Technical Assistance and Business Planning Strategies	
Support and evaluate ongoing state, federal, and other technical assistance programs to ensure the adoption of best practices.	Expand the Farm Agronomic Practices and Nutrient Management Programs to support the increased use of soil erosion reduction practices and alternative manure application techniques, such as soil aeration.*
	Increase the number of VAAFM and UVM Extension specialists, Agricultural Resource Specialists, and other personnel (engineers, soil scientists) available for on-farm technical assistance, education and support.*
Encourage entrepreneurial activity to develop products or provide services that minimize water pollution from food system activities.	Research and inventory innovative products or services used in other parts of the world to minimize water pollution from food system activities. Provide technical assistance to organizations looking to develop those products or services in Vermont.
Financing Strategies	
Support and evaluate ongoing state, federal, and other cost-share and financing programs to ensure the adoption of best practices.	Provide financial incentives to achieve a minimum width (10 feet) of buffer zone along intermittent streams and ditches that pass through annual cropland.*
	Provide financial and regulatory incentives to install fencing (temporary and permanent), watering systems, and stream crossings to improve the management of animals in and around streams and rivers.*
	Broaden the conservation purposes of and annually expend all funds made available through the Wetland Reserve Program (WRP) and Farmland Protection Program (FRPP) to permanently protect and restore wetlands and stream corridors.*
Investigate the potential to reduce water clean-up costs by developing a water quality trading program or PES program.	Develop a water quality trading program or PES program that would finance nutrient management, soil conservation, and other agricultural activities to avoid larger water clean-up costs. Municipalities, state government programs and agencies, and water quality organizations would pay farmers in high-risk watersheds who meet soil quality performance standards. Payment would be based on the value of the environmental service, (i.e., the cost savings from pollution prevention and minimizing the need for mechanical or chemical treatment to clean water).

* These goals were developed by the Agency of Natural Resources. Source: Vermont Agency of Natural Resources, Revised Implementation Plan: Lake Champlain Phosphorus TMDL, pp. 3-4 (2010), available at *www.leg.state.vt.us/reports/2010ExternalReports/252919.pdf*.

FARM INPUTS
Energy

How are energy costs impacting Vermont farmers? What opportunities exist for on-farm energy production?

See Chapter 4, Section 6, Food System Energy Issues, for more information.

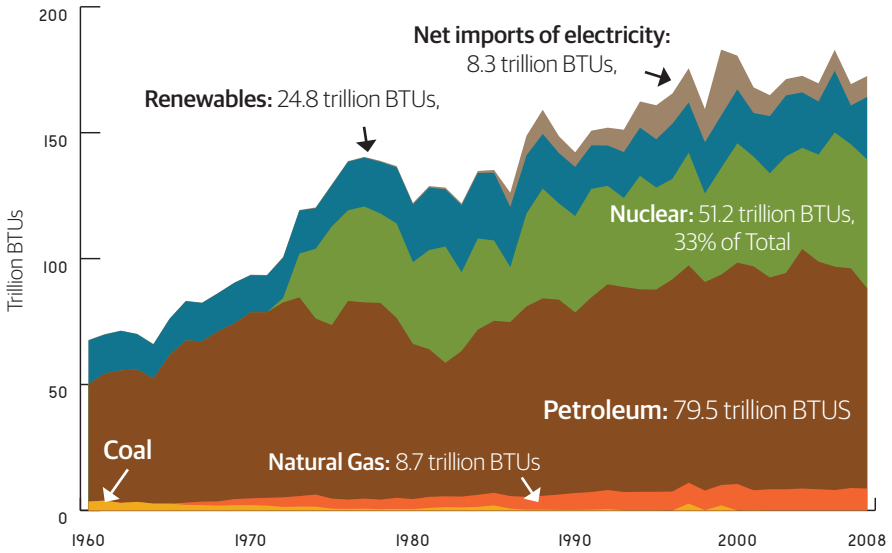
Major productivity gains in America's food system have been made through the increased availability and use of non-renewable energy sources. Food system activities consume a lot of energy, "from the manufacture and application of agricultural inputs, such as fertilizers and irrigation, through crop and livestock production, processing, and packaging; distribution services, such as shipping and cold storage; the running of refrigeration, preparation, and disposal equipment in food retailing and food service establishments; and in home kitchens."[123] The USDA reports that food-related energy use increased from 12.2% of national energy use in 1997 to 14.4% in 2002, and was an estimated 15.7% of use in 2007.

Per capita energy use in the United States declined 1.8% from 1997 to 2002, but **per capita food-related energy use increased by 16.4%. Much of this increase reflects the historic trend of energy-based products and services replacing human labor.** For example, the USDA attributes much of this growth in energy consumption to the outsourcing of food preparation activities at home and within the food service industry to automated food processing. That is, increased consumption of prepared foods and more eating out appear to be the driving force behind the growth in food system energy consumption. Energy used for farm inputs and to run equipment on the farm equaled 14.4% of food system energy consumption in 2002, and it grew about 5% from 1997 to 2002, the third largest increase after food processing and food services.

About 93% of U.S. energy production is generated from nonrenewable energy sources, including coal, petroleum, and nuclear energy. Vermont consumes the least energy of any state in the country (147.6 trillion BTUs in 2010), but ranks 42nd on a per capita basis. Petroleum (53.5% of energy consumed in 2010) and nuclear energy (33.8% of energy consumed in 2010) are Vermont's major energy sources, followed by renewables (16.8%), and natural gas (6%) (Figure 3.2.23). In the absence of complete information, we use the USDA's national estimate of 15.7% to calculate that food system activities in Vermont consumed 23 trillion BTUs of energy in 2010.

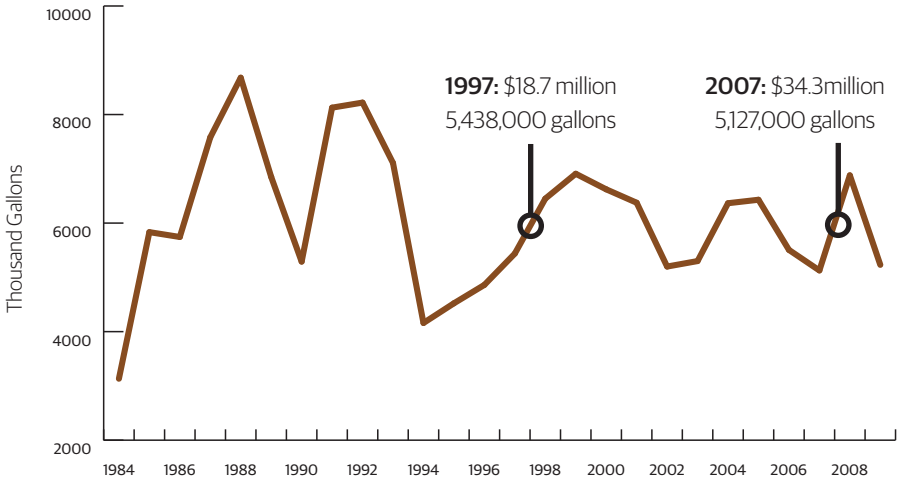
The amount of money Vermont farmers spent on fuel increased 83% from $18.7 million in 1997 to $34.3 million in 2007, even though less fuel was purchased in 2007 (Figure 3.2.24). Between 1984 and 2009 Vermont farmers purchased an average of 6,074,462 gallons of diesel fuel per year. Data about on-farm electricity and thermal energy consumption is not readily available.

