MacDonald, K. B., W. R. Fraser, F. Wang, and G. W. Lelyk. 1995. A Geographical framework for assessing soil quality. Chapter 3 In: *The Health of our soils : Toward sustainable agriculture in Canada*; Pp.19-30. D. F. Acton, and L. J. Gregorich, editors. Ottawa, ON, Canada: Centre for Land and Biological Resources Research.

Information on soil, landscapes, and climate was used to assess inherent soil quality for the Prairie Provinces and southern Ontario, Canada. Actual land use in the Prairie Provinces was estimated using satellite images and the 1991 Census of Agriculture. An **index of inherent soil quality (ISQ)** was developed by ranking soils according to four elements that determine their ability to produce crops: soil porosity, nutrient retention, physical rooting conditions, and chemical rooting conditions. An index of soil quality susceptibility based on soil-landscape and census information was developed to locate areas that are at risk of soil degradation as a result of land use and management practices were identified. Most agricultural land in the Prairie Provinces is classified as good using the ISQ. Limitations to crop production in the region were associated with areas that are dry or saline. Areas most vulnerable to declining soil quality were those under intensive summer fallow. Parts of southern Ontario were at risk of declining soil quality because of intensive cropping. Trends in land use and management practices are discussed. *--CAB Abstracts.*

Inherent soil quality
We developed an **index of inherent soil quality (ISQ)**, which ranks soils according to four elements that determine their ability to produce crops, as follows:

soil porosity (providing air and water for biological processes)
nutrient retention (retaining plant nutrients)
physical rooting conditions (promoting root growth as a result of certain physical characteristics)
chemical rooting conditions (promoting root growth as a result of certain chemical characteristics).

Data for these four elements came from existing land resource inventories. Each ISQ element was rated at one of four levels (good, good to moderate, moderate to poor, poor). Areas with the most restrictive ISQ rating (poor) are best-suited for perennial crops, such as forages, and for grazing. Areas with ISQ ratings better than poor are suitable for annual crops. Inherent soil quality ratings can be used to assess the status of soil quality and to make comparisons between regions. Note that, because they are based on information collected over a number of years, these ratings do not provide a current "snap-shot" of soil health but rather give an overall impression of a soil's capacity to produce crops.
Specific ISQ ratings, however, can be used to determine soil health by interpreting the possible effects of degradative processes. --Authors' Introduction. From URL: http://res2.agr.gc.ca/publications/hs/index_e.htm

Maddonni, G. A., S. Urricariet, C. M. Ghersa, and R. S. Lavado. 1999. Assessing soil quality in the Rolling Pampa (Argentina), using soil properties and maize characteristics. Agronomy Journal 91, no. 2: 280-287.

Edaphic and/or plant indicators suitable for assessing soil quality with regard to functioning as a medium for crop production were investigated. Nine fields with Typic Argiudoll soils were selected for evaluation based on agricultural history and apparent soil structural stability. Soil chemical and physical properties and maize vegetative and reproductive characteristics were measured. Multivariate statistical analyses were applied to the data to determine potential indicators of soil quality. Soil and crop variables explained more than 70% of the variance in soil quality among agricultural histories. The edaphic indicators that showed the greatest change from pristine conditions were organic C, total N, P, Mg, K, B, Ca, and Zn contents and cation exchange capacity. Using crop variables, leaf length, maximum fraction of intercepted photosynthetically active radiation, grain yield, kernel number, prolificacy, and total dry matter at physiological maturity, served to establish a soil quality gradient. Variation of maize growth was associated with edaphic indicators of soil quality and showed the importance of soil aggregate stability in determine changes in soil quality for crop production. --CAB Abstracts.

Magdevski, S. 2001. Soil quality: the nematodes know. Futures (East Lansing) 18/19, no. 3&1/3: 9-10.

The role of soil nematodes as soil quality indicators, and the management of these beneficial organisms, are briefly discussed. Examples of plant parasitic nematodes are mentioned. --CAB Abstracts.

Mandal, D. K., C. Mandal, and M. Velayutham. 2001. Development of a land quality index for sorghum in Indian semi-arid tropics (SAT). Agricultural Systems 70: 335-350.

The present study demonstrates the development of crop specific land quality index (LQI) for sorghum [sorghum bicolor (L.) Moench] under semiarid tropics of India. The method developed as LQI is a function of climatic quality index (CQI) and soil quality index (SQI). The CQI defined as growth index was derived

from the compound product of water satisfaction index and radiation index. The SQI was developed as multiple attributes of soil properties related to sorghum suitable soil quality such as soil depth, available water capacity (AWC), drainage and slope. The LQI was correlated with the actual sorghum yield obtained from benchmarks soils and it was found that LQI bears good agreement with the yield. From the yield correlation, the LQI class has been fixed as LQI value <1.0 rated as high, 1 1.5 as moderate and > 1.5 as low corresponding to the maximum attainable yield of > 50%, 40 50% and less than <40%, respectively. The study also indicated that CQI value of <0.25 and SQI value of <5 correspond to good sorghum growing area. Finally, the isoline maps of CQI and SQI maps were superimposed through TYDAC SPAN GIS system to arrive at LQI class map. The map indicates that out of a total area under sorghum (11.7 m ha), 43% falls under high LQI class, and 38% under moderate, and 19% under low LQI class. The moderate and low LQI areas need proper rehabilitation measures for increasing sorghum yield. The LQI developed may help in planning and management of soils not only under Indian SAT but also in areas of similar soil and climatic conditions occurring elsewhere. *--Authors' abstract.*

