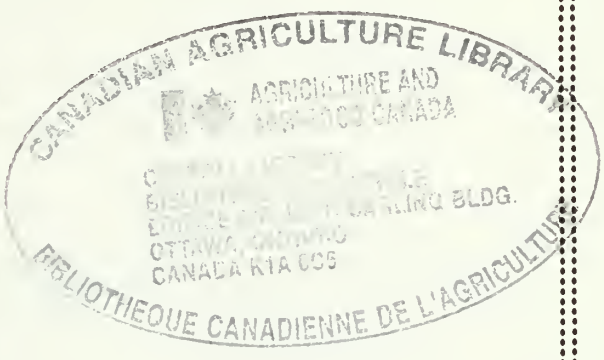
Agri-Environmental Indicator Project : summary of activities in fiscal-year 1995-1996 / prepared by Ranjan Banerjee

AGRI-ENVIRONMENTAL INDICATOR PROJECT



Agriculture and Agri-Food Canada

SUMMARY OF ACTIVITIES IN FISCAL-YEAR 1995-1996

Prepared by:

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On behalf of the Environmental Indicator Working Group
of Agriculture and Agri-Food Canada

April 1996

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1.0 The Agri-Environmental Indicator Project-- A Brief Overview.

The Agri-Environmental Indicator (AEI) Project was initiated in 1993 by Agriculture and Agri-Food Canada in response to recommendations made by several groups, including: the Federal/Provincial Agriculture Committee on Environmental Sustainability (1990), the Green Plan (1990), the Canadian Agri-Food Research Council (1992), and the Auditor General of Canada (1993). All of these recognized a fundamental need to further develop the information base available to decision-makers on environmental conditions and trends in Canadian agriculture.

The AEI Project is focused on six indicators and their associated components: soil degradation risk; risk of water contamination; agroecosystem greenhouse gas balance; agroecosystem biodiversity change; input use efficiency; and farm resources management. Each indicator is described in Appendix 1. The indicators are being developed to assess the degree to which key agri-environmental issues are being addressed and objectives met, help identify areas and resources at risk, help design and target strategies and actions, and to facilitate communication among stakeholders, and between stakeholders and policy-makers.

Implementation of the project is coordinated by an InterBranch Environmental Indicator Working Group which reports to the Departmental Management Committee (DMC) through the Policy Branch. Environment Canada, Statistics Canada and the National Agriculture Environment Committee (NAEC) also participate in this working group. Currently, the project is in a methods development phase and ouputs are released periodically in the form of progress reports and technical papers. A comprehensive report to be released in 1998 will update the indicators using data from the 1996 Census of Agriculture and other sources.

This report summarizes the key activities pursued within the AEI Project in the period from 1 April 1995 to 31 March 1996.

2.0 Project Management Activities within Agriculture and Agri-Food Canada.

The following project management activities were conducted within Agriculture and Agri-Food Canada.

- The Environmental Indicator Working Group held 6 meetings during the course of the year. Major agenda items dealt with:
  - Restructuring of the project to reflect the recommendations made by participants at the Second National Consultation Workshop on Agri-Environmental Indicators for Canadian Agriculture, held in Fredericton, New Brunswick on 9-10 February 1995.
  - Completing a project work plan.
  - Coordinating indicator development activities.
  - Implementing a mechanism for stakeholder consultation.
  - International activities related to agri-environmental indicators.

- A workshop for the principal investigators and managers in AAFC involved with the AEI Project was held on 11-12 May 1995. Workshop participants identified and discussed project deliverables and outputs, opportunities for collaboration among researchers, issues common to all of the indicators and next steps for the AEI Project.

- In September 1995 the AEI Project was further considered by the DMC. Continued work leading to full implementation of the project was endorsed, including establishment of a multi-stakeholder Project Advisory Committee.

- In October 1995, the project work plan, **Description of Indicators and Project Activities and Outputs to 1998** (see Appendix 2), was released. This work plan describes the activities and outputs for the AEI Project and was prepared by the Environmental Indicator Working Group of AAFC in July 1995 and subsequently endorsed by the DMC in September 1995.

- An electronic listserve was established in February 1996. This is being used by the Environmental Indicator Working Group to facilitate communication and consultation on the project within the Working Group. This listserve will be expanded to include other AAFC staff involved with the project.

- A publication series for reports generated through the AEI project was established.

3.0 External Liaison and Consultation Activities.

The following external liaison and consultation activities were carried out by Agriculture and Agri-Food Canada.