Figure 3.2.23: Vermont's Total Energy Consumption, 1960-2008



Source: Energy Information Administration, *www.eia.gov/beta/state/data.cfm?sid=VT#Consumption*.

Figure 3.2.24: On-Farm Diesel Consumption, 1984-2009



Source: Energy Information Administration,
www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=KDOVAFSVT1&f=A

Across the state, Vermonters are stepping up to create a new vision of the future premised on the relocalization of food and energy production. A wide variety of technical assistance providers, renewable energy businesses, and funding sources are helping farmers and other food system businesses install renewable energy systems and become more energy efficient. For example, in 2007 the *Vermont Environmental Consortium* developed a *Farm Energy Handbook* that covered such topics as biodiesel production and wind power and distributed it to 1,200 farmers. The *Rural Energy Council*, convened by the Vermont Council on Rural Development from 2006 to 2007, identified 18 key recommendations for advancing renewable energy production and efficiency, including a call for collaborative leadership by the Administration,state agencies, Legislature, business leaders, and policy makers. Vermont is also signed on to the *25 by '25 Initiative*, a national campaign to generate 25% of our energy from renewables by 2025. *Efficiency Vermont* has worked with most of the state's dairy farms to install energy-saving devices and has historically offered an agricultural equipment rebate program for lighting, plate coolers for dairies, and other types of equipment. The *Clean Energy Development Fund*, VAAFM, *USDA Rural Development*, NRCS, and Vermont's biggest utility (*Green Mountain Power*) has provided funding for the development of anaerobic digesters and other renewable energy projects (e.g., solar photovoltaics).

On-farm renewable energy production provides an opportunity for farmers to reduce input costs and greenhouse gas emissions while generating energy and new revenue. For example, farmers can replace petrodiesel with biodiesel made from oilseed crops such as sunflowers grown in Vermont. Animal feed imports can also be reduced by feeding the meal left after oil is squeezed from oilseeds to livestock. Eight dairy farms enrolled in *Green Mountain Power's Cow Power* program are generating over 14,000 megawatt hours of electricity per year through anaerobic digesters that turn the methane in animal manure into energy. Solids left over after anaerobic digestion can also be used as animal bedding, cutting down on another input cost. Food system activities off the farm can also produce energy: waste vegetable oil from fried foods can be turned into biodiesel, and food decomposing at landfills produces methane that can be captured to generate electricity.

Chapter 4, Section 6 discusses food system energy issues in detail, including strategies for advancing the suite of on-farm renewable energy technologies.

North Hardwick Dairy

Everyone in the Hardwick area knows the *North Hardwick Dairy*—"it's the one on the hill with the wind turbine."

The turbine is evidence of farmer Nick Meyer's focus on meeting his goal of greater self-sufficiency. "I want to produce everything the farm needs on the farm."

The higher and relatively stable milk prices for organic milk allowed the 327-acre, 110-cow (63 adult milkers) farm to plan and experiment. "[Organic] milk price doesn't go up and then drop, up and drop as with conventional milk prices," Meyer explains.

With a 10kW Bergy wind turbine, North Hardwick Dairy makes a dent in its electricity usage (10-12%), and a potential upgrade to a 35kW would cover all the farm's electricity needs.

North Hardwick Dairy uses 4,000 gallons of diesel each year (2,000 gallons of diesel for off-road equipment and 2,000 gallons in their furnace). At an Organic Valley award ceremony to honor North Hardwick Dairy's winning "best organic milk" seven years in a row, Meyer came across a card advertising the BioPro 190, a small automated machine that turns vegetable oil into biodiesel. He purchased a BioPro in 2005 but was unable to get enough used vegetable oil to meet his needs. With a grant from the Vermont Sustainable Jobs Fund, North Hardwick Dairy planted sunflowers and bought an oilseed press. Nick's plan is to use the press to create food grade oil that he would sell to local restaurants for frying and then reclaim the used oil for making biodiesel. In 2011-2012 North Hardwick Dairy will have a chance to test this model.

Sunflowers are planted in May and harvested in October. To maintain optimal storage and pressing moisture, the seed is stored in a huge outdoor bin, where it is dried to about 9% moisture using a fan. The dry seed is put into a seed cleaner. Then, the press produces, along with the oil, a high-protein "licorice-rope looking" meal, ideal for newly weaned calves.

Meyer mixes the oil (whether it's reclaimed or "virgin") with alcohol (methanol) and small amounts of potassium hydroxide and sulfuric acid in the BioPro to create 50-gallon batches of high-quality finished biodiesel. The fuel is ready in about 48 hours, and then it's "washed and dried" to remove residual contaminants. Nick tests every batch to make sure the conversion to biodiesel is complete, and then his fuel is stored for blending with diesel in the tractors and combine. Meyer touts the lubricity value of biodiesel over regular diesel. It costs Nick about $1.55 to make a gallon of biodiesel from used vegetable oil from other sources, and about $2.67 gallon from his sunflower oil. The major cost of the biodiesel is the methanol. If methanol could be sourced at a lower price, says Meyer, then he could be reducing production costs by about $0.50 per gallon.

This summer, Meyer plans to plant 12 acres to produce 10,000-15,000 pounds of sunflower seed. At 50-80 gallons of oil per acre, production would run to 600-960 gallons of oil.

PHOTO CREDIT: VSJF

Taylor and Nick Meyer in a field of sunflowers at North Hardwick Dairy, 2011.

BioPro 190 biodiesel processor at North Hardwick Dairy, 2011.

