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MEASURING SUSTAINABLE DEVELOPMENT

APPLICATION OF THE GENUINE PROGRESS INDEX TO NOVA SCOTIA

GPI AGRICULTURE ACCOUNTS, PART TWO: RESOURCE CAPACITY AND USE: SOIL QUALITY AND PRODUCTIVITY

EXECUTIVE SUMMARY

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September, 2002

EXECUTIVE SUMMARY

Soil is the natural capital asset upon which our agricultural system is based. It is vital to maintain healthy and productive soil if our agricultural system is to continue to function optimally.

Soil is currently undervalued in our food production system. Methods of agriculture that degrade the soil are profitable in the short term under our current system of accounting. This is because the losses of natural capital due to soil erosion or degradation are invisible in conventional economic accounts, and not included directly in the costs of food production.

Soil degradation that results in soil compaction and reductions in the soil's inherent fertility is compensated for by increases in purchased agricultural inputs, such as fertilizer. These inputs can mask, or compensate for the degradation of our soils by allowing crop yields to be sustained and profitable in the short term, at the expense of long-term productivity. By contrast, the GPI natural resource accounts recognize the *long-term* value of our soil assets.

Soil quality is more than the sustained capability of a soil to accept, store, and recycle water, nutrients, and energy. Soil quality is the capacity of soil to sustain *ecological productivity*, maintain *environmental quality*, and *promote plant and animal health*. In this report, soil ecological productivity is emphasized. Ecological productivity minimizes both non-renewable inputs and polluting outputs, while ensuring optimal production over the long term.

Farmers face an important challenge in their attempts to maintain soil quality and productivity. This is not an easy or straightforward task, particularly when faced with an uncertain climate, sloping topography, shallow soils, and/or narrow economic margins, as is frequently the case in Nova Scotia.

In order to achieve genuine progress in agriculture, society as a whole must ensure that soil quality is maintained or improved according to a set of proposed indicators. They can be tracked over time to help us achieve optimal long-term ecological productivity. The soil quality and productivity indicators proposed here include *soil organic matter* (or soil organic carbon); *soil structure*; *soil conservation*; and *soil foodweb health*. For each indicator, measurement methods are presented, sustainability objectives are proposed, trends are highlighted, and preliminary monetary values are estimated.

Soil Organic Matter or Soil Organic Carbon

The maintenance of soil organic matter is the key to sustaining soil quality. Although estimates show that soils in Eastern Canada are presently losing 23 kg of carbon per hectare (ha) annually, the potential to reverse this trend exists in Nova Scotia. Growing perennial forages is one well-established method of improving soil organic matter levels. An indirect measure of the organic matter status of Nova Scotia's soils is the percentage of land in rotation that is planted to a perennial forage. The proposed objective for this indicator is 50% of the land in rotation. On a provincial basis Nova Scotia had 80% of its rotation land in forages in 2001. This is encouraging, as it indicates the potential for all row crop and cereal cropped land to be rotated with perennial forages. On a national basis, only 30% of rotation land is in forages, which is well below the objective of 50%. This indicator should be developed further as more data become available to take into account the extent of actual rotation (i.e. is land used to grow row crops rotated into perennial forages at least 50% of the time?), as well as other means of building up soil organic matter (incorporation of manure, composts, residues, and cover crops).

Table 1 summarizes the methods of estimating the soil organic matter indicator.

Table 1: Summary of Soil Organic Matter Measures, Objectives, Results

Results available for Nova Scotia are marked with an asterisk.

Measure of Soil Organic Matter (SOM)	Objective	Range and Results[1]
Soil organic carbon (SOC) from soil samples or from modeling (e.g. Century Model) (% by weight or t SOC/ha). SOC x 1.7 = SOM	At least 3.8% SOM (or 2.2% SOC); no net long-term losses of SOC (some degraded soils will require net increases in SOC).	Soils range from 1-10% SOC; 0-29 t SOC/ha in top 15 cm; soils can have 53+ t/ha SOC. * Average losses of 23 kg C/ha on Eastern Canadian farms, 2000.
Average annual return of residues and livestock manure to the soil (t/ha)	Enough to ensure no net long-term losses of SOC, at a rate that prevents nutrient overloading.	Dependent on soil texture, condition, and cropping system. Data not available provincially.
Portion of farm land in rotation occupied by soil-building crops (perennial forage)	At least 50%	Farm land ranges from 0-100% * NS farms have achieved and surpassed the 50% objective as an average, although we do not know if the soil-building crops are adequately rotated with potentially soil-degrading crops.

