DEVELOPING ENVIRONMENTAL INDICATORS FOR AGRICULTURE

DISCUSSION PAPER

AGRICULTURE CANADA ENVIRONMENTAL INDICATOR
WORKING GROUP

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1.0 INTRODUCTION.

The purpose of this document is to describe Agriculture Canada's (AC) environmental indicator development project and to provide guidance on the development of indicators of environmental sustainability in Canadian agriculture.

AC initiated a project in January 1993 to develop environmental indicators for the agricultural resource sector. In the first phase, a set of indicators will be developed which make best use of existing data. A second, longer-term phase will focus on improving and refining the initial set of environmental indicators.

Before proceeding to identify and develop indicators, several items need to be considered and clarified. Part 2 of this paper describes various factors associated with the development of environmental indicators for agriculture. Part 3 identifies issues for which environmental indicators are needed, and associated policy questions to guide their development. Part 4 describes the processes being followed to develop the indicators.

A general work plan and schedule for the project is attached in Appendix 2.

2. DEFINING AND DEVELOPING ENVIRONMENTAL INDICATORS.

This section reviews the following factors associated with the development of indicators: definition of the term "environmental indicator", needs and uses of indicators, scale of reporting and aggregation of data, indicator selection criteria, interpretation of data and project deliverables.

2.1 Definitions. The term "indicator" has achieved widespread use in many disciplines, most particularly in economics, where work to develop indicators (such as the System of National Accounts) has been ongoing for decades.

In the environmental field, the development of indicators is much more recent. Focused work generally began in Canada and internationally in the 1970s, but the level of effort declined gradually. The late 1980s saw interest in environmental issues, including environmental indicators, expand considerably. The call by the G-7 countries at their 1989 summit in Paris for better environmental indicators to support decision-making has spurred several national efforts.

As a result of these initiatives, terms such as (among others) "environmental indicators", "ecosystem health indicators", "environmental performance indicators" and "natural resource indicators" are encountered in the literature. Although these terms are not mutually exclusive, and may simply reflect the terminology used by various agencies to express similar concepts, the situation has nonetheless led to confusion.

The following definitions will be used to guide Agriculture Canada's environmental indicator project:

- indicators are repeated measurements made of the same phenomena over time, allowing the identification of long-term trends, periodic change and fluctuations in the rate of change (Gosselin *et. al,* 1991)

- environmental indicators are measures of change in the state of the environment or in human activities which affect the state of the environment, preferably in relation to a standard, value, objective or goal (modified from U.S. EPA, 1972).

Taken together, these definitions suggest that environmental indicators must quantify change in environmentally-relevant phenomena over time, and should identify movement toward or away from accepted values, policy objectives or scientific thresholds.

2.2 Needs and Uses for Environmental Indicators. From Agriculture Canada's perspective, several factors are driving the need to develop environmental indicators for the sector:

- Concise and credible environmental information is needed to provide a means through which the agricultural sector's environmental performance can be evaluated objectively. Such information will help integrate environmental factors into the department's policy-making and decision-making processes and support operational and strategic planning and public communication.

- In the past three years, several studies have recommended that environmental sustainability indicators be developed for agriculture. Specifically, the Agri-food Policy Review identified increased environmental sustainability as one of four pillars of reform for the sector, and the department accepted the recommendations of the Federal - Provincial Agriculture Committee on Environmental Sustainability, one of which is that environmental indicators be developed for agriculture.

- There is a need to support the Green Plan initiative on environmental information, which includes a government-wide commitment to develop a national set of environmental indicators.

As illustrated in Figure 1, a fundamental use of indicators, including environmental indicators, is to assist and support the decision-making process: sound decisions require sound information. Indicators can provide such support in two ways:

- by informing decision-makers and policy-makers about conditions and trends as they relate to key issues, and their ecological, economic and health-related significance;

- by facilitating analyses of issues in support of policy and program evaluation and development.