FARM INPUTS

Labor

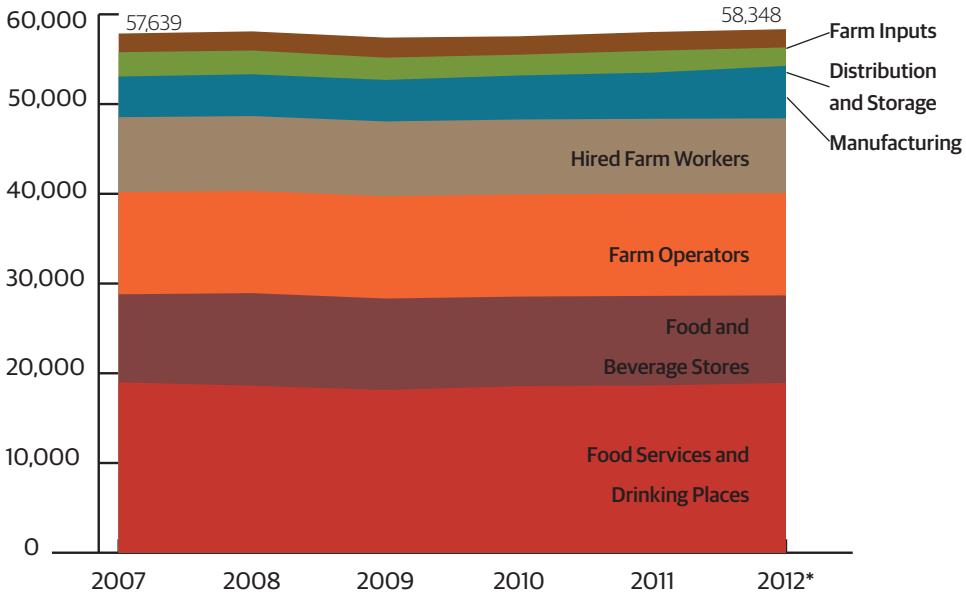
What workforce training and economic development programs are in place for Vermont's farmers? What can be done to attract workers and boost wages?

See Chapter 4, Section 3, Food System Labor and Workforce Development, for more information.

The industrialization of the food system and major transformations in the U.S. economy led to substantial decreases in the number of farm workers over the 20th century. In 1935, there were over 45,000 farmers, family members, and hired workers employed in food production in Vermont.[124] By 2007 the number of farm operators and hired farm labor decreased by 75%, to 19,735. Farm operators and hired farm workers equal about 35% of Vermont's food system workforce (Figure 3.2.25).

Farming has always been a hard way to make a living, with long hours, strenuous labor, infrequent vacations, and little access to health insurance or other workplace benefits. Although farm-related income is earned from various types of production, agritourism, custom work, and forestry, the majority of Vermont farmers derived less than 25% of their household income from farming in 2007. **Nearly 70% of Vermont farms are small, limited-resource, retirement, or residential-lifestyle family farms in which farming is not the primary occupation.**[125] And a little over 71% of Vermont farms (5,010 farms have annual sales of less than $25,000.[126] Farmers interviewed during the F2P process

Figure 3.2.25: Vermont Food System Employment, 2007-2012



Sources: Vermont Department of Labor, Quarterly Census of Employment and Wages 2007-2012, 2007 Census of Agriculture, 2010 US Census Bureau Nonemployer Statistics.
* Second quarter 2012 employment and establishments data.

described the necessity of one or more family members holding full-time jobs to supplement farm income, maintain access to health insurance, or in some cases, cover farm expenses. Nearly 90% of Vermont farms are family owned. Less than 1% were non-family, corporate farms, including any farm where the operator and relatives do not own a majority of the business, farms operated by publicly held corporations, farms equally owned by three unrelated business partners, or farms operated by a hired manager for a family of absentee owners. The principal operators of Vermont farms are primarily male (79%), but the percentage of women who are principal operators on Vermont farms increased 37% from 1997 to 2007.

"Part of the problem is that farm labor wages are obscenely low. That follows from the fact that farm net profitability is not what it ought to be, so farm work is devalued all the way down the line. You find yourself in a situation where you're exhausted because you need more help, but you can't get more help because it's a system that needs more money coming in at the beginning. More people expect food to be cheap and that's a problem."

—Upper Valley focus group participant

The average age of Vermont farmers is 56, and over a quarter are 65 or older. Yet a growing number of people—particularly young people—are looking to build careers in Vermont's food system by becoming farmers or starting food enterprise businesses. Changing demographics can also be found on Vermont organic farms, which draw a higher percentage of female farmers (25% vs. 21% for nonorganic), farmers under 35 years old (15% vs. 5% for nonorganic), and people whose primary occupation is farming (70% vs. 48% for nonorganic).[127]

Hired labor (13.2%), custom work and hauling (3.6%), and contract labor (0.9%), accounted for about $97 million (17.7% of total) in farm expenses in 2007, up from $92 million in 2002. Market demands for cheaper products combined with declining farm parity and challenges with economies of scale, often leave farmers unable to hire additional employees and stay profitable. Small scale farms have plenty of work to do, yet often have difficulty affording outside help or lack the managerial time and administrative expertise to bring on additional workers. Farm work is notoriously labor intensive with fluctuating seasonal demands, and farm businesses struggle with high

Filling a Specific Need: Food Animal Veterinarians

The number of veterinarians practicing food animal medicine in Vermont is declining.[128] Food animal veterinarians include not only those in clinical private practice, but also those working in research, academic, regulatory, and food safety sectors. In response to regional shortages of food animal veterinarians, their services have shifted to focus on routine herd health visits and limited emergency care. Farmers are usually adept at routine animal care procedures such as vaccinating and treating common ailments. Good management practices can minimize the need for veterinary care for illness or emergency treatments, and nearly all farmers can carry out humane euthanasia when necessary. However, despite many farmers' competency with these routine practices, veterinarians are needed to work with them on practices that focus on herd nutrition, preventive health care, and herd production.

In 2009, a group of Vermont stakeholders attempted to implement a state-supported loan forgiveness and/or repayment program to attract more food animal veterinarians to Vermont. The findings in support of such assistance are summarized in a 2009 report to the Vermont State Legislature that responds to Section 22 of Act 44. Although this initial attempt failed, the Vermont State Veterinarian has revived the original concept in an application to the federal Veterinary Medicine Loan Repayment Program (VMLRP) to request assistance for food animal veterinarians who practice in two defined shortage areas within the state. VMLRP will offset educational debt by up to $25,000 annually for veterinarians who commit to practicing for at least three years in defined shortage areas. In addition, during the 2011 legislative session, the Jobs Bill included $30,000 in loan forgiveness funds for large animal veterinarians, to be administered through the VAAFM.

Shortages of food animal veterinarians in one region of Vermont can have an impact on all regions of the state. These veterinarians often serve as the first line of defense against the introduction and spread of zoonotic and other high-consequence livestock diseases. If veterinary professionals are not practicing in adequate numbers, there is an increased risk that diseases appearing on single underserved farms can spread to all farms in the state and affect human health.

labor costs relative to overall business income. Interested farm worker candidates are often deterred by low wages and the lack of health care insurance, leaving farmers challenged by high employee turnover and the lack of a skilled, flexible, and reliable workforce. Longtime farmers, beginning farmers, and hired workers all identified the high cost of health insurance as a major barrier to job creation and the ability to farm full-time.

