DISCUSSION PAPER 6
Environment and Agriculture

Food Secure Canada is a national membership-based organization committed to fighting against hunger and to building a healthy, fair, and ecological food system. Our vision is encapsulated in *Resetting the Table: A People's Food Policy for Canada.*

FOOD SECURE CANADA DISCUSSION PAPERS

The People's Food Policy is based on ten detailed discussion papers. These discussion papers were generated through 350 Kitchen Table Talks, hundreds of policy submissions, dozens of tele-conferences, online discussions, and three national conferences. Over 3500 people participated in their development. These papers cover a breadth of issues and include detailed policy recommendations for rebuilding Canada's broken food system. Unlike *Resetting the Table,* they are not consensus documents and not every member of Food Secure Canada has signed on to every recommendation in them. Rather, they are living documents, intended to inform debate, stimulate discussion and build greater understanding of our food system and how it should be—and must be—fixed.

1) Indigenous Food Sovereignty
2) Food Sovereignty in Rural and Remote Communities
3) Access to Food in Urban Communities
4) Agriculture, Infrastructure and Livelihoods
5) Sustainable Fisheries and Livelihoods for Fishers
6) Environment and Agriculture
7) Science and Technology for Food and Agriculture
8) International Food Policy
9) Healthy and Safe Food for All
10) Food Democracy and Governance

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Environment and Agriculture

EXECUTIVE SUMMARY

A healthy environment is the basis of a resilient and sustainable agro-ecosystem. Agriculture affects and is affected by the natural world, and as such it must work within natural systems. Canadian agricultural systems must build and maintain healthy soil, clean water and air, reduce dependence on fossil fuels, mitigate and adapt to climate change, protect and enhance biodiversity, protect farmland, and reduce waste.

1. Because agriculture affects, and is in turn affected by the natural environment, policy measures must ensure that soil, water, air and biodiversity of the environment is protected for agriculture and that agricultural practices contribute to the ongoing health of the environment. For example, if an industrial practice (such as emitting toxic particulate matter) harms surrounding agricultural land or has deleterious effects on the food it produces, the industry must be required to alter its process so it is safe for agriculture. In turn, if an agricultural practice (such as applying manure at excessive rates) harms the surrounding environment with impacts on its integrity and sustainability, those practices must be altered to ensure that the environment is protected.

2. Agriculture and the global food supply are exceedingly vulnerable to the impacts of climate change. At the same time, ecological agricultural provide significant climate change benefits, through its increased capacity to sequester carbon in to soil, by improved energy efficiency by reducing fossil fuel derived pesticides and synthetic fertilizers and by reductions in emissions of greenhouse gases, particularly nitrous oxide and methane. Therefore, agriculture policy and climate change mitigation policy must actively promote the shift to ecological farming methods.

3. Program, policy and regulatory measures must promote transition to more ecologically sustainable methods of farming and must remove financial and fiscal incentives that support ecologically damaging farming practices. The current safety net programs encourage specialization, concentration and increased scale of production, increasing both environmental costs and the risks of catastrophic

failure. At the same time, farmers who convert to certified organic production shoulder the burden of carrying all the economic risks during their transition period. Policy should provide effective carrots and sticks to promote the uptake of sustainable agriculture.

4. Education is a key to ensuring broad public support for environmental sustainability, so formal and informal methods must be used to promote knowledge and understanding of the ecology of agriculture and the impacts of agriculture on the environment. As food becomes an ever more significant factor in worldwide social stability, the need for the population to have a fuller understanding of food production will be increasingly important. School curricula at every grade level need to incorporate both practical and academic lessons about sustainable agriculture. Community colleges, universities and informal education providers also need to be supported in providing research, training and skill-development to educate the upcoming generation of ecological agriculture producers.

INTRODUCTION

Agriculture *affects* and *is in turn affected by* the natural environment. Sustainable agriculture[1] ensures the ongoing health and resilience of the ecosystem and requires a healthy ecosystem in order to function. Healthy, living soil and clean water and air are the foundation of life. Sustainable agriculture must enhance soil biology and provide for filtration of water in order to maintain these fundamentals for future generations. Additionally, sustainable agricultural systems must minimize fossil fuel use, incorporate renewable energy, reduce greenhouse gas emissions, adapt to climate change impacts, enhance biodiversity, and reduce waste. Finally, sustainable agriculture must internalize the costs associated with agricultural systems so that the full cost of producing food is included in the final price.

