GPI Atlantic

Genuine Progress Index for Atlantic Canada / Indice de progrès véritable - Atlantique

MEASURING SUSTAINABLE DEVELOPMENT

APPLICATION OF THE GENUINE PROGRESS INDEX TO NOVA SCOTIA

GPI AGRICULTURE ACCOUNTS, PART TWO: RESOURCE CAPACITY AND USE: INTRODUCTION

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Needless to say, any errors or misinterpretations, and all viewpoints expressed, are the sole responsibility of the authors and ***GPI****Atlantic.*

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1. Overview

Food is essential for life. The resources used in agricultural production are also essential for life. Agricultural land, soil, and water resources are the focus of this report. Future reports will focus on other essential resources such as livestock, people, and communities. Our society realizes that we must conserve these resources in order to have vital rural communities and healthy food. But unless we put a dollar value on what these resources are worth, people unfamiliar with farming are unlikely to make the choices needed to keep agriculture, not only economically viable, but thriving for future generations.

Food security has long been recognized as an essential component of national and regional security (Gardner, 1996). In an era of volatile and unpredictable global markets, it is more essential than ever for Nova Scotians to be able to rely on a secure, local source of food and nutrition. Maintaining and enhancing the potential capacity of our agricultural resources is therefore an essential indicator of *genuine progress* in the Nova Scotia Genuine Progress Index (GPI).

There are five sections to this report: this Introduction; Soil Quality & Productivity; Input Use Efficiency; Water Capacity & Quality; and The Value of Biodiversity. Each section examines a number of relevant indicators used to assess genuine progress in agriculture.[1] Data on the physical status of each indicator are presented, as well as some preliminary monetary valuations that tell us where we are losing value and where we are gaining it. Valuations of particular investments in conservation are also presented. Not surprisingly, these often constitute a far smaller figure than the cost of 'fixing' or neutralizing damage after it is done, or the cost of replacing valuable resource capacity that has been irreparably damaged.

The indicators and economic valuations presented here will be used at a later time to develop the agricultural component of the Genuine Progress Index.

Any measure of progress must answer the question 'progress towards what?' This question necessarily involves value choices. In the Genuine Progress Index, those values are explicit. For example, there is broad social consensus in favour of livelihood security, peaceful and secure communities, a healthy population, clean air and water, and healthy natural resources. Similarly, the food security of future generations is a fundamental social objective that depends on a healthy farm sector. For this reason, the health and economic viability of agriculture represents a core social value that defines an explicit goal in the GPI against which progress can be assessed. In each section of this report, therefore, the potential goals or thresholds against which progress can be measured will be suggested at the outset.

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[1] Readers will notice this report is not complete, and that we have not attempted to present a comprehensive analysis. Certain aspects of agriculture have been highlighted by selecting what we consider to be some of the most relevant indicators of progress. Indeed, these reports will never be 'complete,' as agriculture is a very dynamic sector in constant flux. As circumstances change, and new evidence emerges, this report will be updated. We have done our best, given the limitations of time and resources, to present information that will be useful in initiating a discussion on indicators of progress in agriculture.

Some analysts may express discomfort with such values. However, it must be acknowledged that when the Gross Domestic Product (GDP) is commonly used to assess how 'well off' we are as a society, it is also not value-free. When GDP measures are used to assess wellbeing, *more* consumption and *more* output are considered 'better' for social wellbeing.

Given that the Genuine Progress Index (GPI) includes social and environmental values and objectives not considered in standard economic growth measures, *less* may sometimes be *better* in the GPI. For example, less crime, less sickness, less pollution, less waste, and fewer greenhouse gas emissions are all indications of genuine progress in the GPI. By contrast, burning more fossil fuels and spending more money on crime, sickness, war, and pollution cleanup, make the economy grow and are misleadingly interpreted as signs of progress and prosperity in measures based on the GDP.

In the GPI agriculture accounts, progress is indicated by optimum *net* gains that account for costs, rather than by maximum gross gains like farm revenues or outputs, as in the GDP. Unlike conventional accounting practices, we also attempt to include *uncounted* costs and benefits in our determination of net gains (or losses). We also try to incorporate a long time-frame into the analysis of resource use. Genuine progress means optimal levels of quality food production over time with as little waste and pollution as possible, and as much conservation of resources as possible. Net income was the focus of Report #1 on Farm Viability (Scott, 2001). We continue to explore net benefits (or costs) in this report, particularly in the discussion of input and resource use efficiency.

Progress towards thriving and healthy agriculture may require more than just 'sustaining' what we have at this point in time. In agriculture we have the opportunity to 'build' soil and 'enhance' habitat. Producers in the agricultural community who conserve and enhance resources are making a significant social contribution to the common good, to future generations, and to 'genuine progress' in agriculture. Ideally, this contribution will be compensated by long-term production gains as well.

Real progress may also require a shift to *preventing* resource degradation rather than fixing the problem after losses and damage have occurred. We have attempted to show where preventive investments offer opportunities for long-term savings.

Working towards optimal levels of production and resource use will be the most interesting challenge of this enterprise: the crop requires balanced levels of fertility to grow well, but too much fertility can lead to losses, disease, and environmental damage as surely as too little fertility. The ecosystem with optimal, balanced fertility and nutrient cycling will show vigour, productivity, and resilience in the face of stress. The truly successful farmer will know where these 'optimum' levels lie, whether in the fields of soil fertility, farm work, livestock numbers, or time for leisure. A truly successful society will also be able to discover optimum levels of economic activity that are based on the successful nurturing of the resources on which this activity depends.

