AGRI-ENVIRONMENTAL INDICATOR PROJECT

Agriculture and Agri-Food Canada

REPORT NO. 10

DESCRIPTION OF INDICATORS AND PROJECT ACTIVITIES AND OUTPUTS TO 1998

Environmental Indicator Working Group
of Agriculture and Agri-Food Canada

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INTRODUCTION

The Agri-Environmental Indicator (AEI) Project of Agriculture and Agri-Food Canada (AAFC) was initiated in 1993. To December 1993, work was largely confined to internal discussions within AAFC to identify potential AEIs for Canadian agriculture. In December 1993, a national consultation was held with stakeholder groups to review and prioritize agri-environmental issues and potential indicators for each. Twelve AEIs were selected and development work was initiated. A second national consultation was held in February 1995. As a result of the points raised at this meeting, the twelve AEIs were integrated into a smaller number of indicators and their components. These were subsequently linked to corresponding issues and performance objectives (see Figure 1).

In November 1994, the Environmental Indicator Working Group of AAFC developed a first draft of an implementation plan for the project as a basis for internal and external discussions and to guide development work on AEIs. The implementation plan has since evolved to reflect consultations held with stakeholders as well as decisions taken regarding the activities and deliverables of the project.

This document describes the indicators, activities and outputs of the AEI Project as specified by the Environmental Indicator Working Group of AAFC in July 1995. The work plans provide a basis for managing activities within the project and for preparing and scheduling deliverables. The work plan will evolve as required to reflect changing circumstances, requirements and opportunities regarding the development of AEIs, and will be updated periodically.

To date, several papers and publications have been prepared which discuss the developmental aspects of AEIs or present results of completed research. A list of such publications, and additional information about the project, is available from:

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Continued work leading to full implementation of the Agri-Environmental Indicator Project, including establishment of a multi-stakeholder Project Advisory Committee, was endorsed by the Departmental Management Committee of AAFC in September 1995.

INDICATOR: SOIL DEGRADATION RISK

COMPONENTS:
A. Soil erosion - wind, water
B. Soil salinization
C. Soil organic matter.

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 at higher relative risk of degradation and provides a measure of progress in managing agricultural lands sustainably.

MEASURABLE PARAMETERS
A. Estimated erosion rate, % change in erosion rate; Universal Soil Loss Equation "C" factor, erosion reduction by crop residue
B. Electrical conductivity, land area, topography, net aridity (climate), ratio of permanent cover to summerfallow
C. To be determined.

NUMERICAL UNIT(S) OF EXPRESSION
A. Tonnes/ha/yr expressed in 5 classes of risk (tolerable, low, moderate, high, severe)
B. Dimensionless multiplicative index (1 to 40) divided into three classes of salinity risk (low, moderate, high).
C. To be determined.

SPATIAL COVERAGE
A. Wind: cultivated land in prairies at the Soil Landscapes of Canada (SLC) polygon scale. Water: cultivated land in Canada at the SLC scale.
B. Agricultural areas of the prairies.
C. To be determined.

TEMPORAL COVERAGE
A and B. 1981 to 1991, with updates every 5 years after 1991.
C. To be determined.

PERFORMANCE OBJECTIVE
A. To be in lowest two classes of estimated erosion rates
B. To have low salinity risk related to agricultural activities (some high risk areas affected by geology may remain high)
C. To stabilize/ increase soil organic matter levels.

PRINCIPAL DATA SOURCES
A. Soil Landscapes of Canada database, Census of Agriculture, Atmospheric Environment Service climate data, results of questionnaire in Prairies, EPIC simulations
B. Soil Landscapes of Canada database, Census of Agriculture, Soil Quality Evaluation Program research, Geological Survey of Canada, Atmospheric Environment Service
C. To be determined.

ACTIVITIES & OUTPUTS
Work on all components builds on the research carried under the Soil Quality Evaluation Project and related research, such as the National Soil Erosion Study of CLBRR. Work activities will focus on extending coverage of the soil erosion and salinity risk analyses reported in the Health of Soils Report, on developing an approach for extending the soil organic matter component and on contributing to an Environment Canada Environmental Indicator Bulletin on agriculture.

Outputs
1. July 1995 -- Report on "Health of Our Soils: toward sustainable agriculture in Canada".
2. November 1995. Background technical report on soil erosion risk for Environment Canada Environmental Indicator Bulletin.
3. March 1996 -- National level report & map on water erosion risk at SLC scale for 1981-1991.
4. March 1996 -- Report & map on prairie wind erosion risk at SLC scale for 1981-1991.
5. March 1996 -- Report on soil salinity change in prairie region at SLC scale for 1981-1991.
6. 1997-98 -- Update all components for inclusion in comprehensive indicator project report.

