How Will Your Farm Cope With A Changing Climate?

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The vast majority of climate scientists know Climate Change is happening and that human activities are a primary cause. What we are experiencing is not just a product of natural forces and not just the typical variations we see from season to season. In fact, food production and distribution are two of the most significant contributing factors, responsible for up to 30% of all emissions connected to the main activities of the economy. And now, this reality is creating moisture stress, damaging fields and infrastructure on and off the farm, compromising animal health, driving up insurance and other costs.

The key question for agriculture is whether we can transform farming systems to drastically reduce the dependence on fossil fuels and shift to crops and livestock that are more resilient to the impacts of a rapidly changing climate and produce the food and fibre society needs. The transformation needed to respond to the effects of climate change will require a major redesign of farming systems. This redesign will be more difficult to undertake the longer a landowner waits to start making changes.

Although many organic farmers think they will be protected from the effects of climate change, and relative to conventional farmers, they may be more resilient, due to their more diversified rotation, the impacts of a rapidly changing climate will be so significant that all farmers will need to reassess their farming system. To illustrate how some farmers are making their farms more resilient, less reliant on fossil fuel use and restoring natural areas, we will look at the farming system changes that the Gilvesy, Budd and Shepard families have made.

Bryan Gilvesy is an award-winning rancher in Norfolk County, recognized for his commitment to environmental improvement on his farm and across Ontario. He converted a tobacco farm on sandy soils to tall grass prairie and warm season grasses that grow easily in a hot, dry climate and have root systems that go deep into the soil, unlike cool season grasses that don't go as deep. He also changed the management of the wooded areas and water courses to enhance biodiversity, including fencing the cattle out of those spaces. The farm is 350 acres and he raises Texas Longhorns on the rough grasses using rotational grazing techniques, baling it to feed his cattle through the winter. The Longhorns live outdoors, require much less management than other breeds, and gain weight well on tall grass, being 30% more efficient converters of rough grasses than most other breeds. He direct markets much of his meat, selling about a third of it to individuals from his farm store, and the rest to some dozen restaurants that focus on local, sustainable, foods. He also minimizes energy use with solar pumps for water and a hybrid delivery van.

His grasslands provide an extensive range of environmental services, including habitat for a wide range of birds, pollinators and other wildlife. The farm sequesters a large amount of carbon, reduces soil erosion, and improves water quality. Brook trout have been re-introduced in a creek that bisects the property. It is much more resilient to climate stress, staying green even in drought conditions.

Texas Longhorns on Tall Grass Prairie: Gilvesy Farm, Norfolk County

Bob and Bev Budd live on an 80-acre property located south of Goderich, a few kilometres inland of Lake Huron. When purchased in 1989, the majority of their property was cash cropped and due to the fact it was situated on glacial beach deposits, erosion from both wind and water was a significant problem. Moisture retention was also a challenge.

Perimeter windbreaks were planted. Areas of blow sand were planted to white pine, spruce and poplar. High slope clay hills were swaled on contours and planted with pine, cedar, soft maple, poplar and black walnut. The remainder of the workable land is used for permanent pasture, hay production, market garden and a mixture of fruit and nut trees. They also have a passive solar home, powered by a small windmill and solar panels.

The landscape has become much more resilient and bio-diversity has increased remarkably. In the early years heavy rainfall produced damaging quantities of runoff from the clay slopes. Now there is virtually no run-off from the property and the landscape's tolerance to drought has improved greatly.

Budd Farm: Central Huron

New Forest Farm: Wisconsin: Formerly in corn, wheat and soybeans, the Shepard family purchased 106 acres in 1995 to grow perennial crops, modelled on the native Oak Savannah forest, to produce food, fiber and fuel while restoring critical ecosystem services. The farm design is informed by permaculture, regenenerative agriculture, the Yeomans' keyline plan , zero emission thinking and carbon sequestration, harvesting from the decay process, and living machines . The motivation was to achieve all these environmental improvements and to be profitable. They have planted over 250,000 trees and shrubs over the last 25 years.

Their primary crops are hazelnuts, sweet chestnuts, walnuts, hickory, pine nuts, apples, pears and cherries. They also grow asparagus and winter squash. They multicrop to maximize production with apples growing under chestnuts and grape vines growing on the chestnuts and hazelnuts. They've found the combination to be the most photosynthetically efficient, with the highest biomass produced for livestock. Products are nuts, cider from the apples (they have their own press), vegetables, and nut oil for biodiesel. They also pasture some cattle, pigs, chickens, turkeys and sheep between the trees.

The Keyline Plan was developed in Australia by P.A. Yeomans, and it uses naturally occurring topographical features and creates small berms and pathways in their fields to distribute water flow and moisture retention, minimize soil erosion, and to build fertility as well. Ponds, swales and berms distribute the rainfall (using gravity) to ensure that the runoff doesn't cause erosion or wet spots in the fields, and to optimize availability for plant growth. Trees and shrubs planted beside the swales are spaced to allow for pasture and other crops. The farm is powered by wind, solar and biodiesel from non-food crops.

