Big Farms, Small Farms

Strategies in Sustainable Agriculture to Fit All Sizes

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Foreword

So, what more is there to say about sustainable agriculture that hasn't already been said before? Starting back in 1987 with the Brundtland Report, "Our Common Future", the dialogue on sustainability has followed with two Earth Summits in Rio de Janeiro and Johannesburg, all leading to the creation of Agenda 21 and the Millennium Development Goals. A search of Amazon.com reveals 651 books on file with at least a mention of 'sustainable agriculture'; Google the phrase and 11.5 million web sites making reference to the term instantly appear in 0.28 seconds.

Much has been said about sustainability over the last twenty years but achievement remains elusive. The human population continues to increase even though 800 million people go to bed hungry every night. Each decade, human ingenuity matches the swelling populace with more food production, and emerging technologies continue to deny Malthus his prophecy. Only political ineptitude keeps the poor hungry, and no social system has yet figured out how to say that 6 billion people is enough.

But how much longer can we continue to produce more and more and more, and at what cost? Modern agriculture – the 'green revolution' – is only 50 years young and when the application of its technologies and techniques is unconsidered and unchecked, the result has been soil erosion, chemical contamination, water depletion and environmental degradation. In short, unfettered development chased by unlimited production is…unsustainable.

The term 'sustainability', however, is loaded with vagueness and ripe with contradictions. Much of the documentation refers to the term in an absolute context as if there exists a pre-ordained state, leading to rhetoric and open-ended statements. The daily reality of farming is closer to a relative paradigm – how far can a farmer push the envelope of sustainability and still earn a decent living while producing food enough for 6…8…10 billion people. Taking a relative approach, however, means that sustainability lives on a scale of which everyone has their own interpretation. The current debate over biotechnology epitomizes the relative framework of sustainability, with proponents saying it's a 'sustainable' technology and opponents claiming it will lead to unsustainable food production. Even when it comes to the closest mimicry of a 'natural' state that agriculture can re-produce – a beef cow and its calf out on pasture – the unsustainable flags start to fly because by some calculations livestock production consumes too many resources.

Despite the muddy and swirling waters that surround the sustainability question, one thing is clear: if we are to continue to produce enough safe and nutritious food for 10 billion people without depleting the natural resources of this earth, then progress in terms of sustainability – however it's defined and applied – must be achieved, and quickly. Within this context, the Agricultural Institute of Canada (AIC) has, through this paper, acted to inform the discussion and debate on the issue of sustaining agriculture in Canada with the aim of identifying strategies to support sustainable agriculture in this country.

Successful strategies are composed of three major elements: information, planning and resources. The objective of this paper is to provide the AIC with the information necessary for its members, and the agricultural community throughout Canada, to be able to move forward on the second two components.

As noted at the beginning of this foreword, there already exists a wealth of information on sustainable agriculture; the challenge of this paper has been to extract from this mass of knowledge the essential elements that can be used to elaborate the strategies that will result in action for a more sustainable agriculture in Canada. And actions always speak louder than words alone.

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Executive Summary

Much has been said about sustainability over the last twenty years but achievement remains elusive. Each decade, human ingenuity matches the swelling world population with more food production but at a cost of water depletion and environmental degradation that is unsustainable. Within this context, the Agricultural Institute of Canada (AIC) has, through this paper, acted to inform the discussion and debate on the issue of sustaining agriculture in Canada. The aim is to identify strategies to support sustainable agriculture in this country that will result in an agri-food sector that is economically viable, producing safe and nutritious food, supporting vibrant rural communities and conserving or enhancing natural resources and the environment.

This is a particular challenge for agriculture because it faces the double burden of continuing to expand production for a hungry world while trying to maintain the sustainability of food production. Progress in achieving sustainability has also suffered from the vast differences of interpretation in the application of sustainable practices. This paper has avoided getting stuck on the meaning of "healthy" versus "safe and nutritious", and to focus on sustainability in terms of goals, objectives and indicators – what is it that should be targeted and how will it be achieved – as a basis for undertaking strategic actions in support of agricultural sustainability in Canada.

Overall Strategies

Big Farms, Small Farms

Given the continuing trend towards larger farms – 2% of farms now produce 35% of the food in Canada – this paper proposes that strategies for sustainable agriculture must include both small and large farms. Small farms may meet the non-economic criteria for sustainability but they have not been able to remain economically viable in the modern context; with substantial and increasing divergence between the different sizes of farms, there needs to be differentiated treatment of the two principle types of agricultural operations.

Paying for Sustainability

Canadian agricultural policy and programs need to integrate ecological parameters into income support measures (similar to the revised Common Agricultural Policy for the European Union.) These also need to go further than just eco-compliance and provide income assistance through environmental enhancement programs where of all of society benefit from the results such as protecting wetlands. Other suggested measures for supporting sustainability are:

- A consumer levy on food to provide farmers with a stabilized and equitable income to enable greater adoption rates for sustainable practices.
- Greater exploitation of biomass for energy, both for off-farm fuel products (ethanol, biodiesel) and on-farm energy substitution (electricity from manure.)

Targeted Actions

Safe and Nutritious Food

Although there is considerable effort being made with regard to food safety regulations and systems (traceability, HACCP, etc.), there are some larger questions which require strategic approaches in terms of food safety and nutrition.

- Trust – The creation of an independent food authority along the lines of a commissioner's office to provide an arm's length review of the scientific and regulatory issues related to food safety would be a big step towards re-building consumer trust.
- Transparency – The approval process for agri-food technologies is not as transparent as it could be and should be addressed through improved processes that support peer review and independent verification of research findings.
- Understanding – there is substantial confusion surrounding food issues in the public domain, and there is a need for a national centre with a specific focus on communications and education related to issues in the agri-food sector.

- Traceability – the capacity to track food back to its point of origin risks undermining one of the important tenants of sustainability – small farms – through burdensome regulations and paperwork. Elements of practicality are required in these systems which respond to farm size.
- Nutrition – utilization of modern information technology could be better applied to provide consumers with detailed nutritional information.
- MPI – minimal process interference could become an indicator of sustainability by showing just how far evolved a particular food product is from its natural state, including the use of crop protection materials, processing changes and additions, and packaging and distribution.
- Future foods – The 'disassembly' of whole foods into constituent parts is now beginning to move forward into the molecular realm. Such capacity has huge implications for questions of sustainability and requires discussion and debate before the products appear on supermarket shelves.

Vibrant Rural Communities

There is an exodus from Canada's rural communities, in particular farming ones. Rather than looking at strategies to only increase the number of small farms, this paper proposes approaches that look at ways in which agriculture can make a contribution to the vibrancy of rural communities, big farm or small.

- Owner/operator – local ownership of farms, regardless of farm structure, should be encouraged to ensure greater socio-economic commitment to the local community by larger farms.
- Value Added – the presence of local post-production processing and/or distribution facilities creates employment and economic development opportunities, and should be encouraged.
- Strategic Alliances – the notion of exchange and/or co-operation between farmers in order to provide greater critical mass in terms of production and processing capacity need to be formalized and expanded in order to maintain farm numbers while providing benefits from economies of scale.
- Farm succession – intergenerational transfers must be better facilitated if there is going to be a next generation of farmers in Canada.
- Fiscal – both federal and provincial governments have progressively removed many of the fiscal incentives that made the 'cash poor, paper rich' nature of farming viable. Rejuvenated fiscal strategies would be welcome support for encouraging young farmers.
- Non-farming farmers – new programs are needed to facilitate partial farm ownership or share cropping as further incentive for re-engagement of non-farmers in agriculture and, therefore, rural communities.
- Immigration – Few immigrants choose to settle in rural communities. Some possibilities to encourage immigration into rural communities are more flexible provisions for immigrant professionals to be able to work in rural areas, allowances for overseas seasonal workers to become landed immigrants, and development of social structures to assist new arrivals, such as community-owned cooperative housing, to settle in rural areas.

Conservation of Resources and Environment

Much attention has been paid to the environmental impact of agriculture in the last 20 years, and, as a consequence, a variety of policies, programs, and regulations have been developed – such as water protection policies, environmental farm plans and nutrient management plans. Most have targeted containment (pollution reduction) or focused on management practices. The five major aspects in this regard and their targeted results are:

- Livestock facilities – All facilities should be leakage free with tolerable but minimal odour and dust.
- Nutrient management – Application of nutrients to meet crop needs while maintaining optimal crop yields and soil fertility, and to minimize the risk of nutrient run-off and leaching.
- Soil erosion – Soil erosion is reduced to a level where soil productivity can be maintained for the foreseeable future, and its impact on water quality in permanent watercourses does not prevent the water from meeting current standards for maximal usage.

- Energy efficiency – The farm should generate true carbon credits, and the energy efficiencies achieved are at least such that if the harvested biomass from a farm was to be converted into ethanol, the amount of energy in the ethanol would exceed the energy expenditure used for the production, transport and treatment of the raw biomass.
- Biodiversity – Wetlands, highly sensitive lands, forested lands that are inadequate for agriculture should be protected, and watercourses should be targeted as corridors for both wildlife shelter and restored as routes for animal migration

Other strategic elements that should be considered in minimizing environmental risks and conserving natural resources:

- Watershed management – management by watershed objectives enables the participation of all interested stakeholders, the establishment of benchmarks and the measurement of site-specific improvements.
- Windbreaks – soil erosion is a major pathway by which nutrients and other pollutants reach watercourses. Further improvement can be achieved through the establishment of windbreaks which have the added benefit of diversifying habitat.
- Energy – higher fossil fuel prices present potential opportunities for farmers to enhance local production by displacing imported food that becomes more expensive to transport, and the generation of energy from biomass sources for on-farm use and sales to energy providers.

Research and Extension

Progression in agricultural sustainability requires systems information – knowledge – rather than just new applied technologies, and this aspect is threatened by the decline and/or transformation of the research and extension network which warrants new approaches.

- Research levy – A levy on commodities will be necessary to inject new funds into research and extension on sustainable agricultural practices.
- Producer-operated extension structures – New structures are required to ensure that extension services are available to all farmers on an unconditional basis.
- Information technologies – Some farms are still on party lines and cannot use a fax; there needs to be the creation of programs and provisions that allow the comprehensive uptake of advances in information technologies in rural areas.

Incentives, Regulations and Indicators

The imposition of a regulatory framework regarding sustainable agriculture is likely to further accelerate the trend towards bigger farms, for which there needs to be strategic responses.

- Variable regulations – Agri-environmental regulations need to be modulated to reflect the particular situation of individual farms and support variable applicability (on a farm-by-farm basis.)
- More management – environmental management aspects have to be integrated in conjunction with the regulatory framework. The movement toward individual environmental farm plans is an example of one such strategy.
- Incentives – While regulations set the framework, incentives are the positive reinforcement, and the identification of opportunities whereby farmers can be compensated for providing a service would greatly assist in the incorporation of sustainable practices.
- Indicators – A considerable amount of work has already been done on identifying what the indicators should be, the next step needs to be to work out what should be benchmarked, how is that to be carried out, and what is the level of change to be achieved?

Introduction

The purpose of this paper, as defined by the Agricultural Institute of Canada (AIC), is to inform the discussion and debate on the issue of sustaining agriculture in Canada. This has been carried out through a comprehensive review of scientific research and credible literature, and includes background information on sustainable agriculture and an exploration of the various issues pertaining to sustainability.