Retaining employees in the food system depends on providing competitive wages and other benefits. According to the Vermont Department of Labor, the average wage for farmworkers is $11.32 per hour (the median wage is $10 per hour). Although this rate is significantly higher than the federal minimum wage, it is far from a livable wage, especially considering that most farmworkers work part-time. Many farms, especially dairy farms and larger-scale fruit and vegetable farms, depend on guest and migrant workers from Mexico, other Latin American countries, and the Caribbean. Recent media attention has highlighted Vermont's struggling dairy industry, in particular, and dairy farmers' use of undocumented migrant workers to stay afloat. Although the exact number of undocumented workers is unknown, VAAFM estimates that between 1,500 to 2,500 undocumented migrant workers are on dairy farms throughout the state.

Both farmers and undocumented workers they hire face significant risks because of the workers' status. Comprehensive immigration reform on a national level has been stalled for many years, though seasonal and temporary workers may be hired through the *H-2A visa program*. Because the H-2A program allows for the hiring of only seasonal or temporary laborers, it does not help farms that require dependable year-round labor, such as Vermont's dairy and livestock farms.

Business planning and human resources planning assistance to farmers to incorporate livable wages, access to health care, and cost of workers compensation and other insurance costs needs to be expanded, as well as consumer education and outreach that ties the cost of food to farm production expenses.

Farm Support Establishments

Farm supply establishments include all the businesses that rent, sell, and repair the equipment (e.g., plows, tractors, sprayers, tillers, and milking equipment) needed for farm production; wholesale merchants of farm supplies, such as animal feeds, fertilizers, agricultural chemicals, pesticides, and plant seeds; as well as veterinary services. Some portion of these establishments provided supplies, repairs, and maintenance for farmers that cost over $68 million in 2007 to (equal to 11.8% of total production expenses).

According to the *Vermont Department of Labor's Covered Employment and Wages* (QCEW) statistics for the second quarter of 2012, Vermont has at least **185 farm support establishments that collectively employ at least 1,330 people.** The QCEW figures do not account for farm support establishments operated by sole proprietors or partnerships. When the 2010 *U.S. Census Bureau's Nonemployer Statistics* (the latest available figures) are added to these QCEW figures, **the number of farm support establishments grows to at least 1,068, and the number of employees is at least 2,035**. This figure is likely an undercount, as a number of businesses (e.g., construction companies, engineers) derive income from providing services to farms that are not captured by official statistics. For example, *Harrison Concrete* in Addison County builds dairy farm barns in addition to other kinds of construction projects. Harrison vice president Jim Harrison has become a spokesperson for the dairy industry because "without dairy farms, I'd be out of business."

These establishments depend on the viability of Vermont's dairies and other farms to stay in business. As the owner of the largest feed business in Vermont, *Bourdeau Brothers Inc.*, Jim Bushey knows the close financial connection between his business and so many other farms and supply vendors. "Their success will be our success," he stated. In addition to supplying grain, most feed companies also provide services such as forage testing, ration balancing, record keeping, continuing education seminars, and technical assistance for herd health and management. Vermont has a robust combination of small and midsize locally owned grain companies, as well as several companies that operate on the regional, national, and international scales. Both organically produced and conventionally produced grains are readily available, and farmers can select from a variety of companies.

Increased local food consumption and successful local farms have the potential to create new jobs in farm support services. For example, several F2P stakeholders noted

that more large animal veterinarians will be needed in the state if livestock numbers grow to meet consumer demand for local meat.

☼ Climate Change Impacts on Working Conditions

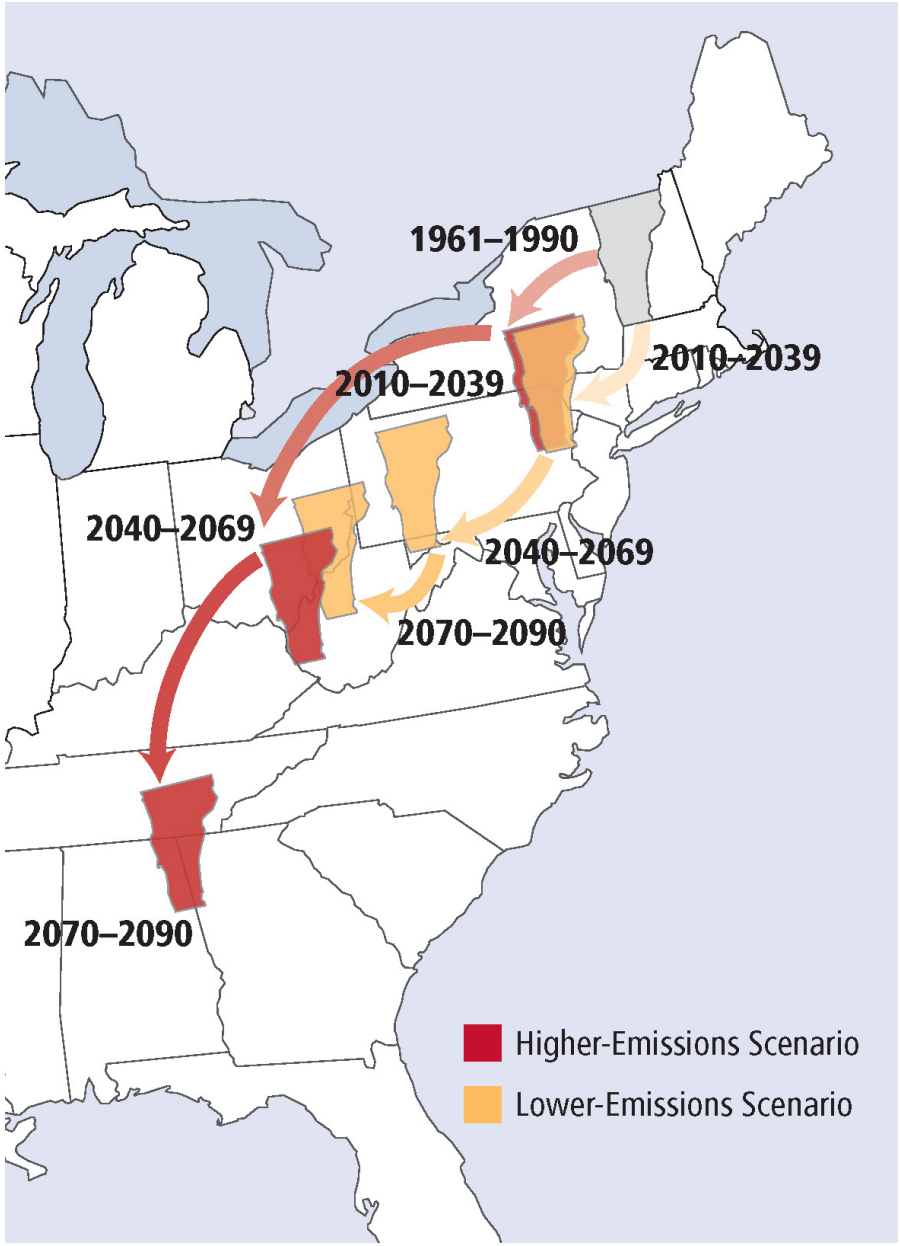
The *Union of Concerned Scientists* says that "Changes in average summer heat index—a measure of how hot it actually feels, given temperature and humidity—could strongly affect quality of life in the future for residents of Vermont." Figure 3.2.26 indicates that Vermont could experience conditions similar to the South under high emissions scenarios.[129] The *Vermont Agency of Natural Resources* states that the possible health effects of climate change are large and include:

- Injuries, illnesses, and deaths related to extreme heat and weather events
- Infectious diseases related to changes in vector and zoonotic biology as well as changes in water and food contamination
- Allergy and respiratory symptoms related to increasing plant and mold allergens and irritants in air.[130]

Farmers and farm workers will be on the frontline of these changes since they spend most of their days outside. State agencies, including the Vermont Department of Health, health care providers, technical assistance providers, and food system workers need to begin exploring monitoring and prevention systems to mitigate emerging health problems.