The current industrial food system does not maintain healthy ecosystems. It uses inputs (such as energy, fertilizers, pesticides, and water) as though they are of limitless supply and treats the environment as though it is limitless in its ability to absorb waste and pollution. It is crucial that we move away from these linear systems that are increasingly reliant on purchased inputs, dependent on environmentally harmful practices, and that create severe waste problems. Instead, food production must move toward more integrated cyclical systems. We must shift to sustainable uses of renewable resources, and production based on society's needs. We must work with, not against, nature's nutrient and water cycles.

The global food system relies on relatively cheap energy and a plentiful supply of nitrogen, potassium and phosphorus fertilizers in order to produce cheap ingredients for highly processed and packaged food. Energy for agriculture is mostly derived from fossil fuels while synthetic nitrogen fertilizer accounts for one third of the entire agricultural energy budget. These underpinnings of the global food system, as well as adequate clean water, are limited in supply.

Our challenge is to build a vibrant, healthy, resilient and sustainable food system before cheap food and cheap oil disappear. Positive environmental outcomes are inextricably linked to sustainable livelihoods. Family farmers are stewards of the land. If farmers are financially stable and are able to live and work in strong and connected communities, they can invest more easily in their farms and make good long-term decisions that contribute to both their own health and the health of their community and environment. Ecological agriculture can also feed a growing population. According to the United Nations Special Rapporteur on the Right to Food,[2] a widespread global shift to ecological agriculture would not only be environmentally superior to continuing an extensive reliance on chemical fertilizers, but it would double food production in key areas of hunger in less than ten years, strengthening resilience to respond to climate change. The environmental policy recommendations presented in this discussion paper are intertwined with the recommendations presented in other papers, in particular Discussion Paper # 4: Agriculture, Infrastructure and Sustainable Livelihoods.

This chapter is about respecting natural systems and adapting our approaches to agriculture in order to mirror these systems. It's about long term thinking, planning and acting. It's about producing food today and generations from now. In short, we want a country rich with healthy soil, clean air and water that can support resilient agricultural communities by producing healthy, local food for all citizens now and in future generations.

SOIL

Healthy soil is the basis of all sustainable agricultural systems. Soil is made up of minerals and rock, air, water, organic matter; and living organisms, including bacteria, fungi, protozoa, nematodes, and arthropods and larger organisms, such as earthworms. "Soil quality is more than the sustained capability of a soil to accept, store, and recycle water, nutrients, and energy. Soil quality is the capacity of soil to sustain *ecological productivity*, maintain *environmental quality*, and *promote plant and animal health*."[3] Healthy soil has good composition and good structure or "tilth," which allows for better root penetration and easier uptake of water and nutrients, as well as resistance to soil erosion. The components of healthy soil comprise a vibrant and diverse soil food web or ecosystem, which is required for the decomposition of organic matter and release of nutrients into the soil. Poor quality soil is vulnerable to compaction and has a reduced ability to retain water and nutrients. Poor soils are readily eroded by wind and water, resulting in millions of tonnes of soil being lost each year. Soil on poorly managed land is susceptible to erosion, and each year 10 million hectares of farmland is destroyed due to topsoil loss.[4] Under conventional agriculture practices, average soil erosion rates per year are estimated to be greater than 1 mm of soil. This is 10 to 100 times greater than the rate of natural soil formation and erosion rates.[5]

In order to maintain healthy soil, which in turn provides a plant filter to maintain clean water, it is necessary to keep soil covered as much as possible. Techniques to achieve soil cover include planting cover crops in rotations when cash crops are not growing, underseeding legumes with annual cereals and mulching row crops and fruit trees. Plant breeding to develop perennial cereal crops offers another promising way to produce annual yields without annual tilling. Other techniques are no tillage, reduced tillage or conservation tillage techniques. These are designed to use fewer passes than conventional tillage, reducing compaction, and leaving most of the crop residue on the surface. No till and reduced tillage techniques that depend heavily on pesticides are detrimental to soil biota necessary for healthy and resilient soil. Organic matter is also crucial to maintaining healthy soil and is added in green manures (crops, usually nitrogen-fixing legumes, which are planted with the intention of tilling them into the soil), brown (farmyard) manures and crop residues. Organic matter feeds soil microbes that bind soil particles into good soil structure, improving both water holding capacity and aeration of the soil and leading to improved plant growth and less runoff of water. Mixed livestock-crop farming practices facilitate this process. Healthy soil includes many living creatures that are essential for decomposing biological materials into available plant nutrients. Well-nurtured soil contributes to healthy plant growth while pesticides, particularly in excess, inhibit soil life.

In order to protect soils from erosion, hillsides and ravines should not be cultivated, and to the greatest extent possible, forested land should be maintained. In order to protect the soil, land where soils are sandy, rocky, hilly, and saline and thus not suitable for cultivation should be put into pasture for raising livestock.