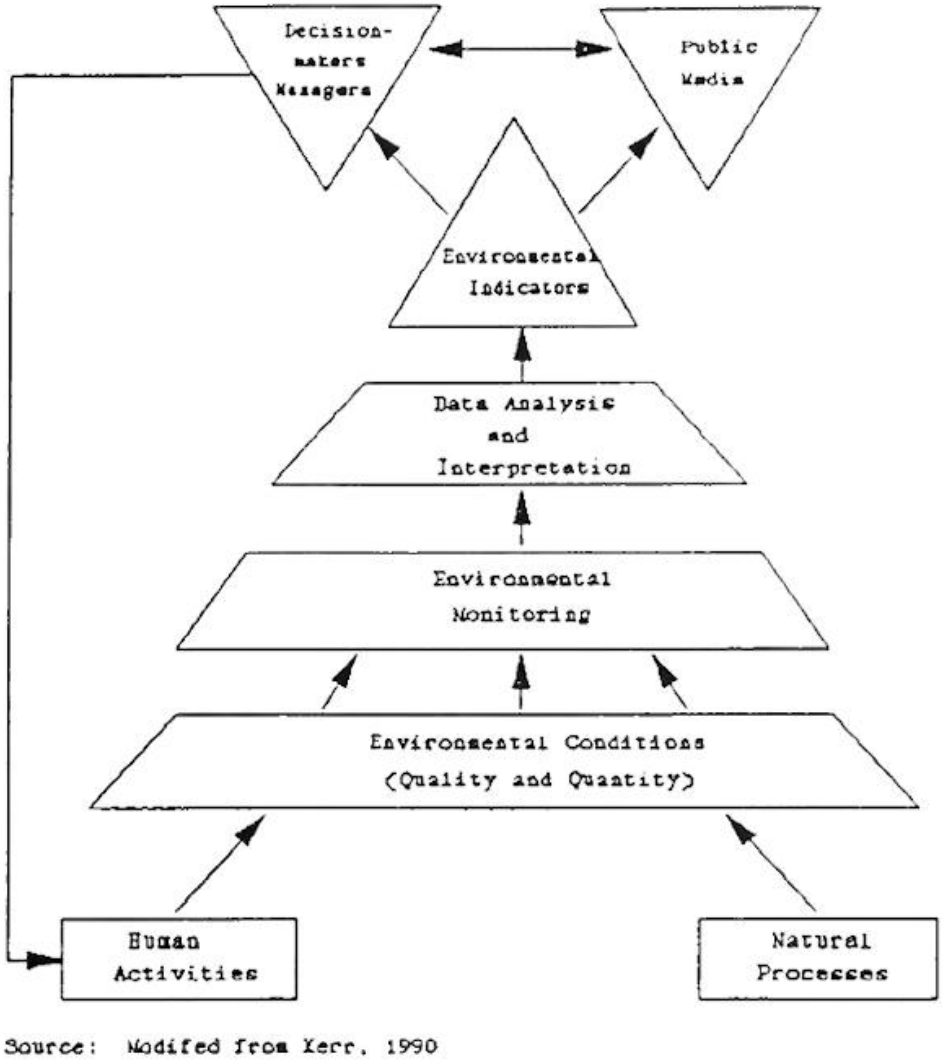
Decision-makers and policy-makers in the agricultural sector range from individual farmers to industry officials (e.g. national farm organizations) to the Ministers of agriculture. The kinds of decisions made therefore vary: from day-to-day farm-level operational decisions to broad-ranging policy decisions with provincial, national or international implications. And herein lies a fundamental question: for what level of decision-making should environmental indicators be developed and reported? VHB Research & Consulting (1989) discussed this question and noted that there are two contradictory requirements, each tailored to a different level of decision-making:

- Coverage: all important trends should be covered;

- Convenience: the indicators should be concise and handy.

A large set of detailed indicators will be useful to analysts and researchers who independently have reasons for focusing on particular aspects or issues. They will be less useful for informing policy-makers, or the interested public, about overall conditions and trends in the sector, or very broad priority areas.

A smaller set of aggregate indicators will be useful for providing senior policy-makers with an overview of environmentally-related trends in the agricultural resource sector. They will be less useful to analysts and researchers who generally require detailed data for analyses, modelling and related applications.



Source: Modified from Kerr, 1990

FIGURE 1: The Relationship Between Environmental Information And Decision-making.

Agriculture Canada proposes to develop environmental indicators primarily to inform senior policy-makers in government and industry, on an ongoing basis, of environmentally-related trends in the agricultural resource sector. This suggests the indicators should be grouped by issue. This approach is appropriate as decision-makers and the media (and therefore the public) tend to focus on issues and will be more likely to understand and use them if they are so organized.

To support research and analytical work, the detailed data used to develop (and thus represented by) an indicator can be accessed and augmented as needed.

2.3 Scale of Reporting and Aggregation of Data. Closely linked to the intended uses of the indicators is the scale and detail at which they should be reported. Relevance to policy-making implies that the complete (i.e. detailed) picture, with all spatial, temporal and other variations, cannot be conveyed. The indicators should therefore not be too numerous or detailed and should be reported in a manner which maximizes their ability to be understood.