New Forest Farm: Wisconsin

These are only three examples of how some farming families have transformed their farming systems.

Fred Kirschenmann, a leading thinker on farming and food systems has identified five key principles that should be considered in the design of more resilient and ecologically sound farming systems:

1. Restore biological health to the soil
2. Restore ecological integrity to the landscape
3. Redesign farms around resilience as opposed to production
4. Redesign farms around bio-synergies
5. Replace control management with adaptive management

You will have to look at what will work for your farming system based upon your landscape, soils and markets.

What's critical to each of these farming systems is the approach they took to developing a more resilient farming system based upon how they have assessed the impacts of increased climate variability that they were experiencing on their farm. While at the same time reducing use of non-renewable fuel and fertilizers, ecological production and restoration of biodiversity. A recent report on climate change and biodiversity suggests that many of our current challenges can be addressed with conservation practices that are manageable and that will help develop more resilience. We will now explore what conservation practices can be incorporated into farming systems to develop more resilience, restore and improve the health of rivers and forests, reduce fossil fuel use and maintain productivity.

Developing more resilient farming systems will be essential to coping with Climate Change because we will not be able to mitigate emissions fast enough to turn the situation around quickly. There is a lag between when emissions are released and their impacts, so even if we stopped emitting greenhouse gases today, we are going to experience growing impacts for many years to come! These impacts will adversely affect agriculture more than any other sector of the economy.

Environment Canada, in a report titled 'Adapting to Climate Variability and Change in Ontario'. points to a greater need to adopt practices in all sectors of the economy that will help to conserve water and protect the health and resiliency of our river systems, prime agricultural land and forests. Some of the major adaptations that are recommended in the report, and can help farmers begin the process of transforming their farming systems, are:

- adopting conservation tillage practices,
- rotating crops that include cover crops,
- converting agricultural land with low moisture retention capacity to other uses,
- planting more wind breaks,shelter belts and hedgerows,
- implementing agro forestry (inter planting trees and crops),
- increasing forest cover in headwater areas, river valleys, flood plains and stream corridors
- reducing runoff so that it will infiltrate the soil
- reducing the loss of soil and nutrients.

The key challenge is to design farming systems so that surface water storage and movement are not unduly compromised by the combination of extreme heat, drought and variable rainfall patterns. Many farms have significant periods of the year with minimal soil cover, inadequate soil organic matter levels, high levels of compaction, and drainage systems that are more likely to take away excess water rather than conserve it. All these conditions are likely to lead to reduced capacity to adapt to periods of too much and too little water. There are many agronomic management strategies proposed for increasing one's capacity to adapt, some of which include cropping systems, conservation tillage, changing seeding and planting dates, changing varieties and keeping stubble higher to trap moisture. Larger landscape management strategies are also critical. Following are a few of the strategies that appear to be most promising.

Cropping systems and conservation tillage

There are a spectrum of cropping system strategies farmers can employ to increase their resilience and flexibility in the face of climate variability. At the more resilient end of the spectrum are complex crop rotations characterized by significant use of green manures, intercrops and legumes, reduced tillage, deep and extensive root masses, high soil organic matter levels, and good soil tilth.

Studies from the U.S. mid-west, examining corn, soybean, and wheat systems reveal that longer rotations involving legumes leave farms better able to withstand drought. Studies also support the idea that it is important to include perennials when possible and it is advisable to choose crops with extensive root systems. An Ontario study following different rotations over a 20-year period also found higher carbon sequestration with rotations involving alfalfa compared to conventional corn and corn-soybean rotations. It appears that certain kinds of crop rotations will make greater contributions to important forms of organic matter than others.

Soil cover

Winter plant cover is critical when there is so little snow on the ground and regular freezing – thawing cycles are the norm. In the absence of such cover, wind and water erosion will probably increase during extreme events. Although pastures may seem protected, good pasture management, to prevent both overgrazing and compaction from animal traffic, will also be essential.

Tillage

To be more resilient in the face of climate variability, tillage operations must strike a balance between organic matter decomposition, weed control and moisture retention. With steady and significant additions of organic matter, tillage is important at key times for accelerating the creation of organic matter fractions that promote aggregation and tilth. Too much tillage, however, will result in the breakdown of soil tilth more rapidly than aggregates can be created and stabilized. It will also dry out the soil, so tillage for weed control must be balanced with cover cropping and mulching.

Cover Crop:

Agro forestry

Forest cover is extremely important for maintaining water cycles, but also has even wider benefits in the climate change story. A Michigan study looking at a range of cropping systems found that two perennial crops (alfalfa and poplars) added more carbon to the soil than any cropping systems. The alfalfa results have been confirmed in an Ontario study as well. In the Michigan study, native plant communities of all stages – early, mid- and late successional forests - had much lower greenhouse gas emissions than conventionally farmed lands; and, in fact, most were net emissions sinks, which speaks both to their mitigation potential and their resilience.