It is expensive for a farmer who does not have livestock to replace lost soil organic matter. Purchased compost is costly, and replacing a cash crop with a forage will mean a reduction in net annual income. Local manure sources are the best way to replace lost soil organic matter because they supply crop nutrients as well as humus. Integration of livestock farms into crop producing areas of the province would be the most effective way to ensure that soil organic matter is maintained on all agricultural land, because these farms provide both manure and a demand for forage crops – both of which enhance soil organic matter content.

Table 2 summarizes examples of values associated with soil organic matter. The first is an estimate of the annual fertilizer value contributed by soil organic matter. If the soil organic

[1] References for figures listed in executive summary tables are marked in the report text.

matter were seriously depleted, approximately $102/ha per year in fertilizer would be required to compensate for the nitrogen and phosphorous it would have contributed to the crop. This value is not complete as it does not account for the other services, such as water retention and pest and disease control, which would have to be replaced if soil organic matter were lost. The second valuation outlines two methods of maintaining soil organic matter so that it is not lost in the first place (avoidance value). Integrating forage into a corn system may require a $70 per ha annual investment (lost income when corn is rotated with forages). Manure additions would bring net benefits of approximately $288 per ha per year due to the fertilizer-saving potential of the nutrients in manure. In this example, *avoiding soil organic matter loss is more economical than compensating for, or replacing it*. The third valuation in Table 2 estimates what it would cost to *replace* the soil organic matter if it were lost – a significantly higher investment of $682 per ha annually.

Table 2: Summary of the Value of Soil Organic Matter (SOM)

Results available for Nova Scotia are marked with an asterisk.

Valuation method	Stock of resources	Flow of resources
1. Partial estimate: N & P fertilizer required to compensate for the contribution of nutrients from SOM (compensatory value)	*$945 million (N fertilizer only)	*$17.5 million per year or $102/ha
2. Investment in maintaining SOC so it is not lost in the first place (5.8 t C/ha annual addition to the soil in crop residues and manure addition) (avoidance value)		*$70/ha annually in lost income to implement corn/forage rotation
		*$288/ha annual net benefit for spreading beef manure
3. Cost of replacing SOC lost by continuous vegetable cropping (5.8 t C/ha) annual addition to the soil (restoration value)		*$682/ha per year for purchased compost

Soil Structure

Good soil structure is an indication of soil quality. Soils with good structure are more productive due to better root penetration, more efficient uptake of water and nutrients, resistance to soil erosion, and a reduced need for energy during cultivation. Soil compaction is sometimes a result of soil structure deterioration. Inputs of soil organic matter are part of a comprehensive management strategy to reduce or prevent soil compaction. Minimizing trips around the field and reducing the pressure on soils by using ‘reduced ground pressure systems’ will also lessen compaction due to wheel traffic.

In Nova Scotia, farming practices may be increasing soil compaction. This trend seems to be a result of an intensification of row crop production in certain areas of the province and a reduction of area in tame pasture. Remediation of soil compaction requires a short-term investment, but adoption of methods to prevent further compaction should prove profitable in the long term due to improvements in nutrient use efficiency, reduced fuel costs, increased crop yields, and avoided climate change damages (many of these damages may already be affecting farm profitability). Table 3 outlines four ways to assess soil structure along with sustainability objectives.

Table 3: Summary of Methods for Assessing Soil Structure

Results available for Nova Scotia are marked with an asterisk.