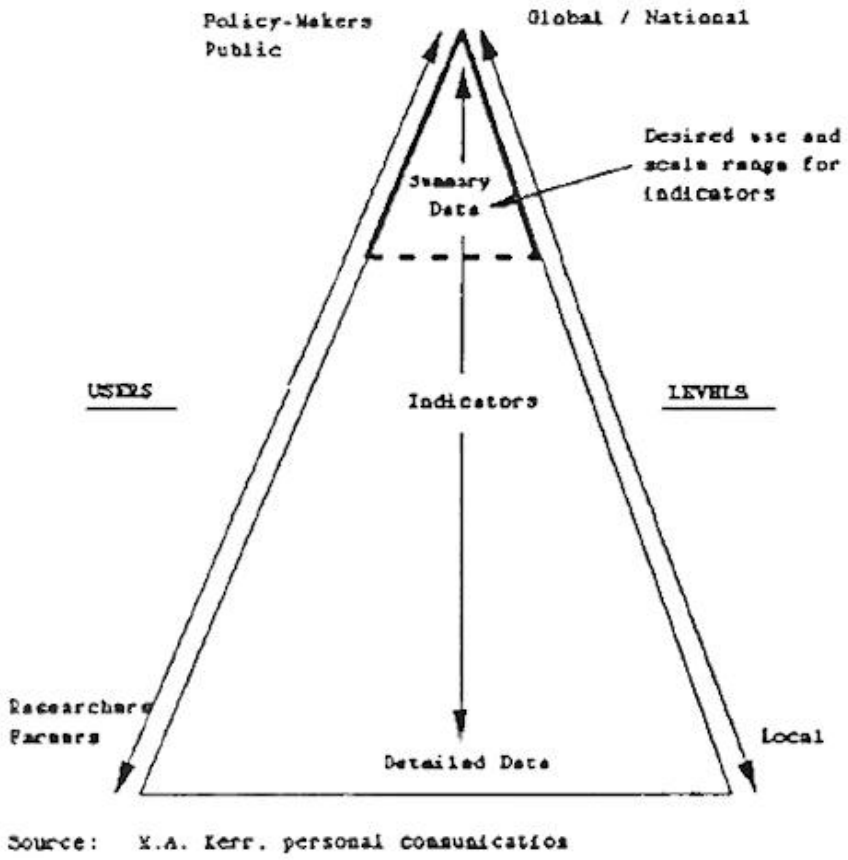


FIGURE 2. Use and Scale Hierarchy of Indicators.

As illustrated in Figure 2, the targeted users and corresponding level of detail for the indicators are in the upper third of the pyramid. To develop and report indicators at this scale, methods of selecting key indicators and of aggregating data will be required. Examples of such methods include:

- Aggregating or summing single-variable data (eg. tonnes of soil loss per hectare) upward to the desired (and scientifically appropriate) scale (eg. provincial, national, etc);

- Selecting, out of a range of variables associated with a given issue, the key strategic variable(s) which is (are) broadly representative of overall conditions. In the case of soil quality, for example, the strategic variable selected as an indicator might be levels of organic matter, one of several factors which influence quality, such as soil pH and bulk density;

- Combining related variables into a composite index. For example, this approach has been used to report air quality (a function of levels of several pollutants) and to report the contributions of various countries to global warming (by converting all greenhouse gas emissions into carbon dioxide equivalents).

Notwithstanding the approach taken to develop indicators for senior decision-makers at a higher level of aggregation, it will often be necessary and/or desirable to dis-aggregate an indicator into components. Necessity stems from the fact that Canadian agriculture is largely regionalized in terms of environmental factors (eg. weather) and production systems. Desirability stems from the fact that it will often be useful to compare and contrast factors of interest.

Sub-components of an indicator can be based on such factors as geography (eg. watershed, ecozone), jurisdiction (eg. province), socio-economic variables (eg. farm income, farmer education) and farm type (eg. crop, livestock). For example, in addition to tracking adoption of specific farming practices nationally, it may be interesting and useful to also do so regionally, by farm income and by type of farm.

Determination of an appropriate scale for reporting environmental indicators, and their dis-aggregation into component parts, will be made on a case-by-case basis.

2.4 Criteria for Selecting Environmental Indicators. Selection criteria for environmental indicators have been reviewed by several analysts.

Gelinas & Slaats (1989) suggested that indicators should be feasible to obtain, scientifically credible, understandable, provide early warning, and detect spatial and temporal trends. VHB Research & Consulting (1989) identified criteria for designing indicators (detail, scope definition), for choosing among indicators (uniqueness, relevance to priorities, indicative of multiple environmental features, and consistency and availability) and criteria that selected indicators must meet (convey understanding, be useful and be clear). Ward (1990) added that indicators should be limited in number if they are to be useful to decision-makers and should be capable of identifying changes in environmental conditions and the agents of these changes. Environment Canada (1991) stated that indicators should be relevant to stated goals, objectives and issues of concern, and (ideally)

have a target or threshold level against which observed values can be compared.

These criteria are generally consistent with one another and relevant to Agriculture Canada, which will identify and develop environmental indicators that:

- *Are policy relevant.* The indicators should inform of movement toward or away from established policy objectives or science-based thresholds, or relate to key environmental issues and values in agriculture.

- *Are scientifically sound.* The indicators should be sound measures technically and their attributed significance should be scientifically defensible and accepted.

- *Are understandable.* What the indicators represent, and the significance of the values reported, should be readily understood by those who are intended to make use of them.