The incorporation of agroforestry techniques into the farming system may provide a solution, by allowing farmers to generate financial benefits in the short to mid-term. Agroforestry is an approach to land use that incorporates trees into farming systems. It allows for the production of trees and crops/animals from the same piece of land, in order to obtain economic, environmental and cultural benefits. Agroforestry has many applications, including windbreak systems, silvopastural systems where trees and animals are integrated, intercropping of trees and plants (e.g., walnuts with wheat, soybeans and hay), integrated riparian management systems to control stream bank erosion, and forest farming.

Shelter belts and hedge rows have long been used to modify microclimates around fields. Properly designed, they reduce evapo-transpiration from plant and soil surfaces. They consequently often result in yield increases relative to conventional practice, while occupying around 7% of the land area. The key is to design 'wind filters' that don't block the wind and create lees, but rather filter it. Deciduous trees may be better because they transpire more moisture into the passing winds than do conifers.

Research at the University of Guelph on Ontario systems has revealed that tree - cereal crop intercropping systems can be managed to reduce competitive interactions and augment complementary ones, resulting in economic benefits to farmers. Nitrogen is transferred to adjacent crops from tree leaf fall, soil organic carbon increases by up to 30% relative to monocultural systems, nitrate loading to streams is reduced by half, and earthworm populations are augmented. In drought years they've found that these tree intercrop systems increase yield 100% compared to conventional cropping systems because the trees help retain ground moisture.

A further variant on this strategy would be to plant trees or other perennial plants within fields, rather than conversion of entire fields or areas. There is some Canadian evidence to show that it is more profitable, cost-effective to set aside marginally productive lands within fields rather than keep them in cropping. Setting aside these areas would reduce GHG emissions, sequester carbon and provide wildlife benefits as well.

New Forest Farm, Wisconsin:

Protecting and restoring riparian zones, headwater areas, river valleys, flood plains and stream corridors

For water management, these areas:

- Play an integral part in the water cycle.
- Slow runoff and reduce local and downstream erosion and flooding.
- Act as natural filters by capturing sediments, neutralizing contaminants and purifying water.
- Recharge groundwater sources for wells.
- Provide water for irrigation, livestock and crop spraying.
- Have plant communities surrounding them that provide a source of hay, help control the spread of salts into crop land, reduce erosion and trap snow in the winter, reduce sedimentation in streams and can lengthen the economic life of reservoirs, canals, and recreational lakes.

Pletch-Scott Farm: East Wawanosh - Windbreaks, Stream Restoration and Riparian Buffer, Storm water Detention Ponds were planted over the last 15 years

Rural Stormwater Management: Slow it Down, Spread it Out, Soak it In!

When intense thunderstorm events occur, you need to ensure that you have pathways in place to both detain and funnel the runoff to an outlet without eroding the soil. A key strategy will be the development of a stormwater management system for the farm. This strategy should identify the pathways and the detention areas (wetlands/stormwater ponds) that runoff will follow from all parts of the farm to where it will empty into a watercourse.

Collecting, detaining and gradually outletting the water from these runoff events will be a central strategy for managing the effects of intense rainfall and or rapid snow melt events. Properly designed grass waterways, storm water detention areas and outlets are essential components of a storm water management plan if farmers are to prevent valuable soil and nutrients from being washed off their farms and into watercourses. This strategy will also reduce the frequency of cleanouts of outlet drains.

Pletch-Scott Farm: Rural Storm Water Management System in Action:

Can you make it pay?

Studies generally suggest that increasing the resiliency of a farm can pay, both short-term and long-term. The key is to find the right set of management changes. For example, an Ontario study suggests that the payoff comes in more diverse rotations rather than in tillage changes. The possibility of shorter-term payoffs relative to long-term ones can be increased with more targeted and integrated approaches, e.g., intercropping trees and crops, or focusing on specific parts of fields rather than entire fields. Since the kinds of adaptation proposed here also help with mitigation, if government programs reward farmers to mitigate, there will be an additional payoff for those implementing adaptation strategies. There will also be substantial savings in clean up costs. If damage from extreme events can be avoided, overall costs will go down significantly.

Although much attention is paid to on-farm energy production (crop-based ethanol and biodiesel), in ecological farming systems there is evidence that only small percentages of a farm should normally be devoted to such energy crops, growing perennials on marginal lands for solid, rather than liquid fuel, production.

Whether your farming system is organic or conventional, you will not be immune to the effects of climate change. You will need to decide what changes you should make to your farming system to cope with an increasingly variable climate. Focus on your experiences of drought and heavy rainfall and imagine the implications of seasons characterized by these two extremes. Is the soil quality on your farm sufficient to provide some buffering of these extremes? Do you manage the water resources on your farm to give you maximum resilience? Are you properly managing your natural features - forested areas, stream corridors, flood plains, river valleys, ponds and watercourses - to protect the quality and quantity of your water supply? Does your livestock management contribute to or detract from your ability to manage under extreme weather? And are farm organizations doing enough to help their members prepare and putting enough pressure on governments to assist with those transitions? Farmers have always talked about the weather. It's time to think about how you will transform your farming system to adapt to a rapidly changing climate, improve the health of our ecosystems and maintain productivity!