Martyniak, J., and D. Martyniak. 2002. The Natural and anthropogenic condition for regionalization of red fescue seed production in Poland // Original Title: Przyrodnicze i antropogeniczne uwarunkowania rejonizacji uprawy kostrzewy czerwonej na nasiona w Polsce. Biuletyn Instytutu Hodowli i Aklimatyzacji Roslin 223/224: 203-212.

This Polish study developed a "soil quality estimate index" as a rating tool to relate land areas (on a map) to suitability for the crop production of red fescue seed. [Polish language precludes full analysis of this article; requires translation.]

Masera, O. R., M. Astier, and S. Lopez Ridaura. 1999. Sustentabilidad y manejo de recursos naturales: el marco de evaluacion MESMIS.GIRA, Mundi-Prensa e IOnstituto de Ecologia-UNAM, Mexico.

McBratney, A. B., and I. O. A. Odeh. 1997. Application of fuzzy sets in soil science: fuzzy logic, fuzzy measurements and fuzzy decisions. Geoderma 77, no. 2/4: 85-113.

This paper explains, in-depth, the applicability of 'fuzzy set (Gaussian)' mathematics to soils numerical analyses. It includes good explanation of the Semantic Import model, and is important in the use and development of SQ Indexing, or to the modelling of soil physical properties in spatial/image analysis; & multi-attribute decision making (ie. decision support systems theory). {It ties together/explains the statistical techniques used or discussed in various recently-published soil quality articles.--ch notes] (See p.109 re indicators and "a soil agglomeratic index.")

McQuaid, B. F., and G. L. Olson. 1998. Soil quality indices of Piedmont sites under different management systems. Chapter In: Soil processes and the Carbon cycle; Pp. 427-434. R. Lal, J. M. Kimble, R. F. Follett, and B. A. Stewart, editors. Boca Raton, FL: CRC Press.

Mohr, D., F. Nicolini, and W. Topp. 2002. Are microbial parameters reliable indicators for soil quality? A synthesis of field studies and laboratory studies // Sind mikrobielle Parameter verlassliche Indikatoren fur Bodenqualitat? Eine Synthese aus Freilanduntersuchungen und Laborversuchen. [LA=German] Presented at Workshop Kommission III 'Bodenbiologie', 7-9 October 2002, Neuherberg/Munchen, Germany. *Mitteilungen Der Deutschen Bodenkundlichen Gesellschaft* 99: 163-164.

Monréal, Carlos. 2001. "Crop production systems and sustainability of agricultural landscapes in Manitoba." [MRAC R&D projects], AAFC/MRAC. From URLs:
http://www.mrac.ca/index.cfm/fuseaction/prj.details/ID/093A330F-A1FB-3347-85E477EAD487A74C/index.cfm ; http://www.mrac.ca/research/indexprojects.htm

A CAIP R&D Program; Project Duration: October 1, 1998 - October 31, 2001
Total Project Cost $200,000.00 Project Objectives

1) To assess the impact of various crop production systems on the present and long-term sustainability of crop and soil productivity in two agricultural landscapes.
2) To determine the impact of various crop production systems on soil carbon dioxide gas production and the capacity of these soils to capture CO2 gas in two agricultural landscapes.

Project Description:
The planned activities were carried out at two sites in an undulating glacial till landscape, one south of Bagot, MB and one north of Minnedosa, MB. Sampling, biological and chemical analysis have been completed. Surface soil samples were collected for soil erosion assessment using the Cs dating methodology.
Observations and Conclusions:

The first objective focused on soil productivity as a component of sustainability of management systems. This issue was pertinent to the comparison of management practices, primarily tillage, at the Minnedosa site. Although **soil quality indices** were compared between phases of a rotation at the Bagot site, these comparisons represented successive, not alternate, practices within a single management system. At the Minnedosa site, the differences in soil quality observed between the two fields with contrasting tillage practices were less than anticipated from small-plot studies. Of the 11 soil quality indices measured, only dehydrogenate activity clearly differed between fields, with greater activity in the conventionally tilled field. Interpretation of this observation must consider that "greater" is not necessarily "better". Rather, in the context of sustainability this observation indicated more rapid turnover and/or supply of a labile soil organic matter fraction. Such interpretation is consistent with promotion of biological oxidation of soil organic matter by tillage, and the identity of no-till as a conservation practice in small-plot studies. Differences in soil organic C mass between fields were addressed in subsequent discussion of the second objective. As previously stated, topography, not management practice, was the principal determinant of soil quality at this site. Furthermore, the comparison was based on the entire A horizon, which extended below the tillage layer in the conventionally tilled field and the layer of soil organic matter accumulation in the no-till field. It is important to reiterate that these results indicated that soil quality at sites such as Minnedosa must be assessed and managed within a topographic/hydrologic framework. They point to precision-farming as a tool for managing soil quality, in addition to crop productivity. From:www.mrac.ca/research/indexprojects.htm -- *AskJeeves Online abstract; MSN online abstract.*