In short, 'genuine progress' in the GPI is seen as the product of balance and efficiency rather than of simple gross quantitative growth, as indicated by measures that rely on GDP.

2. Methods and Framework

There are two components in all the GPI natural resource accounts that are also considered in this report:

1) Physical Account – an assessment of the physical losses or gains associated with the use of a resource. For example, if the average annual soil erosion rate is 3.3 t/ha of cultivated land, and if there are 112,364 ha of cultivated land in the province, we can estimate that 370,801 t of soil per year are being displaced by erosion.
2) Monetary Account – an assessment of the monetary value (market and non-market) of the physical losses or gains. Extending the example above, we may discover that for every tonne of soil displaced there is $35 in market-related losses and $106 in non-market related costs. If 370,801 t of soil are displaced per year, this translates into $52 million per year in losses for the monetary account. This is a hypothetical example, but it illustrates that the monetary accounts are a secondary and derivatory analysis, always based on a prior set of physical accounts.

Our analysis will not be as complete and simple as the example above implies. There is still much data missing, and more time is needed to review and summarize existing data. However, we have attempted to include some of the more important values in the physical and monetary accounts.[2]

With both accounts, there are several levels of analysis (Table 1). There are values that can be experienced and measured *within* the boundaries of farms, like soil productivity, and there are societal impacts that exist *outside* farms, like agricultural run-off to water courses. It is also important to look at short-term and long-term costs and benefits from agriculture. Monetary values are broken down into market values (the value of resources traded on the market) and non-market values (the value of resources not traded on the market; e.g. soil ecosystem services, farm aesthetics, air and water quality, unpaid labour). It is the non-market values that are challenging to determine, but we must make an attempt, otherwise they will be assigned no value in determinations of resource use.[3]

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[2] It must be emphasized that these GPI accounts are a template and framework for future research and policy analysis rather than a definitive, rigid, or final set of results. Improvements in methodology and data availability over time will vastly improve our store of knowledge and the quality of these accounts.
[3] We are not suggesting here that society should charge money for non-market services like fresh air that constitute a public good. On the contrary, activities that degrade the value of these "free" public goods, like polluting the air, should be penalized, while activities that enhance air quality should be given credit. The valuation of non-market services suggests that resource use, production levels, and prices accurately take into account economic activity that enhances or depletes public goods like the supply of clean air, potentially resulting in fewer activities that pollute the air and more activities that enhance the quality of air.

Table 1: Levels of Analysis for Physical and Monetary Accounts

		Internal effects (to the farm)		External effects (societal)	
		Short term	Long term	Short term	Long term
Physical value					
Monetary value	Market value				
	Non-market value				

Our analysis attempts to highlight externalities and long-term effects that should be counted. Economists use the term 'externality' for those costs and benefits that are side effects of an economic activity and which are not accounted for in the prices paid by consumers or producers (Pretty et al., 2000)[4]. One cause of market failures[5] is that we do not generally account for the externalities associated with an economic activity. Emphasis on short-term (rather than long-term) effects of agriculture has also caused serious market imperfections.[6] Externalities and long-term effects are often not incorporated into the price of farm products (or farm inputs), potentially leading to distorted prices and consumption patterns, and to long-term costs borne on farms and by society. Some of these normally uncounted values are estimated and included in the GPI analysis.[7]

[4] An example of a beneficial externality, known as an external economy, would be the incidental, free pollination services provided by a beekeeper to neighbouring farms. An external dis-economy, on the other hand, means that the externality-generating activity lowers the *production* or *utility* of the externally-affected party. An example of a negative externality would be manure pit discharge into a river that prevents safe fishing downstream. Pretty et al. (2000) extend this definition of externalityto the production or utility *or pricing of goods and services* that does not reflect the side effects (good or bad) of an economic activity.

[5] Technically, market failure is the inability of a system of private markets to provide certain goods, either at all or at the most desirable or 'optimal' levels. In the presence of externalities, markets may fail to produce the optimal levels of output. We suggest that markets also may fail to produce in an *optimal manner*. For example, the externalization of environmental costs effectively transferred the cost of the Sydney Tar Ponds cleanup from the market price of steel to taxpayers and government. A more efficient accounting mechanism incorporating the 'polluter pay principle' would have encouraged more responsible, effective, and environmentally benign production methods that could have avoided the damage costs now borne by several layers of government and funded by taxpayers. Similarly, the costs of poorly-managed agricultural runoff in Walkerton, Ontario, were transferred to the public sector in the form of death, illness, and legal and other costs. From the GPI perspective, the internalization of social and environmental 'externalities' is a key principle of full-cost/full-benefit accounting that enhances market efficiency.

[6] An example of this is included in the report titled *The Value of Biodiversity*. Orchardists used an insecticide that improved marketable yield in the short term, but killed beneficial insects, leading to more severe pest outbreaks – and higher production costs – in the long run.

[7] On farms, 'externalities' can often be felt more directly and acutely than by society at large. Since farms are generally large tracts of land, externalities are often experienced and paid for within the boundaries of the farm. For example, water contamination can be a hidden externality with clean-up costs normally paid for by government and citizens. If the contamination remains within the farm, the cost of water quality maintenance is borne by the farmer. Experiencing the cost of such externalities first hand can cause farmers to behave more responsibly as stewards of their land than consumers or industry who are further removed from the effects of their actions. Similarly, long-term effects (positive and negative) may be felt by succeeding generations on the same family farm, creating a greater sense of stewardship in the interests of future generations.