- *Identify temporal and/or spatial change.* The indicators should be referenced in time and/or space, to allow spatial and/or temporal trends to be identified.

- *Are feasible to obtain/develop.* The indicators developed should make use of existing data as much as possible. Similarly, the indicators should not be so complex that they discourage regular monitoring, can only be developed over a long time period or are prohibitively expensive to develop.

2.5 Interpreting Environmental Data. The utility of data for decision-making and policy-making is increased when they are collated and interpreted appropriately. If environmental indicators are to influence decision-making they will have to be readily understood, therefore methods of interpreting data are needed.

Several approaches can be used to organize and interpret environmental information and environmental indicators. The following are briefly reviewed here:

- framework approach
- reference value approach
- associating variables through ratios
- developing indices of change.

All of the above approaches and techniques have been used, either alone or in combination, by different agencies and in different reports. For example, the Organization for Economic Cooperation and Development's (OECD) environmental indicator programme uses a framework approach to group indicators into categories which represent key relationships in a larger model of sustainable agriculture (illustrated in figure 3). Direct use of reference values such as scientific thresholds is not generally made, in part because of the variability in such thresholds among member countries.

The "reference value" approach, a term used here to denote a desired state, goal or condition (see Table 1), is used by many agencies and appears to be gaining in acceptance. With this approach, indicators are designed to track movement toward or away from scientifically accepted targets or thresholds, policy goals or other generally-accepted values and objectives. As an example, Forestry Canada has developed a set of indicators which relate Canada's performance in managing its forests to publicly accepted social, economic and environmental values for forests.

TABLE 1: Examples Of Reference Values

TYPE OF REFERENCE VALUE	APPLICATION
Environmental Quality Guideline, Objective or Standard	Indicator tracks contaminant levels in environmental media against acceptable levels (eg. drinking water quality guideline)
Policy Target or Goal	Indicator tracks movement toward or away from accepted policy target or goal (eg. Montreal Protocol targets for phase-out of ozone-depleting substances)
Comparative Value	Data in indicator compared against background conditions or conditions at other appropriate reference sites
Ecological threshold	Data in indicator compared against levels or conditions which induce adverse biological effects (eg. minimum population size required for viability)

Source: Modified from McRae, 1991.

Environment Canada (EC), in its indicator development programme, uses several approaches by grouping indicators into an environmentally-relevant framework and, where possible, designing indicators so that they provide an indication of movement toward or away from scientific or policy targets.

A similar approach is proposed for Agriculture Canada: indicators can be grouped into relevant categories (described in section 3) and linked to appropriate reference values. These values can range from a broadly accepted goal for the sector (eg. reduction of soil erosion) to a more rigorous target (eg. the Canadian Drinking Water Quality Guidelines). The extent to which this approach is implemented will influence the utility of an indicator for policy-making and communication.

For some indicators, it may also be useful to portray data in some other way, perhaps in association with another variable or set of variables. For example, acreage of land under conservation tillage can be expressed as a ratio of total land under tillage. Similarly, trends in emissions of air pollutants can be reported in relation to changes in the Gross Domestic Product. These types of ratios are used extensively by the OECD as a way of integrating environmental data with economic data.

Another approach, also used extensively by the OECD, is to design the indicator to reflect percent change from a base year. This approach is especially useful in demonstrating relative change among related variables normally measured in different units, and has also been used to compare or integrate environmental data with economic data.

2.6 Project Deliverables. To ensure a focused effort, it is essential that the results of an initiative to develop a set of indicators be concretely defined.

There are at least three options for indicators:

- An "Environmental Indicator Bulletin" on agriculture, in cooperation with the State of the Environment Reporting Organization at Environment Canada (SOER), following the format developed for this series of publications;

- A "state of agriculture report" which would include a section or sections presenting indicators of sustainable agriculture;

- A set of environmental indicators for agriculture. These could be combined in a single report or reported separately by issue.

The first option (Environmental Indicator Bulletin) offers two main advantages: use of an established vehicle for product delivery, and an early contribution by AC to the larger federal indicator effort. However, EC's indicator programme may not in itself provide a suitable framework around which to organize AC's indicator work. It may be more appropriate to focus initial efforts on more preliminary work to develop a set of indicators, some or all of which could form the basis of a contribution to the indicator bulletin series in the future.

The second option, a state of agriculture report with indicators built in, can be thought of as an expanded version of the agriculture chapter of the 1991 National State of Environment Report. This is the approach being followed by Forestry Canada, whose annual report to Parliament on the state of Canada's forests contains a chapter on sustainable forestry indicators. However, there may be other, more effective, ways of incorporating the information represented by the indicators into the sector's policy-making processes.

The third option is proposed as the focus for the project. Each indicator will be reported at an appropriate spatial & temporal scale and supplemented with text which:

- defines the issue context for the indicator (or group of related indicators);
- assesses the relationship of the indicator to specified selection criteria;
- interprets the significance of the indicator.