Activities and outputs for the soil organic matter component will be identified in fiscal-year 1995-1996.

LEAD INVESTIGATORS
A. Dr. G. Wall, CLBRR, Research Branch.
B. Mr. R.G. Eilers, CLBRR, Research Branch.
C. Dr. C. Monreal, CLBRR, Research Branch.

INDICATOR: INPUT USE EFFICIENCY

COMPONENTS

A. Use Efficiency for fertilizers, pesticides and energy.
B. Irrigation application system efficiency.

DESCRIPTION:

A. Indicator component reports input use efficiency (productivity) by measuring long-term trends in the amounts of selected environmentally-sensitive inputs used per unit of aggregate production output.
B. Indicator component tracks area under irrigation by irrigation systems of various efficiencies.

MEASURABLE PARAMETERS

A. Aggregate fertilizer, pesticide, and energy inputs (implicit quantity in constant dollars). 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.
B. Area of land being irrigated; water use efficiency of various irrigation systems.

NUMERICAL UNIT(S) OF EXPRESSION

A. Ratio of inputs over outputs expressed as an index with the base year set at 100.
B. Hectares of land being irrigated by systems of various efficiencies, defined as the proportion of water supplied utilized by the crop.

SPATIAL COVERAGE

A. National, prairie & non prairie regions of Canada.
B. Western region of Canada (where over 90% of irrigation occurs).

TEMPORAL COVERAGE

A. Base year is 1980 with annual updates.
B. To be determined, depending on data records. A baseline in the early to mid-1980s may be available for some provinces or regions.

PERFORMANCE OBJECTIVE

A. To increase use efficiency and productivity of environmentally-sensitive farm inputs.
B. To increase use efficiency of irrigation water use in agriculture.

PRINCIPAL DATA SOURCES

A. Statistics Canada, Agriculture and Agri-Food Canada, Fertilizer industry.
B. Census of Agriculture, Provincial agriculture departments, irrigation districts.

ACTIVITIES & OUTPUTS

A. Input Efficiency. Indicator is derived from ongoing analysis of factor productivity in agriculture. Initial calculations of the indicator have been completed and a discussion paper is being prepared.

Outputs

1. September 1995 -- Discussion paper & progress report on input use efficiency indicator.
2. March 1996 -- Final paper on input use efficiency.
3. 1997-98 -- Update for inclusion in comprehensive indicator project report.

B. Irrigation Efficiency. Analysis of data sources is in progress, data collection phase will begin in fall 1995. Estimates of water application efficiency by irrigation system type are being investigated.

Outputs

1. December 1995 --Database assembled.
2. March 1996 -- Report on irrigation efficiency component for chosen baseline year.
3. 1998 -- Update for inclusion in comprehensive indicator project report.

LEAD INVESTIGATORS

A. Dr. S. Narayanan, Policy Branch.
B. Mr. T. O'Brien, PFRA.

INDICATOR: RISK OF WATER CONTAMINATION

COMPONENTS
A. Nutrient Contamination Risk
B. Pesticide Contamination Risk.

DESCRIPTION:
Indicator identifies trends in 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.

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

NUMERICAL UNITS OF EXPRESSION
Ratio of the potential contaminant concentration (mg/L) to the maximum allowable concentration (mg/L) . Indicator may be reported in risk classes.

SPATIAL COVERAGE
National coverage calculated at the ecodistrict level and in selected watersheds and aquifers in agricultural areas of Canada.

TEMPORAL COVERAGE
Baseline year for national indicator will be 1981 with updates from 1991 on a 5-year cycle to coincide with the Census of Agriculture.

PERFORMANCE OBJECTIVE
To preserve and enhance water quality in agricultural and adjacent areas. Water quality guidelines and standards established for specific uses will be used to establish acceptable and unacceptable levels of water quality.

PRINCIPAL DATA SOURCES
Census of Agriculture, Soil Landscapes of Canada data base, meteorological data, crop and livestock surveys, input use surveys, federal & provincial water quality monitoring and survey programs.

ACTIVITIES AND OUTPUTS
Regional calculations will draw on existing water quality studies in place across Canada. Calculation of the national-level indicator is a new activity. A concept paper and a draft methodology paper have been prepared and further development of the methodology is in progress. Work on the nutrient component will be initiated in 1995-96; the pesticide component will be developed in 1996-97.