This has been carried out within the definition of sustainable agriculture as determined by AIC (for the purposes of this discussion paper):

> *The application of husbandry experience and scientific knowledge of natural processes to create agriculture and agri-food systems that are economically viable and meet society's need for safe and nutritious food and vibrant rural communities, while conserving or enhancing natural resources and the environment.*

This definition is *grosso mondo*, consistent with most descriptions of sustainable agriculture given that it addresses the major elements that have an impact in this area – the environmental, social and economic aspects that inter-relate with agri-food activities. The reference to husbandry experience and scientific knowledge is, of course, particular to AIC's membership being that they are directly involved with food production, and the organization's role in providing information on science-based solutions regarding environmental sustainability, food safety and food sufficiency.

Background

Despite the fact that the basics of farming function pretty much the same as they have since humans began to collect seeds from harvest to re-plant the following year, and to domesticate animals for the purposes of planned food production, agriculture has changed significantly in the way it functions over the last 100 years. Agriculture has changed due to the introduction of the combustion engine and electricity for power, the advent of synthetic fertilizers and crop protection materials, and the non-stop arrival of new technologies. From hydraulics to artificial insemination to genetically engineered crops, changes have been significant. The corn stalk still grows upright in the field, but nothing about the way it grows and how it is harvested and processed has been left untouched by the 'green revolution'.

Agriculture, previously considered more of a socio-cultural component of human society, has rapidly developed, along with the processing of food, to become commoditized, industrialized and globalized within the last 50 years. In developed nations, and increasingly in developing nations such as Brazil which is now a major commodity exporter, agriculture has become a significant part of the modern economy; in Canada in 2002, the bio-food sector contributed $113 billion, or 12% of GDP and over half of the sector's vitality depends on exports outside the region of production (interprovincial and international)[1]; in 2004, agri-food exports amounted to $24 billion, shipments growing at a rate of more than 10% annually.[2] The changes have brought considerable increases in productivity for a hungry world, and greatly minimized the risks that farmers have to face in bringing in a crop.

Like all industrialized sectors, the benefits have also produced negative impacts, in particular the 'footprint' that farming has left on the ecology that provides the basic components to produce food: soil degradation, contaminated and depleted water sources, poor air quality and reduced biodiversity. The human ecology has also been impacted with a tremendous drop in farm numbers, an on-going exodus from rural areas and poor economic and working conditions for those engaged and employed in the sector. The capacity of human-created technologies and processes has extracted from nature many benefits, but at the same time has become overpowering, particularly in the shadow of unrelenting population growth. Mother Earth may have been able to absorb uncontrolled expansion and exploitation if there were just a billion people, but as world population reached and passed three and four and five billions of people, the evidence became clear: the human presence on earth, unless it changed, was becoming unsustainable.

Thus the emergence of the term 'sustainable development', and, as applied to farming, sustainable agriculture. In essence, how can human society continue to feed itself without destroying the environment, contaminating the food that comes from the natural landscape, and rendering the surrounding communities uninhabitable? "If civilization is to survive, it must live on the interest, not the capital of nature. Ecological

markers suggest that in the early 1960s, humans were using about 70 per cent of nature's yearly output; by the early 1980s, we'd reached 100 per cent; and in 1999, we were at 125 per cent. Such numbers may be imprecise, but their trend is clear – they mark the road to bankruptcy."[3]

The response to such predictions has been a rapid evolution of thinking and planning related to agricultural production, moving from awareness of the need for change into research, education, policy development, strategies for implementation and ultimately, action itself. Whole movements have emerged around issues of sustainability in human affairs – sustainable energy, sustainable transportation, even sustainable tourism. Only agriculture carries with it a double burden: we can use less energy for heating by insulating our homes better, we can improve air quality by using mass transit systems more effectively, we can reduce the ever-growing ecological footprint of tourism by staying at home more often. But we still have to eat everyday, and make sure that there is enough food for the additional 6 billion people that are expected to fill this planet in the next century. Agriculture is different as it faces the double challenge of continuing to expand production while trying to maintain its sustainability.

What is Agricultural Sustainability?

Different definitions of sustainability – and there are many – generally revolve around the core elements described at the beginning of this paper: economic viability, safe food, vibrant rural communities and environmental conservation. Sustainability is, however, in the eye of the beholder, and very much related to not just the choice of words used in the description but also their interpretation. One definition maintains that to "be sustainable, human activity, as well as the means to carry it out, must be capable of being continued indefinitely" (NFU, p. 21). Other common descriptions often utilized are "long-term", "foreseeable future" and, in the case of the definition used in this paper, there is no reference to timeline at all.

But rather than getting stuck on the meaning of "healthy" versus "safe and nutritious", the examination of sustainability is better viewed in terms of goals, objectives and indicators – what are we aiming for, how will this be achieved and, most importantly, how will we know we've arrived (or more appropriate to the context of sustainability, how far along the journey have we traveled.) The goals and objectives have been set (see box), and much work has been done on indicators.[4] The real challenge is implementation, potential strategies for action which are presented later in this paper.

Elements of agriculture and rural system sustainability[5]

Agronomic Sustainability	▸ the ability of the land to maintain productivity of food and fiber output for the foreseeable future;
Micro-economic Sustainability	▸ the ability of farms to remain economically viable and as the basic economic and social production unit
Social Sustainability	▸ the ability of rural communities to retain their demographic and socio-economic functions on a relatively independent basis
Macro-economic Sustainability	▸ the ability of national production systems to supply domestic markets and to compete in foreign markets
Ecological Sustainability	▸ the ability of life support systems to maintain the quality of the environment while contributing to other sustainability objectives.

Exploration of Issues and Conflicts in Sustainability

Following is a brief description of the key issues (adapted in part from Agriculture and Agri-Food Canada, Sustainable Development Strategy and the University of California)[6] and dichotomies related to sustainability in agriculture.

Water Quality and Use

Nutrients

Nutrients are applied to crops in the form of chemical fertilizers or manure. Used sustainably, these inputs help maintain soil health and increase productivity and economic returns. However, applied in excess or under the wrong conditions, they may contribute to the pollution of surface water and groundwater, negatively affect yields, and waste farm resources. Some excess nutrients, such as nitrates, can pose a human health risk when concentration levels in drinking water exceed guidelines.

Pathogens

Pathogens are disease-causing agents, such as bacteria or viruses. Where pathogen concentrations from agricultural outputs (such as manure run-off into water systems) exceed drinking water guidelines for surface water or groundwater, negative effects on human health may result.

Pesticides

Controlling pests and diseases is fundamental to the production of safe, high-quality, and abundant agricultural products for Canadians. Pesticide residues can make their way into water systems, where they may pose a threat to human health and local ecosystems.

Water Conservation

The sustainable use of water requires that withdrawal rates from water sources not exceed recharge rates or compromise other water uses. On a national level, agriculture uses about nine per cent of the water withdrawn in Canada, mainly to grow crops, water livestock, clean farm buildings and equipment, and meet domestic needs. Although agriculture returns less than 30 percent of the water it uses to its source, a much higher percentage is returned indirectly to the environment.

Air Quality

Particulate Emissions

Farms emit particulate matter as primary particles (most commonly dust from soil erosion and cultivation, and smoke from burning crop residue) and secondary particles (formed in the air from gases emitted by agriculture, such as ammonia). Exposure to particulate matter may have adverse effects on ecosystems and human health.

Odours

Farm odours can cause significant conflict between farmers and neighbouring communities. In some areas such conflicts have given rise to municipal action to control the siting of intensive livestock operations.

Greenhouse Gas Emissions

About 10 per cent of Canada's human-produced greenhouse gas emissions come from agricultural production, excluding the use of fossil fuels or the emissions from fertilizer production. The main greenhouse gases emitted by agricultural activities are nitrous oxide, from fertilizer and animal manure, and methane, from cattle and livestock manure. Carbon dioxide is also emitted from soils and energy combustion. However, agriculture also has the ability to remove carbon dioxide from the atmosphere through cultivation practices which reduce disturbance to soil and enhance the build-up of organic carbon in the soils. Greenhouse gas emissions contribute to climate change.

Soil

Soil Erosion

Soil erosion is the redistribution of soil in the landscape by agents such as wind, water, and tillage. The effects of soil erosion on crop quality and yields can be substantial. Erosion may also negatively affect off-farm air and water quality, as well as wildlife habitat.

Soil Organic Matter

Loss of soil organic matter leads to the depletion of soil organic carbon. This results in the breakdown of soil structure, greater vulnerability of the soil to erosion, and reduced fertility. These factors lead to reductions in yield and sustainability of the soil resource. Increased decomposition of soil organic matter contributes to rising levels of atmospheric carbon dioxide, a greenhouse gas implicated in climate change.

Livestock

Intensive Operations

The consolidation of farming units has resulted in the growth of intensive livestock operations (ILO) which can house thousands of animal units in one location. This has resulted in increases in 'nuisance' activities such as noise, dust and odours, as well as concerns related to water contamination from manure storage and spreading. The emergence of ILOs has lead to much heavier regulation of farming activities and the development of regulatory and management tools such as environmental farm and nutrient management plans.

Feed Consumption

Modern livestock production depends heavily on the consumption of high energy grains and protein oilseeds. There are concerns that this is an inefficient way of producing food calories, and that direct consumption of grains by humans would help alleviate food shortages in other parts of the world and promote a healthier diet based on less meat consumption. Livestock producers maintain that much of the feed used for livestock production is not as suitable for human consumption and modern genetics have made livestock into much more efficient converters of feed grains in meat protein.

Animal Welfare

Many of the intensively raised livestock are confined in housing that severely limits their space and ability to move around, as well as access to the outside. This has raised ethical questions about the treatment of animals even within their short lifespan, and revisions to livestock housing and welfare codes have been on-going.

Energy

Fossil Fuels for Food

Modern agriculture has become a significant consumer of fossil fuel based inputs, from synthetic fertilizers to pesticides. Some estimates peg the caloric ratio of energy consumption to food produced at more than eight to one, a rate that is unsustainable in the long term and contributing to higher food costs as energy prices rise. Minimum tillage, low-input and organic farming methods are increasing in use as ways to address the question of energy dependence.

Equipment

Agricultural production operations run on diesel fuel and electricity, with relative increases as mechanization and production intensity also increase. Farms are experimenting with bio-fuels and electricity generation from manure and other renewable sources (wind, solar.)

Biodiversity

Habitat Availability

Loss and alteration of habitat are the leading causes of depletion of the earth's wildlife species, and biodiversity. Conversion of natural land to agriculture has contributed to declining wildlife habitat. However, agriculture offers better habitat than many other land uses by humans, such as urban development.

Species at Risk

The protection of threatened and endangered species is a priority issue both within Canada and internationally. As of May 2000, the Committee on the Status of Endangered Wildlife in Canada determined that 12 Canadian species are extinct and an additional 341 species are at risk. These numbers do not reflect the status of the many invertebrates, micro-organisms, and lower plants that have not yet been evaluated. Many of these species are important agents in the regulation of the ecological processes that underpin sustainable agriculture.

Impact of Wildlife

Wildlife on farmland offer advantages, such as pollination, predation of crop and livestock pests, aesthetic appeal, hunting, and fishing. They also pose some disadvantages, such as reduced crop yield, livestock kills, and damage to buildings.