- Meetings were held with the National Agriculture Environment Committee (NAEC) in the spring of 1995 to discuss its views on the developement of AEIs. This process culminated with NAEC's endorsement of AEI Project in May 1995.

- B. MacDonald, T. McRae, and C. de Kimpe met with representatives of the Crop Protection Institute in June 1995 to discuss general aspects of the AEI Project and the Indicator of Risk of Water Contamination.

- A preliminary draft Environmental Indicator Bulletin for agriculture was prepared by Environment Canada's State of the Environment Directorate in autumn 1995 (in its capacity as lead federal agency for the National Environmental Indicators Series). The draft bulletin focused on the following indicators: agricultural land use, soil residue cover, risk of soil erosion by water, risk of soil erosion by wind, and risk of soil salinization. The draft bulletin was derived from research reported in the report - "The health of our soils - towards sustainable agriculture in Canada" (released by AAFC's Research Branch in July 1995) and by other AEI Project documentation. Input to the draft bulletin was provided by the AAFC researchers developing the specific indicators

and the draft Bulletin was reviewed by other AAFC staff involved with the AEI Project. Work by Environment Canada on the draft bulletin is ongoing.

- A multi-stakeholder AEI Project Advisory Committee was established and held its first meeting in December 1995. Committee membership (see Appendix 3) includes representation from agricultural producers, farm organizations, academia, environmental organizations, farm input manufacturers, and government agencies (federal and provincial). The Committee's mandate, which extends to the completion of the comprehensive report on AEIs in 1998, is to advise AAFC on the development and reporting of AEIs to ensure their relevance, objectivity, and credibility.

- AAFC participated in a process to identify a preliminary set of indicators for reviewing Canada's progress in meeting its national greenhouse gas commitments (stabilization of emissions at 1990 levels by the year 2000). This process was established by the National Air Issues Coordinating Committee (NAICC) and is being implemented by the Sub-Group on Climate Change Performance Indicators (SGCCPI) of the NAICC's Socio-Economic Analysis Task Group. A draft document outlining potential indicators was prepared and circulated within AAFC and to the National Agriculture Environment Committee and the Canadian Fertilizer Institute for review. Comments obtained were relayed to the SGCCPI.

4.0 International Activities.

AAFC participated in the following international activities focused specifically on environmental or agri-environmental indicators.

- The Organisation for Economic Cooperation and Development (OECD) is pursuing an activity to develop agri-environmental indicators. AAFC participated in the OECD initiative by:
  - attending two meetings (June and December 1995) of the OECD Joint Working Party on Agriculture and the Environment, which is overseeing the OECD's AEI Program.
  - contributing to an OECD pilot survey of AEI development activities underway within OECD member countries.
  - chairing an OECD consultation meeting on AEIs in October 1995.
  - reviewing and commenting on several versions of the core OECD document on AEIs, **Developing a Set of OECD Agri-Environmental Indicators**.

- A paper prepared by T. McRae, N. Hillary, R.J. MacGregor, and C.A.S. Smith, **Role and Nature of Environmental Indicators in Canadian Agricultural Policy Development** (see Appendix 2), was presented at the Symposium of the Resource Policy Consortium on Environmental Indicators on 12 June 1995 in Washington, D.C.

- Two papers related to the AEI Indicator project were presented at the North American Workshop on Monitoring for Ecological Assessment of Terrestrial and Aquatic Ecosystems, held in September 1995 in Mexico.
  - T. McRae, N. Hillary, R.J. MacGregor and C.A.S. Smith, **Design and Development of Environmental Indicators With Reference to Canadian Agriculture** (see Appendix 2).
  - C.A.S. Smith, **Research and Development Needs in Monitoring Agro-Ecosystems in Canada** (see Appendix 2).

- An OECD paper on biodiversity indicators, **OECD Core Set of Environmental Indicators--Biodiversity and Landscape**, was reviewed.

5.0 Progress on the Development of Individual Indicators.

This section briefly outlines activities to develop individual indicators and their components, including meetings held, outputs achieved, and future activities.