This approach will focus efforts squarely on developing indicators in relevant areas and allows flexibility for reporting the indicators, perhaps as a bulletin, as part of a larger report, or in some other manner. Supporting data for each indicator can also be included.

3.0 CATEGORIES OF ENVIRONMENTAL INDICATORS.

To provide guidance on the selection and development of indicators, a list of areas and policy questions for which indicators are needed is required. These should correspond to relationships and issues which characterize the interface between Canadian agriculture, its resource base and environmental sustainability.

Agencies and reports which present environmental indicators typically adopt a conceptual framework early in the indicator development process. The OECD, which is presently developing indicators for the integration of environmental considerations into

agricultural policies, has developed a broad framework (illustrated in Figure 3) which incorporates the economic, social, cultural and environmental dimensions of sustainability in agriculture (OECD, 1993).

Agencies in Australia are working to develop indicators for agriculture in three areas: management indicators (aspects of finance, profitability and planning), production indicators (productivity of crops and animals relative to inputs) and resource-base indicators (which concentrate predominantly on soil and water) (Hamblin, 1991).

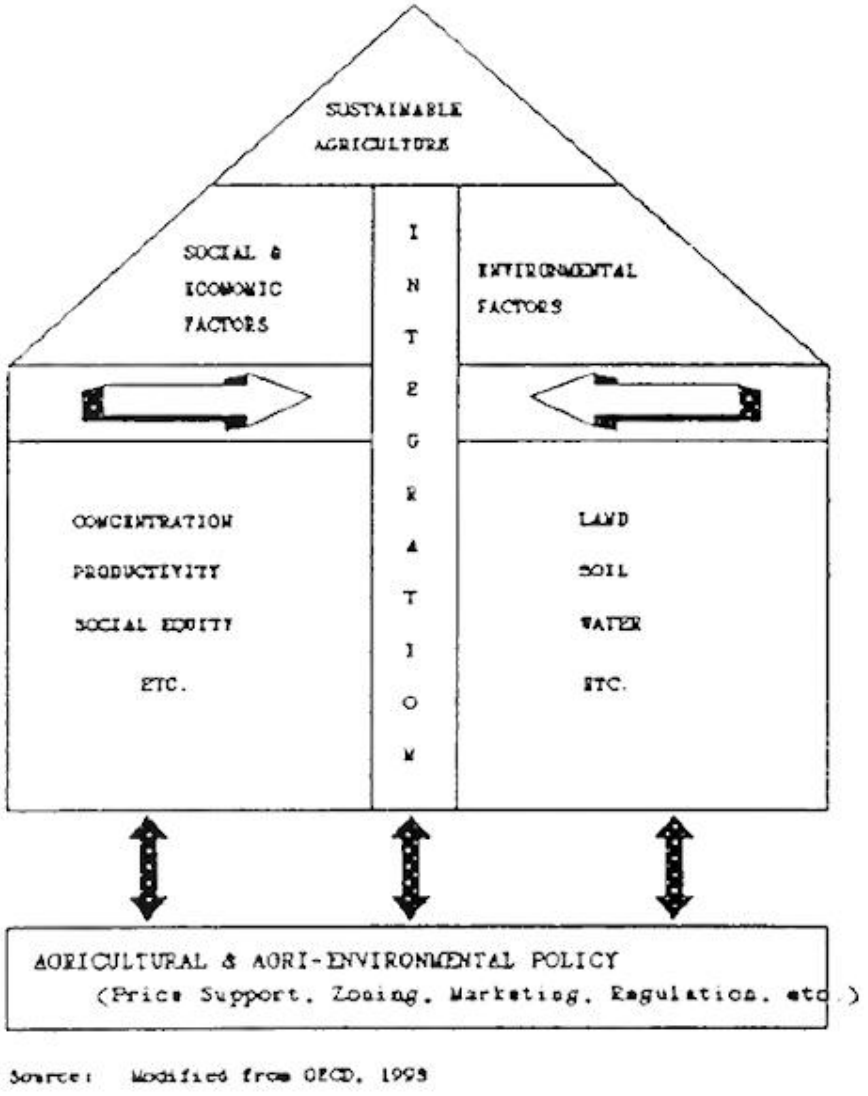


FIGURE 3: Conceptual Model of Sustainable Agriculture.

In the United States, through the agroecosystem component of the Environmental Monitoring & Assessment Program, indicators are being developed in relation to three broad

societal values for agriculture (supply of agricultural commodities, quality of natural resources and conservation of biological resources). Seventeen quantifiable assessment endpoints have been identified which relate to the broader societal values, and indicators will be developed to track movement toward or away from these endpoints. Examples of these endpoints include crop productivity, soil & water quality, agrichemical use, genetic diversity, water quantity and wildlife populations (Heck *et. al.*, 1992).