Income Risks

Forces of Nature

Extreme natural events such as drought, hail, and insect population explosions can have a significant impact on farmers' income. For example, back-to-back droughts on the Prairies in 2001 and 2002 slowed production growth for some crops with value-added potential and created uncertainty for potential investors in processing plants. Droughts and flooding (Manitoba 2005) have driven home the importance of sustainable farming practices and income stabilization programs.

Politics of International Trade

Protectionist agriculture policies in other countries, such as trade-distorting domestic support and export subsidies, remain an impediment to expanding world agricultural and agri-food trade. For example, the US Farm Bill and European Union agricultural policies stimulate production and put downward pressure on commodity prices, affecting the competitiveness of Canadian exports in these markets.

Variations in Markets

Markets are not immune to price swings. Producers must cope with changes in commodity prices and market preferences, which are often difficult to predict.

Food Safety

Food Safety

Food safety is a basic requirement for a modern food system. Surveys show that food safety is a key consideration for Canadians who are demanding greater assurances about the food they eat. Recent high-profile incidents involving Bovine Spongiform Ecephalopathy (BSE) in Europe and Canada, dioxin contamination in Europe, and *E. coli* 0157:H7 in hamburger and unpasteurized juice in North America underline the importance of food safety. Such incidents have notable economic and social consequences, causing significant monetary loss for the sector, and, in some cases posing serious health risks.

Rapidly Evolving Consumer Preferences

Greater public concern about food safety issues is raising awareness in the sector of the need to adopt common industry standards at the farm and processor levels. As well, consumer interest in how agricultural products are produced, including potential environmental impacts such as pesticides, antibiotics and biotechnology, is growing. This interest is creating new market opportunities for agricultural products produced in environmentally friendly ways, such as organic and reduced-pesticide production.

Threat of Exotic Pests and Fast-moving Diseases

Outbreaks of diseases or pathogens within the food production and processing chain were once isolated in small areas. Today's intensive farming and the greater movement of goods and people have made such threats much more difficult to contain. As a result, outbreaks—whether arising from natural causes or bio-terrorism—can spread throughout a country and around the world in a remarkably short time.

Rural Development

Fewer But Larger Farms

Canadians who make up the agriculture and agri-food sector reside mainly in Canada's rural communities. Although, over time, there has been a trend towards significantly larger farms, 98 per cent of all farms are still family-owned and-operated.

Demographics

According to the 2001 Census, the job of running the farm in Canada is increasingly falling to fewer and older farmers. Farm operators also have a median age much higher than the comparable labour force population of self-employed workers. Although reductions in the total number of farmers may reflect increased productivity in the sector, a lack of younger workers entering the field may cause labour shortages in the future.

Employment
Many rural communities have seen their populations falter as employment opportunities decline. This also has an impact on social infrastructure and the capacity of rural communities to remain viable.

Dichotomies

Given the context of modern civilization, sustainability is not an easy concept to tackle at the best of times. It evokes notions of greater responsibility for the world which we inhabit, more discipline in how we exploit its resources and the exercise of better judgment in how we apply the distinctive characteristic of *homo sapiens* – the acquisition and use of knowledge. Sustainability with regards to agriculture is even more complex because of its cultural connections to food, the socio-political dynamic of rural decline and the double-duty of feeding the world while conserving the environment. Mass tourism is a relatively new human activity that is stamping its footprint across the world, but there are some pretty straightforward remedies that are impeded not by a lack of viable options but mostly by the tourists overwhelming desire to have a good time come what may. Agriculture doesn't have the same margin of maneuver.

Sustainable agriculture, aside from dealing with the basic approaches of sustainability along the lines of 'reduce, re-use, recycle', also has to resolve a number of dichotomies fundamental to any approach that might be taken to achieve greater levels of sustainability. Left unsettled, these conflicts will, at best, be a hindrance to any substantial progress in this regard, and, at worst, mire the sector in a never-ending debate. It is instructive to note that in 2004 the New Zealand Parliamentary Commissioner for the Environment published a large study on intensive farming and the environment. In early 2005, follow-up workshops with regional agricultural communities were conducted and the evaluations from over 500 participants clearly displayed the divide when it comes to sustainability in agriculture: just over one half agreed that farming was mostly sustainable but that some issues needed to be addressed, and just under one half agreed that farming is mostly unsustainable and change is required at all levels.[7]

Following is a brief description of the important dichotomies related to sustainability in Canadian agriculture. Many of the points raised are touched upon in more detail in other sections of the paper.

Science and Technology
Science and technology have quite clearly helped get us into this mess – who knew that those very effective and efficient pellets of fertilizer would also kill fish when leached out of the soil – and some believe that science and technology will get us out of it. Amongst several issues in this regard, biotechnology is prominent. Proponents assert that genetically engineered crops and livestock can increase productivity while reducing the need for inputs, thus making agricultural production more sustainable. Opponents contend that biotechnology goes beyond the bounds of acceptable genetic improvement through 'natural' methods of breeding, as well as posing unacceptable risks to the environment and human health and food safety. There are also issues of control (patents and technology agreements), as well as corporate concentration. Half the farming world has readily embraced this new technology, while the other half is battling hard to keep it out; humans have rarely said "no" to technology before, and on what basis do we decide one way or the other, if at all?

Risk/benefit Versus the Precautionary Principle
The foundation of all applications of scientific knowledge is the risk/benefit analysis: what are the risks and to what extent, and what are the benefits and do they outweigh the risks? If the risks are minimal and manageable, and the benefits are substantial and demonstrable, science says that the product or process is safe and useable. The precautionary principle, an outcome of the debates around sustainability, changes the emphasis on the question: if the risks are unknown or unquantifiable, then even if there are benefits, caution should be applied until the risks are known or have been quantified.[8] The apparent absence of risk gives the green light under the risk/benefit scenario; the inability to determine risk (as one would determine benefits) and therefore definitively pronounce there is none gives the red light under the precautionary principle. The applied use of molecular technologies, potentially very beneficial to agriculture, may come to a stop unless this difference of assessment is remedied.

Safe Versus Unsafe

Probably the most complex issue within the discussion of sustainability is whether food, as produced in the modern context, is safe or not. Along the lines of biotechnology, there are two camps each claiming that science is on their side, with consumers sitting in the middle saddled with a "once burned, twice shy kind of caution" (Miller, 2001, p. 105). Are there pesticide and antibiotic residues in food; is it safe to eat foods containing genetically-engineered materials, and what is a safe level anyway? There is a huge volume of data that suggests food is safe as produced using modern practices and technology, and yet there are claims that this is not so. Many of these come from specific instances of environmental contamination, for example a pesticide spill, and from invocation of the precautionary principle – bacteria exposed to antibiotics could become resistant, therefore antibiotics should not be used in food production. Even though systems have been instituted to ensure food safety, there are still many questions to be debated related to the parameters of these systems (what is safe in the first place?)

Animal Versus Vegetable

Livestock have been an integral part of farming since the beginning of human civilization, and their capacity to consume plant matter otherwise inedible for humans and transform the material into highly nutritious food and fiber could arguably be claimed to be one of the key factors in the establishment of modern civilization. The place of livestock on the pedestal of human society is no more, especially in the developed world where the easy adaptability to intensive production methods has begun to result in livestock being treated as a scourge rather than a resource. Surpluses of manure, odours and consumption of high-energy grains have earned the sector a bad name. On the other hand, manure from livestock is a very valuable fertilizing resource, and meat production can provide better levels of nutrition for the malnourished. In a sector that has become very intensified, what are the factors of sustainability in livestock production?

Intensive Versus Extensive

Until the modern era, much of agriculture was extensive, and until the advent of modern technologies all civilizations that engaged in intensive production without regard to basic agronomic principles failed not only in producing food but also contributed to the collapse of the civilizations themselves.[9] Today, with virtually all the available agricultural land already under cultivation, and any remaining areas of the planet likely to be fragile or marginal, there are few options other than to intensify production in order to produce yet more food; intensification can lead to environmental problems, such as salinity from irrigation, which runs counter to the tenets of sustainability. Extensive production alone cannot meet the growing food requirements of the human population and would demand more farm land than there is available. When and where is it appropriate to follow one production path or the other?

Economics Versus Culture

Even in this time of fast food outlets, eating food is an essential element of human culture. Loaded with tradition and blessed with emotion, the culture of food is frequently raised as an element of sustainability.[10] Conversely, the human population has not only embraced but actively sought a secure and cheap source of foodstuffs, driving the commoditization and commercialization of food. Food production is now an integral part of the global economy with freight car loads of grain being treated in the same manner as containers full of widgets. Is modern, commoditized agri-food production now a part of our culture as well?

One Planet Versus Many Worlds

The evolution of human society is one of concentration and consolidation: single cities bigger than entire nations, nation-blocks occupying large segments of continents (EU), regions becoming one global economy. The world is headed economically and structurally in one direction, sustainability calls for more emphasis on local production. Can these two seemingly opposite forces co-exist within the parameters of sustainability?

Rural Versus Urban

The farming population, once prevalent in rural areas, has diminished to the extent that even in regions where agriculture is predominant, farmers and their families average less than 15% of the rural population, often well below 10%.[11] The urban population knows less and less about how food is produced, and very often seems to care little beyond the cost/quality assessment that every item in the grocery receives when being considered for purchase: what am I getting and how much will it cost? Urban expansion is continually eating up prime farm land that surrounds cities and, once the urban perimeter has become established, town folk want to know nothing about the nuisances of farming practices.

Structural Evolution of Farming in Canada

Many of the issues related to sustainable agriculture have been attributed, in part, to the intensification of agriculture exhibited through the increasing use of technology, higher rates of capitalization and consolidation of farming units. In effect, farms have become bigger, investing more in capital expenditures and adopting technology on a continuous – some would even argue – on an addictive basis.

This structural evolution is mostly characterized throughout the reviewed literature on sustainable agriculture as 'big is bad, small is beautiful'[12], an assessment reached mostly on the basis that larger farms employing intensive production practices have been chiefly responsible for the consequences described in the introduction (environmental degradation, etc.). Invariably, proponents of sustainability portray the benefits of small farms as the best way to attain increased levels of sustainability in agriculture.[13]

There is some truth to this description, but not necessarily the whole truth. The increasing size of farms and the adoption of modern chemical and other technologies have resulted in environmental problems and social dislocations. Small farms respond to many of the criteria elaborated as necessary to achieve sustainability, while the legacy of larger farm units often makes it difficult to see them in the same light. Smaller-sized, family farms (defined in this paper using the threshold of less than $100,000 in gross sales) are touted as the route to sustainability and, if only government policies, markets and regulations were more favorable, these farms would be viable.[14]

The difficulty of this paradigm, however, is that the reality is very much different. Farming in Canada is headed the other way as a greater percentage of the remaining farms are increasing in size because under current economic parameters, it's the only way to stay in business.[15] If the trend continues – and the certain impact in this regard of BSE on farm exits has not yet been registered in the databases – then there will be at a minimum 10% fewer farmers every five years, meaning that in twenty years there will be 35% fewer farmers than today. In addition, given that 30% of today's farmers are producing 70% of the food[16], and 2% are producing 35%[17], a much higher proportion of the remaining farmers in twenty years are going to be classified as *large* farms (defined in this paper using the threshold of at least $500,000 in gross sales.)