5.1 Soil Degradation Risk

- Activities:
  - Deliverables were produced by the Centre for Land and Biological Resources Research (CLBRR) Soil Degradation Study team.
  - Water Erosion Risk: a standardized approach to producing water erosion risk maps for Canada was implemented using Enumeration Area data processed for 1981 and 1991 on a Soil Landscapes of Canada (SLC) polygon basis. Methods and data were archived in preparation to process 1996 Census data. Census data will be incorporated as soon as they are available in 1997.
  - Salinity Risk: salinity risk maps for the prairie provinces were calculated using a standardized land use database for the years 1981 and 1991.
  - Wind Erosion Risk: wind erosion risk maps for prairie provinces were completed and archived in preparation for processing of 1996 Census data. Data on wind and water erosion risk were provided to Environment Canada for inclusion in the Environmental Indicator Bulletin on agriculture that is under development.

- Outputs:
  - Water erosion risk maps for all of Canada on an SLC polygon basis for 1981 and 1991.
  - Wind erosion risk map for the prairie provinces on an SLC basis for 1981 and 1991.
  - Revised soil salinity map of the prairie provinces on an SLC basis for 1981 and 1991.
  - Data for the draft Environmental Indicator Bulletin on agriculture..

- Meetings:
  - Agri-Environmental Indicators Workshop, Ottawa, May, 1995.
  - CLBRR Unit Head's Meeting, Ottawa, November, 1995.
  - Soil Quality Assessment for the Prairies (Canada-Alberta Environmentally Sustainable Agriculture Agreement) Workshop, Edmonton, January 1996.
  - CLBRR Soil Degradation Study Planning Workshop, Edmonton, March 1996.

- Future Activities
  - Work to finalize the presentation of the Environmental Indicator Bulletin on agriculture is ongoing and expected to be completed in the upcoming fiscal year.
  - A soil erosion risk trend analysis report is being prepared and is expected to be completed in the fall of 1996.
  - New activities toward the development of an organic matter quality and quantity indicator will begin in fiscal year 1996/97.

LEAD INVESTIGATORS:

Soil Erosion - Wind, Water

-Dr. G. Wall, Harrow Research Station

Soil Organic Matter

-Dr. C. Monreal, Eastern Cereal and Oilseeds Research Centre (ECORC)

-Dr. H. Dinel, ECORC

Soil Salinization

-Dr. R.G. Eilers, Brandon Research Station

5.2 Risk of Water Contamination

- Activities:
  - Methodology as proposed in the Working Draft **Indicators of Risk of Water Contamination: Methodological Development** (see Appendix 2) was reviewed in detail by the technical team and revised for implementation.
  - Census of agriculture data for 1981 and 1991 were compiled by ecodistrict. Members of the technical team are currently grouping the land use figures into representative farming systems with documented levels and kinds of inputs. Maps of the ecodistricts in each region were prepared to accompany the data.
  - Preliminary definition of crop rotations have been compiled for Ontario and the procedures used documented and circulated to the technical team for revision and comment.
  - Work is proceeding in the Maritimes, Quebec, Ontario, and British Columbia to compile and model information on small watersheds to provide validation for the national level indicator.

- Outputs:
  - There were no specific outputs from the 1995/96 year.

- Meetings:
  - Technical team meeting, Ottawa, May 1995.
  - Environmental Indicators Workshop, Ottawa, May, 1995.
  - Meeting with Crop Protection Institute of Canada (T. McRae, B. MacDonald and C. de Kimpe), June 1995.
  - CLBRR Unit Head's Meeting, Ottawa, November 1995.
  - Meeting with CLBRR scientists, Ottawa, February 1995. The purpose of this meeting was to collaborate on the calculation of moisture balances for Ontario.

- Future Activities:
  - Hold a technical team meeting in 1996.
  - Meet with the AEI Project Advisory Committee, June 1996.
  - Prepare a report, revised procedures and maps showing the Indicator of Risk of Water Contamination related to nitrogen.
  - Incorporate risk of water contamination by phosphorus and pesticides into the procedures.
  - Recalculate the indicator(s) based on the 1996 census data when available in 1997.

LEAD INVESTIGATORS:

-Dr. B. Bowman, London Research Station
-Dr. C. Chang, Lethbridge Research Station
-Dr. K.B. Macdonald, Harrow Research Station
-Dr. P. Milburn, Fredericton Research Station
-Dr. R. Simard, Ste. Foy Research Station
-Dr. B. Zebarth, Agassiz Research Station

5.3 Agroecosystem Greenhouse Gas Balance

- Activities:
  - A national carbon dioxide (CO_2) gas balance for Canadian agriculture was calculated using the Century model to determine changes in soil carbon over time. This information and CO_2 production through the burning of fossil fuels by agriculture were combined to determine the net CO_2 flux to the atmosphere.
  - Work to calculate a net balance for agricultural methane (CH_4) was pursued (and is also near completion). This value is based largely on livestock numbers and their distribution. Work also continues to examine the utility of the DNDC (denitrification/decomposition) model to calculate the net flux of nitrous oxide (N_2O) from agricultural land to the atmosphere.