Another essential principle of full-cost, full-benefit accounting used in GPI analyses, is that *fixed costs* be translated into *variable costs* whenever possible. For example, the full costs of water used for irrigation should be *based on usage*, which will, in turn, affect production methods and consumption patterns. Consider the following example: (1) Groundwater is a public good or public natural capital asset; (2) some farmers draw down the aquifer to the point where draw exceeds recharge; (3) governments invest in compensatory water diversion infrastructure; (4) users are then charged for water based on use; (5) the demand for water (and therefore water-demanding production) goes down *or* (6) the price of irrigated crops or watered livestock should go up. As it stands now, many Nova Scotians use groundwater without directly paying for it, thus providing no incentive for conservation, and potentially producing long-term costs and depletion of a vital natural capital asset. If the water is eventually in short supply or becomes polluted by a small number of users, then we all pay for it to be 'fixed' (a very expensive proposition). Variable cost pricing based on actual usage, and reflecting actual resource values, can help overcome these distortions and encourage more efficient production methods and consumption patterns.

A similar situation exists with other public capital infrastructure. For example, highway capital and maintenance expenditures are currently accounted for in the national and physical accounts as soon as they are spent rather than being depreciated over the useful lifetime of the highway. This allows the accumulation of hidden infrastructure deficits as roads deteriorate. This leads to invisible shifting of costs to future generations and the absence of any effective road tracking system that ensures different classes of vehicles pay their true costs. By contrast, if currently *fixed* vehicle registration tax and insurance costs *varied* according to actual vehicle and road usage (number of kilometers driven; weight of the vehicle – quantifiable documentation that is available to public and insurance authorities), then the costs of road maintenance, fossil fuel depletion, air pollution, greenhouse gas emissions, and other 'externalities' would be more effectively incorporated into the prices of items (such as fertilizer, feed, or farm products) that are transported long distances.

Within the matrix shown in Table 1, comparisons can also be made. We may present trends over time (e.g. a comparison of the value in 1971 vs. 2001), as well as spatial comparisons (e.g. a comparison of two different fields, or two different provinces). The comparison matrix is shown in Table 2. These comparisons can help explain which production techniques are the most beneficial and efficient for a healthy and vibrant agricultural sector.

We will not be able to fill in all the cells or account for all the blanks in this report. This framework does, however, help to summarize the findings so far, to indicate current data gaps, and to suggest directions for future research.

Within both types of accounts (physical and monetary), there are a number of different measurement methods. Physical accounts can be measured in various ways, some of which will be explained as we move through the discussion. Definitions of units and measurements will be highlighted in text boxes within each section.

Table 2: Types of Comparison Within Levels of Analysis

Comparison between different…		Physical value	Monetary value	
			Market value	Non-market value
Production techniques				
Agroecosystems (different land uses)				
Aggregation levels	Farms; fields			
	Counties			
	Provinces			
	Regions			
	Countries			
Times (year, season)				

Monetary accounts are determined based on standard methods developed in the literature. We have attempted to summarize some of these key methods here.[8] Monetary valuations can be *direct* or *indirect.* The examples provided below are phrased as costs, but the same analysis can be applied to benefits. Direct valuations are the most obvious and straightforward monetary analyses. Yields decline by X amount if soil loss is at Y level. Therefore, losses of $Z are incurred as a result of Y soil erosion. However, there are also indirect costs associated with (1) trying to fix or *compensate* for the soil loss (compensatory valuation) through other means like addition of synthetic fertilizer; (2) trying to *prevent* soil loss (avoidance valuation); or (3) trying to replace or rebuild the resource once it has been depleted or degraded (restoration valuation). These costs are sometimes called *defensive expenditures,* because they are designed to prevent or compensate for a decline in wellbeing, rather than signifying an actual improvement in wellbeing. Tables 3 and 4 summarize the definitions and examples of these valuation methods. The examples are based on soil quality indicators for illustration purposes.

Avoidance costs[9] are generally far less expensive than restoration costs. Sometimes avoidance costs are also more economical than compensatory costs.[10] Compensatory measures (e.g. synthetic fertilizer use compensating for loss in soil productivity) may actually exacerbate resource degradation and increase long-term costs. Society can benefit in the long run by implementing avoidance or preventive activities, and rewarding those who already do so. The agricultural sector is fortunate because prevention is still relatively easy and economical. The

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[8] GPI Atlantic recognizes the limitations and shortcomings of all monetary valuation methods and particularly the inadequacy of money to value non-market ecosystem services that may be irreplaceable. However we also recognize that lack of monetary valuation generally results in vital social and environmental assets not being valued and therefore attracting inadequate policy attention. GPI Atlantic therefore attempts monetary valuations where possible for strategic reasons, but relies on existing methodologies rather than devising its own.

[9] In the *GPI Greenhouse Gas Accounts* (Walker et al.; 2001), these avoidance costs (or investments) are described as 'control costs' in reference to their function of controlling or reducing greenhouse gas emissions.