Food system labor issues and workforce development needs are covered in detail in *Chapter 4, Section 3*.

Figure 3.2.26: Changes in Average Summer Heat Index



Source: Union of Concerned Scientists, Vermont: Confronting Climate Change in the Northeast, www.climatechoices.org/assets/documents/climatechoices/vermont_necia.pdf.

End Notes

1 Keith Fuglie et al., *Research Investments and Market Structure in the Food Processing, Agricultural Input, and Biofuel Industries Worldwide*, USDA ERS, Economic Research Report No. (ERR-130), 2011, www.ers.usda.gov/publications/err-economic-research-report/err130.aspx. Keith Fuglie, Paul Heisey, John King, and David Schimmelpfennig, "Rising Concentration in Agricultural Input Industries Influences New Farm Technologies," *Amber Waves*, December 2012, www.ers.usda.gov/amber-waves/2012-december/rising-concentration-in-agricultural-input-industries-influences-new-technologies.aspx#.USexdh1CB17.

2 USDA Economic Research Service, www.ers.usda.gov/data/agproductivity/#datafiles.

3 Julian M. Alston, Bruce A. Babcock, and Philip G. Pardey, "The Shifting Patterns of Agricultural Production and Productivity Worldwide," *The Midwest Agribusiness Trade Research and Information Center*, Iowa State University, 2010.

4 Leslie Kaufman, "Chemicals in Farm Runoff Rattle States on the Mississippi," *New York Times*, June 2, 2001, www.nytimes.com/2011/06/03/science/earth/03runoff.html?pagewanted=all.

5 National Research Council of the National Academies, *Toward Sustainable Agricultural Systems in the 21st Century* (Washington, DC: The National Academies Press, 2010), 67-68.

6 USDA 2007 Census of Agriculture, Table 64, www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_State_Level/Vermont/st50_1_064_064.pdf.

7 Richard Heinberg, *Powerdown: Options And Actions For A Post-Carbon World*, (Gabriola Island, BC: New Society Publishers, 2004), 18-19.

8 BP Statistical Review of World Energy, June 2013, www.bp.com/content/dam/bp/pdf/statistical-review/statistical_review_of_world_energy_2013.pdf.

9 Robert L. Hirsch, Roger Bezdek, and Robert Wendling. "Peaking of World Oil Production: Impacts, Mitigation & Risk Management," Sponsored by the National Energy Technology Laboratory of the Department of Energy, 2005.

10 See, for example: Lyle K. Grant, "Peak Oil As A Behavioral Problem," *Behavior and Social Issues*, 2007, 16: 65-88; Kenneth S. Deffeyes, *Beyond Oil: The View From Hubbert's Peak*, (New York: Hill and Wang, 2005); Richard Heinberg, *Powerdown: Options And Actions For A Post-Carbon World*, (Gabriola Island, BC: New Society Publishers, 2004); Robert L. Hirsch, Roger Bezdek, and Robert Wendling. "Peaking of World Oil Production: Impacts, Mitigation & Risk Management," Sponsored by the National Energy Technology Laboratory of the Department of Energy, 2005; James Howard Kunstler, *The Long Emergency: Surviving the Converging Catastrophes of the Twenty-First Century*, (New York: Atlantic Monthly Press, 2005); Paul Roberts, *The End of Oil: On the Edge of a Perilous New World*, (Boston: Houghton Mifflin, 2004).

11 Robert L. Hirsch, Roger Bezdek, and Robert Wendling. "Peaking of World Oil Production: Impacts, Mitigation & Risk Management," Sponsored by the National Energy Technology Laboratory of the Department of Energy, 2005.

12 United States Government Accountability Office, *CRUDE OIL: Uncertainty about Future Oil Supply Makes It Important to Develop a Strategy for Addressing a Peak and Decline in Oil Production*, www.gao.gov/cgi-bin/getrpt?GAO-07-283, 2007.

13 USDA 2007 Census of Agriculture, www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_State_Level/Vermont/st50_1_062_062.pdf.

14 USDA 2007 Census of Agriculture, www.agcensus.usda.gov/Publications/1997/Vol_1_National,_State_and_County_Tables/ac97avt.pdf, Table 50. www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_State_Level/Vermont/vtv1.pdf, Table 62.

15 Interview with David Lane, Vermont Agriculture Credit Corporation, May 10, 2011.

16 Aaron McCright and Riley Dunlap, "Anti-reflexivity: The American Conservative Movement's Success in Undermining Climate Science and Policy," *Theory, Culture & Society*, 27(2-3): 100-133.

17 USDA, *Climate Change and Agriculture in the United States: Effects and Adaptation*, USDA Technical Bulletin 1935. Washington, DC, 2012, www.usda.gov/oce/climate_change/effects_2012/effects_agriculture.htm. Scott Malcolm et al., *Agricultural Adaptation to a Changing Climate: Economic and Environmental Implications Vary by U.S. Region*, USDA Economic Research Service, Economic Research Report No. (ERR-136), July 2012, www.ers.usda.gov/media/848748/err136.pdf.

18 Peter Laderach, *Predicting the Impact of Climate Change on the Cocoa-Growing Regions in Ghana and Cote d'Ivoire*, International Center for Tropical Agriculture, September 2011, www.eenews.net/assets/2011/10/03/document_cw_01.pdf.

19 Jeremy Haggar and Kathleen Schepp, *Coffee and Climate Change: Impacts and Options for Adaptation in Brazil*, National Resources Institute, February 2012, www.nri.org/docs/promotional/D5930-11_NRI_Coffee_Climate_Change_WEB.pdf.

20 Council on the Future of Vermont, *Imagining Vermont: Values and Vision for the Future*, http://vtrural.org/programs/policy-councils/future-of-vermont (2009).

21 USDA 2007 Census of Agriculture, www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_State_Level/Vermont/st50_1_008_008.pdf.