Assessment methods – Soil structure	Objective	Range of values and results
Bulk density (g/cm^3)	Depends on soil texture Lower values are better	The bulk density of agricultural soils ranges from 1.0 to 2.0 g/cm^3
Soil aggregate stability (% 1-2 mm diameter in top 7.5 cm of soil)	Higher values are better	The aggregate stability of agricultural soils ranges from 0-17%
Porosity (% pore space in a soil)	Optimum values of about 50% are better than too little or too much	The porosity of agricultural soils ranges from 20 to 80%
Risk of soil compaction (McRae et al.,2000).	Increase area of soils under management that will reduce compaction	*Decrease in area of 18%
	Decrease area of soils under management that could cause further compaction	*Increase in area of 38.5%
		*Neither objective was met between 1982 and 1996

Table 4 summarizes the benefits of reducing or avoiding soil structure degradation. Yield benefits and increased efficiencies can to some degree offset costs incurred to avoid soil structure degradation. When farmers invest in good soil structure, society also benefits by reductions in greenhouse gas emissions (due to decreased nitrous oxide emissions from soil with good aeration).

Table 4: Summary of the Value of Soil Structure

Results available for Nova Scotia are marked with an asterisk.

Valuation method	Results
1. Direct benefits from non-compacted vs. compacted soils (Moerman, 1994)	* yield benefits of 10-15% * better rooting efficiency, fertilizer use efficiency, N-mineralization (increased by 22 kg N/ha)
2. Avoid compaction by rotation with forages (avoidance value)	* $125.50 per ha, annual cost for a corn production system
3. Avoid compaction by reduced ground pressure systems (avoidance value)	* $66/ha per year net benefit
4. Societal (off-farm) benefit of non-compacted soils due to reduced greenhouse gas emissions	* Between $74,518 and $2,039,440 in avoided global costs due to climate change.

Note: A combination of the two avoidance practices (items 2 and 3) may be required to maintain good soil structure.

In the long-term, it may be prudent to examine the province's cropping mix relative to livestock feed needs. A farmer may be very attracted to the income per hectare of grain corn or other row crop production, but that income must be adjusted to include the two or more years of soil-building crops required to remedy the soil damage that occurs when growing corn. Long-term maintenance of the soil's productive capacity may force us to consider feeding livestock relatively less corn and more forage. This question is examined more thoroughly in a forthcoming report specifically on Livestock Productivity and Health.

Soil Erosion and Conservation

The risk of soil erosion on cultivated land in Nova Scotia is high, due to the nature of our soils and topography, coupled with the high rates of precipitation in the spring and fall. Maintaining soil organic matter, reducing the speed of water movement over the land, and increasing water infiltration, can reduce soil erosion. This can be accomplished in the following ways: by incorporating forage crops into a row crop rotation; applications of manure to increase soil organic matter; conservation tillage; using vegetative cover strips; and contour farming. If soil is naturally formed at a rate of 1 t/ha per year, then losses of more than that will represent a degradation of the resource. Annual soil loss from row crops in Nova Scotia may be as high as 30 t/ha per year (equivalent to about 2 large dump trucks full, per ha), although average rates of soil loss on cultivated lands are estimated to be 6.3 t/ha per year.

Soil erosion is particularly evident where soil is used for row cropping, and where it is left bare over the winter. One way to conserve soil is to minimize the number of days a soil is left bare. The number of days the soil is left bare in a year (bare soil days) can be calculated to indicate progress towards reductions in soil loss. The number of bare soil days declined by 31% between 1981 and 1996 in Nova Scotia, a positive indicator of progress. The area in row crops in Nova Scotia in recent years has increased, while soil conserving practices such as the use of cover crops and conservation tillage are also on the increase.

Table 5 presents a summary of methods to track soil erosion and conservation. Sustainability objectives are proposed, and some trends are presented.

The use of some soil-conserving practices is clearly cost-effective for farmers (Table 6). Estimates of farm losses due to soil erosion are in the millions of dollars annually. It is significant that *incorporating manure and forages into a rotation has significant soil conservation value, with potentially no net cost*. Conservation tillage equipment is less expensive to purchase and maintain than conventional equipment. The implementation of contour farming practices represents a one-time expense for the farmer that will pay off in the long term with improved soil quality. The expenses associated with adopting soil-conserving practices will be more than offset by the reductions in damage costs due to soil loss experienced directly by the farmer.

Table 5: Summary of Methods for Assessing Soil Erosion and Conservation

Results available for Nova Scotia are marked with an asterisk.