[10] The *cost of preventing damage* can be compared with the *value of preventing damage* in order to assess the potential future return on investment, and also to determine the appropriate level of public subsidy where this return will benefit society at large (external benefit). In other words, the value of money saved by not creating the damage can be more than the cost of preventing the damage from occurring, and thus is seen as an investment. Again in the case of greenhouse gas emissions, control costs are compared to damage cost estimates in order to assess the potential return on investment from reducing emissions (Walker et al.; 2001). In the case of agriculture, the cost of sod rotation can be compared to the value of erosion avoided in order to assess the value of the investment and its return over time.

more degraded a resource becomes, the more expensive prevention, compensation, or restoration will become. Likewise, the more we conserve a resource, the higher direct value the resource has, the fewer defensive measures are necessary, and the better the net productive yield is likely to be. Everybody wins in that situation.

Table 3: Direct Valuation Method

Direct Valuation	
Definition	The value of the direct effect of an economic activity, or change in the level of the physical account. This can be actual or estimated.
Market example	Yield and resulting income losses as a result of soil erosion (internal).

Table 4: Indirect Valuation Methods (Defensive Expenditures)[11]

(Note that "internal" refers to the cost being borne by the farmer; "external" indicates that society and/or taxpayers bear the cost)

Compensatory Valuation	
Definition	Expenses incurred to neutralize or repair the effects of damage resulting from economic activity or a change in the physical account.
Market example	Purchase of fertilizer to compensate for declining soil organic matter (internal).
Market example	Department of Transportation expense to dig out ditches from farm soil erosion (external).
Avoidance Valuation	
Definition	Values or costs associated with avoiding or preventing damage to a resource.
Market example	Cost of implementing a 50% sod rotation vs. the value of saving 2 tonnes of soil from being eroded per hectare (internal).
Restoration Valuation	
Definition	Expenditures to restore depleted or degraded natural systems, or their function, partly or completely. The restoration cost may be used to place a value on a resource that has not yet been depleted (in order to assign it a current value based on potential replacement costs – e.g. through human engineering.).
Market example	The cost to replace lost soil organic matter by buying compost (internal).
Market example	The cost of purchasing and releasing natural predatory insects that have previously been displaced or killed through pesticide applications (internal).
Market example	The cost of restocking fish in a stream that has suffered siltation from farm soil erosion (external).

[11] The 1993 *UN Handbook of National Accounting: Integrated Environmental and Economic Accounts* defines 'defensive expenditures' as "the actual environmental protection costs involved in preventing or neutralizing a decrease in environmental quality, as well as the actual expenditures that are necessary to compensate for or repair the negative impacts of an actually deteriorated environment." Statistics Canada defines defensive expenditures as those "undertaken to maintain a given level of welfare or to defend against a decline in welfare." (Colman, 1998).

A fundamental purpose of the GPI full-cost, full-benefit accounting mechanisms is therefore to provide an efficient framework for assessing alternative policy options, by allowing a more accurate and comprehensive valuation of our agricultural resource assets than is possible in current accounting mechanisms. Indeed those conventional accounting mechanisms have too often sent the wrong signals, which have actually encouraged and supported resource degradation and the loss of natural wealth.

It is interesting that in the special case of certified organic agriculture, farmers have taken responsibility for avoidance investments (avoiding damage to the resource), and restoration costs (in some cases restoring depleted or degraded agricultural systems), which is reflected in the higher price charged for organically produced food. Some consumers are willing to pay a premium to have food produced in a way that does not degrade the resource.[12] In Europe, many governments have chosen to pay farmers to convert to organic farming because they recognize that this amplifies positive externalities and minimizes negative externalities (OECD, 1997). The unique case of organic farming will be covered in a separate report. This is not to say that all other farmers do not avoid resource degradation or do not enhance the quality of the environment. Many do. What makes certified organic agriculture unique is that the costs of producing societal benefits are (to some extent) passed on to the consumer or the government, rather than being borne solely by the farmer.

3. Indicator Selection and Viability Thresholds

In order to choose meaningful indicators of genuine progress, we must ask which economic, environmental, and social measures accurately indicate 'flourishing' or 'healthy' agriculture. Some of the indicators suggested in this analysis are well established, while others require new ways of measuring the health of the resource.[13] Report sections and indicators for each are listed in Table 5.

Using these indicators, current trends are assessed against proposed minimum objectives, expressed as resource health goals. The sustainability goals proposed here are based as far as possible on thresholds established in the literature. When no established thresholds for sustainability exist, we have chosen goals that are both achievable (i.e. they *have* been achieved in representative times and places) and/or estimated as necessary for long-term viability. Establishing such goals, of course, is part of the discussion that must take place when proposing new indicators of real progress. The goals proposed here may require adjustment over time as conclusions from new studies and actual experience are incorporated into the analysis.

[12] That assurance is guaranteed by adherence to organic standards, reviewed and inspected by independent inspectors.
[13] New indicators can clearly be added to this framework in future updates of this report.

Table 5: Indicators

Report section	Indicators
Soil Quality and Productivity	Soil Organic Matter Soil Structure Soil Conservation Practices Soil Foodweb Health
Input Use Efficiency	Nutrient Use Efficiency Pesticide Use Efficiency Energy Use Efficiency Greenhouse Gas Emissions
Water Capacity and Quality	Water Availability For Farm Use Groundwater Quality Surface Water Quality
The Value of Biodiversity	Habitat Quantity and Quality Value of Ecosystem Services

Note: All figures used in this series of reports have been adjusted for inflation using the Nova Scotia Consumer Price Index, and are shown in 1997 dollars for comparison purposes.