22 Deb Brighton, Jamey Fidel, and Brian Shupe, *Informing Land Use Planning and Forestland Conservation Through Subdivision and Parcelization Trend Information*, http://svr3.acornhost.com/~vnrcorg/report/Full%20Subdivision%20Report%20with%20Appendices.pdf, September 2010, page 25.

23 U.S. Department of Agriculture, *Summary Report: 2007 National Resources Inventory*, Natural Resources Conservation Service, Washington, DC, and Center for Survey Statistics and Methodology, Iowa State University, Ames, Iowa, 2009, www.nrcs.usda.gov/technical/nri/2007/2007_NRI_Summary.pdf.

24 Farmland Information Center, *Changes in Land Cover/Use, Data Table 2*, www.farmlandinfo.org/documents/38415/FIC_NRI_2007_Data_Tables.pdf.

25 VAAFM, Current Use Program, www.vermontagriculture.com/agdev/currentuse.htm.

26 Vermont Department of Taxes, Property Valuation and Review, www.state.vt.us/tax/pvrcurrentuse.shtml; e-mail communication with Deb Brighton, February 6, 2011.

27 American Farmland Trust, *From the Field: What Farmers Have to Say About Vermont's Farmland Conservation Program*, www.farmlandinfo.org/documents/29389/From_The_Field.pdf.

28 Dan L. Erickson, Sarah T. Lovell, and V. Ernesto Mendez, "Landowner Willingness to Embed Production Agriculture in Residential Areas of Chittenden County, VT," *Landscape and Urban Planning*, 103 (2011): 174-184.

29 Alan K. Betts, *Climate Change in Vermont*, Vermont Agency of Natural Resources, June 2011, www.anr.state.vt.us/anr/climatechange/Pubs/VTCCAdaptClimateChangeVTBetts.pdf.

30 Nir Y. Krakauer, "Estimating Climate Trends: Application to United States Plant Hardiness Zones," *Advances in Meteorology*, 2012, www.hindawi.com/journals/amet/2012/404876/#B4.

31 USDA, *Climate Change and Agriculture in the United States: Effects and Adaptation*, USDA Technical Bulletin 1935. Washington, DC, 2012, www.usda.gov/oce/climate_change/effects_2012/effects_agriculture.htm.

32 David Pimentel, "Soil Erosion: A Food and Environmental Threat," *Environment, Development, and Sustainability*, (8) (2006): 119-137.

33 USDA 2007 Census of Agriculture, www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_State_Level/Vermont/st50_1_044_045.pdf.

34 From 1987 to 2007, nitrogen fertilizer use increased 29.2%, phosphate use increased 14.1%, and potash use increased 6.1%.

35 Leslie Kaufman, "Chemicals in Farm Runoff Rattle States on the Mississippi," *New York Times*, June 2, 2011, www.nytimes.com/2011/06/03/science/earth/03runoff.html?_r=1&pagewanted=2&src=recg.

36 USDA National Resources Conservation Service, *2007 National Resources Inventory*, www.nrcs.usda.gov/technical/NRI/2007/nri07erosion.html.

37 David Pimentel, "Soil Erosion: A Food and Environmental Threat," *Environment, Development, and Sustainability*, (8) (2006): 124.

38 USDA, *Climate Change and Agriculture in the United States: Effects and Adaptation*, USDA Technical Bulletin 1935. Washington, DC, 2012, pages 53-56, www.usda.gov/oce/climate_change/effects_2012/effects_agriculture.htm.

39 Sue Minter, *Update on Vermont's Recovery from Tropical Storm Irene*, Irene Recovery Office, March 2012, www.vtstrong.vermont.gov/Portals/0/Documents/IreneRecoveryreportspw.pdf.

40 USDA, op. cit., page 56.

41 USDA Farm Service Agency, *Conservation Reserve Program: Annual Summary and Enrollment Statistics, 2009*, www.fsa.usda.gov/Internet/FSA_File/fyannual2009.pdf.

42 USDA Natural Resource Conservation Service, *Environmental Quality Incentive Program*, www.nrcs.usda.gov/programs/eqip/2010data/acres-and-dollars.html.

43 University of Vermont, *Crop Rotation on Vegetable Farms*, www.uvm.edu/vtvegandberry/factsheets/Crop%20Rotation.pdf.

44 Roger S. Swift, "Sequestration of Carbon by Soil", *Soil Science*, 166 (11) (November 2001): 858–871.

45 Amy R. Sapkota et al., "What Do We Feed to Food-Production Animals? A Review of Animal Feed Ingredients and Their Potential Impacts on Human Health," *Environmental Health Perspectives*, May 2007, 115 (5): 663-670, www.ncbi.nlm.nih.gov/pmc/articles/PMC1867957/#b69-ehp0115-000663.

46 Kenneth Bailey, *Tracking Milk Prices and Feed Costs*, Pennsylvania State University, 2007, http://pubs.cas.psu.edu/freepubs/pdfs/ua443.pdf.

47 Sapkota et al., op. cit.

48 Cees de Hann, Henning Steinfeld, and Harvey Blackburn, *Livestock & the Environment: Finding a Balance*.

49 USDA 2007 Census of Agriculture, Table 62, www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_State_Level/Vermont/st50_1_062_062.pdf.

50 Personal communication, Louise Calderwood, *Vermont Feed Dealers and Manufacturers Association*.

51 USDA 2007 Census of Agriculture, Table 62, op. cit.

52 Personal communication, Jennifer Colby, Outreach Coordinator, *Vermont Pasture Network*.

53 Alan K. Betts, Vermont Climate Change Indicators, September 8, 2010, http://alanbetts.com/workspace/uploads/akb-vermontclimateindicatorsv2-1286459191.pdf.

54 Ronald Trostle, *Global Agricultural Supply and Demand: Factors Contributing to the Recent Increase in Food Commodity Prices*, USDA ERS, July 2008, www.ers.usda.gov/Publications/WRS0801/WRS0801.pdf.

55 Trostle, op. cit., page 1.

56 USDA ERS, www.ers.usda.gov/Data/FeedGrains/

57 Trostle, op. cit., page 3.

58 U.S. Department of Energy, Energy Information Administration, www.eia.gov/emeu/steo/pub/contents.html.

59 U.S. Department of Energy, Energy Information Administration, www.eia.gov/countries/.

60 Patrick Canning, Ainsley Charles, Sonya Huang, Karen R. Polenske, and Arnold Waters, *Energy Use in the U.S. Food System*, ERR-94, USDA Economic Research Service (March 2010), www.ers.usda.gov/publications/err94/.

61 USDA ERS, www.ers.usda.gov/Data/FertilizerUse/

62 U.S. General Accounting Office, "Domestic Nitrogen Fertilizer Production Depends on Natural Gas Availability and Prices," www.gao.gov/new.items/d031148.pdf.