Outputs

1. March 1995 -- Report: "Indicator of Risk of Water Contamination: Concepts and Principles".
2. March 1995 -- Report: "Indicator of Risk of Water Contamination: Methodological Development".
3. June 1996 -- Progress report on development of the national-level indicator for nitrate at the ecodistrict scale.
4. June 1996 -- Progress report on calculation of the indicator for nitrates in a series of small, regional watersheds to provide regional validation of the national-level assessment, in the following areas: lower Fraser river valley in B.C.; Alberta ranching and feedlot area; SWEEP pilot watersheds in Ontario; Lennoxville research watershed in Quebec; Black Brook watershed in N.B.
5. June 1997 -- Progress report on development of the national-level indicator for pesticides at the ecodistrict scale.
6. June 1997 -- Progress report on calculation of the indicator for pesticides in a series of small, regional watersheds to provide regional validation of the national-level assessment, in the following areas: lower Fraser river valley in B.C.; Alberta ranching and feedlot area; SWEEP pilot watersheds in Ontario; Lennoxville research watershed in Quebec; Black Brook watershed in N.B.
7. 1997-98 -- Update of national-level indicator and regional components for nitrates and pesticides for inclusion in comprehensive indicator project report.

LEAD INVESTIGATORS
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Dr. C. Chang, Lethbridge Research Station
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INDICATOR: AGROECOSYSTEM BIODIVERSITY CHANGE

COMPONENTS
A. Agroecosystem species abundance / diversity.
B. Agroecosystem habitat availability.

DESCRIPTION
A. Indicator component measures change in diversity & abundance of soil fauna & possibly other species groups in relation to major agricultural cropping systems.
B. Indicator component measures change in the availability, and possibly in the fragmentation, of selected wildlife habitats in agroecosystems.

MEASURABLE PARAMETERS
A. Species abundance and taxonomic richness of groups of non-domesticated biota inhabiting agroecosystems, major representative cropping systems.
B. Area of cropland, improved and unimproved pasture; availability of other habitat types in agroecosystems, such as wetlands, grasslands and woodlands.

NUMERICAL UNITS OF EXPRESSION
A. Not yet determined.
B. Changes in area and ratio of unimproved pasture and other land to total farmland.

SPATIAL COVERAGE
A. Not yet determined.
B. Agricultural landscapes across Canada at the SLC polygon level.

TEMPORAL COVERAGE
A. Not yet determined.
B. 1981 baseline year with updates on the 5-year census of agriculture cycle.

PERFORMANCE OBJECTIVE
To preserve and enhance species and landscape diversity in agroecosystems.
A. Indicator component values will be compared against expected or baseline values.
B. Direction of change and proportion to other land uses will be used.

PRINCIPAL DATA SOURCES
A. Baseline data from National collections, published literature and government data bases, agricultural biodiversity research.
B. Initially Statistics Canada Census of Agriculture and potentially data from other relevant sources, such as conservation agencies.

ACTIVITIES AND OUTPUTS
A. Species Component. This indicator component in the early stages of feasibility analysis. Some research is in progress at the London Research Station which explores linkages between cropping systems and soil fauna. Additional work will involve literature reviews, scientific consultations and participation in: a workshop on biodiversity change indicators, the Sustainable Arid Grassland Ecosystems Project at Suffield, Alberta and the Green Plan project in S.W. Ontario.

Outputs
1. March 1996 -- Paper outlining a set of protocols that will clarify the need for and nature of further research and development.
2. March 1996 -- Review papers of biodiversity indicators in agricultural landscapes.
3. March 1996 -- Work plan for developing the species biodiversity component following consultations with interested research institutions across Canada.
4. Other outputs to be determined.

B. Habitat Component. Census of agriculture data have been obtained for the prairie region for the 1991 baseline year at the SLC scale to test the proposed methodology. The WGTA program payment database may also provide usable information. Work will proceed to refine the approach and expand spatial and temporal coverage to other regions. The use of non-census data on other variables such as wetland change will be investigated.

Outputs
1. October 1995 -- Interim report on habitat availability for the prairie region at the SLC scale for the 1991 year.
2. March 1996 -- Complete report for the prairie region at the SLC scale showing change from 1981-1991.
3. March 1997 -- Report on indicator for the non-prairie region at the SLC scale showing change from 1981-1991.
4. March 1997 -- Methodology paper for a habitat fragmentation indicator at SLC scale for prairie region.
5. 1997-98. Update of analysis at the national level for inclusion in comprehensive indicator project report.

LEAD INVESTIGATORS
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INDICATOR: FARM RESOURCE MANAGEMENT

COMPONENTS
A. Soil Cover & Management
B. Farm Inputs Management

DESCRIPTION
A. Component estimates proportion of cultivated land falling under various classes of soil cover (low, medium, high) and the adoption rate of selected soil conservation practices.
B. Component tracks the extent of adoption by farmers of selected best management practices for inputs (fertilizer, manure and pesticides).