4. Glossary and Acronyms

Accounts and accounting: The purpose of accounting is to provide financial information about a household, organization, or government. Accounts are generally divided into "income accounts," which record receipts and outlays (expenditures) during a given period such as a year, and "asset accounts," (or balance sheets) which provide a snapshot of the assets, liabilities, and net worth of an entity at a given date. People are most familiar with the income accounts and balance sheets of businesses, but the same concepts apply equally well to individuals, governments, and nations. Natural resource wealth (natural capital assets) is not accounted for in provincial balance sheets, but Statistics Canada has taken initial steps to begin to incorporate natural wealth into the national balance sheets. These GPI resource accounts are intended as a contribution to that effort.
Aquifer: The underground layer of water-soaked material that acts as a water source for a well; described as artesian (confined) or water table (unconfined).
Arable: Land that is used to produce crops, usually involving tillage.
Arthropod: Invertebrates that have a jointed body and limbs with a hard shell.
Atlantic Maritime Ecozone: Ecozones[14] are the largest mapping unit in Canada's ecological classification system. The Atlantic Maritime Ecozone consists of Nova Scotia, New Brunswick, Prince Edward Island, and part of Quebec (the Gaspé Peninsula). The area is 202.6 km^2, characterized by hills and coastal plains, mixed deciduous-evergreen forest stands, and is cool and wet. The main surface materials/soils include brunisols, podzols, and luvisols. Brunisols are soils with minimal weathering, podzols are acid and well-weathered soils, and luvisols are temperate-region soils with clay-rich sublayers.
Avoidance costs: Actual or imputed costs for preventing environmental deterioration by alternative production and consumption processes, or by the reduction of or abstention from certain activities likely to further resource degradation or depletion. These costs may be viewed as investments when compared to avoided damage costs. Also known as control costs.
Bioaccumulation: A term used to describe a process that occurs when levels of substances increase in an organism over time, due to continued exposure. Sequestration of metals or chemicals in living tissue, such as PCBs in fatty tissue, increases over time with continued exposure.
Biodiversity or biological diversity: The variety of species and ecosystems and the ecological processes of which they are part, covering three components: genetic, species, and ecosystem diversity.
Biological farms: Farms managed to enhance productivity and soil quality without the use of synthetic pesticides or fertilizers. Often composted manure and nitrogen-fixing legumes are the basis of the fertility program.
Biological Oxygen demand (BOD): The amount of dissolved oxygen required for the bacterial decomposition of organic waste in water. When bacteria come in contact with organic material, they utilize it as a food source. The amount of oxygen used in this process is called the biological oxygen demand. It is considered to be a measure of the organic content of waste, and represents the amount of oxygen required to stabilize waste in a natural environment.

[14] Used by Statistics Canada and Environment Canada.

Biomagnification (biological magnification): A cumulative increase in the concentrations of a persistent substance in successively higher levels of the food web.
Biotic regulation: An ecosystem service in which organisms such as bees help with pollination, or organisms such as ground beetles help with pest control. A variety of organisms perform 'jobs' that (even by their existence as a competitor for resources) exert inhibitory or helpful effects on other organisms, thus having an overall regulatory effect.
Carbon dioxide (CO_2): Colourless, odourless, and nonpoisonous gas that results from fossil fuel combustion and is normally a part of ambient air. It is also produced by the respiration of living organisms (plants and animals) and considered to be the main greenhouse gas contributing to climate change.
Carbon sequestration (carbon sink): Biochemical process by which atmospheric carbon is absorbed by living organisms, including trees, soil micro-organisms, and crops, and involving the storage of carbon in soils with the potential to reduce atmospheric carbon dioxide levels.
Carcinogen: Cancer-causing chemicals, substances or radiation.
Cation Exchange Capacity (CEC): Capacity of a soil to retain and supply exchangeable cations (positively charged ions), including nutrients.
Chemical rooting conditions: Chemical characteristics of soil that control root growth.
Coliform bacteria: A group of bacteria used as an indicator of sanitary quality in water. Exposure to these organisms in drinking water can cause serious diseases such as cholera.
Conservation tillage: A tillage system that creates a suitable soil environment for growing a crop and that conserves soil, water, and energy resources mainly through the reduction in the intensity of tillage, and retention of crop residues.
Conservation: The continuing protection and management of natural resources in accordance with principles that assure their optimum long-term economic, ecological, and social benefits.
Consumptive use (of water): The difference between the total quantity of water withdrawn from a source for any use and the quantity of water returned to the source; e.g., the release of water into the atmosphere; the consumption of water by humans, animals, and plants; and the incorporation of water into the products of industrial or food processing.
Contingent valuation: Method of valuation used in cost-benefit analysis and environmental accounting. It is conditional (contingent) on the construction of hypothetical markets, and is one method of estimating the willingness to pay for potential environmental benefits or for the avoidance of their loss. This method of valuation is not used in this set of reports.
Conventional farms: Farms that may use biological methods (see Biological farms above) but also have the option to use synthetic fertilizers and pesticides.
Cost: Measure of what must be given up to acquire or achieve something.
Cost-benefit analysis: Conventionally, an assessment of the direct economic costs and benefits of a proposed program for the purpose of program selection. The cost-benefit ratio is determined by dividing the projected costs of the program by the projected benefits. The GPI full-cost/full-benefit accounting mechanisms include social and environmental costs and benefits generally excluded from the conventional analysis.
Defensive environmental costs: Actual environmental protection costs incurred in preventing or neutralizing a decrease in environmental quality, as well as the expenditures necessary to compensate for or repair the negative effects (damage) of environmental deterioration.[15] Statistics Canada defines defensive expenditures as those "undertaken to maintain a given level

[15] Source: 1993 *UN Handbook of National Accounting: Integrated Environmental and Economic Accounts*.

of welfare or to defend against a decline in welfare," and are contrasted with spending that leads to an actual improvement in welfare (Colman, 1998).