Healthy soil also has potential to mitigate climate change. Since 1850, approximately 10% of the carbon released into the atmosphere has come from the soil as a result of inappropriate farming practices.[6] Fortunately, this process can be reversed. By using organic methods, minimum tillage, and more mixed use and grass-based farming methods, soil carbon stores can be increased up to the point at which a soil carbon equilibrium is reached. Increasing the carbon (or organic matter) in soils has the added benefit of improving soil tilth, making it more resilient to drought, floods and other erratic weather that will accompany climate change.

It is important to ensure that soil inputs contribute to the ongoing health of the soil. In some jurisdictions, biosolids are being used as a soil amendment. While biosolids have the potential to represent a beneficial re-use of a waste product, they are the product of municipal wastewater systems and are comprised of inputs that include human waste, toxic industrial chemicals, personal care products, and pharmaceuticals. There continue to be many questions about the eventual fate of the various organic and inorganic contaminants and pathogens contained within biosolids from sewage treatment plants and at this stage their role in agriculture remains questionable. Until such time as biosolids can be guaranteed free of harmful constituents, the precautionary principle should be applied and such material must kept off of food-producing land.

In order to build and maintain healthy soil, government policies need to:

- Provide research, extension and funding to transition farms to such sustainable practices as maintaining and increasing soil organic matter and soil biota through the use of nitrogen-fixing legumes in crop rotations and the application of compost.
- Recognize the public value of good soil stewardship practices through fiscal and program measures that encourage farmers to maintain grass or forest cover on hillsides, sandy land, riparian areas, wetlands, and shorelines.
- Encourage pastured livestock production as a way to provide economic return to farmland where soil is unsuitable for cultivation due to erosion risks.
- Regulate the removal and sale of topsoil from agricultural land, allowing it only in the case where the soil will be used to increase food production.
- Stop the use of biosolids from municipal sewage on agricultural lands until the health and environmental effects of these biosolids (which include human waste and residues from personal care products, pharmaceuticals, heavy metals and industrial chemicals) can be segregated from the waste stream or reduced to a level that would represent an acceptable risk.

WATER

Water cycles continuously throughout our environment. Water evaporates from oceans, lakes, rivers and other sources, condenses into clouds, and returns to the earth through precipitation. Water is taken up by plant roots and is released through transpiration from the leaves. When water, in the form of rain or snow, returns to the land, it soaks into the soil or flows over the ground as surface run-off. Water not used by growing plants enters rivers and streams to returns to lakes and oceans, or seeps into the soil to replenish underground aquifers. Clean water is essential for farmers, wildlife and all other users. Agriculture must be practiced in such a way as to protect and maintain a clean water supply both on the surface and underground.

The degrading of our water systems by industrial agriculture happens in a number of ways. The over-application of manure from intensive livestock production can cause nutrient pollution of surface and groundwater, leading to eutrophication of lakes and rivers and contamination of drinking water by nutrients, antibiotic resistant bacteria, and growth hormones.[7] Additionally, run-off from manure and chemical fertilizers creates algal blooms, which, as they decompose, deplete oxygen resources of nearby bodies of water, resulting in aquatic dead zones. Pesticide and herbicide run-off and leaching can lead to water pollution. Veterinary antibiotics have also been detected in surface and groundwaters due to run-off and leaching from nearby livestock operations. The effects of veterinary pharmaceuticals on aquatic life and wetlands is relatively unknown, though the feminization of fish due to endocrine disrupting hormones has been observed.[8] Irrigation can diminish water resources if used excessively. Environmental impacts associated with irrigation include the depletion of underground aquifers and increased soil salinity.

It is unknown how climate change will affect water systems. The loss of climatic predictability means agriculture needs to become more resilient in the face of droughts, floods, intense storms, dry or too-full irrigation reservoirs, and other potential outcomes.

In order to maintain clean water, we must:

- Provide research, extension and funding to transition farms to sustainable practices that will improve soil tilth. Soil that is better able to absorb and retain water will provide both flood and drought resistance.
- Maintain wetlands, riparian zones, shorelines, pastures, and forested areas in order to provide natural filtration of water that improves water quality and provides more constant water supply due to the natural slow release processes.
- Maintain natural areas that support biodiversity, including large and small predator species. This will result in fewer pest problems and thus reduce risks of pesticide contamination of water.
- Reduce toxic chemical pollution by encouraging sustainable agricultural practices. Require detailed third party verified and publicly available accounting of pesticide, manure and fertilizer use, and set enforceable limits for allowable use.
- Enact legislation to control the location, size and animal density in confined animal feeding operations in order to improve animal health and decrease the use of antibiotics in livestock production. Require prescriptions for use of veterinary antibiotics. Publish information on the quantities and types of antibiotics used within a given watershed.
- Ensure that activities in rural areas protect watersheds. The promotion of sustainable agriculture should be seen as an investment in watershed protection. Promotion of the consumption of locally-produced food through watershed agricultural councils can help consumers connect the quality of their water with their support of watershed land stewards' businesses.[9]