While large farms are usually portrayed as pushing small farms out, it is also a case of picking up the pieces after farmers operating smaller units decide to quit. The reasons are quite clear – small farmers grow tired of hard, physical labour that pays so little that they must hold at least a part-time job off the farm in order to earn a decent salary. The benefits of operating a small family farm are quite clearly related to family heritage, lifestyle and other social factors, but outside of particular niche markets, they are not economical in the current context.[18]

And this is not a new trend. Dave McIntosh, in "When the work's all done this fall – the settling of the land"[19], extracted from the National Archives of Canada a treasure trove of anecdotes, letters, and memoirs relating to the early rural development of Canada. On numerous occasions he records instances where the farmers were eager to get away from the back-breaking labour of farming and move onto greener pastures, or encouraged family members to work as domestic or manufacturing labour for the cash wages. The initial increase in the number of farmers in Canada did not come so much from the off-spring of farmers becoming farmers (French-speaking Quebec being an exception) but from a continual stream of non-farming immigrants seeking a better life; once the mass emigrations to rural Canada ceased in the early part of the 20th Century, so the decline in farm numbers begins.[20] Today, in 21st Century rural Canada, there are very few people lining up to become farmers, and most of those who could inherit a farm are choosing not to do so as is evident from the continuing exit rate from the farm sector. Small may be beautiful, but not at the going price.

Rather than speak of only small farms, this paper proposes that strategies for sustainable agriculture in Canada include both small and large farms. This is a practical approach derived from the following assessment:

- Small farmers are exiting the sector at an increasing rate each census period, a trend that will not likely subside given the current income situation for Canadian farmers[21] and the aging farm population without comparable numbers indicating a willingness and capacity to take over as the next generation;

- Continuing reductions in federal and provincial government programs and services that would be essential to maintaining smaller farms (i.e. extension), as well as policies that actually encourage small farmers to do something else – politely referred to as "renewal" in the terminology of Agriculture & Agri-Food Canada's "Sustainable Development Strategy."[22]
- Macro-economic trends that point towards continued decreases in farm gate prices[23], continued increases in productivity through applications of new technologies and the continued opening of world markets and global trade in food commodities – all parameters that mitigate against the maintenance of smaller farms.

Regardless of what an individual believes should be changed at the World Trade Organization (WTO), in the structure and operations of transnational corporations, and about the introduction of new technologies such as genetically engineered organisms, these are factors already in play and likely to be so at least in the medium term (15-20 years). Any changes – and there will be some – are more likely to come about through political action, but the predictability and extent of that change (related to impacts on sustainability) are anybody's guess. In the meantime, developing and implementing strategies leading towards greater sustainability through the 'application of husbandry experience and scientific knowledge of natural processes' for all components of Canadian agriculture seems to be a far more pragmatic and productive approach.

Again, in all the reviewed literature, a singular treatment was accorded to the subject of agricultural sustainability – one size of analysis and suggested action fits all types of farms. Given that there are substantial and increasing differences between the different sizes of farms, there needs to be differentiated treatment of the two principle types of farms that, regardless of the subdivisions of categorization, are beginning to dominate the farming landscape: "operators who run large-scale businesses and operators who treat farming as a secondary income" (Toma and Bouma, and Stantec Consulting, 2003).

This treatment need not be entirely exclusive as the sustainability of each of these classes of farms is tied in some respects to the development of the other. Small farms need large farms, and vice-versa:

- Large farms will be able to provide custom operations that small farms can no longer afford to maintain or which must comply to more demanding levels of regulation, as well as serving as local points of trade, exchange and service for supplies, commodities and expertise that might otherwise not exist or be as readily available;
- Small farms will provide large farms with seasonal and experienced labour that is very difficult to find through regular employment channels, as well as contributing to the maintenance of the local socio-economic infrastructure and services.

The two types of farms are also complementary in terms of the space that they occupy in the agricultural landscape. Large farms will continue to generate the volume of agricultural produce that fulfills the needs of expanding domestic and export markets.[24] Smaller farms will target niche and local markets while continuing to generate family income through off-farm sources.

While large farms will remain highly specialized in their operations, they will integrate numerous subsidiary activities such as transport, handling and processing of farm produce. This has already been anticipated in recent changes to the mandate of Farm Credit Canada which now includes agriculturally-related activities as part of its lending portfolio.[25] Small farms will be more likely to be mixed and engage in pluriactivity operations (agri-tourism, etc.).[26]

Thus, strategies that focus on the complementary existence of small and large farms would be most beneficial in terms of sustainability, with a respective emphasis on those elements that have the greatest impact on each category (i.e. economic viability for small farms, environmental conservation for large farms.)

Economic

Paying for Sustainability

To be economically viable within the context of sustainability, Canadian agricultural policy and programs need to shift gears to a third level: the integration of ecological parameters into income support measures. The United States has taken small steps with the conservation measures incorporated into the Farm Bill[27], and the European Union is taking bigger strides with the integration of environmental measures in the Common Agricultural Policy (CAP). Canada is the only industrialized country without a major agricultural conservation program[28] and so it has no choice but to follow.

Farm policy in Canada for the first 100 years was directed at support for the development of food production for an expanding nation. From the free box of seeds and a shovel for every immigrant family willing to take on the task of clearing and cultivating a new farm, through to the crop insurance and farm credit programs, the objective was to make sure that the nation was well fed. The success of these programs, coupled with the advent of the 'green revolution', lead to post-WWII surpluses and the arrival of new orientations geared towards markets – consumers domestically, and for export. Again, from a limited perspective, the market-oriented policies and programs have been a success: Canadian consumers now have access to a much wider range of Canadian-produced foodstuffs, and exports have more than doubled in the last decade.[29]

Success for farmers, especially within the sustainability framework, has been less evident. Despite remarkable achievements in productivity, farm income increases have been modest at best – and negative at worst as the 2003 year woefully demonstrated.[30] Even the supply management programs, which have arguably provided dairy and poultry farmers with the most stable and consistent returns in the farming sector, still have not been able to prevent the mass exodus of farmers and provide escape from farm consolidation and production intensification. Every conceivable formulation of income support program has been tried by the federal and provincial governments with little success; even the vaunted income stabilization programs available to Quebec farmers, arguably the best-financed and structured in the country using cost-of-production and return-on-labour formulations, are sometimes assailed as inadequate by the provincial farm organization, the Union des producteurs agricoles.[31] The continuing decline in Quebec farm numbers, similar to elsewhere, would support that assertion.

This is not to say that farm income support programs should be abandoned; indeed, given the projected economics of agriculture they will continue to be necessary and, if the principles of sustainable development are adhered to, then there needs to be societal support in order to keep farms economically viable. That being said, however, there is evidently a limit to what governments are prepared to pay, even in disaster situations (BSE-related payments being the latest case in hand), and a lack of political will to maintain subsidies based on production criteria continually and indefinitely.

A new parameter is required, and the integration of environmental factors into the policy and program mix targeting the economic viability of farmers makes more sense:

- There is an emerging and growing recognition that environmental improvements produce a societal benefit for which society should make a contribution towards[32];
- Environmental payments are de-coupled from production, allowing farmers to produce for the market without distorting influences from income supports;
- Environmental supports are compatible with international trade rules;
- Environmental payments can be made to all types of farms without disadvantage or discrimination, and could be of significant assistance to smaller farms that have lower production volumes;
- Environmental support programs lend themselves well to the emergence and development of 'green' produce and the opportunity to exploit market opportunities in this regard.

The EU provisions are probably the most comprehensive and far-reaching yet. Although provisions for market and income policy (Pillar 1) are maintained in the CAP, program payments will only be accessible through cross-compliance measures contained in the section on sustainable development for rural areas

(Pillar 2). In instances where requirements exceed recognized "good farming practices", additional payments will be made for agri-environmental measures. The program includes specific sub-programs targeted on biodiversity, genetic resources, genetically engineered organisms, climate change (including renewable energy from biomass), soil protection, pesticide use, nitrates, water use and quality, the development of agri-environmental indicators and forestry.[33]

While similar components of the new CAP approach are present in various Canadian policies and programs, including Agriculture and Agri-Food Canada's Strategy for Sustainable Development, perhaps the biggest challenge to implementing a similar type of program would be federal-provincial jurisdiction. Whereas the EU policy brings individual nations together for a 'common policy', the Canadian system devolves implementation out into 10 provincial jurisdictions, each one with its own set of policies and programs. The decade it has taken to put together a Canadian organic standard stands witness to the monumental task of implementing an effective initiative along the lines of the EU CAP.

This being said, there are a number of opportunities for governments to associate income support with environmental enhancement programs. A coalition of Canadian farm groups has proposed the concept of Alternative Land Use Services, or ALUS.[34] This program would provide incentives to agricultural producers to protect wetlands, improve wildlife habitat, conserve riverbank areas and enhance water quality. Another mechanism would be through environmental farm plans (EFP) which have evolved from a voluntary effort in Ontario supported by the "Green Plan" initiated by the Progressive Conservative government in the late 1980s, to an integral part of AAFC's Agricultural Policy Framework. EFP allow farmers to develop a comprehensive plan that includes both mandatory reporting requirements (nutrient management plans) and environmental conservation measures. Although the federal government is contributing $48.8 million towards the further uptake of EFPs at the provincial level, these are funds targeted at implementation rather than income support substitution.

Both these programs, and other similar variations, offer the opportunity to support the economic viability of farms while achieving other sustainability goals at the same time. Development of strategies in this regard through AIC would be very timely for Canadian farmers.

Tax on Food

A tax on food is probably a very unpopular proposal with Canadian consumers given that they live in one of the highest taxed nations in the western hemisphere, but they are also the same consumers who enjoy the lowest cost food in the world[35] while the people who produce that food are struggling with a substantial drop in income.

Preferably a last resort as a way to raise resources to ensure economic viability for agricultural producers, but a justifiable one none-the-less, such a measure could be implemented as a sales tax on food. Farmers and other social groups fought to exclude food when the GST was enacted in 1991 on the argument that there would be a public backlash and that it was an unjust tax for low-income families given the essential nature of foodstuffs. Sales taxes are now common place, and tax rebate measures have been instituted based on income levels. The 7% GST alone on grocery store sales would generate an estimated $3.3 billion annually[36], still a considerable sum if only half of it were to be dedicated to supporting economic viability measures for farmers linked to sustainability goals and objectives.

The tax would be efficient to administer given that the collection system is already in place, and would increase annually along with the rate of inflation and any increase in agri-food imports to ensure an effective and on-going level of support. It would only cost consumers 0.02% of their disposable income[37] which is minimal considering the potential economic and environmental benefits that would accrue.

Biomass for Energy

The promotion of crops for alternate uses (hemp and flax for fiber, corn and grasses for ethanol, and soybeans for biodiesel) has shown potential but has yet to demonstrate returns for farmers. They offer farmers the opportunity to diversify markets and the expectation that shifting commodities over from foodstuffs to energy and fiber will increase demand and therefore prices. They also offer environmental benefits by lowering greenhouse gas emissions and providing farmers with more paying alternatives for crop rotations. Lastly, certain crops, such as switchgrass, are well suited to extensive production on less productive land, thereby increasing revenue from low-output land and keeping it from being intensively cropped.[38]

Safe and Nutritious Food

"One man's meat is another man's poison" is a very apt adage for the current debate around food: is it safe and just how nutritious is it? On the one hand, former federal agriculture minister Lyle Vanclief prefaced the announcement of the discovery of the first case of BSE with the statement that Canada has the safest food system in the world. On the other hand, the Sierra Club of Canada has labeled agriculture as a potential "major threat to the environment" in launching its "Safe Food and Sustainable Agriculture" program.[39]

Food is a complex bundle of personal emotions, family ties, cultural and religious affiliations overlaid by ethical, environmental, political and economic issues. This mix has become volatile as agricultural production, and food processing and distribution, have become more industrialized and ready integrators of new scientific and technological advances. In addition, the consuming public is beginning to suffer from information overload contaminated with the nutrition/diet fad of the week and spiked with propaganda from special interest groups of all stripes.