In Canada, the report of the Federal-Provincial Agriculture Committee on Environmental Sustainability (1990) (henceforth referred to as "the Committee"), provides a suitable starting point for identifying issues around which to organize environmental indicator development work. The work of the Committee is focused on *environmental* sustainability in agriculture (in contrast to the broader concept of sustainable agriculture), and identifies eight issues and three broad objectives for the sector.

ISSUES

- agricultural soil resources.
- surface and ground water quality.
- water quantity.
- wildlife habitat.
- air and climate.
- energy.
- pollution and waste management.
- genetic resources.

OBJECTIVES

- Conserve and enhance Canada's natural resources, which sustain agro-ecosystems.

- Protect the environment beyond the sector so that agriculture is not causing harm to others.

- Be proactive in protecting the agri-food sector from the environmental impacts caused by other sectors and factors external to agriculture.

For the purpose of this project, the indicators developed in relation to these issues and needs can be grouped into categories as follows:

1. Indicators related to the state and management of the agricultural resource base;

2. Indicators related to the environmental impacts of agriculture beyond the sector itself, and to impacts on agricultural resources from other sectors;

3. Indicators related to agricultural inputs and environmental risk;

4. Indicators related to the use of environmentally-sustainable farming practices.

The remainder of this section reviews these categories and lists, for each issue, general policy questions which will guide subsequent efforts to identify and develop environmental indicators for agriculture. Refinement of the policy questions and/or the development of more specific questions (as required) will take place as subject-area specialists become more directly involved with the project.

3.1 State & Management of the Agricultural Resource Base. Two of the eight issues identified by the Committee are included in this category: agricultural soil resources and genetic diversity.

Agricultural Soil Resources

The Committee identified two sub-issues, soil degradation and loss of agricultural land (particularly Classes 1-3), and offered the following vision to guide actions:

> "A secure and well managed resource base of agricultural land and soil to support the long-term productivity and competitiveness of the Canadian agri-food industry".

For these issues, indicators are required to address the following policy-related questions:

* *Is the productive capacity of Canada's agricultural land and soil resource base being sustained and improved?*

* *Is the quantity of Canada's prime agricultural land being maintained?*

* *To what extent are land management and cropping practices which enhance the productive capacity of the land and soil resource base being employed?*

These questions suggest that indicators are required: to assess changes in the inherent characteristics of the soil resource base which affect crop production potential (eg.

organic matter levels, soil erosion rates, etc); to identify trends in the quantity of available prime agricultural lands; and to track land use and management practices which contribute to enhancing the productivity of land and soil resources (eg. use of conservation tillage techniques, crop rotations). The challenge will be to select, from a suite of possible factors, those which best represent overall soil quality, land quantity and soil/land stewardship, reported at an appropriate national and/or regional scale.

Genetic Diversity

The Committee identified two sub-issues, the loss of genetic diversity and the narrowing of the genetic base for agriculture, and offered the following vision to guide actions:

> "Canada to have an accessible and sufficiently diversified genetic resource base that can be effectively utilized to assure the sustainability of agriculture for future generations".

For these issues, indicators are required to address the following policy-related questions:

* *How have the genetic bases and the diversity of the key plant and animal species used in Canadian agriculture changed?*

* *Are the biological resources and biodiversity required to ensure environmentally-sustainable agriculture in Canada being maintained?*

These questions suggest that indicators will be required which identify how the diversity of the genetic stock, and the distribution, of key plants and animals used in agriculture have changed, and the implications of observed changes to sustainability in agriculture. Indicators which identify efforts being made to preserve/enhance the genetic diversity and biological resources of Canadian agriculture can also be included.

3.2 Environmental Impacts of and on Agriculture. Three issues identified by the Committee are included in this category: surface and groundwater quality, wildlife habitat, and air and climate.

Surface and Groundwater Quality

The Committee identified four sub-issues: contamination by pesticides, contamination by nutrients, contamination by agricultural by-products and contamination by agricultural

sediment, and developed the following vision to guide actions:

> "An agri-food sector that contributes to improved surface and groundwater quality through the use of environmentally-sustainable production and processing practices".

The indicators developed for these four issues should address the following policy questions:

* *Are contaminants from agricultural sources being detected in surface waters or ground waters at levels which exceed guidelines (eg. the Canadian Drinking Water Quality Guidelines) developed for the most sensitive & likely use?*

* *To what extent are agricultural practices and resources which conserve and protect aquatic ecosystems, and which minimize the risk of water pollution from agricultural sources, being employed?*

To address these questions, indicators will be required which identify the nature and extent of off-site impacts on water quality (eg. trends in concentrations of selected pesticides, nutrients and faecal coliforms in surface & groundwater) and use of agricultural practices (eg. manure management, use of buffer strips) which minimize the risk of water pollution from agriculture.

Wildlife Habitat

The Committee identified one sub-issue: conservation, and offered the following vision to guide actions:

> "Canada's agrifood sector and wildlife resources to be managed for sustainability and long-term mutual benefits".