AIR

The air we breathe is roughly composed of 78% nitrogen, 20% oxygen, 0.9% inert argon, 0.039% (or 390 parts per million) carbon dioxide and various amounts of water vapour. Present in trace amounts are about 13 additional gases, many of which are considered pollutants. Our air supplies oxygen, which is essential for respiration and growth of nearly every organism. Plants, algae and plankton are able to fix (transform) atmospheric carbon dioxide into organic carbon. Certain plants with special root zone rhizobial bacteria associations are able to fix atmospheric nitrogen into organic nitrogen, a building block for proteins. Fixing inorganic nitrogen and carbon into organic forms is essential to the carbon and nitrogen cycles necessary for life and which provide nutrition for all the organisms in our terrestrial ecosystem.

Air impurities or pollutants are produced through manufacturing, transportation, energy generation, mining, as well as many agricultural activities. The wind can carry air pollutants substantial distances from their point of origin. Acute and/or chronic exposures to these gases have negative impacts on organism health in our environment. Air pollution (such as nitrogen oxides, ammonia, sulphur oxides, ozone, fine and inhalable particles) causes chronic breathing problems (asthma, allergies) leading to premature deaths in humans and other animals and significantly reduced yield in plants.[10] Moreover, increases in the concentration of greenhouse gases, primarily methane, carbon dioxide, and nitrous oxide, in the atmosphere trap long-wave radiation and are responsible for increasing global temperatures leading to climate instability.

Leaves of plants are damaged and yields reduced when plants are exposed to ozone, sulphur dioxide, fluoride and nitrogen oxide gases. These pollutants are mainly emitted from non-farm sources. Agricultural activities that generate the above pollutants, as well as ammonia and particulate matter, are also injurious to plants.[11] Although acute toxicity levels may seldom be present, the chronic exposure to low doses reduces growth, causing plants to be more vulnerable to other stresses.[12] Furthermore the additive or synergistic effects of several pollutants on plant growth and yield have yet to be fully explored.[13]

Agricultural practices can have profound effects on air quality. Soil microbes change nitrogen into nitrous oxide gas under moist conditions. Nitrous oxide is a powerful greenhouse gas that contributes to the depletion of ozone in the stratosphere.[14] Major sources of nitrous oxide are synthetic nitrogen fertilizers and manures. However, high soil carbon levels help to mitigate nitrous oxide formation.[15]

Many pesticides are applied by aerial spraying. During application, pesticides can drift onto non-target organisms, killing them or causing devastating injuries. Volatilization (evaporation into the air) of pesticides not only contaminates the air but also can contaminate surface and ground water through deposition in rainwater. Pesticide drift and volatilization are sources of long-term contamination that can accumulate and harm wildlife (especially bees), forests, wetland and grasslands.

Intensive livestock practices can negatively affect air quality by emitting methane, ammonia, hydrogen sulphide, particulate matter, volatile organic compounds and odours. Sources of these emissions come from animal housing, manure storage and application to the land.[16] The odoriferous nature of manure is mainly due to hydrogen sulphide, ammonia and airborne particulates produced during manure application to the land.[17] Odours are intensified as a result of chemicals produced when stored manure decomposes in the absence of oxygen.

Intensive livestock production is a major contributor of ammonia.[18] Long-term exposure in the 25-ppm range can cause pneumonia, skin and eye irritations. Hydrogen sulphide is a very toxic gas with a rotten-egg odour. Eye irritations occur at 10 ppb and death at 700 ppb. Hydrogen sulphide is heavier than air and will accumulate in underground pits and areas where ventilation is poor. Particulates (both coarse and fine) are generated from animals, feed, bedding material and manure.[19] As well, volatile ammonia can form aerosol nitrate, an additional particulate. Lung diseases from chronic exposure to particulates are bronchitis, farmer's lung disease, asthma and organic dust toxic syndrome.[20] Improving the air quality in livestock agriculture improves the health, welfare and production of animals, improves the health and safety of workers, and reduces emissions to the outside environment.[21]

Strong odours, particularly from intensive swine and poultry operations, can have a strong negative impact on the general well-being of those in the surrounding area and downwind.[22] Technologies to remediate air quality in and around these operations are expensive and not always reliable. Reducing the scale of intensive livestock operations would reduce these air pollutants.