In a generalized sense, food produced in Canada today is as safe and nutritious as it has ever been, a statement that, no matter how true, becomes meaningless with just one outbreak of salmonella poisoning, one episode of pesticide contamination, or the discovery of just one 'mad cow'. Food safety, as good as it is, lives constantly on the edge, confined by regulation, affected by practice and subject to mishap.

The devil is, of course in the details, and although Canada has established a definition of 'safe', the discourse continues at the level of the subsidiary clauses. Safe is defined by the Canadian Food Inspection Agency (CFIA) as a reasonable certainty of no harm while noting that absolute safety cannot be guaranteed and that deliberate study is required to establish whether something is safe in the "broadest sense". The agency also determines that a substance has a history of safe use as a food if it has been an accepted part of the diet for three or more generations in a large, genetically-diverse human population, and used in ways and at levels that are well defined and similar to those expected or intended in the new population.[40] How is it, then, that the relatively new (this generation) introduction of genetically modified corn constitutes a safe product? The current interpretation of 'substantial equivalence' determines that GM corn is the same as conventionally-bred corn, and the battle over wording and its interpretation goes from there and has an impact on everything from assessment of novel foods to product labeling.

In this context, this paper cannot delve into, let alone resolve, the many issues revolving around food safety and nutrition; they are far too complex and whole books devoted to the subject have been insufficient to do the same. A more appropriate focus for this paper concerns the issues that can help to resolve some of these debates, those of trust, transparency and understanding. The issue of food safety regulations (HACCP, FSEP, COFFSP, etc.) is covered in a later section on Regulations and Incentives.

Trust

All the declarations of sound science mean little if the public – the mass of individuals who affect policy and regulations through their consumption and voting decisions – do not trust the science. There is little doubt that the public's trust is diminishing with regards to science in general, and there is a loss of confidence in food safety specifically.[41] Even though the human health consequences resulting from the evolution of BSE have, on a relative basis, been uncertain and minimal (not that this in any way diminishes the tragedy of those afflicted by Creutzfeld Jakob Disease), the governmental messages of "It's OK, don't worry" have lacked credibility and undermined the scientific position. This has been further compounded by the dueling debates carried out through the superficial filter of the media ("it's meat… no, it's poison") and the sure and steady transfer of research and development into the commercial arena which, despite its many innovations and achievements, has its own particular biases.

The deterioration of trust regarding the science of food safety has to be reversed and restored to a level that exhibits greater confidence between senders and receivers. This is vital not only on the question of food safety but also for scientific advancement in general – if every new technology gets hooted down simply because there is no trust, society will lose the potential benefits of untold innovations. The case of recombinant Bovine Somatotropin (rBST) in Canada is instructive on this matter: the first applied use of recombinant biotechnology for agricultural production, whatever its merits or misgivings, ended up stalled in Canada due to rampant mistrust throughout the entire approval process. Mistrust of the manufacturer,

mistrust of the regulatory process, and mistrust of the science for what has turned out to be a "minor addition to the technology options available to dairy farmers" (Barham & Foltz, 2002). Some would even argue that, despite the minor overall increase in US milk production (3.5%) resulting from rBST use over the last 11 years, the aggregate effect has been to reduce the number of cows being maintained for production, thus reducing the demand for feed and attendant reductions in the use of water, fuel, and crop inputs.[42] By many standards, such an outcome would be seen as improving the sustainability of agriculture.

There is not one single answer to this question of trust, but evidently it must be tackled through multiple strategies (see following sections on Transparency and Understanding.) One direct approach would be the creation of an independent food authority[43], perhaps a commissioner's office to provide an arm's length view, and review, of the scientific and regulatory issues related to food safety. This would relieve the Canadian Food Inspection Agency (CFIA), as it has sometimes been criticized[44], of being both judge and jury when it comes to the approval process for genetically modified crops since it has both a regulatory and promotional role in food safety issues.

Transparency

Many of the issues related to food safety relate to the use of technology – pesticides, antibiotics, biotechnologies – know-how that has been developed, or at least applied, on a commercial basis. Knowledge in these cases has value, and after tens of millions of dollars invested in research, companies are reticent to make that information available to just anyone. This has lead to a situation whereby the approval process is conducted behind closed doors between the applicant and the regulatory authority and, inevitably, that this "lack of transparency in the current approval process leads to an inability to evaluate the scientific rigor of the assessment process, and thus compromises the confidence that society can place in the regulatory framework"(Freeman, 2001). See also section "trust" above.

Even though this recommendation was made by The Royal Society of Canada Expert Panel on the Future of Food Biotechnology, the suggestion applies equally to all types of technology and processes that have a potential impact on food safety. And rather than being viewed as an additional burden of the regulatory process, it should be regarded as an investment in "sound science" – the peer review and independent verification of research findings that are the foundation principles of the scientific method. The entire debacle concerning transfats could possibly have been avoided if greater scrutiny had been given to addressing the potential for harm that these materials introduced into processed foods.

Not only will such an investment result in safe and nutritious food but it will also help greatly to avoid the futile debates that have resulted due to a lack of trust in those who develop and regulate food production and processing technologies. The key question in this regard is what kind of process will accommodate open and rigorous analysis with the need, where appropriate, to maintain proprietary discretion?

Understanding

Questions surrounding food safety and nutrition involve the production, processing and distribution, and consumer components of the agri-food chain. Each is segmented at the regulatory level but the lines blur and the issues meld when viewed as a whole – which is how consumers see the food on their table. This has lead to an unholy mess in terms of how the issues involved in food safety and nutrition are understood, and how that information is acted upon.

A good example is the use of growth hormones in beef production where the popular impression is that feedlot beef are fed buckets-full of the same substances body-builders take to win gold medals – just because they're called steroids. There is little appreciation for the fact that there are many different compositions for hormones and that the amounts present are measured in nanograms (billionths of a gram). One hundred grams of beef coming from a steer treated with a synthetic estrogen-like hormone growth promotant will contain less than 3 nanograms of estrogen; compare that to the 400 nanograms in a serving of peas and the 20,000,000 nanograms present in 100 milliliters of soybean oil and it can be clearly seen that "without such comparative information, consumers are handicapped in choosing the food they eat" (Fairbairn, 1989).

The flood of information will only continue to grow as new advances in technology and processing emerge into the agri-food sector, again complicated by the dueling of special interest groups and self-promoters in the mass media. The consequences will not be pretty: as one example, the Atkins Diet, long buried in the

backwater obscurity of nutritional fads, rocketed to fame and fortune in 2002 with media-fueled claims of nutritional nirvana for those eating more meat protein over carbohydrates. In August 2005, the company holding the rights to the diet plan declared bankruptcy after suffering a $341 million loss due to slumping demand and competing products.[45] Those who live by the media sword will surely die by the same hand.

There are a number of strategies that could be invoked with regard to improving understanding in matters regarding food safety and nutrition, and the AIC, given its mandate and member resources, could be a key player along with other partners.

Agri-food Communications Centre

There is a need for a national centre with a specific focus on communications issues in the agri-food sector. The Food Safety Network[46] has been a start as an information resource, as has the SPARK[47] program, both located at the University of Guelph. The Farm Credit Corporation has also initiated the "Ag 101 on Highway 1" program for journalism students. While there are web sites and publications that address the importance of food safety and food-borne illness, they are limited and there is a definite lack of data (noted by WHO[48]) to create an accurate portrait to adequately educate the public about the hazards of unsafe food. Unless an individual is deliberately seeking information concerning food safety, it is unlikely that they will come across the pertinent facts that would be informative about food additives, GMOs, antibiotics or food-borne illnesses. The most common promotion of food safety awareness occurs on fact sheets or FAQ sections within the majority of government and ministry websites and while these are available to the public they are not explicitly evident for educational purposes. It is essential that the consumer have access to accurate, comprehensive and up-to-date information so that they may make educated decisions when purchasing and preparing food.

These types of initiatives need to be built upon and expanded in their range of activities, especially those that include the media and educational programs. Improving access to information is a first step, but this should be followed by training programs for journalists and teachers, as well as support for regional and provincial programs in this regard.

Agri-food in the Classroom

The Agriculture in the Classroom programs are, in principle, a necessary and beneficial activity in promoting understanding about agricultural production. They are, however, limited by a crowded academic agenda and minimal access for the overwhelmingly urban clientele to farms and agri-food facilities. These programs need to be supported beyond their current ad hoc and under-resourced status, but they also need to be expanded to include what used to be called home economics. Re-introducing cooking into the school curriculum would not only provide important life skills beyond the capacity to microwave a frozen dinner, it would also present the opportunity to broaden the knowledge and understanding of students and teachers about food – and what makes it safe and nutritious. This could certainly be included within the mandate of the Agricultural Communications Centre as well.

There are also a number of *PATs* (pay attention to's) that require some consideration within the context of sustainability and food safety/nutrition.

Traceability

The capacity to track any morsel of food back to its point of origin has become, to some extent, the holy grail of food safety policies and programs. While this capability is recognized by all, including farmers, as an essential component in safeguarding the modern agri-food system, it also risks undermining one of the important tenats of sustainability – small farms – which are beginning to drown in paperwork that literally requires filing forms when moving livestock from one pasture to another. As with all government programs, farmers need some elements of practicality in their implementation which will require differentiation related to farm size, even separate systems adapted to local markets.[49]

Nutrition

On any given produce container found on today's supermarket shelves, consumers can find more information about the contents than they care to digest. Information, however, does not equate with understanding, and it is a question worth posing just how much understanding is fostered through the placement of truncated values in miniscule font on the back of soup cans. The utilization of modern information technology seems to be an appropriate solution in that very detailed information regarding the general elements of nutrition

and the specific attributes of a given item could be key coded into a database and made available from a terminal at the point of purchase (scan the bar code and up comes that product's information), and also on the Internet. Such a mechanism would also help promote understanding about fresh fruits and vegetables. A common claim is that organic tomatoes taste better than conventionally-produced ones; it isn't because the tomatoes are organic, it's because the conventional tomatoes are picked green before they ripen to prevent damage during transportation and therefore have less sugar in the fruit when finally stimulated to turn red through ethylene gasification.

MPI

The crop sector has developed IPM, or integrated pest management, as a strategy to minimize the use of synthetic inputs in the production of a particular commodity. With regard to food safety and nutrition, this acronym needs to be flipped with the developed of strategies for MPI – minimal process interference. MPI could become an indicator of sustainability by showing just how far evolved a particular food product is from its natural state, including the use of crop protection materials, processing changes and additions, and packaging and distribution. An untreated apple plucked from a tree scores a 10, baked goods made with transfats ends up way down the list. A tricky process to develop such an indicator, but no doubt a stimulus to move towards more sustainable production practices.