63 Trostle, op. cit., page 8.

64 U.S. Department of Energy, Energy Information Administration, www.eia.gov/countries/.

65 Trostle, op. cit., page 12.

66 Ibid., page 5.

67 Ibid., page 21.

68 Ibid., pages 23-24.

69 Ibid., page 18.

70 Figure 3.2.13 includes the total U.S. supply of corn, sorghum, barley, and oats used as feed grain. Corn constitutes the majority of the total grain depicted in Figure 3.2.13. Source: Allen Baker and Heather Lutman, *Feed Year in Review (Domestic): Feed Grain Prices Remained Strong*, USDA Economic Research Service, March 2010, http://usda.mannlib.cornell.edu/usda/current/FDS-yearbook/FDS-yearbook-03-04-2010_Special_Report.pdf, page 2.

71 USDA, *Climate Change and Agriculture in the United States: Effects and Adaptation*, USDA Technical Bulletin 1935. Washington, DC, 2012, page 89, www.usda.gov/oce/climate_change/effects_2012/effects_agriculture.htm.

72 USDA, op. cit., page 62.

73 U.S. Global Change Research Program, Global Climate Change Impacts in the United States, 2009, www.globalchange.gov/images/cir/pdf/National.pdf.

74 Scott Malcolm et al., *Agricultural Adaptation to a Changing Climate: Economic and Environmental Implications Vary by U.S. Region*, USDA Economic Research Service, Economic Research Report No. (ERR-136), July 2012, www.ers.usda.gov/media/848748/err136.pdf.

75 USDA, op. cit., page 91.

76 USDA, op. cit., pages 91-97.

77 http://future.aae.wisc.edu/data/annual_values/by_area/10?tab=prices.

78 Kevin O'Connor, "'End of an Era': Vt. Dairy Farm Count Keeps Falling," *Barre-Montpelier Times Argus*, August 5, 2011.

79 SJH and Company, *Economic Analysis of Agricultural Markets in Vermont: Organic/Grass-fed Dairy and Livestock for Meat*, August 26, 2006. Prepared for the Vermont Agency of Agriculture, Food, and Markets and the Vermont Department of Economic Development.

80 http://nofavt.org/sites/default/files/December%202010%20Statistics.pdf.

81 Ibid.

82 www.ams.usda.gov/AMSv1.0/ams.fetchTemplateData.do?startIndex=1&template=TemplateV&page=FluidMilkSalesDataMonthlyandYeartoDate

83 Northeast Organic Dairy Producers Alliance, www.nodpa.com/payprice_update_031411.shtml.

84 Resource Systems Group, Inc., *"Fair Trade" Milk Market Research Study*, prepared for the Vermont Agency of Agriculture, Food, and Markets, September, 2007.

85 Carolyn Dimitri and Lydia Oberholtzer, *Marketing U.S. Organic Foods: Recent Trends From Farms to Consumers*, USDA Economic Research Service, 2009, page 20, www.ers.usda.gov/Publications/EIB58/EIB58.pdf.

86 Timothy A. Delbridge et al., "Economic Performance of Long-Term Organic and Conventional Cropping Systems in Minnesota," *Agronomy Journal*, 2011, 103(5): 1372-1382.

87 http://nofavt.org/sites/default/files/December%202010%20Statistics.pdf.

88 The Census of Agriculture indicates that cropland used for pasture or grazing decreased 64%, from 131,686 acres in 1997 to 46,686 acres in 2007. During this same period, the amount of land described as permanent pasture or rangeland increased from 86,835 acres in 1997 to 137,165 acres in 2007. The Census of Agriculture defines permanent pasture or rangeland as grazable land (e.g., meadow, prairie, or range consisting of various types of grasses) of variable quality. However, the decrease in cropland acreage devoted to pasture or grazing and the increase in permanent pasture appears to reflect a question order change in the Census of Agriculture. For example, in the 2002 (and earlier years) Census report forms the Cropland Pasture question was included in item 1a. In 2007, it was moved

to item 2c. The Permanent Pasture question was included in item 3 in 2002 (and earlier years), but in 2007 it was moved to item 2a, above Cropland Pasture. Consequently, it is unclear how to read this trend. Personal interview with Ty Kalaus, Deputy Director, New Hampshire Field Office, USDA/NASS, July 2011.

89 Dennis O'Brien, "Cattle Pastures May Improve Soil Quality," *Agricultural Research*, March 2011, page 6, www.ars.usda.gov/is/AR/archive/mar11/soil0311.pdf.

90 http://nofavt.org/sites/default/files/December%202010%20Statistics.pdf.

91 www.uvm.edu/pss/vtcrops/?Page=articles/Mycotoxins.html.

92 Emily J. Stebbins, *Homegrown Feed, Food, & Fuel: The Market Potential of Farm-Scale Oilseed Crop Products in Vermont*, prepared for *Vermont Sustainable Jobs Fund*, February 2008, www.vsjf.org/assets/files/VBI/FFP_Final_Report_2008.pdf, page 24.

93 Texas A&M University, http://forages.tamu.edu/PDF/scs2000_23.pdf, University of Minnesota, www.midwestforage.org/pdf/529.pdf.pdf, University of Kentucky, www.uky.edu/Ag/AnimalSciences/dairy/extension/nut00024.pdf, North, Dakota State University, www.ag.ndsu.edu/news/columns/dairy-focus/dairy-focus-reduce-feed-costs-to-optimize-returns/.

94 Philip H. Howard, "Visualizing Consolidation in the Global Seed Industry: 1996-2008," *Sustainability*, 2009, 1: 1266-1287.

95 Anna Lappé, "The Battle for Biodiversity: Monsanto and Farmers Clash," *The Atlantic*, March 2011, www.theatlantic.com/life/archive/2011/03/the-battle-for-biodiversity-monsanto-and-farmers-clash/73117/.

96 Donald L. Bartlett and James B. Steele, "Monsanto's Harvest of Fear", *Vanity Fair*, May 2008, www.vanityfair.com/politics/features/2008/05/monsanto200805?printable=true&currentPage=all.

97 USDA Economic Research Service, www.ers.usda.gov/Data/BiotechCrops/. Jorge Fernandez-Cornejo and Margriet Caswell, *The First Decade of Genetically Engineered Crops in the United States*, USDA Economic Research Service, April 2006, www.ers.usda.gov/publications/eib11/eib11.pdf.

98 Charles Benbrook, *The Magnitude and Impacts of the Biotech and Organic Seed Price Premium*, *The Organic Center*, December 2009, www.organic-center.org/reportfiles/Seeds_Final_11-30-09.pdf, pages 1 and 7.

99 Lappé, op. cit.

100 Andrew Pollack, "U.S. Approves Genetically Modified Alfalfa," *The New York Times*, January 27, 2011, http://www.nytimes.com/2011/01/28/business/28alfalfa.html.