Denitrification: The principal loss mechanism of oxidized N from wetlands. NO_3^- is converted to N_2 gas under anaerobic conditions by heterotrophic bacteria.

Depletion costs: Monetary value of the quantitative depletion (beyond replenishment or regeneration) of natural assets by economic activities. Depletion of natural resources results from their use as raw materials in production or directly in final (household) consumption.

Discounting (of natural assets): Determining the present value (net worth) of assets by applying a discount rate to the expected net benefits from future uses of those assets. The discount rate reflects the social preferences for current (as compared with future) uses. Discounting is the process of projecting and converting costs and benefits in different years to a common metric so that they can be properly compared to one another. The higher the preference for current over future consumption, the higher the discount rate. In other words, the higher the discount rate, the less value society places on the future. Adherence to the principle of inter-generational equity, which is the cornerstone of a sustainable development strategy, would require use of a low discount rate. Statistics Canada uses a rate of 4%, a figure also used by GPI Atlantic in other studies for assessment of long-term environmental impacts (Colman, 1998).

Drought: A prolonged period of abnormally dry weather that depletes water resources. A shortage of precipitation is classified here as 'severe' if it is 40% less than the 30-year mean.

Ecosystem service: Any service provided by life forms, such as water purification (for example by cattails or bacteria) or nutrient cycling by soil micro-organisms.

Emergent macrophytes: These are plants rooted in the sediment and extending through the water surface to the atmosphere, effectively linking the air and sediment. This creates an oxic environment near the plant roots and rhizomes, allowing aerobic bacteria to degrade organic compounds in the sediment. Included in this category are cattails (Typha spp.), bulrushes (Scirpus spp.), and common reeds (Phragmites spp.)

Environmental accounting: In national accounting, physical and monetary accounts of environmental assets and the costs of their depletion and degradation. In corporate accounting, the term usually refers to environmental auditing, but may also include the costing of environmental impacts caused by the corporation.

Environmental costs: Costs connected with the actual or potential deterioration of natural assets due to economic, social, or political activities. Such costs can be viewed from two different perspectives: (1) as costs caused, that is, costs associated with economic units actually or potentially causing environmental deterioration by their own activities, or (2) as costs borne, that is, costs incurred by economic units independently of whether they have actually caused the environmental impacts.

Environmental damages: Harm caused to the environment by natural or human activities. These damages are frequently measured in dollars, but some damages may be non-measurable, particularly when lost ecosystem services are irreparable (e.g. through species loss or irreversible climate change).

Environmental degradation: Deterioration in environmental quality from ambient concentrations of pollutants and from other activities and processes, such as improper land use and natural disasters.

Environmental externalities: Uncompensated environmental effects of production and consumption that influence an externally-affected party's utility and enterprise cost outside the market mechanism. Externalities may be positive or negative. Examples of positive externalities to do with farming include landscape and aesthetic value; recreation value; pollination services; flood control; or carbon sequestration. An example of a negative externality might include contamination of water downhill from a farm manure pit, making an (off-farm) river area unfit for catching fish. As a consequence of negative externalities, private costs of production exclude social and environmental costs, and therefore underestimate the true (or full) costs of production. This leads to market inefficiencies through depressed consumer prices that do not reflect actual production costs, and the consequent transfer of these residual costs to the public sector and taxpayers.

Environmental services: Qualitative functions of natural non-produced assets of land, water, and air (including related ecosystems) and their biota. There are three basic types of environmental services: (1) disposal services, which reflect the functions of the natural environment as an absorptive sink for residuals; (2) productive services, which reflect the economic functions of providing natural-resource inputs and space for production and consumption; and (3) consumer or consumption services, which provide for physiological as well as recreational and related needs of human beings.

Epigaeic: Living near the surface of the soil.

Eutrophication: The result of high levels of nutrients in water. Algae and plant growth is stimulated, and decomposition of the extra plant material leads to anoxic water. With no oxygen, fish, invertebrates, protists and many bacteria will die, and the water body will become lifeless.

Existence value: Value of knowing that something (e.g. a particular species, habitat, or ecosystem) does and will continue to exist. Such value is independent of any use the valuer may or may not make of the resource.

Extensive agriculture: Extensive agriculture (to the Europeans) involves using fewer synthetic inputs such as fertilizers and pesticides; adding N inputs of less than 50 kg N ha^{-1} yr^{-1} to land; relying less on imported feed for livestock; and reducing livestock stocking densities. **Intensive agriculture** involves using more synthetic inputs such as fertilizer and pesticides; adding N inputs of more than 50 kg N ha^{-1} yr^{-1} to land; relying more on imported feed for livestock; and increasing livestock stocking densities. Both are relative terms.

Externality: Activity that affects others for better or worse, without those others respectively paying or being compensated for the activity. Externalities exist when private costs or benefits do not include social costs or benefits.