- Outputs:
  - A progress report entitled **Agroecosystem Greenhouse Gas Balance Indicator: Carbon Dioxide Component** was prepared and distributed in December 1995. Net CO_2 production was estimated to be about 17.5 million tonnes CO_2 for the year 1990. Of the total emissions, just over 40% comes from soil carbon loss, the remainder from the burning of fossil fuels.

- Meetings:

  The study team participated in numerous greenhouse gas and Indicators workshops around the country during fiscal year 1995/96.
  - Ray Desjardins made a presentation to the Indicators Project Advisory Committee in December 1995 and the Environment Canada Global Warming meeting in Toronto in January 1996.
  - Workshop on Carbon Cycling in Mid-Latitudes: Field Tracer Studies in Chalk River, On., August 1995.
  - Symposium on Greenhouse Gas Emissions in Quebec, P.Q., July 1995.
  - Symposium on Nitrous Oxide Emissions in Guelph, On., February 1996.

- Future Activities
  - A report of net methane emissions will be prepared in early fiscal year 1996/97 and methods established and calculations made to estimate N_2O balance by March 1997. This will complete the methodology development for the three major greenhouse gases and will leave the study group ready to update these calculations following receipt of the 1996 Census of Agriculture data in 1997.

LEAD INVESTIGATORS:

-Dr. R. Desjardins, ECORC
-Dr. E. Pattey, ECORC
-Dr. H. Janzen, Lethbridge Research Station
-Dr. P. Rochette, ECORC

5.4 Agroecosystem Biodiversity Change

5.4.1 Species component

- Activities:
  - The major activity of the year was hosting the SAGE (Sustainable Arid Grassland Ecosystems) Workshop examining approaches and protocols for environmental monitoring and the development of indicators of biodiversity. The workshop was held in Ottawa in October 1995 and attended by approximately 70 participants representing government agencies and universities active in biodiversity and species research. Contacts were made with researchers across the country towards the preparation of a work plan for future sampling and analyses.

- Outputs:
  - In cooperation with Environment Canada's Environmental Monitoring and Assessment Network (EMAN) a proceedings of the October 1995 workshop was published. The proceedings contains numerous articles relevant to the establishment of biodiversity monitoring and reporting for agriculture.

- Meetings:
  - SAGE Workshop, Ottawa, October 1995.
  - Wildlife Habitat Canada Forest Biodiversity Workshop, Merrickville, February 1996.
  - EMAN Annual Meeting, Halifax, January 1996.
  - Atmospheric Change and Biodiversity Workshop, Toronto, February 1996.

- Future Activities:
  - Workplans to form partnerships within the Research Branch of AAFC will lay the groundwork to begin systematic sampling of representative agro-ecosystems during fiscal year 1996/97. It is expected that by 1998, the end of preliminary baseline information and sampling protocols will be in place to facilitate ongoing temporal and spatial biodiversity assessments.

<u>LEAD INVESTIGATORS:</u>

-Dr. I. Smith, ECORC
-Dr. V. Behan-Pelletier, ECORC
-Dr. K. Fox, London Research Station

5.4.2 Habitat component

- Activities:
  - The Prairie Farm Rehabilitation Administration (PFRA) produced a prairie habitat availability map for the 1991 year (integrating the 1991 Census data on "unimproved" land for pasture, grazing or hay with the SLC polygons provided by CLBRR) using a Geographic Information System (GIS).

- Outputs:
  - There were no specific outputs for 1995/96.

- Meetings:
  - Second National Habitat Workshop, Sackville, New Brunswick, August 1995. A presentation on this indicator component was used as an introduction to a break-out workshop,"Using Biodiversity Indicators and other innovative techniques for habitat inventories".

- Future Activities:
  - Continuing work on prairie land cover mapping project in relation to the Western Grain Transition Payments Program. This program will enhance the current information on available grassland, wetland and woodland for the Prairies and provide a database with potential for developing an index or model of habitat fragmentation. This database is projected to be available by March 1997.