The indicators developed for this issue should address the following policy questions:

* *Is the quantity and quality of wildlife habitat in the agricultural regions of Canada increasing or decreasing?*

* *Are wildlife populations residing in agricultural regions of Canada being sustained?*

To address these questions, it will be necessary to identify specific species, and habitat types required, which are closely associated with agricultural landscapes, such as woodlots, wetlands and waterfowl species, and identify indicators which track quantitative and/or qualitative change in these variables.

Air and Climate

The Committee identified three sub-issues in this area: stratospheric ozone depletion, air quality and climate change, and offered the following vision to guide actions:

> "an agri-food sector that is able to respond to air and climate change and which does not itself contribute to air and climate problems".

The indicators developed for this issue should address the following policy questions:

* *Is Canadian agriculture a net source or a net sink of atmospheric carbon?*

* *Is agriculture in Canada being affected by changes in atmospheric chemistry?*

To address the first question, a carbon budget for the agricultural sector will be required which identifies trends in net carbon accumulation or release. The second question will require indicators which identify changes in production risk as related to atmospheric phenomena, such as changes in length of growing season (temperature) and in plant available moisture (precipitation), and indicators which identify resulting effects on production, such as ground-level ozone and decreased yields.

3.3 Agricultural Inputs. The issue of agricultural inputs was addressed indirectly by the Committee. Indicators developed for this group will address the following issues: water quantity & use, energy use, and environmental risk associated with fertilizers and pesticides.

Water Quantity

The Committee identified one sub-issue for this area, supply imbalance, and offered the following vision to guide actions:

> "an agri-food sector that has adapted itself to, and manages on a sustainable basis, the surface and groundwater resources available to it".

The indicators developed for this issue should address the following questions:

* *Are agricultural management practices contributing to the conservation of moisture and promotion of water use efficiency?*

* *Is agricultural water use per unit of production increasing or decreasing?*

* *Is agriculture being affected by the availability (or lack thereof) of water?*

The water quantity issue is closely linked to the climate issue. To address these questions, indicators will be required which measure the extent to which water availability affects agricultural production, efficiency of water use (defined as input per unit of output) and use of specific water management practices, such as snow-trapping.

Energy

The Committee identified two sub-issues in this area, energy inefficiency and lack of alternative sources, and offered the following vision to guide actions:

"an agri-food sector that is more energy efficient, less polluting and less dependent on non-renewable energy sources".

The indicators developed for this area should address the following questions:

* *Is the energy mix used in the agrifood sector changing, and if so, how?*

* *Is energy use per unit of agricultural production (output) increasing or decreasing?*

Indicators which address these questions will track changes in energy sources used in agriculture (renewable versus non-renewable) and efficiency of use, defined as unit of input per unit of output.

Fertilizers and Pesticides

The Committee discussed fertilizers and pesticides indirectly, and primarily in relation to two issues: Surface and Groundwater Quality, and Energy. In relation to the water quality issue, practices such as Integrated Pest Management, more use of pest-resistant crops, soil testing, nutrient cycling and better correlation between crop needs and nutrient application are identified and encouraged. For energy, the substitution of synthetic fertilizers with manures, integrated fertilizer and pesticide management practices and the use of nitrogen-fixing crops in rotations, are encouraged. All of these suggest a more targeted and efficient approach to fertilizer and pesticide use.

The indicators developed for this area should address the following questions:

* *Are environmental risks associated with the use of fertilizers and related soil amendments (eg. manure) increasing or decreasing?*

* *Are environmental risks associated with the use of pesticides increasing or decreasing?*

In relation to the first question, indicators will be required which identify trends in the ratio between crop nutrient requirements and nutrient applications (mass balance approach) and trends in the ratio of nutrient applications to crop yield (productivity).

For the second question, an indicator is required which combines trends in pesticide use with characteristics of the pesticides which determine environmental risk (eg. toxicity, persistence, etc), to determine whether the environmental risks associated with pesticide use are increasing or decreasing.

3.4 Use of Environmentally-Sustainable Farming Practices. The Committee identified, in each of the eight issue areas it considered, actions that would contribute to resolving the issue. These actions include agricultural practices, research, education, policy & program reform, etc. The Committee also recognized that there was a high degree of cross-linkage among the issues and actions proposed. For example, many of the actions suggested for improving soil and land management are also relevant to the water quality, wildlife and climate change issues. Similarly, minimizing environmental risks associated with pesticide use will have benefits in terms of improved water quality and wildlife preservation.

For the environmental indicator project, it is therefore appropriate to track the extent of adoption by farmers of specific actions and practices which contribute to an enhanced resource base and which minimize the environmental risks and impacts from agriculture. The challenge is to identify a set of practices beneficial to the largest possible range of issues, and supported with useful data. A general policy-relevant question might be:

* *To what extent are agricultural practices which conserve resources and which minimize environmental risks being employed?*

As work proceeds to identify indicators for the categories identified above, where it is appropriate to do so, indicators will be developed which track management practices which address the specific issue or concern. It is likely that land management practices will provide a useful starting point, as land is a fundamental resource whose management has implications for wildlife, water, soil and climate.