Methods of assessing Soil Erosion & Conservation	Objectives	Range of Values and Results
1. Rate of erosion (cm depth or t/ha) determined by RUSLE or cesium 137 method.	- loss of no more than 1 t/ha annually - 6 t/ha/yr 'tolerable'	- 30 t/ha potato/cereal rotation - 20 t/ha potato/cereal/hay rotation * Nova Scotia average in 1991 = 6.3 t per cultivated ha (Statistics Canada, 1996)
2. Soil conservation practices		
- leaving crop residue on soil surface	As much as possible	*Up from 8% to 20% of crop area (1991-2001)
- planting cover crops so the soil is covered during high risk periods	As much as possible	One study showed soil erosion reduced by 83% *Down from 10% to 6% of crop area (1991-2001)
- strip cropping and terracing	As much as possible	Can reduce erosion by as much as 74% * Approx. 4% of crop area (2001)
- use of windbreaks and shelterbelts	As much as possible	* Approx. 7% of crop area (2001)
3. Number of bare soil days per ha per year (McRae et al., 2000)	Decrease in number of days soil is bare	*The average number of bare soil days (per ha, annually) has declined by 31% from 50 in 1981 to 34 in 1996.

Table 6: Summary of the Value of Soil Conservation

Results available for Nova Scotia are marked with an asterisk.

Direct Value	Results
1. Revenue and expense differences due to eroded soil in 1986	Yields 5-50% higher on non-eroded vs. eroded soils * $11.5 million annual farm losses due to eroded soil
2. Average annual cost of soil degradation (erosion and compaction) (1986)	
NS farms	* $64/ha of improved land (crop and tame pasture)
PEI farms	$99/ha of improved land
NB potato farms	$332/ha of potato land
Indirect Value	**Results**
3. Nutrient replacement of eroded topsoil (compensatory value)	* $682,500/year provincially
4. Increasing soil organic matter (avoidance value)	Incorporating manure ($288/ha net benefit) and forages ($70/ha cost) into a rotation potentially has no *net* cost.
5. Covering bare soil with hay mulch (avoidance value)	May reduce soil loss by as much as 40 times compared with bare soil, and costs $105-135/ha annually. * Covering all row crop area in NS would cost $1.6 million annually.

Table 6: Summary of the Value of Soil Conservation continued

Results available for Nova Scotia are marked with an asterisk.

Direct Value	Results
6. Conservation tillage (avoidance value)	Costs of conservation tillage are not different from conventional tillage: no net cost.
7. Strip cropping and terracing (avoidance value)	Costs range from $0 to $525/ha to implement (a one-time cost). * An estimated $3.1 million one-time cost for implementation on all 2001 row crop land in Nova Scotia.

Soil Foodweb Health

Soil foodweb analysis is a relatively new approach to describing soil health. The health of the soil foodweb has been proposed as an indicator of soil quality. The soil foodweb is the complex mixture of bacteria, fungi, protozoa, nematodes, and microarthropods that control the cycling of nutrients within an ecosystem. Bacteria convert additions of easily decomposable organic matter into humus. Fungi convert more recalcitrant organic matter, such as lignin, into humus. Protozoa feed on bacteria and release nutrients to the soil solution as a by-product of this activity. Nematodes and microarthropods consume both bacteria and fungi and also release nutrients to the soil solution.

The soil foodweb structure can be disrupted by excessive pesticide or fertilizer use, and by growing intensive field and row crops year after year. When the soil foodweb is out of balance, the soil's 'digestive system' doesn't work, decomposition rates are low, nutrients are not retained by the soil, and losses of nutrients to groundwater and surface water can result. It is no surprise that amending soils with composted manure or grass/legume residues not only increases soil organic matter, improves soil structure and reduces soil erosion, but also creates a healthier soil foodweb. Researchers and farmers have found that the use of manure, and the reduction of synthetic fertilizer and pesticide use, all contribute positively to soil biological activity. Several measures of soil biological activity can be used as part of the soil foodweb health assessment. These are summarized in Table 7.

Applications of animal manures are known to promote a healthy microbial population (and increase soil organic matter). In 2000, about 33% of Nova Scotian farm area that had fertility added received applications of manure, compared to only 7.5% nationally, while about 62% received synthetic fertilizer compared to 66% nationally. Thus NS farms are in a favourable position to enhance soil foodweb health with manure additions relative to Canadian farms as a whole.