Star Trek Menu

Despite rapid advances in food technology, we are still a long way off from the type of computerized 'food' generators popularized in the Star Trek television series. But the 'disassembly' of whole foods into constituent parts has been underway for sometime, and is now beginning to move forward into the molecular realm. Corn is no longer grown just for the kernel but for the starches and oils – both indigenous and modified – that are segregated and reassembled as something else, and nanoscience will take this even further with the ability to synthesize proteins and other molecular substances; this will have significant bearing on the application of definitions such as substantial equivalence and novel foods.[50] Such capacity has huge implications for questions of sustainability, and although there are no ready answers now, leaving the debate until after these products hit the supermarket shelves will be an abdication of the scientific discourse.

Vibrant Rural Communities

Worldwide, there is at least one consistent pattern amongst human societies: the movement of populations from the countryside to the cities. Whether it is Mexico, India or South Africa, populations are heading toward the urban centers, driven by socio-political pressures and in search of a perceived better life. The further the rural region is away from a predominant urban concentration, the more this appears to be the case. In Canada, rural residents are abandoning the farthest points of rural regions to add to the immigrant-fueled expansion of major cities and adjacent corridors: Quebec City-Windsor, Calgary-Edmonton, and Vancouver-Fraser Valley.

The history of much of rural Canada since settlement by European immigrants is synonymous with farming, and farmers made up us much as 31.7% of the Canadian population in 1931[51], and a much greater proportion of the rural population as well. Today, the farm population numbers sit at less than 2.4% of total population (2001 census), and an average of only 11.5% of the rural population, which itself is declining as a percentage of total population.[52] In this context, many rural communities once made 'vibrant' by their farm population are struggling with fewer employment opportunities, school and hospital closings and an aging population.

Within the parameters of sustainable agriculture, the literature repeatedly lays the blame for this situation on some combination of large/corporate/industrialized farms, along with an attendant claim that going back to having more small farms will resolve the situation for rural communities. While it is true that large/corporate/industrialized farms have come to dominate the farming landscape, is it true that they are the cause or really just the outcome? The single largest decline in farm numbers occurred in the decade up to 1961, the same period when most farms became electrified and tractors, along with useful adjuncts such as hydraulics, replaced horses as the main source of agri-production power.[53] Another example of this parameter are the supply managed farms which, despite being afforded the most border protection of all Canadian commodities from the negative affects of freer trade, have not been able to escape from a similar decline in farm numbers.

Numerous studies have demonstrated that more small farms can make an overall greater contribution to rural community vitality than fewer large farms[54]; this only stands to reason given that there would be more people present in the particular location. But without massive state intervention the resurrection of many more small farms is unlikely to happen given that small farms are (in a general sense and in the current context) not economically viable, spending as much as $1.68 in operating expenses in order to take in one dollar of receipts.[55] Rather than looking at strategies to specifically increase the number of small farms, the approach should be to look at ways in which agriculture can make a contribution to the vibrancy of rural communities, big farm or small.

Owner/operator

One of the most frequent references to the detrimental affects of large farms to the life of rural communities is the use of the term "corporate". Certainly rural communities, and agriculture itself, have lots to fear from non-farming corporations owning and operating agricultural production capacity in order to ensure supply and quality parameters for the processing and distribution ends of the agri-food chain, especially when this is carried out at a loss in order to make larger profits further downstream. As a reminder of where this can lead, in the United States, 110 farms representing 0.18% of the total number of hog farms, holds 54% of livestock inventory in this sector.[56]

If current trends continue, more and more farms will become incorporated as they grow in size, which will simply reflect appropriate management strategies rather than any conspiracy of corporate concentration. The key element for sustainability will be to develop a framework whereby policies and programs favour the operation of the farm by the owner(s), a term that would, by necessity, include local farm operators with land ownership and/or long-term leasing arrangements. Operation by local ownership, regardless of farm structure, would ensure greater socio-economic commitment to the local community by larger farms (based on the same assumptions for small farms that local presence brings benefit), as well as more extensive engagement in environmental conservation.

No doubt such a strategy will entail considerable debate in order to define practical application, but it will be much more useful than to continue using such terms as "large" or "corporate". It may be difficult to mandate an 'owner/operator' status by regulation, but would certainly be achievable through policy and program approaches encouraging such a status, for example by restricting access to income supports.

Value Added

It's become a bit of a cliché to say that "adding value" beyond the farm gate will act as a panacea for all that ails the economics of agriculture. There is no doubt, however, that the presence of a local post-production processing and/or distribution facility creates employment and economic development opportunities. Even though farm employment has declined, employment in the agri-food sector past the farm gate has grown faster than the overall economy[57], an indicator that there is value to be had for rural communities when agricultural production is combined with locally situated processing and distribution activities.

Strategic Alliances

Strategic alliances may be just another cliché, but nonetheless the concept is appropriate in this context. The predominant macro-trend in the agri-food sector is concentration – fewer and bigger farms, processors and retailers – and little in the way of policies or programs seems to be making a difference in this regard. Farmers have tended to stay as individuals (even as members of collective structures such as co-operatives, or in direct contractual relationships such as integration) and therefore remain less capable of resisting the 'get big or get out' syndrome.

The notion of exchange and/or co-operation between farmers in order to provide greater critical mass in terms of production and processing capacity (i.e. custom combining, livestock transport) has been part of farm operations and management for the longest time. There appear to be benefits that can accrue by expanding the range of these types of working relationships between farmers on a strategic basis in order to maintain farm numbers while providing benefits from economies of scale.

Luc Robitaille, of Mont-St-Gregoire, Quebec, was one of the farmers interviewed for this paper. He owns a typical Quebec hog farm with 1,500 acres of crop land providing feed for 5,000 feeder hogs and 1200 sows.

He is, however, the pivot man for 57 other farms connected through strategic alliances that includes a further 10,000 acres of crops, a feed mill processing 180,000 tonnes of grain a year and an abattoir that slaughters 4,000 hogs a week, in addition to the sharing of a multitude of technical and professional resources. Some of the participating farms have shares in the various operations, some just purchase services, and others have contracts – each unto their own.

Farm Succession

A typical policy recommendation from farm groups is that farm succession, or intergenerational transfers, must be facilitated if there is going to be a next generation of farmers in Canada.[58] An aging farm population and an exit rate, if left unchanged, will reduce the number of Canadian farmers to less than 150,000 farms by 2021, which means that encouraging and facilitating farm transfers will be a critical aspect of sustaining agriculture. It is a daunting task given that in Quebec, even though a young farmer has support from a stabilized or supply managed income based on cost-of-production formulas, access to subsidized farm credit and a start-up grant as much as $40,000 depending on the level of post-secondary education, farm numbers are declining on par with other provinces.

The easy answer is to make farming more economically attractive, but in the meantime there are a number of strategies that might be pursued:

Fiscal

Both federal and provincial governments have, over the last two decades or so, progressively removed many of the fiscal incentives that made the 'cash poor, paper rich' nature of farming viable. The zeal of tax departments to ensure that absolutely no city doctor or lawyer receives any tax advantage from operating their country estate as a farm has left bona fide young farmers bereft of most of the former fiscal enticements their parents enjoyed – being able to deduct house taxes and electricity consumption against income tax were not huge amounts but were sufficient to assist in farm start-ups and low income years. Rejuvenated fiscal strategies would be welcome support for encouraging young farmers.

Non-farming Farmers

The success rate of converting non-farmers to the farming way of life has been mixed, and it is to be expected that engaging in full ownership of a farm with little experience and or training is not a recipe for high rates of achievement. However, if there is to be an infusion of new blood in the agriculture sector, then many of those prospective participants will have to come from non-farming backgrounds. Throwing them cold turkey into farming situations is no more likely to result in success than before; establishing training and employment opportunities targeted at skilled agricultural workers will allow new job participants to acquire experience in the sector while assisting larger farms through the provision of an improved labour pool. New programs to facilitate partial farm ownership or share cropping, such as is commonly done with dairy herd milkers in New Zealand, would be a further incentive for re-engagement in agriculture and, therefore, rural communities.

Immigration

Canada is a country that was founded on immigration and continues to grow through an influx of new arrivals in the 21st Century – few of whom choose to settle in rural communities.[59] There are many possibilities to encourage immigration into rural communities, but they all require some change in government policies and programs to come about; some suggestions are:

- More flexible provisions for professionals (doctors, teachers, etc.) to be able to work much sooner after arrival on condition they take up placement in rural locations for a designated period; this would also improve the social infrastructure for rural communities, which is also a contributing factor to exodus.
- Allowance for seasonal workers brought in from other countries to become landed immigrants after several years of engagement on that basis;
- Development of social structures to assist new arrivals, such as community-owned or cooperative housing, that provides them with some stability for their new family life.

Conservation of Resources and Environment

Agriculture is one of the biggest users of 'space' amongst the different economic sectors in Canada, occupying some 68 million hectares of land mass across the country, 61% of which is cultivated.[60] Add in to that expanse the increasingly intensive production methods of the last 50 years and the fact that large segments of agricultural land is located near urban populations, and agriculture has resulted in some negative impacts on the environment as well as being a major consumer of off-farm resources.

Much attention has been paid to the environmental impact of agriculture in the last 20 years, and, as a consequence, a variety of policies, programs, and regulations have been developed and put into place – such as water protection policies, environmental farm plans and nutrient management plans. Some have targeted containment (strategies to reduce pollution), others have focused on management practices, and yet others have highlighted the need to raise awareness levels. The two main criteria used to judge the environmental sustainability for agriculture are how well the natural resources that support agricultural production are managed and conserved, and how compatible agricultural systems are with natural systems and processes.[61]

This can be done, and in so doing helping to minimize negative environmental impacts, by assessing agricultural operations in terms of their environmental risk and then managing and developing them to minimize that risk.[62] This strategy implies three assumptions:

- that the correct aspects of the farm are being assessed;
- that the assessment is as accurate as possible; and
- that the farmer is able to implement the necessary changes (as well as maintain current practices where no changes are required.)

The five major aspects of the farm which should be evaluated, acted upon and monitored are

- livestock facilities and infrastructure
- land nutrient management (including manure, fertilizer and other soil amendments)
- soil erosion
- energy efficiency
- biodiversity

The anticipated results that should be obtained once any necessary changes have been implemented, and the practices that are most likely to achieve them, are shown in the following table.