MEASURABLE PARAMETERS
A. Proportion of farmland under various crops, summerfallow, pasture, conventional tillage, conservation tillage, no-till; adoption of selected erosion control practices (eg. strip cropping, grassed waterways, winter cover crops, etc).
B. Not yet determined. Could involve factors such as type of manure storage, use of soil tests, timing of fertilizer and pesticide application, etc.

NUMERICAL UNITS OF EXPRESSION
A. Percent adoption of soil conservation practices, trends in area of cultivated land with high, medium and low cover.
B Not yet determined, but could be % of targeted producers using desirable inputs management practices.

SPATIAL COVERAGE
A. National coverage disaggregated by province and ecodistrict.
B. Not yet determined but likely national coverage disaggregated by commodity group (eg. fruit and vegetable, grains and oilseeds, dairy, beef, hogs, poultry) and region (eg. provincial level).

TEMPORAL COVERAGE
A. Soil cover sub-component will use 1981 as baseline year; management practices sub-component will use 1991 as baseline year. Both to be updated on a 5 year cycle to
coincide with the Census of Agriculture.
B. Baseline year will likely be 1995, followed by periodic updates.

PERFORMANCE OBJECTIVE
A. Maintain sufficient soil cover to protect land from degradation; adopt economically viable and environmentally sound land management practices.
B. Adopt economically viable and environmentally sound input management practices.

PRINCIPAL DATA SOURCES
A. Statistics Canada Census of Agriculture.
B. Statistics Canada special surveys.

ACTIVITIES AND OUTPUTS
A. Soil Cover & Management: Land management practices for the 1991 baseline year have been collected through the 1991 Census of Agriculture. Cover component draft methodology developed and preliminary analysis completed at the national and provincial scales. Additional work will involve extending the national analysis to the ecodistrict scale, providing input to Environment Canada's Environmental Indicator Bulletin and validating the methodologies and assumptions used. As this indicator also provides data used in the calculation of other indicators, tabulation of the 1996 census data onto SLC polygons represents a key activity.

Outputs
1. October 1995 -- Draft technical report on soil cover trends from 1981-1991 at national and provincial levels.
2. November 1995 -- Background technical report on soil cover trends for input into Environment Canada Environmental Indicator Bulletin.
3. March 1996 -- Report on soil cover trends from 1981-1991 at ecodistrict scale.
4. 1997-98 -- Update of soil cover and management components for inclusion in comprehensive indicator project report.

B. Inputs Management. A data gap presently exists at the national level on input management practices. A survey will be conducted by Statistics Canada in fall 1995 through which information on use of BMPs for inputs will be collected. This survey will be updated in 1997-98.

Outputs
1. July 1995 -- Discussion paper on a survey of inputs management practices.
2. May 1996 -- Report on baseline data for 1995 year collected through Statistics Canada inputs management survey.
2. 1997-98 -- Update of baseline data for inclusion in comprehensive indicator project report.

LEAD INVESTIGATORS
A. Dr. E.C. Huffman, CLBRR, Research Branch
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M. Spearin, Policy Branch
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INDICATOR: AGROECOSYSTEM GREENHOUSE GAS (GHG) BALANCE

DESCRIPTION:
Indicator tracks the accumulation and release of the principal greenhouse gases from the agricultural sector (carbon dioxide, methane, nitrous oxide) and reports the net integrated balance.

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

NUMERICAL UNITS OF EXPRESSION
Net emissions and/or uptake of each greenhouse gas (GHG) will be expressed in tonnes per year. The integrated GHG balance will be expressed in tonnes of CO_2-equivalent units.

SPATIAL COVERAGE
Initially at 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 COVERAGE
1986 baseline year with periodic updates.

PERFORMANCE OBJECTIVE
To contribute to the national objective of stabilizing GHG emissions at 1990 levels by the year 2000 through the use of management and cropping practices that reduce greenhouse gas emissions.

PRINCIPAL DATA SOURCES
Agriculture Canada Greenhouse Gas and Climate Change Program, CANSIS database, Census of Agriculture.

ACTIVITIES AND OUTPUTS
Development of this indicator draws on research underway through the national initiatives portion of the Green Plan agricultural component. Considerable work has already been carried out to quantify sources and sinks of GHG from agriculture. Work activities will focus on validating the models used to develop the indicator (CENTURY model) and on improving accuracy of the existing estimates of the sources and sinks of the individual gases.