Another indirect way to measure soil foodweb health is to assess the potential of livestock in the area to contribute manure to nearby soils. An evaluation of livestock concentration (Manure Anumal Units – MAU – per hectare) in Nova Scotia shows that there needs to be more livestock raised in many areas of the province in order to provide enough manure to keep the soil foodweb healthy.

Table 7: Summary of Soil Foodweb Health Assessment Methods

Results available for Nova Scotia are marked with an asterisk.

Methods to Assess Soil Foodweb Health	Objectives	Range of Values and Results
1. Ratio of fungal to bacterial biomass (F:B)	F:B ratios of less than 1.0	Forest soils: F:B >1.0 Prairie grassland soils: F:B<1.0
2. Soil organic carbon	See section on soil organic matter	
3. Number of earthworms per m^2 (top 15 cm of soil)	Higher values are better	0-200/m^2
4. Microbial biomass carbon (kg/ha, top 15 cm of soil)	Higher values are better	0-375 kg/ha (Glover et al.,2000) 111-1760 kg/ha (Carter et al., 1998) 226-474 kg/ha (Patriquin et al.,1986)
5. Microbial biomass nitrogen (kg/ha, top 15 cm of soil)	Higher values are better	0-100 kg/ha (Glover et al., 2000)
6. Area fertilized with manure	Higher values are better, as long as the rate of manure application is not excessive.	*33% of crop and tame pasture land in NS was fertilized with manure in 2000
7. Livestock concentration and distribution	1.7 to 3.3 manure animal units (MAU)/ha	*2 NS counties have MAU concentration in the desirable range. *Province-wide, the concentration is 0.87 MAU/ha, which is low

The value of a healthy soil foodweb is very difficult to quantify. A summary of estimated values associated with the health of soil life is presented in Table 8. Soil microorganisms perform a variety of ecosystem services including nutrient cycling, fixation and retention, purification of waste products, and detoxification of pesticides and chemicals, to name but a few. The rotation effect is one benefit attributed to a healthy soil foodweb. We can estimate that crop yields on land with a healthy soil microbial population are 10% higher than yields on land with poor soil health because of the competitive interactions between a diversity of soil microorganisms, which prevent the proliferation of deleterious rhizobacteria.

Investing in the maintenance of a healthy soil foodweb by applying manure annually should not be expensive if a manure source is locally available. Using perennial forages in a crop rotation when manure is not available will benefit the cash crop farmer through reductions in disease and pest problems, reduced fertilizer costs, and the maintenance of sustained yields of valuable crops. The current system of accounting does not place adequate value on soil quality – our natural wealth – or on perennial forage crops, which can maintain and enhance soil quality. This omission makes such forage crops appear to be an uneconomical approach to soil foodweb maintenance in the short term. This is misleading. If our natural wealth were properly and fully valued, there would be financial incentives to support such investments.

The estimates in Table 8 show again that preventing soil quality deterioration may have no net cost if manure is spread. Incorporating forage into the crop rotation would require Nova Scotia farmers to invest about $8 million annually (depending on the farm system), but will likely yield benefits that are close to or surpass the costs of avoiding the problem in the first place (possibly $6 to 14 million annually).

Table 8: Summary of Foodweb Health Values

Results available for Nova Scotia are marked with an asterisk.

Valuation method	Value	Net result
1. Microbial biomass carbon yield effect (direct value)	$0.50/kg of microbial biomass C	*$6.0 million benefit per year for all crop land, 2001
2. Microbial biomass – yield effect (direct value)	10% of crop value lost if microbial biomass is degraded	*$14.0 million benefit (10% of crop receipts for 1999) per year.
3. Application of livestock manure at 2t dry matter per ha (avoidance value)	$10/ha to spread, $26/ha in nutrient benefit	*No net cost
4. Incorporating forage into the cropping rotation (avoidance value)	See SOM section	*$70/ha per year in lost income multiplied by 119,219 ha crop land = $8.3 million annual investment required

Estimates shown here for all the indicators of soil quality and productivity have the same pattern. Investing in the soil to avoid degradation will pay greater dividends in terms of productivity. Attempts to compensate for soil degradation, or replace productive capacity will often be more expensive than the cost of avoiding the problem in the first place, especially in the long run, as we will see in the next section.