Montréal Process Working Group [1998]/, and Canadian Forest Service. 2001-2003. *The Montreal process: Year 2000 Progress Report* . From URL: http://www.mpci.org/rep-pub/2000/rep2000_e.html **;**

Vignette on Canada at URL: http://www.mpci.org/rep-pub/2000/rep2000_e.html#v3

The Montréal Process is the Working Group on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests. It was formed in Geneva, Switzerland, in June 1994 to develop and implement internationally agreed criteria and indicators for the conservation and sustainable management of temperate and boreal forests.
"Criterion
· A category of conditions or processes by which sustainable forest management may be assessed.
· A Criterion is characterized by a set of related indicators which are monitored periodically to assess change.
Indicator
A measure (measurement) of an aspect of the criterion. A quantitative or qualitative variable which can be measured or described and which, when observed periodically, demonstrates trends.
Montréal Process Criteria
The Montréal Process Working Group agreed on a framework of criteria and indicators that provide member countries with a common definition of what characterizes sustainable management of temperate and boreal forests. The framework identifies seven criteria that are further defined by 67 associated indicators which are aspects of the criteria that can be identified or described. "
--URL: http://www.mpci.org/whatis_e.html accessed Sept.09/03 --clh.

Mueller, Paul, Nancy Creamer, Mike Linker, Frank Louws, Mary Barbercheck, Cavell Brownie, Michael Wagger, Michele Marra, Shuijin Hu, Charles Raczkowski, and Joan Ristaino. 2001. Federal projects: Long-term, Large-scale systems research directed at Agricultural sustainability. $230,000. USDA SARE.

Projects implemented by CEFS Faculty since 1997 [PDF/Adobe Acrobat]
This project is the second, three-year grant for the major farming systems experiment at CEFS. Initiated in 1998, the farming systems project encompasses 200 acres, and compares five diverse systems: a BMP short-rotation cash-grain system, an organic production system, an integrated crop/ animal system with a 15 year rotation, a forestry/woodlot system, and a successional ecosystem. The experiment is slated to continue in perpetuity. A wide range of parameters is being measured. These include: above-ground biomass of cover and cash crops, nutrient/energy flows, decomposition, **soil quality indices (physical, chemical, biological)**, soil microbiology, microarthropods, entomopathogens, insects, weeds, disease, crop yield and quality; and,

economics."
--*Web resource at URL: http://*www.cefs.ncsu.edu/federalprojects-COLOR1.pdf -- *MSN online abstract.*

Murage, E. W., N. K. Karanja, P. C. Smithson, and P. L. Woomer. 2000. Diagnostic indicators of soil quality in productive and non-productive smallholders' fields of Kenya's Central Highlands. *Agriculture, Ecosystems & Environment* 79, no. 1: 1-8.

A study was conducted to identify indicators of soil fertility status that are consistent with farmers' perceptions of soil fertility. Physical, chemical and biological properties of soils (Kikuyu red clay, Humic Nitisols) were measured from paired fields identified as either productive or non-productive by 12 farmers and compared to findings of a household survey on soil fertility management. Special attention was given to the potential of different soil organic matter fractions to serve as diagnostic indicators of soil fertility. Farmers' criteria for distinguishing soil productivity included crop performance, soil tilth, moisture and colour and presence of weeds and soil invertebrates. All farmers attributed low fertility to inadequate use of organic and inorganic fertilizers (100%) and removal of crop residues (100%). Other causes included continuous cropping (83%), lack of crop rotation (66%) and soil erosion (42%). Productive soils had significantly higher soil pH, effective cation exchange capacity, exchangeable cations, extractable P and total N and P than non-productive soils. Total organic C and several estimates of soil labile C including particulate organic C (POC), three Ludox density separates of POC, KMnO4-oxidizable C and microbial biomass C were significantly greater in productive soils. Soil microbial biomass N, net N mineralization and soil respiration were also significantly higher in productive soils. Soil microbial biomass N, net N mineralization and soil respiration were also significantly higher in productive soils. Farmers' perceptions of soil quality were substantiated through soil chemical analyses and soil organic matter fractions provided precise information on these differences. The similarity of soil physical properties in productive and non-productive fields suggests that differences in chemical and biological indicators may have resulted, in part, from smallholders' management and are not inherent properties of the soils. --*Authors' abstract.*