LEAD INVESTIGATORS:

-Mr. T. Weins, PFRA
-Mr. B. Harron, PFRA

5.5 Input Use Efficiency

5.5.1 Irrigation by Application System Efficiency (IBASE) component

- Activities
  - Using available reports and data on application system efficiencies, common ranges of application system efficiencies were determined for uniform application in the IBASE Indicator component.

- Outputs
  - There has been no formal output for 1995/96.

- Meetings
  - A conference call meeting with provincial specialists was held on September 11 to discuss the irrigation data compiled to date and to define the regional breakdown for the indicator.
  - A conference call meeting with provincial specialists was held on December 20, at which time the application system efficiency values were discussed and common efficiency ranges were agreed to among indicator team members.

- Future Activities
  - Prepare a report on the indicator identifying the trend in irrigation application efficiency in Western Canada. The report will also include a discussion of the range of activities that are contributing to overall efficiency improvements in water distribution and energy use. Recommendations on future related indicator work will be included.

LEAD INVESTIGATOR:

-Mr. T. O'Brien, PFRA

5.5.2 Fertilizers/Pesticides/Energy component

- Activities:
  - Calculation of input efficiency indeces for fertilizers/pesticides/energy for Canada (prairie and non-prairie and national regions) and documentation of methods and results in a discussion paper. A related activity was the calculation of similar indices for the U.S. and ten E.U. countries for a paper to be presented at the International Association of Agricultural Economists (IAAE) Symposium in April 1996.

- Outputs:
  - A discussion paper was prepared in the summer of 1995, and released for review in October 1995.

- Meetings:
  - Presentation on indicator components to the May 1995 workshop of principal investigators and managers in AAFC involved with the AEI Project.
  - Discussion of the Indicator component at the AEI Project Advisory Committee meeting in December 1995.

- Future Activities:
  - Continued work to refine the indicator and periodic updating with more recent data.

LEAD INVESTIGATOR:

-Dr. S. Narayanan, Policy Branch

5.6 Farm Resource Management

5.6.1 Land Cover/Management component

- Activities
  - Agricultural land management information was compiled on an SLC basis for 1981 and 1991 using the Statistics Canada Enumeration Area Census of Agriculture database. This activity resulted in the calculation of an agricultural land cover indicator as well as a soil management (tillage) indicator and preparation of a draft progress report. Inconsistencies in the Census of Agriculture data led to some re-evaluation of tillage data for eastern Canada.
  - SLC based land use datasets were made available to the Soil Degradation Indicator team for use in updating their indicators for these two Census years.

- Output:
  - There were no specific outputs released in 1995/96.

- Meetings:
  - Environmental Indicators Workshop, Ottawa, May 1995.
  - Discussion of the Indicator component at the AEI Project Advisory Committee meeting in December 1995.

- Future Activities:
  - A progress report on soil residue cover trends for 1981 and 1991 at the national and provincial levels will be available early in fiscal year 1996/97.
  - A summation of soil residue cover trends from 1981 and 1991 at the ecodistrict scale will be produced in fiscal year 1996/97.
  - Procedures will be finalized for receipt of 1996 Census of Agriculture data in 1997 to quickly generate the SLC land use datasets needed by other indicators teams to generate their trend analyses.

LEAD INVESTIGATOR:

-Dr. E.C. Huffman, ECORC

5.6.2 Inputs Management component

- Activities:
  - Initial consultation in the summer of 1995 within AAFC and NAEC on design of the farm inputs management survey. A draft questionnaire of the farm inputs management survey was circulated and discussed with various stakeholders, including all provinces and the input industry. The survey was carried out by Statistics Canada in December 1995. The sample size was 6000 farms. Data were compiled and analyzed in January - March 1996 and results of the survey are expected to be available in June 1996.

- Output:
  - Discussion paper (July 1995), **Farm Resource Management Indicator: Inputs Management Component - Discussion paper on a survey of inputs management practices**, and a draft questionnaire. These papers were circulated widely to various stakeholders (NAEC, provinces, non-governmental organizations, etc.).
  - Finalized survey content and design.

- Meetings:
  - Numerous meetings of the Statistics Canada/AAFC team charged with designing and carrying out the survey.

- Future Activities:
  - Continued analysis of survey results and preparation of a report.