Long Term Soil Quality and Productivity Studies

Most of the discussion in the previous sections assumes a short time frame for benefits and costs of maintaining soil quality and productivity. In this section, a number of multiple-year studies are reviewed to assess the long-term effects of soil management. The longest-running study reported here is 122 years in duration, and the shortest studies are 10 years.

Long-term field studies (of 10 or more consecutive years) indicate the value and contribution of organic matter to long-term productivity, and the increasing costs over time of allowing a soil to become degraded. Since soils differ considerably in their inherent ability to withstand practices such as continuous cropping, it is necessary to interpret studies and trends based on indicators of one soil relative to itself, rather than relative to another soil. Many soils in Nova Scotia are inherently shallower, more acid, and more easily degraded than the soils studied in some of the reports summarized below. Keeping this in mind, the long-term studies are nevertheless instructive, as they indicate that pushing a soil too hard today may have serious ramifications in the future.

The studies reviewed here measure some indicators of soil quality and productivity, such as soil organic matter (organic carbon) levels, bulk density (a measure of soil structure), soil erosion, and soil foodweb health. A summary of soil quality and productivity indicators, their measures, and proposed objectives are presented in Table 9 for reference when discussing study results.

Table 9: Summary of Soil Quality and Productivity Indicators

Indicator	Measure	Objective
Soil organic matter (SOM) or soil organic carbon (SOC)	% soil organic matter by weight	3.8%
	% soil organic carbon by weight	2.2%
	t SOC / ha	No net loss over time, in some cases net gain may be necessary
	(SOM= SOC * 1.7)	
Soil structure	Bulk density (g/cm^3)	Lower values are better
	Soil aggregate stability (various units)	Higher values are better
	Porosity (%)	Optimum values of about 50% are better than too little or too much
Soil erosion	Rate of erosion (tonnes/ha)	Less than 1 t/ha per year. 6 t/ha is considered to be 'tolerable'
	Topsoil depth	No net loss, prefer gain.
Soil foodweb health	Ratio of fungal to bacterial biomass (F:B)	F:B<1.0
	Soil organic matter or carbon (SOM, SOC)	See SOM above
	Number of earthworms per m^2 (top 15 cm of soil)	Higher values are better
	Microbial biomass carbon (kg/ha, top 15 cm of soil)	Higher values are better
	Microbial biomass nitrogen (kg/ha, top 15 cm of soil)	Higher values are better

The pattern that emerges from the studies is that soil quality and productivity is often based on two critical factors: the application of manures and integration of grass/legume forages into the rotation. Synthetic fertilizer can be beneficial to soil quality and productivity indicators in the short-term if it increases the crop biomass and consequently the residues returned to the soil. However, longer-term comparative studies demonstrate that synthetic fertilizer treatments have the potential to have a cumulative negative effect on yield, crop quality, and soil quality if not used in combination with crop rotation and organic matter inputs.

Often it is the combination of manure applications and perennial forage rotation that keeps a soil productive over the long-term, not either of these methods alone. Long-term studies demonstrate that soil biological activity (soil foodweb health) is consistently greater where manure is applied, and synthetic pesticides and fertilizer avoided.

Experience of Soil Quality and Productivity in Kings County

Comments and examples from farmers in Kings County, Nova Scotia about soil quality and productivity are presented below.

Comments:

"I can't say that we have been the best stewards. We lose a lot of soil in the ditch and the pond. I don't like to see it."
-Kings County pork and poultry farmer.

"I feel very personal about all of our land. I want to build it up in quality. Luckily this isn't too hard since it was mostly forage and orchard…"
-Kings County mixed farmer.

"…Erosion is the difficult thing. The problem is there isn't much animal agriculture in the Valley anymore and not much money in hay. We could have a rotation of sod, but in the Valley the climate lends itself to vegetable production. Really we need [ruminant] animals for hay rotation and manure."
-Kings County poultry and vegetable producer.