Table 1. Anticipated Results and Best Management Practices

Farm aspect	Expected results once practices or changes implemented	Best practices to achieve results
Livestock facility management and infrastructure	▸ All facilities should be leakage free ▸ Tolerable but minimal odour and dust	▸ Water tight and certified manure storage ▸ Filter strips/fields around potential sources of contaminated water such as leachates from bunker silos and run-off from outside yards ▸ Windbreaks around facilities, placed on the side of the dominant wind.
Nutrient management	▸ Application of nutrients from manure and other sources to meet crop needs while maintaining optimal crop yields and soil fertility ▸ Method and timing of application and speed of incorporation to minimize the risk of nutrient run-off and leaching.	▸ Application and incorporation of nutrients should be such that: – the mineralization of nutrients and crop uptake are synchronized and therefore both the inorganic content of the material and the C/N ratio should be taken into account when deciding timing for application and incorporation – the application of nutrients should not compromise the physical health of the soil and therefore soil moisture content should be taken into account when deciding timing for application.
Soil erosion	▸ Soil erosion is reduced to a level where soil productivity can be maintained for the foreseeable future ▸ Soil erosion is reduced to a level where its impact on water quality in permanent watercourses does not prevent the water from meeting current standards for maximal usage*	▸ Implementation of a three-way strategy: – increase soil permeability – control soil surface water – protect highly sensitive areas such as drains, concentrated flow outlets and ditch and river banks[63] ▸ Maximize soil coverage.
Energy efficiency	▸ The farm generates true carbon credits ▸ The energy efficiencies achieved are at least such that if the harvested biomass from a farm was to be converted into ethanol, the amount of energy in the ethanol would exceed the energy expenditure used for the production, transport and treatment of the raw biomass.	▸ Best management practices for energy are: – optimizing nutrient management (see second section) – minimize soil tillage (see third section) – selecting crops which will be dry or require minimal treatment before storing – install energy efficient technology in buildings
Biodiversity	▸ Wetlands, highly sensitive lands, forested lands that are inadequate for agriculture are protected ▸ Watercourses used as a corridor for both wildlife shelter and restored as routes for animal migration	▸ Leave existing wetlands intact; ▸ Install vegetated/treed buffer strips along permanent watercourses (see third section)

* A body of water can be used for many purposes; the more polluted the water is, the less it can be used. If the water can be used for drinking, swimming, fishing, irrigation, boating and other aesthetic purposes, including the absence of (noxious) odours, then it is considered to be in a state of maximal usage. Soil erosion should be such that if it was the only source of contamination or pollution, it would be so minimal that one would get maximal usage from that water.

Other strategic elements that should be considered in minimizing environmental risks and conserving natural resources:

Watershed Management

Watercourses are a neutral and common space shared between agriculture and other segments of society. The watercourses are not developed or used in the same sense as land, yet they are important to all who occupy their borders. They have also become a flashpoint for environmental conflicts between farmers and surrounding rural residents as well as downstream urban populations. Much of this revolves around who is responsible for what portion of environmental damage when there is non-point source pollution from agriculture as well as point source pollution from industry, municipal sewage and residential septic systems.[64]

Management by watershed objectives enables the participation of all interested stakeholders, the establishment of benchmarks and the measurement of site-specific improvements.[65]

Windbreaks

Although manure receives most of the bad rap for non-point source pollution, soil erosion is much more of a culprit given that the movement of soil particles from the fields carries potential pollutants along with them.[66] Soil erosion is a major pathway by which nutrients and other pollutants reach watercourses.

A lot of progress has been made in this regard through best management practices that prevent excessive water run-off and leaching, as well as the reduction in airborne erosion through minimum tillage practices. Further improvement can be achieved through the establishment of windbreaks which have the added benefit of diversifying habitat. While windbreaks are often in conflict with the size of modern machinery, programs to target the most sensitive areas would contribute significantly to soil erosion reduction and riverbank stabilization.

Energy

It will probably be the most unpopular statement in this paper, but the higher the cost of fossil fuel energy goes, the better it will be for the sustainability of agriculture. The era where the demand for energy is exceeding conventional supplies is upon us and all sectors of society will be forced to reconsider their energy sources and the way it is consumed.

A great deal of work has already begun on the role of agriculture in contributing to the reduction of global warming by reducing the production of greenhouse gasses, and increasing the sequestration of carbon in the soil. These are potential sources of revenue or tax credits, but will require further assessment of current levels of energy efficiency and the implementation of energy efficient farming practices.

Higher fossil fuel prices present two potential opportunities for farmers:

- Imported food (i.e. tomatoes from Florida) will become more expensive to transport, opening the door to local production through improved market economies ;
- The generation of energy from on-farm sources such as manure and biomass will become more economically viable, acting as on-farm substitutes for current sources of energy as well as the possibility of sales to energy providers (co-generation). Large farms will have a size advantage in this regard, but can also work with surrounding small farms to secure raw material in exchange for energy supplies.

Roles and Potential Impacts

Research and Extension

One of the fundamental pillars of agricultural development in North America has been the research and extension network, particularly in the United States where a series of federal laws enacted starting in 1862 lead to the creation of the land grant university system that joined with state-run cooperative extension networks to serve the farm and rural populations.[67] The applied research results taught to university students and transferred to the agricultural sector through outreach programs can arguably be cited as one of the most important investments in the development of the world's most productive agricultural nation.

Canada has instituted some variations to the land grant/cooperative extension model, institutions and services that have been developed on a less consistent and pervasive basis than in the US, and one that has now "decreased significantly due to declining resources" (Toma & Bouma, 2004). Typical of the situation is specialization of research facilities, with research itself becoming more market driven and intellectual property and patenting issues restricting the dissemination of research.[68]

This is of particular concern to the progression of sustainability in agriculture because there is a need for systems information – knowledge – rather than just new applied technologies, and those applied technologies required within the context of sustainability seem to have less commercial appeal for the current system of development. Where are the drought resistant or less fertilizer dependent crop varieties that have been part of the promise of biotechnology for some years?

There are numerous studies and reports in recent years that provide many good suggestions on actions to be taken with regard to agricultural research and extension (which includes the notion of technology transfer.)[69] Unfortunately, many of these suggestions include the phrase "the government should" which, given the retreat by both federal and provincial governments from fully-funded programs in these areas over the last two decades, is not going to move the agricultural sustainability agenda very fast. Following are some suggestions to get things moving a little faster.

Research Levy

A levy on commodities is one way to inject sufficient funds to expand in the short-term research and extension efforts on sustainable agricultural practices. This will obviously not be popular with farmers given that research and extension services have largely been provided at little cost to farmers to date, but it should be viewed as an investment that will return dividends through improved margins. A commodity levy will have the benefit of allowing farmers to direct research according to their needs, especially for on-farm research, and allow them to access existing government programs which are mostly allocated on a matching fund basis. The government can make a contribution to the research/extension agenda through the provision of fiscal incentives to ensure that there is longer term stability in the network.

Producer-operated Extension Structures

The general demise of a uniform (at least at the provincial level) and state-run extension network has left in its place an ad hoc network of programs, services, organizations and institutions providing information and services to farmers. This means that some farmers, particularly the furthest away, lack service, and that some services are more targeted towards, and accessible by, larger farms. In addition, an increasing amount of information and service provided to farmers is through farm suppliers even though it is not necessarily the preferred source.[70]

As with research, it is unlikely that the existing extension services will be resurrected to their former state, or expanded beyond where they currently exist. As much as extension-type information was important in the past, it will be equally important in the future as the pace of scientific knowledge and technological innovation continues unabated. There is, in this context, the need for new structures to ensure that extension services are available to all farmers on an unconditional basis. Already some interesting models have emerged, from soil and crop associations in some provinces, to the producer clubs and centers of expertise in Quebec. The role and place of these structures needs to be refined and expanded given that they are a particularly important mechanism for supporting and serving smaller-sized farms.

Information Technologies

Agriculture benefited enormously from the introduction of electricity which was accomplished in a relatively rapid time span through public policy initiatives that aimed to provide all Canadians with access to service on an equitable basis. The same can be said about early telecommunications in rural areas, such as radio and telephone. Not so in the modern information era: there are still some rural residents, farmers amongst them, who cannot operate a fax machine because they are still on a party line. The knowledge economy is far removed from many of these communities because the upgrade in infrastructure required for the provision of hi-speed Internet and the like will occur… sometime.

The deregulation of the telecommunications sector, from a rural perspective, has been a tremendous disservice and a failure of public policy to support the development of non-urban areas at a time when the relative benefit of new technologies could have much more impact given the greater distances and dispersed locations that are characteristic of service provision in the regions. There needs to be the creation of programs and provisions that allow the comprehensive uptake of advances in information technologies in rural areas within much shorter time frames after their introduction in urban markets. This will either require compensatory resources from public funds, or provisions that facilitate and support local telecommunications initiatives over the longer term.

Incentives, Regulations and Indicators

Environment

In the past few years the implementation of environmentally friendly farming models and practices have been driven by a mixture of regulations, incentives, education, and personal values. It is clear however that regulations and incentives are the most effective way to achieve rapid change on a large scale. In North America, a number of regional governments have adopted a mixture of regulations and incentives to compel farmers into changing their practices in order to minimize the environmental impact. These packages come in various combinations, which impose constraints on farming practices, and sometimes the regulations must be met in order to have access to government programs – this is often referred to as "eco-compliance", or "éco-conditionnalité" in Quebec. Other programs offer payments for setting aside farm land in order to protect marginal types of land or create buffer zones next to fragile bordering areas. On occasion, programs have made payments for the adoption of specific cultural practices such as planting cover crops for winter periods.

This brings about two consequences for farmers. The first is that they must adopt environmentally friendly farming practices that are defined by the regulations. Because the farm is a system, changes to one aspect of the farm's management will affect other aspects of the farm. For example, it might be necessary to apply liquid hog manure in the spring to avoid late fall application which has become restricted by regulation in some areas. This requires better spreading equipment to avoid soil compaction and the addition of increased storage capacity for the manure. It also impacts on the time available for planting, and the choice of crops.

The second consequence is that the farmer must be able to monitor what is being done, and to complete the paper work in order to be able to produce a trail for auditing and monitoring. Even though much of the paper work is handled by professional agronomists and technicians, the farm manager must still be aware of the implications in order to be able to make effective management decisions. In this regard, the farm manager must have the ability to control the bureaucratic aspects of the regulations as they apply to the farm.

Both these effects put pressure on individual farm systems, and on the farming community as a whole. It also tends to wean out of agriculture the farms that are not able to meet the regulatory constraints (assuming that they are environmentally 'unfriendly'), but also the farms which are unable to adapt to the imposition of the regulations and the bureaucratic burden that comes with them. This has raised a major issue with farmers in that measures to make farms more environmentally sustainable are, at the same time, stimulating some farmers to exit the sector.

The farms that are most likely to be able to meet the regulatory constraints and survive the paper work requirements are likely to be those with more resources at their disposal (often larger farms) and higher levels of management skills. These farms have more capacity and depth to handle the increasing demands with regard to agri-environmental management. Consequently, the imposition of a regulatory framework regarding sustainable agriculture is likely to further accelerate the trend towards bigger farms.

Two important questions emerge at this point which are essential in the consideration of strategic approaches to environmental and resource management:

- Should the regulations be adjusted to fit the size of the farm, that is to say to fit the size of the footprint that different farms leave behind?
- What should be included in the regulations to ensure that the farm models that evolve out of it meet the criteria for sustainable agriculture?

Variable Regulations

In one respect, this is the direction that has already been taken by most regional governments. The regulations tend to leave out the very small farms and phase in farms over time according to their size, the bigger and newer farm operations being targeted first. This gives more time for smaller farms to comply with environmental constraints.

However, the regulations are not modulated according to the size of the farm, that is to say that every farm that has to comply, has to comply with the same regulations. An extensive cow-calf operation with 50 animal units located away from any permanent watercourse with an effective land use to animal unit ratio of more than 2:1 has to face the same regulatory burden as an intensive hog or poultry farm in an opposite situation. This 'one size fits all' characteristic appears to have more to do with matching regulations to available government monitoring resources than with the effective agri-environmental management of the particular farming operation.