LEAD INVESTIGATORS:

-Mr. D. Culver, Policy Branch
-Ms. N. Hillary, Statistics Canada
-Mr. M. Spearin, Policy Branch

6.0 Expenditures.

The following dollar resources were expended by AAFC on the AEI Project in 1995/96. These estimates exclude salaries and include only costs directly incurred on AEI development. The ongoing costs of maintaining databases that are being used to develop AEIs (and which also support other programs and activities) are not included.

ACTIVITY/INDICATOR	INDICATOR COMPONENT	DOLLARS (,000)
Project Coordination, Consultation & Reporting		15
Data Management & Coordination		6
Soil Degradation Risk	Erosion, Salinity, Organic Matter	6
Greenhouse Gas Balance	CO_2 , N_2O , CH_4 , integration	11
Agroecosystem Biodiversity Change	Species level	11
	Habitat level	3
Risk of Water Contamination	Nutrients & Pesticides	11
Farm Resource Management	Soil Cover & Management	8
	Inputs Management	125
Input Use Efficiency	Fertilizer, Energy, Pesticides	10
	Irrigation System Application Efficiency	3
Total		209

Appendix 1

DESCRIPTION OF AGRI-ENVIRONMENTAL INDICATORS [1]

1. Risk of Water Contamination

- DESCRIPTION:
  - This indicator identifies trends in the risk of water contamination from agri-chemicals. The indicator will track primary agriculture's success in minimizing water pollution risks and will identify areas at higher relative risk. The components of this indicator are nutrient contamination risk and pesticide contamination risk.
  - The indicator will be expressed as a ratio of the potential contaminant concentration (mg/L) to the maximum allowable concentration (mg/L). Indicator may be reported in risk classes.

- MEASURABLE PARAMETERS:
  Precipitation, evapotranspiration, nutrient inputs, nutrient outputs, crop yields, livestock densities, pesticide use, soil characteristics, land management practices, water quality data.

- COVERAGE:
  - SPATIAL: National coverage calculated at the ecodistrict level and in selected watersheds and aquifers in agricultural areas.
  - TEMPORAL: Baseline year for national indicator will be 1981 with updates from 1991 on a 5-year cycle to coincide with the Census of Agriculture.

2. Agroecosystem Biodiversity Change

- DESCRIPTION:
  - The species abundance/diversity component measures change in diversity & abundance of soil fauna & possibly other species groups in relation to major agricultural cropping systems. The habitat availability component will report on changes in the availability of broad habitat types such as wetlands and woodlands.
  - The habitat availability component of this indicator will be expressed in changes in area and ratio of unimproved pasture and other habitat types to total farmland. The unit of expression for species abundance/diversity has not been determined.

- MEASURABLE PARAMETERS:
  - Species abundance/diversity: species abundance and taxonomic richness of groups of non-domesticated biota inhabiting agroecosystems, and major representative cropping systems. Habitat availability: area of "unimproved" land for pasture, grazing or hay and eventually the area of grasslands, wetlands, and woodlands.

- COVERAGE:
  - SPATIAL: Not yet determined for the species abundance/diversity component. The habitat component will first report on habitat on agricultural land in the three prairie provinces, then the rest of the agricultural areas in Canada.
  - TEMPORAL: Not yet been determined for the species abundance/diversity component.The habitat component will use 1991 as a baseline year. If possible it will be compared with 1981 or 1986 and also with 1996 when Census data become available in 1997.

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[1] A more complete description of each AEI is available from the Environmental Indicator Working Group (1995) **Description of Indicators and Project Activities and Outputs to 1998** (see Appendix 2).

3. Soil Degradation Risk

- DESCRIPTION:
  - Indicator reports trends in the extent, severity, and vulnerability of agricultural lands to soil erosion, salinization and change in soil organic matter levels. The indicator will identify areas of higher relative risk of degradation and measure progress in managing agricultural lands sustainability.
  - The soil erosion (water, wind) component of this indicator will be measured in tonnes/ha./yr expressed in 5 classes of risk (tolerable, low, moderate, high, severe). Soil salinization will be expressed in a dimensionless multiplicative index (1 to 40) divided into 3 classes of salinity risk (low, moderate, high). Units of expression for the soil organic matter component have not been determined.

- MEASURABLE PARAMETERS:
  - Estimated erosion, % change in erosion rate; Universal Soil Loss Equation "C" factor, erosion reduction by crop residue. Soil salinization measures electrical conductivity, land area, topography, net aridity (climate), and ratio of permanent cover to summerfallow. The parameters for soil organic matter are to be determined.