Flow vs. Stock: A flow variable is one that has a time dimension or that flows over time (such as stream flow; or greenhouse gas emissions; or the services provided by nature); a stock variable is one that measures a quantity at a point in time (such as the water in a stream at a particular moment; or the actual concentrations of greenhouse gases in the atmosphere at a point in time; or the total volume of timber in a forest).

Genetic erosion: The loss of genetic diversity between and within populations of the same species.

Gross Domestic Product (GDP): One of the most frequently quoted items in the National Income and Product Accounts (NIPA). GDP measures the nation's total output of goods and services and the total income of the nation generated by that output. GDP at market prices measures the sum of the dollar values of consumption, gross investment, government purchases of goods and services, and net exports produced within a nation during a given year, where these transactions are valued at market prices. It also represents the incomes earned as wages, profits, and interest, as well as indirect taxes. In addition to the totals for the nation, the NIPA provide a

rich array of data on output and incomes in different industries and regions, as well as a record of international transactions.
Groundwater recharge: The rate of inflow to an aquifer.
Groundwater: The supply of fresh water found beneath the earth's surface that is often used for supplying wells and springs and maintaining base flow in streams.
Humus: The very well-decomposed part of the soil organic matter.
Integrated Fruit Production (IFP): IFP is an attempt to achieve pest control equal to that of conventional orchard practices, while relying less on pesticides and more on parasites, predators and pathogens.
Integrated Pest Management (IPM) or Integrated Farm System: Control of pests using a combination of techniques such as crop rotation, cultivation, and biological and chemical pest controls.
Invertebrates: Animals lacking a spinal column, e.g. earthworms.
Keystone species: Those species that are in some way central to the survival of a host of other species and therefore produce a degree of stability in an ecosystem. A coyote is an example of a keystone species in canyons. The coyote keeps the size of the populations of other predatory mammals, such as raccoons, in check. When the coyote is not present, populations of these smaller predators explodes, leading to the extinction of other breeding birds or small mammals.
Land degradation: Reduction or loss of the biological or economic productivity and complexity of rain-fed crop land, irrigated crop land, range, pasture, forest, or woodlands resulting from natural processes, land uses, or other human activities and habitation patterns, such as land contamination, soil erosion, and destruction of the vegetation cover.
Leaching: The removal of soluble organic and inorganic substances from the topsoil downward by the action of percolating water.
Ley: An area on a farm that may be grazed by livestock, but it is not a permanent pasture as it is rotated with other crops.
Marginal cost: Increase in total cost required to produce 1 extra unit of output.
Marginal revenue: Increase in total income by producing one extra unit of output.
Market valuation: (1) Market price of an item between willing buyers and willing sellers; (2) value of natural resources and of their depletion and degradation, imputed in environmental accounting and estimated on the basis of expected market returns.
Monoculture: Production of the same annual crop in the same field year after year.
Mycorrhizal relationship: The mutually beneficial relationship that develops between plant roots of most crops and fungi. The fungi help plants obtain water and phosphorous by acting like an extension of the root system and in return receive energy-containing chemical nutrients from the plant.
N: Nitrogen
Natural resources: Natural assets that can be used for economic production or consumption.
Nitrogen fixation: The conversion of free nitrogen in the atmosphere to nitrogen combined with other elements; specifically regarding soils, the assimilation of atmospheric nitrogen by soil organisms to produce nitrogen compounds that eventually become available to plants.
Nonmarket activity: Economic activity that produces goods and services not distributed by markets.
Non-renewable resources: Natural resources that can be used up completely or else used up to such a degree that it is economically impractical to obtain any more of them; e.g., coal, crude oil, and metal ores.

NSDAM: Nova Scotia Department of Agriculture and Marketing. In late 2000, the department was amalgamated with the Department of Fisheries to create the **NSDAF**, or Nova Scotia Department of Agriculture and Fisheries.
Opportunity cost: These are the losses incurred from not being able to take advantage of the best alternative use of an asset. Wetlands can require significant land area, land which could perhaps be more profitably used for crops or livestock. Countering this lost revenue are the non-monetary benefits derived from the water treatment and other goods and services provided by wetlands.
Organic farming: A system of farming employing biological methods of fertilization and pest control as substitutes for synthetically created fertilizers and pesticides; adhering to a set of organic farming standards verified by peer review and independent inspector visits to the farm on an annual basis.
Organic: (1) Referring to or derived from living organisms. (2) In chemistry, any compound containing carbon.
P: Phosphorous
Parasite: Parasites consume parts of their prey rather than the whole.
Parasitoid: A group of insects that lay their eggs in or near other insects. The larval parasitoid then develops inside its host, killing it. It is estimated that parasitoids account for about 25% of the world's species.
Parts per million (PPM): The number of "parts" by weight of a substance per million parts of water. This unit is commonly used to represent pollutant concentrations. Large concentrations are expressed in percentages.
Pasture: Grasses, legumes, and/or other herbage used or suitable for the grazing of animals.
Pathogen: A causative agent (bacterial, fungal, or viral) of disease.
Pathogenic microorganisms: Microorganisms that can cause disease in other organisms including humans, animals, and plants.
Pathogens: Disease-causing agents such as bacteria, viruses and parasites.
Percolation: The movement of water downward through the soil to the zone of saturation.
Pest: Any organism that is annoying to mankind.
Pesticide: A substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest. Pesticides can accumulate in the food chain and/or contaminate the environment if misused. The term pesticide can be an umbrella term for insecticide, herbicide, miticide, rodenticide, or fungicide.
Physical accounting: Natural-resource and environmental accounting of stocks and changes in stocks in physical (non-monetary) units, for example, weight, area, or number. Qualitative measures, expressed in terms of quality classes (e.g. age or species mix), types of uses, or ecosystem characteristics, may supplement quantitative measures.
Pollution: (1) Presence of substances or heat in environmental media (air, water, land) whose nature, location, or quantity produces undesirable environmental effects.
Precautionary principle: According to Part One, Section 2 (b) (ii) of the Nova Scotia Environment Act: "The precautionary principle will be used in decision-making so that where there are threats of serious or irreversible damage, the lack of full scientific certainty shall not be used as a reason for postponing measures to prevent environmental degradation." This principle is internationally accepted as a guide to environmental protection and sustainable development. In practice, the principle of precautionary action has four parts. (i) Governments, businesses, and individuals have a duty to take anticipatory action to prevent harm. (ii) The burden of proof of