More Management

So far, efforts by governments in terms of monitoring, and by farmers in terms of adopting new practices, have been implemented using a variety of models and with different levels of emphasis. It is still unclear, however, whether these efforts have resulted in the expected outcomes as far as environmental quality is concerned. One of the weaknesses of the current approach is that the monitoring of change implementation, and the consequent effects, lags behind the assessment and recommendation stages. In other words, when a farmer makes a plan and complies with government standards, the follow-up on the implementation of the changes included in the plan and their impact on the environment is inadequate or missing entirely. In effect, there is a significant amount of resource being dedicated to regulatory compliance with less focus on the monitoring of the impact or outcome, and with little purposeful integration of the regulatory measures within the management regime of the farm. The 'Bilan phosphore' (soil phosphorus level report) in Quebec, and similar mechanisms in some other provinces, is a regulatory requirement linked to eco-compliance[71] beyond which there is no environmental management component – as long as farmers file the report to demonstrate that their land does not exceed threshold levels, they are deemed to be in compliance.

Sustainable agricultural practices within the regulatory context could be advanced through the development of strategies that support variable applicability (on a farm-by-farm basis) and integration of environmental management aspects in conjunction with the regulatory framework. The movement toward individual environmental farm plans is an example of one such strategy.

Incentives

While regulations set the framework, incentives are the positive reinforcement that gets things moving. The case of the Watershed Agricultural Council in New York state is a prime example. The organization has negotiated a 'fee-for-service' arrangement with New York City for providing clean water in the Hudson River watershed which provides the city with its drinking water. The funds permit the Council to pay farmers and foresters to implement practices that ensure clean upstream water, such as set asides and buffer zones along feeder tributaries. The city pays for these services as a preventative measure that reduces their costs for water treatment.[72]

Farmers have been advocating for support for the multifunctional nature of agriculture, and the identification of opportunities whereby farmers can be compensated for providing a service would greatly assist in the incorporation of sustainable practices within farming operations.

Indicators

"How can you be lost when you don't know where you're going" is a fitting saying when it comes to indicators. It's a new field of endeavor but an important one in terms of taking the vagueness and contradictions out of the sustainability concept. How can the rate of improvement be judged if there isn't an

established starting point, such as the state of water quality in a given river, and an on-going monitoring of that condition? How can farms be judged as economically viable under the parameters of sustainable agriculture if there aren't indicators to demonstrate that things have or haven't improved?

A considerable amount of work has already been done on identifying what the indicators should be[73], the next step needs to be to work out the details of the monitoring process – what needs to be benchmarked, how is that to be carried out, and what should be the level of change that should be achieved?

Safe and Nutritious Food

A very sophisticated and comprehensive set of auditing, monitoring and certification systems are being put in place through the agri-food chain to meet the growing demands to ensure that food is safe and nutritious. The Hazard Analysis Critical Control Point (HACCP), Safety Enhancement Program (FSEP), Canadian On-Farm Food Safety Program (COFFSP) , as well as organic certification, regional product identification, etc. are all examples of this activity at different levels.

The concern with systems such as these is not that they will not ensure food safety and nutrition, but that they could lead to complacency that additional monitoring methods can be developed *ad infinitum* to cover new forms of food production or processing. Is there any limit to the number of critical control points within the concept of sustainability? Considerable reflection must be given to just how much monitoring systems can do in terms of producing safe food in a sustainable manner. Part of this comes back to the notion of minimal process intervention (MPI), and part of it comes back to the burden that small farms and small agri-food enterprises face in complying to yet another set of standards.

Things to Think About...

There is no end to the list of items that may be considered in terms of strategies to advance the sustainability of Canadian agriculture. Some fit in with common categories, such as with the approaches to environmental conservation already mentioned in this paper. There are others, however, that are less suited to categorization but still worth giving some thought to.

Natural Advantage

Great advances in food production have been made through scientific and technological improvements – the two predominant crops in Quebec today are grain corn and soybeans, both virtually impossible to grow on a commercial basis until hybrid vigor and cross-breeding provided varieties suitable to the region in the 1970s and 1980s. These types of developments have tended to overshadow the existence of the natural advantages that still exist in all agricultural regions.

- In Quebec and Ontario, there are vast areas of farm land well suited to forage production that are slowly but surely being abandoned to more intensive production on the better soils and closer to the urban markets. This represents untapped potential as ruminant feed for the production of red meat under very sustainable conditions.
- The western provinces have set aside the natural prairie grasses to grow cash crops, even in areas that, from an environmental perspective, would be better off left in their natural state. The potential of biomass as an energy source presents an opportunity to exploit the natural advantage inherent in these plants.
- The pig became domesticated as the trash collector of the barnyard, an omnivore that did well on the left-overs from the household and the feed troughs of other livestock. There are vast amounts of vegetable waste from processing and food preparation that would sustain many pigs, an option waiting for exploitation for want of an organized collection system.

These types of suggestions are not intended to supplant current production practices but to be complementary while contributing to agricultural development in a sustainable way.

Technology

Farmers have generally benefited immensely from new technology, but not in the way they would most like: making money. Despite the promise of higher profits, technological developments at the farm level have mostly helped farmers to increase production and ensure that the crop is harvested or the livestock get to market. These are, of themselves, considerable attractions for farmers whose greatest risk is having no crop or livestock to sell due to weather, disease or other production calamity; technology has provided insurance to maximize yield and for marketable volumes, but has failed to increase profits over the long term.

Given that economic viability is an important component of sustainability, farmers need to give more emphasis to the profit potential of new technologies. Do they provide a greater return on investment, or will they just increase production which ultimately leads to lower prices? Strategies to better evaluate technologies would be of great assistance in this regard.

Check-offs

No doubt another unpopular suggestion, but it remains that agriculture is one of the most under-funded professional sectors of the economy. Union and professional associations (doctors, engineers, etc.) routinely charge membership fees of 1-3% of gross, and companies often spend more than 10% of revenues on marketing, including the activities of representation and advocacy. If Canadian farmers gave over just 1% of gross sales towards their organizational representation and advocacy (maybe some research funding as well), they would have over $500 million at their disposal. By comparison, the national organization for Canadian farmers, the Canadian Federation of Agriculture, has to cover all the bases on just over a million dollars annually, and some provincial farm organizations barely have any budget at all.

It can (and will) be argued that given the mediocre level of net farm income in the last few years, this would be too high a sum to charge to farmers at this time. It could also be argued that until farmers put sufficient financial clout behind their organizations for lobbying, legal representation, engaging consumers, ensuring

independence and researching the sustainability of their future, their policy requests will forever begin with the phrase "the government should…"

One Voice

There is growing interest in the idea that farmers should speak with one voice[74], emulating the success of Quebec farmers through the Union des producteurs agricoles. As with other professional organizations, having one voice is much more effective in persuading government in terms of policy and programs, and will give farmers much more clout when dealing with larger issues such as consumer relations and corporate concentration in the food chain. Not an easy feat by any means, but if maintaining farm numbers is a part of sustainability, then effective political organization is essential.

Leadership

In an indirect way, agriculture is suffering from a 'brain-drain' in that more people are leaving the sector than coming in. This is especially so as years of farming experience and agricultural leadership disappears every time a farmer retires and is not replaced by a younger person following in their mentor's foot steps. In associated agri-food industries, there are many skilled and knowledgeable people who grew up and worked on a farm who will not be replaced in kind.

Where will the next generation of agricultural leaders come from given the meager commitment to leadership development in the industry? There is the Canadian Agricultural Lifetime Leadership program at the federal level, but only for those who can afford it; there is the Ontario Advanced Agricultural Leadership program which is forever on the funding brink. Whether it be 4-H, post-secondary programs, or other types of leadership programs such as the Outstanding Young Farmer competition, there needs to be substantially more commitment in assisting potential agricultural leaders to build a knowledge base, develop a set of skills and engage in leadership networks for the long term benefit of sustainable agriculture.

Incremental Progress

Politics has a significant impact on the policies, programs and regulations that affect agriculture, and something that is common to all economic sectors is that they suffer from the three-year syndrome: with an election coming up within the year, policy gets tinkered with by government to contribute to the prospects of re-election. Farming, and especially sustainable agriculture, is a long term proposition, and will progress little if policies and programs are not established for longer periods of time and with attendant plans for incremental implementation.

It's a mundane example, but when Canada converted to the metric system in 1978, it was accompanied by a 20-year plan that envisioned incremental change from gallons to liters, through inches to centimeters, and on towards pounds to kilos. It took a whole generation of school children to think in liters per 100 kilometers instead of miles per gallon, and the process is still transforming acres to hectares in the minds of some. But it works. Progression in sustainable agriculture doesn't stand a chance if the three-year syndrome is not set aside and long term commitments and planning (20 years +) are not instituted.

What the Farmers Said...

A number of farmers were interviewed for this discussion paper, in person, by telephone and by e-mail. Summertime did not make it easy to get hold of potential interviewees, let alone ask them to give up a couple of hours to discuss their views regarding sustainability, so the information here is limited in its scope. But there were a few items that farmers consistently referred to, and on which they offered consistent opinions.

Income

Farmers must be able to retrieve from the marketplace better levels of income if they are to be able to participate in sustainable agriculture practices. They all said that there is no room for them to maneuver with current farm gate prices and their ability to engage in development activities that do not result in immediate financial returns is very limited.

Multifunctionality

Farmers support initiatives to conserve the environment and are willing to participate in them as they see this as a benefit for their farms and for the surrounding community as a whole. However, in line with the comments regarding income, the farmers noted that they must receive compensation for multifunctional activities, such as enhancing biodiversity, that benefit all of society. Without support, they do not have the capacity to take on additional levels of activity.

Farm Size

For farmers, farm size is irrelevant; it is how the operation is managed that is important. Big farm or small farm, the capacity to practice sustainable agriculture relates to a farmer's attitude, approach and capability to engage in changing the management focus of the farm. Programs to support the capacity of farmers to progress in the area of agricultural sustainability are much more important than regulating or targeting farms based on size.

The Last Word(s)

We're Canadians, eh.

It has become common in the debates about modern agricultural practices to hear or read allusions to *mega* and *factory* farms, citations which are just as often accompanied by US references to make the point that big farms are not sustainable. There may be some truth to these assertions of size as 98% of dairy farms in the states of New Mexico and Arizona have at least 2,500 milking cows, and there are comparable examples in most commodities and in many regions to the south.

But it must be recognized that we are Canadians and there is not one dairy farm of that dimension north of the border. This is not to diminish the value of questioning the scale of agricultural production in the US, but it is unfair to transpose the state of American agriculture into the Canadian context as if it were the *status quo*. Those comparisons are useful, however, as a 'heads up' to ensure that the Canadian characteristic of 'smaller farms' is maintained with regard to agricultural production in this country, which places even more importance on the need for progression in terms of the elements of sustainability.

Maynard's Law of Unintended Consequences

While not reaching the mythical proportions of Murphy's Law, Maynard's Law of Unintended Consequences is rooted in the fundamentals of physics: any given action will result in an equal or greater reaction. Such is the nature of change – something unexpected is sure to happen, whether it is a new policy, program or technological innovation. Drainage ditches increased crop production but also lowered water tables; herbicides killed weeds but also stimulated resistance; income supports helped increase production, further driving down prices. The list goes on.

Anticipation and scrutiny are the watch words here – every effort must be made to try and foresee what might happen when new policies are implemented and new technologies are introduced. This is particularly important with relation to sustainable practices because there is little room in the margin of error, and the long term nature of the progression means there is little time available to start again. The "reasonable certainty of no harm" is a constructive yardstick by which to conduct that scrutiny and ensure that any unintended outcomes will have as little unintended consequence as possible.

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