To preserve and improve air quality and reduce pollution, policies must:

- Eliminate the practice of aerial spraying of pesticides and herbicides because of the high risk of spray drift.
- In light of the risk of harm to wildlife, soil, forest, wetland and grassland biodiversity that the rising use of pesticides pose, provide research, extension and funding to promote transition of farms to integrated pest management and non-toxic forms of weed, pest and disease control, with the goal of phasing out the use of toxic insecticides, herbicides and fungicides.
- Enact legislation to control the location, size and animal density in confined animal feedlots in order to decrease ammonia and greenhouse gas production.
- Phase out liquid manure storage and replace with dry composting.

- Ammonia and hydrogen sulphide emissions from livestock operations should be regulated in the same manner as such emissions from other industries.

ENERGY

Our current agricultural system is based on cheap fossil fuels. It is energy intensive and highly dependent on nonrenewable energy. Consider the following uses of nonrenewable energy from farm to plate. Intensive energy use at the production stage includes the manufacturing of nitrogen fertilizers from natural gas using the Huber-Bosch process, the mining of potash, the manufacturing of petroleum-based pesticides and herbicides, and the manufacturing and use of tractors and other farm equipment. The manufacturing of synthetic fertilizers and pesticides is one of the most energy-intensive parts of the agricultural production system, comprising 40% of all energy used in agriculture.[23]

Beyond the farm gate, energy is used in the transport of inputs from source to farm, and then of food from field to processor to market, with additional energy used for refrigeration, processing, packaging, and waste disposal. It is also important to recognize the effects of long distance transport on other stages of the food system. For example, food travelling long distances often requires freezing or refrigeration. It requires more packaging and may see more spoilage. As the distance our food travels continues to increase, we must rapidly rethink our energy usage in the face of escalating oil prices, peak oil, and the climate crisis.

Biofuels are still being touted as part of the solution to peak oil. However, studies[24] have found that large scale biofuel production has a weak to negative return on energy investment. When the energy use of the fertilizers, pesticides, farm equipment and processing of monocultured crops is measured against the energy outputs, using food land for biofuel production is not appropriate. Additionally, one must also consider the impact of the loss of organic matter on agricultural ecosystems, the loss of valuable food producing land, and the human rights issues in developing nations where foodland is being converted to biofuel production. While there is some potential for the small scale application of biofuels, these uses should be for increased on-farm self sufficiency and not for fueling our car culture.

Determining energy hot spots in the food system can help us pinpoint areas in which we can reduce our consumption. In order to redesign our agricultural systems to be less energy intensive, we must:

- Provide research, extension and funding for transition of farms to local sources of nitrogen such as nitrogen-fixing legume crops and animal manures from sustainable livestock production.

- Encourage smaller scale agriculture in order to reduce the need for larger machinery and energy-intensive infrastructure.
- Create incentives for renewable energy opportunities on farms, such as solar and wind power.
- Create incentives to encourage the use of waste heat from non-agricultural activities to heat greenhouses.
- Promote grass-fed/pastured livestock production, reducing the need to grow energy-intensive feed crops, transport feed long distances, energy-intensive housing, and manure handling technology.
- Localize the food system to reduce energy required for transportation, as well as associated energy use due to refrigeration and freezing, packaging, processing and waste disposal.
- Promote low-energy alternative food storage and preservation methods, such as root cellar cold-storage, drying, canning, pickling, and lacto-fermentation (e.g. sauerkraut).

CLIMATE CHANGE

Agriculture both contributes to and is affected by climate change. Estimates of the contribution of the food chain in developed countries to greenhouse gas emissions range from 15 to 20%[25] and as high as 1/3 of GHG emissions globally.[26] For agricultural systems, it is important to note that not just carbon dioxide emissions must be considered, but also the global warming potential of methane and nitrous oxide. Methane is produced through enteric fermentation and anaerobic decomposition of manure, while nitrous oxide is emitted from soils that are susceptible to denitrification caused by large applications of nitrogen fertilizer. Methane and nitrous oxide have global warming potentials 25 and 298 times that of carbon dioxide, respectively.[27]

Loss of soil organic matter contributes to carbon emissions. As noted above, since 1850 approximately 10% of CO_2 emissions can be attributed to soil carbon losses.[28] According to the Intergovernmental Panel on Climate Change, soil carbon sequestration represents 89% of agriculture's GHG mitigation potential.[29]