"… We struggle to do the right things…. We have a responsibility to maintain our agricultural and land resources. The burden on farmers is unfair."
-Kings County vegetable farmer.

"Organic people are bringing out the importance of maintaining the soil and the environment around us. We should have an awareness of these. We have changed practices and are evolving to reflect this new thinking. But there is so much information that it is hard to keep up."
-Kings County vegetable farmer.

"Do you know who is the biggest [soil] eroder? Man. With every house built that land is lost. It can never go back into agricultural land, as with every highway."
-Kings County vegetable farmer.

"There is no question but that land is alive. All in a life cycle…. To have productivity you have to have life for the breakdown process. We have been lucky… we have 18 [inches of topsoil]. That's why people are practising minimum till or no till. To preserve this topsoil."
-Kings County poultry farmer.

"Valley farms are losing the livestock sector and I'm concerned about the need for diversity. It would be ideal to turn the soil back into sod for two to three years [between annual crops], and crop rotation is really important. The reason I pay attention to soil organic matter was the soil erosion and yield losses I saw with continuous potatoes… the soil around Canning has been really depleted over time."
-Kings County pork, grain, & beef farmer.

"In general, soil organic matter is increasing due to green manure use, although it is more challenging to build up in sandy soils. We are developing an understanding of how to work it better."
-Kings County poultry and field vegetable farmer

"Organic matter is incorporated routinely. Plant health, weed, insect, and bird life are all used as indicators of soil quality. It's been a modest, slow process, with noticeable improvement."
-Kings County mixed farmer.

"Soil organic matter is building up slowly with the use of composted manure and green manures. It's a slow process."
-Kings County dairy farmer.

"The purpose of farming is to increase the resource; the crop is a by-product."
-Kings County garlic grower.

Examples:

Soil organic matter levels range from 1-2% (low) in some areas, and 3-4% (good) in others. Corn stalks, wheat stubble, and green manures are used to increase soil organic matter. High soil organic matter helps to retain calcium in the soil.
-Kings County pork, grain, & beef farmer.

In the past, up to 50% of the soil was left bare, because one main crop was harvested late, with no time to establish a green manure. Now 20% is left bare because they no longer grow that crop. On 35 acres, straw was used to cover the soil over the winter.
-Kings County poultry and field vegetable farmer

Composted manure and green manures have been used to improve soil. No synthetic fertilizers or pesticides have been used for 11 years.
-Kings County dairy farmer.

The yields were low initially, but now the crops are 70% or better than they were before no-till. No-till saves on tilling costs and decreases soil compaction.
-Kings County pork, grain, & beef farmer.

Although the comments and experience of this small sample of farmers may not adequately represent farming in the county, it does show how much these producers are doing to learn about and preserve soil quality. They see it is in their interest to do so. Because average figures on a provincial or national basis do not show the wealth of interesting detail, thought, caring, and innovation that are evident on a daily basis at the farm level, this short section of personal comments is useful to supplement the statistical analysis in this report.

There are some documented negative trends in soil quality and productivity on Nova Scotia farms, such as declines in soil organic carbon, potential soil structure problems, increased rates of erosion, and inadequate integration of livestock into cropping areas. However, we have also documented that Nova Scotia farms have good potential for enhancing soil quality and productivity relative to the average figures for Canada. On average, farmers have a good proportion of farm land in perennial forages, which is encouraging, as long as these perennial forages are being rotated with the annual crops. It is obvious from the comments above that growers have a vested interest in keeping their soil productive, but the decline of livestock farming in the areas most suited to potentially soil-degrading row crops is a major stumbling block for all soil quality and productivity indicators.

By estimating the value of the investments required to maintain soil quality, it is apparent that measures taken to avoid soil quality problems will cost less than the losses suffered as a result of soil quality problems, or attempts to replace what is lost. Long-term studies show that compensating for lost soil quality and productivity by using synthetic fertilizer may create accumulated problems and expenses that only become apparent after a number of years.

It is very important to track trends in soil quality and productivity over a long time period, as soil is the foundation of our productive wealth and represents our potential to produce food for generations to come. If society cares about farmers and local food production, farmers, in turn, will more likely have the resources to care for the land.