harmlessness of a new technology, process, activity, or chemical lies with the proponents of the technology, not with the general public. (iii) Before using a technology, process, or chemical, or starting a new activity, there is an obligation to examine a 'full range of alternatives'. (iv) Decisions applying the precautionary principle must be 'open, informed, and democratic' and 'must include affected parties.'[16]

Precipitation: Water falling, in a liquid or solid state, from the atmosphere to a land or water surface (i.e. rain, snow, sleet, hail).

Predators: Predators kill their prey.

Productivity: Yield per unit input, in a given unit of time. Inputs can include energy, costs, time, labour, area, nutrients, etc. Productivity is often measured based on the most limiting or expensive input. Ecological measures of productivity are based on minimizing non-renewable inputs and polluting outputs.

Public good: A commodity whose benefits may be provided to all people (in a nation, region, or town) at no more cost than that required to provide it for one person. The benefits of the goods are indivisible, and citizens cannot be excluded from using it. Examples include fresh air, a beautiful landscape, a public park, or climate regulation and ecosystem services provided by land, forests, and oceans.

Renewable Resource: Natural resource (e.g., tree biomass, fresh water, fish) which regenerates itself and whose supply has the potential not to be exhausted (if used sustainably), usually because the rate of production (or regeneration) is above the rate of use.

Resilience: The ability of a system (economic system or ecosystem) to recover from, or buffer against, stress (a measure of the rate of productivity recovery after a disturbance). Examples of stress are climate change or volatile markets.

Resistance: A measure of the change in productivity in response to a particular intensity of disturbance (e.g. drought, flood etc.).

Restoration costs (environmental): Actual and imputed expenditures for activities aimed at the restoration of depleted or degraded natural systems, partly or completely counteracting the (accumulated) environmental impacts of economic activities.

Semi-natural: This is a term used often in European studies. It refers to managed meadows and managed woodlands. The **meadows** are minimally managed hayland or pasture. They generally receive no synthetic fertilizer or pesticides. Manure may be used, as well as lime. The areas are generally grazed once or mowed once per year.

Sod: A dense covering over the entire land surface, comprised of a mixture of grasses, legumes and other herbs. Usually all land classified as pasture and hay can be assumed to have a sod cover.

Soil cover: Vegetation, including crops, and crop residues on the surface of the soil.

Soil organic matter: Carbon-containing material in the soil that derives from living organisms.

Soil quality: It encompasses two distinct, but related parts: *Inherent quality*, or the innate properties of soil such as those that lead to soil formation; and *dynamic quality*, covering the main degradation processes (physical, chemical and biological) and farm management practices.

Species diversity: The number of different species within an ecosystem (**species richness),** the number of individuals within each species (**species abundance**), or the relative abundance of a number of species (**species evenness**).

[16] from *Rachel's Environment and Health Weekly*, Feb. 1998.

Surface water: All water open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries, etc.).
Sustainability: A measure of the ecological productivity of an agro-ecosystem over a long period of time, in order to be able to assess its resistance, and resilience in the face of change.
Trickle irrigation: Trickle or drip irrigation is the precise, slow application of water as discrete drops, continuous drops, small streams, or miniature sprays through mechanical devices called emitters at low water pressure. The theory behind trickle irrigation is to apply sufficient moisture to the roots of the crop to prevent water stress. There are several types of trickle irrigation, including surface, subsurface, bubbler, spray, mechanical-move, and pulse systems. The most commonly used types of trickle irrigation in Nova Scotia are surface and subsurface (buried) installations.
Water conservation: The care, preservation, protection, and wise use of water.
Water contamination: Impairment of water quality to a degree that reduces the usability of the water for ordinary purposes or creates a hazard to public health through poisoning or the spread of diseases.
Water quality guidelines: Specific levels of water quality that, if reached, are expected to render a body of water suitable for its designated use. The criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, fish production, or industrial processes.
Water quality: A term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose, such as aquatic habitat, drinking water for human beings, and irrigation.
Water table: Zone of water saturation in soil; upper surface of groundwater, found at a depth at which the pressure in the water equals atmospheric pressure.
Well: A pit, hole, or shaft sunk into the earth to tap an underground source of water.
Wetlands: Lands where water saturation is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the surrounding environment. The term ‘wetlands’ includes bogs, ponds, estuaries, and marshes.

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