Every aspect of agriculture is increasingly affected by climate change and farmers must now learn how to adapt to these changes. As the earth warms and weather patterns become more unpredictable, farmers will be contending with more floods and droughts. Frost dates will change, and mid-winter thaws will likely become more frequent. Previously available agricultural land may no longer be suitable for farming. While the climate will be warmer, this does not mean that agriculture will simply shift northward. The agriculture belt in Canada is bordered in the north by the boreal forest. The forest soil is acidic, poor in the nutrients required by food crops, and in many cases there is only rock or peat bog. The soils of the boreal forests are not suitable for agriculture. Thus, the land available for agriculture will decrease. Additionally, while it has been suggested that elevated CO_2 levels could increase plant yield by stimulated photosynthesis, several studies have found that this is not the case, as increased CO_2 or carbon will only increase growth if it is the limiting nutrient to growth.[30]

Climate change will affect the crops, crop varieties, and livestock breeds that are suitable for agricultural production, especially those that may not adapt to new environments. We will likely see more pests as well as new pests that could not previously survive in the Canadian climate, or that would have died during colder winters. We are also likely to see more disruption in transportation due to infrastructure damage by storms and floods, an important consideration for a global market dependent on international trade to buy and sell both farm inputs and farm products.

In face of such uncertainty, the best strategy is resilience and redundancy. Our current industrial agriculture model has become increasingly specialized, concentrated, and centralized. These characteristics make industrial agriculture brittle and therefore very vulnerable to the impact of climate change.

To encourage climate change mitigation, we must:

- Set farm, processing and transportation targets to reduce GHG emissions in the food system, including impacts from methane and nitrous oxide produced by intensive livestock operations and due to the use of synthetic nitrogen fertilizers.
- Provide research, extension and funding for renewable energy opportunities on farms through feed-in tariffs and support for building renewable energy infrastructure.
- Provide research, extension and funding to develop low energy and renewable energy technologies and management practices for on-farm use.
- Provide research, extension and funding to encourage farming practices that assist in building organic matter in soils, and thus increasing carbon sequestration.
- Encourage dry manure composting methods that limit methane and greenhouse gas production.

To increase our resilience in the face of climate uncertainty, we must:

- Provide research, extension and funding for increasing localization of food production, storage and processing.
- Provide research, extension and funding for farmers to increase biodiversity and resilience in order to adapt to changing weather, pests and crops.
- Protect and promote the use of heritage breeds of livestock and heritage seed varieties that embody diverse traits that may be needed as the climate changes.

- Provide research, extension and funding for improving soil tilth, so it is more drought and flood resistant. Vulnerable soils and hillsides should be put into pasture or forest in order to reduce flood and drought impacts.

BIODIVERSITY

Biodiversity is essential in the maintenance of healthy, resilient agricultural ecosystems. Sustainable agriculture should be seen as part of the ecosystem. Forested lands, wetlands, and other natural areas provide habitat for wildlife. These natural areas support beneficial insects, pollinators, birds, and other animals. When the environment is polluted or habitat is destroyed, these life forms can no longer be supported. Amphibians, in particular, are susceptible to agricultural chemicals and die out when habitat is polluted. Bird populations decline when their insect prey is killed off and/or poisoned by insecticides. Some honeybee colonies have experienced mortality in Canada due to direct poisoning from pesticides. Also of concern is the prolonged sub-lethal exposure from pesticides on bee health, reduction in genetic diversity of bees, and lack of diverse pasture for bee forage.[31]

Mixed farming, with a wide variety of breeds and crops, helps to develop a farming system that is more resilient and interdependent. Increased on-farm biodiversity reduces risks of disease or pest outbreaks. Monocultures -- where only one breed or cultivar is grown -- are vulnerable, as one pest or disease is capable of wiping out an entire crop. Monocultures are more heavily reliant on pesticides and herbicides to control pests and diseases, whereas sustainable agricultural systems foster diverse systems that mimic and are in balance with the natural environment.

Diversity is also important at the genetic level. It is important to not only have a variety of species, but also diversity amongst individual plants and animals. Heirloom seeds, open pollinated varieties, and heritage breeds of animals have greater diversity in their genetics. This means that a range of traits are available that allow the species to adapt to unpredictable future challenges. Industrial agriculture, on the other hand, relies heavily on a small number of crop cultivars and animal breed lines selected for their performance under industrial conditions rather than traits such as resiliency, flavour, nutrition, or adaptability. Complex crop rotation systems provide biodiversity over time. By changing the crop in a given field or plot such that the same type of plant is never grown two seasons in a row, disease and insect problems are minimized so that chemical herbicides and insecticides can be avoided.