- COVERAGE:
  - SPATIAL: Wind erosion addresses cultivated land in the prairies at the SLC polygon scale; water erosion addresses cultivated land in Canada at the SLC scale. Salinization covers agricultural areas of the prairies. The spatial coverage for soil organic matter is to be determined.
  - TEMPORAL: Soil erosion and salinization are both assessed from 1981-1991, with updates every 5 years after 1991.

4. Input Use Efficiency

- DESCRIPTION:
  - This indicator consists of two components: irrigation by application system efficiency and use efficiency for fertilizer/pesticide/energy. The irrigation by application system efficiency component tracks the efficiencies of various application systems and the land area upon which water is applied by each of these systems. The fertilizers/pesticides/energy use efficiency component reports input use efficiency (productivity) by measuring long-term trends in the amounts of each input used per unit of aggregate production output.
  - Fertilizers/pesticides/energy use efficiency is expressed as a ratio of inputs over outputs expressed as an index with the base year set at 100. Irrigation by application system efficiency is expressed as the percentage of the water that passes through the applicator that is used by the crop.

- MEASURABLE PARAMETERS:
  - Fertilizers/pesticides/energy use efficiency measures aggregate fertilizer, pesticide, and energy inputs (implicit quantity in constant dollars) and aggregate primary output of crops (grains, oilseeds, forages, fruits, vegetables, etc.) and livestock (cattle, hogs, dairy, poultry). Total use, intensity of use, and use efficiency. Irrigation application system efficiency uses information available from research and field trials on the efficiency of the application systems, tracks the land area being irrigated and the application systems in use.

- COVERAGE:
  - SPATIAL: Fertilizers/pesticides/energy use efficiency is covered nationally, and is disaggregated by prairie and non-prairie regions of Canada. Irrigation application system efficiency covers Western Canada.
  - TEMPORAL: For fertilizers/pesticides/energy use efficiency base year is 1980 with annual updates. The irrigation application system efficiency indicator will be measured from 1981, however the area included will vary depending on the data records.

5. Farm Resource Management

- DESCRIPTION:
  - The soil cover & management component estimates the proportion of cultivated land falling under various classes of soil residue cover (low, medium, high) and the adoption rate of selected soil conservation practices. Farm inputs management tracks the extent of adoption by farmers of selected best management practices for inputs (fertilizer, manure, and pesticides).
  - Soil cover & management is expressed as a percent adoption of soil conservation practices, and trends in areas of cultivated land with high, medium and low soil residue cover. Farm inputs management will be expressed as the distribution and frequency of use of the identified inputs management practices.

- MEASURABLE PARAMETERS:
  - The soil cover/management component determines the proportion of farmland under various crops, summerfallow, pasture, conventional tillage, conservation tillage, no-till; and adoption of selected erosion control practices.
  - The farm inputs management component includes factors such as: how liquid manure is stored; how commercial (chemical) fertilizer was applied; and whether any pest control methods other than chemical pesticides are used .

- COVERAGE:
  - SPATIAL: Soil cover & management: national coverage disaggregated by province and ecodistrict. Farm inputs management: province and ecozone.
  - TEMPORAL: Soil cover & management component: 1981 is baseline year and will be updated on a 5 year cycle to coincide with the Census of Agriculture. Farm inputs management has a baseline year which is 1995, followed by periodic updates.

6. Agroecosystem Greenhouse Gas (GHG) Balance

- DESCRIPTION:
  - This indicator tracks the accumulation and release of the principal greenhouse gases from the agricultural sector and reports the net integrated balance.
  - This indicator is measured in net emissions and/or uptake of each greenhouse gas and will be expressed in tonnes per year. The integrated GHG balance will be expressed in tonnes of CO_2 equivalent units.

- MEASURABLE PARAMETERS:
  Fertilizer use, cropping patterns, fossil fuel consumption, animal populations, manure production and storage, estimated soil carbon flux and other related factors.

- COVERAGE:
  - SPATIAL: Initially at a national level and eventually also at the provincial level. It may be possible to also report components of the indicator at more detailed levels.
  - TEMPORAL: 1986 baseline year with periodic updates.

Appendix 2

PUBLICATIONS/REPORTS RELEASED TO DATE

Environmental Indicator Working Group, 1995. **Description of Indicators and Project Activities and Outputs to 1998**. Environment Bureau, Policy Branch, Agriculture and Agri-Food Canada, Ottawa.

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Appendix 3

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Appendix 4

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