Outputs

1. September 1995 -- Report on the net carbon dioxide balance for the years 1986 and 1990.
2. March 1996 -- Report on the net methane balance for the years 1986 and 1990.
3. March 1997 -- Report on the net nitrous oxide balance for the years 1986 and 1990.
4. 1997-98 -- Updated report on the net GHG balance for agriculture for the years 1986-1996.

Note: A preliminary report on the integrated GHG balance indicator may be available before 1998. Preliminary data on each of the three GHG gases have been generated but additional analysis and validation is required, particularly for methane and nitrous oxide.

LEAD INVESTIGATORS
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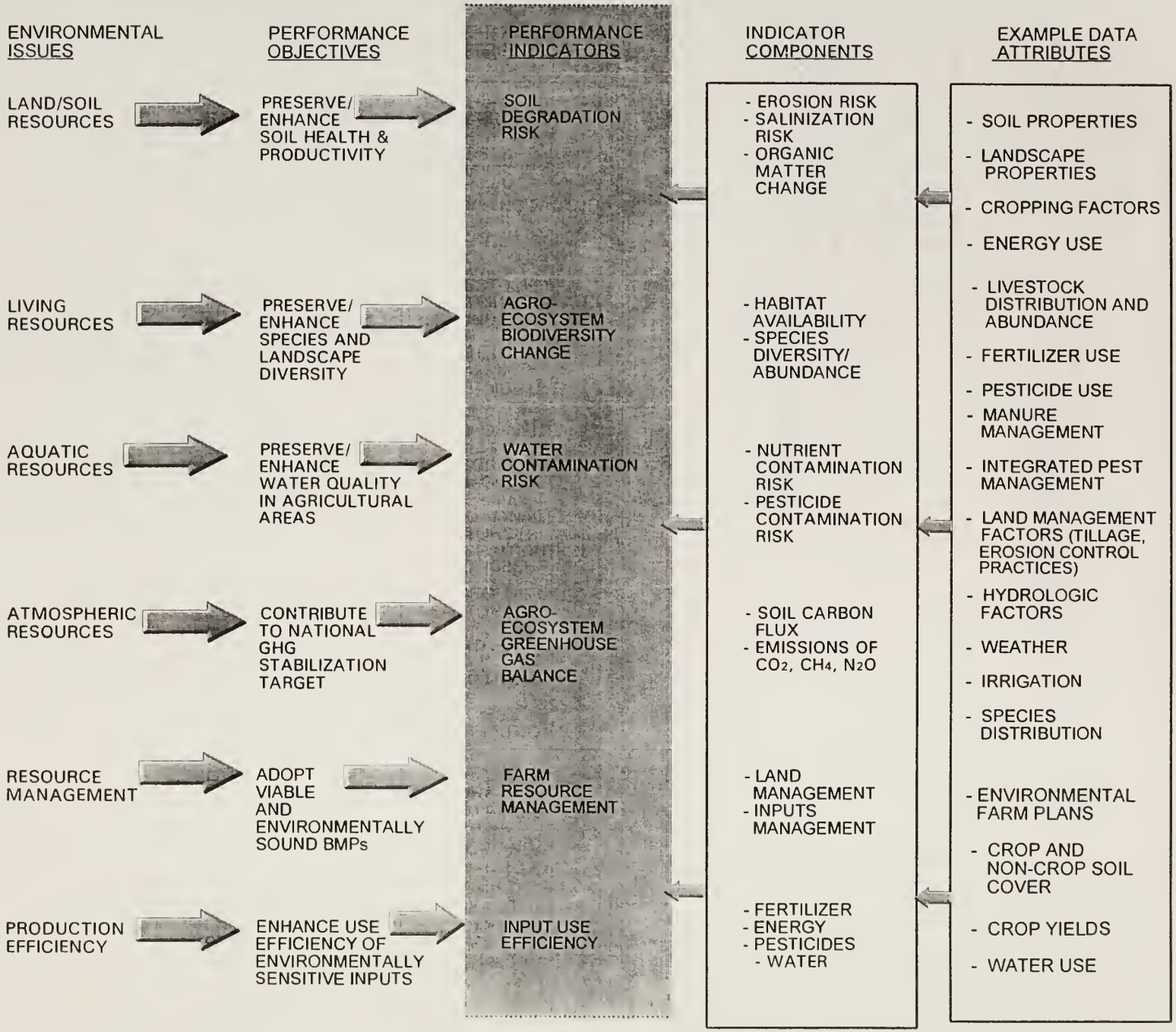
Figure 1: Linkages between agri-environmental issues, objectives, indicators and supporting data.



ATTACHMENT 1: Members of the AAFC Environmental Indicator Working Group

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