Genetic engineering is discussed in greater detail in Discussion Paper #7: Science and Technology for Food and Agriculture; however, it bears mentioning that genetic engineering narrows and restricts crop biodiversity by promoting the use of monocultures. The environmental impacts of genetic engineering are largely unknown and, unlike other types of pollution, when genes are released into the natural environment, they cannot be contained. GMOs increase the uniformity of monocropping and have a high dependency on pesticide application. Routine herbicide spraying eliminates plants that would provide some habitat for other species, and also damages soil microorganisms. Glyphosate is damaging to aquatic ecosystems when sprayed on or near streams, lakes and wetlands.[32] Glyphosate resistance is one of the primary traits of GMO crops in Canada. The other primary GMO trait is pest resistance due to the inclusion of the Bt toxin in the plant tissue. Bt kills certain types of insect pests; however, it is not specific and kills related non-pest insects as well. There is evidence that decomposing GMO Bt crop residues have a detrimental effect on soil microorganisms and nearby aquatic ecosystems.[33]

In order to sustain biodiversity in our agricultural systems, we need to:

- Provide research, extension and funding to promote biodiversity at all levels, from soil organisms to crops to animals, through sustainable practices including crop rotations and the growing of heritage breeds and heirloom seeds.
- Promote weed and pest management practices that do not require the use of broad spectrum herbicides, insecticides, and fungicides.
- Given the increase in incidence of colony collapse in bee populations, place tight regulations on pesticides known to harm bee populations.
- Develop policies to protect and maintain natural areas, including wetlands, riparian zones, forested lands, and ecologically sensitive lands, both on and beyond farms. Protect watercourses and ensure corridors for wildlife migration.
- Promote predator-friendly livestock production and compensate farmers who lose animals due to predators. Examples of this could include the use of guard dogs in place of shooting coyotes and calving/lambing in late spring when the young are less vulnerable to predation.
- Provide research, extension and funding to protect the genetic diversity of local seed supplies and encourage farmers to select, clean and save superior seed for their farm conditions.
- End the practice of seed patenting. This exercise of monopoly rights by patent holders exerts undue pressure on farmers to reduce the genetic diversity of their seed supply.
- Protect non-GMO crops from incursion of GMO crops and provide compensation when documented contamination takes place.

FARMLAND PROTECTION

Although Canada is a vast country with diverse landscapes, a mere 6% of the land is suitable for agriculture and only 0.5% is designated as Class 1 farmland.[34] As of 2001, 3% of Canada's dependable farmland (Classes 1-3) and 7.5% of our best farmland (Class 1) had been converted to urban areas.[35] Some of the best agricultural land is located near large cities, such as Toronto and Vancouver, and as a result, it is increasingly being lost to encroachment by residential and commercial development. More than 56% of Canada's Class 1 land is found in Ontario, primarily southern Ontario, which is heavily urbanized. When agricultural land is part of the speculative real estate market, the land is often priced out of the reach of farmers, particularly new entrants, creating additional barriers for those considering a career in agriculture. Once agricultural land has been developed for residential and commercial purposes, it is permanently gone, and with it, its potential for producing food and feeding our citizens.

Climate change may reduce the amount of land that can be farmed, as dependable farmland may become increasingly vulnerable to flooding and drought conditions. For example, in Nova Scotia, 10% of the most actively farmed land, some of the highest quality farmland in the province, is dykeland.[36] As ocean levels rise and hurricanes intensify, these farms may end up under water. As noted above, moving north is not a solution as soils of the boreal forest are not suitable for agriculture.

As global financial markets become increasingly unstable, and as the expectation of rising food prices increases, investors, corporations, and foreign entities looking for safe investments are buying farmland in Canada and around the world. This takes farmland (foodland!) out of the hands of farmers and local communities and puts it under the control of multinational and foreign companies and foreign governments, which may be halfway around the world. Non-farm ownership has environmental implications, as these entities will be looking for short-term profits or maximum production, rather than managing the land for long-term sustainability. This issue of non-farmer land ownership is explored in greater detail in Discussion Paper # 4.

In order to retain our capacity to produce our own food, we must:

- Use Canada Land Inventory Classification to identify land that needs to be protected for food crops and use zoning regulations to preserve those lands from urban sprawl, commercial development, and the impacts of speculation that prices land out of the reach of farmers.
- Develop regulations and measures, such as Agricultural Land Conservation easements, Farmland Trusts, and Greenbelts to protect farmland.
- Take appropriate measures to strengthen and maintain dykes and barrier defenses to protect farmland, farm structures and communities, as sea levels rise and flooding increases in many coastal areas of Canada.

- Provide research, extension and funding to support farmers and food processors as they work to achieve profitability while farming sustainably. Many issues with regard to farmland conservation are due to lack of profitable food growing in Canada when imported food is less expensive. For many farmers, selling their land to a developer is the only way they can retire with dignity, while new farmers cannot compete with developers to purchase farmland. (See Discussion Paper # 4: Agriculture and Sustainable Livelihoods for concrete policy recommendations)

WASTE

Waste is a symptom of the linear model of agricultural systems. A truly sustainable agricultural system would generate minimal waste, as all outputs would be used as inputs elsewhere in the system.