101 Vermont Legislature, www.leg.state.vt.us/docs/2014/bills/Intro/H-112.pdf.

102 NOFA Vermont, *Press Release: NOFA Vermont Joins Lawsuit Challenging Monsanto's Patents on Genetically Engineered Crops* (March 2011), http://nofavt.org/sites/default/files/PUBPAT%20PR%20march29.pdf.

103 Stephanie Strom, "Major Grocer to Label Foods With Gene-Modified Content," *The New York Times*, March 8, 2013, www.nytimes.com/2013/03/09/business/grocery-chain-to-require-labels-for-genetically-modified-food.html?pagewanted=all&_r=0.

104 USDA, *Climate Change and Agriculture in the United States: Effects and Adaptation*, USDA Technical Bulletin 1935. Washington, DC, 2012, page 141, www.usda.gov/oce/climate_change/effects_2012/effects_agriculture.htm.

105 Chris Boerboom and Micheal Owen, *Facts About Glyphosate-Resistant Weeds*, *Purdue Extension*, http://www.ces.purdue.edu/extmedia/gwc/gwc-1.pdf. William Neuman and Andrew Pollack, "Farmers Cope With Roundup Resistant Weeds," *The New York Times*, May 3, 2010, www.nytimes.com/2010/05/04/business/energy-environment/04weed.html.

106 Benbrook, op. cit.

107 *The Organic and Non-GMO Report*, Volume 11, Issue 5 (May 2011), www.non-gmoreport.com/ArchivesTwo/org&nongmo_may11.pdf.

108 Dimitri and Oberholtzer, op. cit.

109 Delbridge et al., op. cit.

110 National Research Council of the National Academies, *Toward Sustainable Agricultural Systems in the 21st Century* (Washington, DC: The National Academies Press, 2010), 59.

111 Laura Medalie and M. A. Horn, "Estimated Water Withdrawals and Return Flows in Vermont in 2005 and 2020," *U.S. Geological Survey Scientific Investigations Report 2010–5053* (2010), http://pubs.usgs.gov/sir/2010/5053.

112 Neil M. Dubrovsky and Pixie A. Hamilton, *Nutrients in the Nation's Streams and Groundwater: National Findings and Implications*, , U.S. Geological Survey Fact Sheet 2010-3078, http://pubs.usgs.gov/fs/2010/3078/.

113 Lake Champlain Basin Program, Issues in the Basin: Phosphorus Non-Point Sources, www.lcbp.org/Atlas/HTML/is_pnps.htm.

114 Austin Troy et al., "Updating the Lake Champlain Basin Land Use Data to Improve Prediction of Phosphorus Loading," *LCBP Technical Report #54*, May 2007, Page 45, Table 2-11. www.lcbp.org/techreportPDF/54_LULC-Phosphorus_2007.pdf.

115 Stone Environmental, Inc., *Identification of Critical Source Areas of Phosphorus Within the Vermont Sector of the Missisquoi Bay Basin*, Prepared for Lake Champlain Basin Program, December 2011, www.lcbp.org/PDFs/IJC_MBBP/LCBP_CSA_Final_Report.pdf.

116 USDA 2007 Census of Agriculture, www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_State_Level/Vermont/st50_1_044_045.pdf.

117 U.S. Drought Monitor, http://droughtmonitor.unl.edu/monitor.html.

118 U.S. Global Change Research Program, *Northeast*, 2009, www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/regional-climate-change-impacts/northeast.

119 U.S. Environmental Protection Agency, *EPA Takes Step to Improve Lake Champlain Water Quality* (January 2011), http://yosemite.epa.gov/opa/admpress.nsf/0/73DB2705E25A948B85257822006EEF39.

120 Vermont Agency of Natural Resources, Revised Implementation Plan Lake Champlain Phosphorus TMDL (2010), www.leg.state.vt.us/reports/2010ExternalReports/252919.pdf.

121 Travis Greenwalt and Deborah McGrath, "Protecting the City's Water: Designing a Payment for Ecosystem Services Program," *Natural Resources and Environment*, 2009, 24 (1), www.cardnoentrix.com/documents/Greenwalt-Mcgrath.pdf.

122 American Farmland Trust, www.farmland.org/programs/environment/workshops/documents/WhitePaper-AppendixB.pdf.

123 Patrick Canning, Ainsley Charles, Sonya Huang, Karen R. Polenske, and Arnold Waters, "Energy Use in the U.S. Food System," *ERR-94*, U.S. Department of Agriculture, Economic Research Service (March 2010).

124 USDA 1950 Census of Agriculture, www.agcensus.usda.gov/Publications/Historical_Publications/1950/Vol1_New_England/23230735v1p1ch3.pdf.

125 USDA 2007 Census of Agriculture, Table 62 www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_State_Level/Vermont/st50_1_062_062.pdf.

126 USDA 2007 Census of Agriculture, Table 64, www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_State_Level/Vermont/st50_1_064_064.pdf.

127 USDA 2007 Census of Agriculture, Table 48, www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_State_Level/Vermont/vtv1.pdf.

128 Report to House and Senate Committees on Agriculture and Education Related to Large Animal Veterinary Loan Repayment/Incentive Options (2009), www.leg.state.vt.us/reports/2009ExternalReports/251134.pdf.

129 Union of Concerned Scientists, *Vermont: Confronting Climate Change in the Northeast*, www.climatechoices.org/assets/documents/climatechoices/vermont_necia.pdf.

130 Lee Karlsson, "Vermont Climate Change Health Effects Adaptation," Vermont Agency of Natural Resources, May 2011, www.anr.state.vt.us/anr/climatechange/Pubs/VTCCAdaptHealthEffects%20.pdf.

Dorr Farm.

PHOTO CREDIT: Sonya Terjanian

ANALYSIS OF VERMONT'S FOOD SYSTEM

Farm Inputs

Vermont Sustainable Jobs Fund

farm to plate STRATEGIC PLAN

farm to plate NETWORK

VERMONT FOOD SYSTEM ATLAS

Credits

3.2 Farm Inputs was prepared by Scott Sawyer, Kit Perkins, and Doug Hoffer.

Thanks to Ben Waterman, Mike Ghia, Jenn Colby, Rachel Gilker, Tom Stearns, Louise Calderwood, Len Bull, Dave Rogers, and Jake Claro for document reviews.

Joyce Cellars provided the *Intervale Center's* Farms Program vignette.

Carrie Abels provided vignettes for *Maple Wind Farm* and *High Mowing Organic Seeds*.

Diane Reynolds provided the *North Hardwick Dairy* Vignette.

Maps: Dan Erickson, *Advanced Geospatial Systems, LLC*

Copyediting: Patsy Fortney

Layout and Design: Scott Sawyer, Heather Pipino, and Katie-Marie Rutherford, www.katierutherford.com

For more information:

Vermont Sustainable Jobs Fund
www.vtfoodatlas.com
www.vsjf.org
3 Pitkin Court, Suite 301E
Montpelier, VT 05602
info@vsjf.org