Waste represents a significant use of energy and cause of pollution in the food system. Studies from the UK and Sweden have found that approximately one quarter of all food entering institutional and household distribution systems is lost.[37] In Canada, this number could be even higher. A recent study found that approximately 40% of the food we produce is wasted, with half of that waste occurring at the household level.[38] All this food waste represents inputs that did not need to be used. Thus energy, pesticides, herbicides, fuel and machinery were used to produce food that was never eaten. Additionally, in areas without composting facilities, this food waste is not returned to the soil and adds to landfills where it decomposes anaerobically, producing methane gas and accelerating climate change.

Another form of waste is the production of food products we do not need. As much as a third of total energy inputs in the food system are related to items of little nutritional value, such as snacks, sweets and carbonated beverages.[39] Others have suggested that reducing junk food consumption would be the single most effective strategy for reducing energy consumption in the food system, even more effective than reducing food transport, improvements in food processing, or production technology improvements.[40]

Waste is also generated through inappropriate scale. Consider the manure produced in intensive livestock operations. It has become a waste disposal problem due to the scale of the farms and the quantities of manure concentrated in a small space. A valuable fertilizer has become a pollutant. Phosphorus is a non-renewable resource and an essential component of all living cells. When it runs off the land due to over-application of manure, it not only causes degradation of aquatic and marine ecosystems, but it ends up on the bottom of the ocean, forever lost to agriculture.

To create a food system that minimizes waste, we must:

- Provide education for everyone associated with the food system, from beginning to end, about the value of decreasing waste and of composting what remains.
- Ensure that acceptable food from wholesale, retail, and consumer waste is composted and returned to farms for use on agricultural land.
- Strictly control manure management to prevent phosphorus depletion in the overall agriculture system.
- Enact product stewardship regulations and incentives that would make manufacturers responsible for packaging, encouraging reuse, and recycling containers and materials as much as possible.
- Continue to increase awareness that over-consumption of food results in poor health outcomes, requires production of more food, and generates more waste.

CONCLUSION

To attain our goal of food sovereignty in Canada, we must build and maintain a sustainable agriculture system. This system must work with the natural environment and recognize that a healthy environment is the basis of a resilient agro-ecosystem.

Canadian food and agriculture policies must be designed to maintain and protect healthy soil, clean water, and clean air, and support farmers in maintaining or shifting their practices to support ecological sustainability. We must reduce toxic chemical pollution and intensive livestock operations, as well as increase biodiversity by encouraging sustainable agricultural practices

As energy becomes increasingly expensive, Canadian food and agriculture policies must encourage increased energy efficiency, renewable energy, and carbon sequestration. In the face of climate change, policies must promote increased resilience and localization of the food system.

Biodiversity, of both ecosystems and genetics, is essential in the maintenance of healthy, resilient agricultural ecosystems. Canadian policies must support increased diversity.

There is a finite amount of farmland in Canada. Canadian agricultural policies must protect the most dependable farmland so that future generations have the capacity to feed themselves. Policies must protect farmland from urban sprawl, commercial development, and the impacts of speculation. Policies must also take into account climate change and the unknown effects it will have on our food producing land.

Finally, Canadian food and agriculture policies must reduce waste and encourage closed loop systems, as waste represents significant use of energy and cause of pollution in the food system and a decline in long-term food production capacity.

In conclusion, if we put the necessary policies into action, we will create a country with rich soil, clean air, and clean water that will to support resilient agricultural communities and produce healthy, local food for all citizens now and in future generations.

ENDNOTES

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Food Secure Canada is based on three interlocking commitments:

Zero Hunger: All people at all times must be able to acquire, in a dignified manner, adequate quantity and quality of culturally and personally acceptable food. This is essential to the health of our population, and requires cooperation among many different sectors, including housing, social policy, transportation, agriculture, education, and community, cultural, voluntary and charitable groups, and businesses.

A Sustainable Food System: Food in Canada must be produced, harvested (including fishing and other wild food harvest), processed, distributed and consumed in a manner which maintains and enhances the quality of land, air and water for future generations, and in which people are able to earn a living wage in a safe and healthy working environment by harvesting, growing, producing, processing, handling, retailing and serving food.

Healthy and Safe Food: Safe and nourishing foods must be readily at hand (and less nourishing ones restricted); food (including wild foods) must not be contaminated with pathogens or industrial chemicals; and no novel food can be allowed to enter the environment or food chain without rigorous independent testing and the existence of an on-going tracking and surveillance system, to ensure its safety for human consumption.