4.0 THE INDICATOR DEVELOPMENT PROCESS

This section reviews the process in place within Agriculture Canada to develop indicators and several elements of a strategy developed to implement the project.

4.1 Project Management and Coordination. Agriculture Canada's environmental indicator project was initiated in January 1993. The indicator development process will build on past and ongoing work in areas relevant to the project. As mentioned in Section 1, the project will proceed in two phases. Phase one will focus on identifying and developing indicators which make best use of existing data. Phase 2 will focus on enhancing and improving the indicators developed in phase one.

Within the department, the project is being coordinated through a departmental Working Group. In addition, issue-specific teams are being established to develop indicators for the issue areas listed in Section 3 of this paper. These teams provide a mechanism for engaging subject-matter specialists in the process. The selection of indicators will be considered by the Working Group as a whole.

4.2 Principles to Guide Indicator Development. The following principles of operation will guide the indicator initiative:

A. *Responsibility for developing specific indicators will reside with the appropriate centres of expertise.* This principle is intended to safeguard the scientific and policy validity of each chosen indicator.

B. *Interested stakeholders will be consulted on the selection of indicators.* This principle recognizes that an indicator is only useful if it is accepted by stakeholders, and that the diversity of views on what constitutes environmentally- sustainable agriculture must be considered.

C. *Indicators of agricultural sustainability will speak to the values, objectives and issues Canadians associate with the agricultural sector, in particular, as articulated by the report of the Federal-Provincial Agriculture Committee on Environmental Sustainability in Agriculture.* Adherence to this principle will ensure that the indicators selected are understandable and relevant to the issues and concerns of Canadians as they relate to environmentally-sustainable agriculture.

4.3 Consultations With Stakeholders. Consultation with stakeholders is essential to the success of new initiatives in the form of policies, programmes, regulations, etc. Such consultations must form an integral part of any initiative to develop sustainability indicators for agriculture.

A considerable amount of consultation has already taken place, through the Agri-food Policy Review, to define goals, objectives and a new vision for the sector, and we can build on this work. Beyond that, *three consultation processes will be pursued:*

* *scientific & technical consultations on an as-required basis among individuals and groups developing indicators;*

* *ongoing consultations with interested stakeholders, including a workshop, on the overall thrust of the project and on the selection of indicators;*

* *consultations following development of an initial set of environmental indicators.*

4.4 General Project Work Plan and Schedule. A general work plan & schedule to guide work on the development of environmental indicators for agriculture is outlined in Appendix 2. The plan addresses the *short-term aspects* of indicator development only, by aiming for

the development of indicators based largely on existing data, in fiscal-year 1993-94. Subsequent efforts to improve the initial set of indicators, such as data collection and research, are not addressed in detail in appendix 2.

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APPENDIX 1: Indicator Categories, Issues And Policy Questions.

CATEGORY	ISSUE	RELATED POLICY QUESTIONS
STATE & MANAGEMENT OF THE AGRICULTURAL RESOURCE BASE	Agricultural Soil Resources	* Is the productive capacity of Canada's agricultural land & soil resource base being sustained? * Is the quantity of Canada's prime agricultural land being maintained? * To what extent are land management & cropping practices which enhance the productive capacity of the land & soil resource base being employed?
	Genetic Diversity	* How have the genetic bases and the diversity of the key plant & animal species used in Canadian agriculture changed? * Are the biological resources and the biodiversity required to ensure environmentally-sustainable agriculture in Canada being maintained?
ENVIRONMENTAL IMPACTS OF AGRICULTURE	Surface & Groundwater Quality	* Are contaminants from agricultural sources being detected in surface or ground waters in quantities which exceed guidelines developed for the most sensitive & likely use? * To what extent are agricultural practices and resources which conserve aquatic ecosystems, and which minimize the risk of water pollution from agricultural sources, being employed?
	Wildlife Habitat	* Is the quantity and quality of wildlife habitat in the agricultural regions of Canada being maintained? * Are wildlife populations residing in agricultural regions of Canada being sustained?

CATEGORY	ISSUE	RELATED POLICY QUESTIONS
ENVIRONMENTAL IMPACTS OF AGRICULTURE (continued)	Air & Climate	* Is Canadian agriculture a net source or a net sink of atmospheric carbon? * Is agriculture in Canada being affected by changes in atmospheric chemistry ?
AGRICULTURAL INPUT USE	Water Quantity	* Are agricultural management practices contributing to the conservation of moisture and promotion of water use efficiency? * Is agricultural water use per unit of production increasing or decreasing? * Is agriculture being affected by the availability (or lack thereof) of water?
	Energy	* Is the energy mix used in the agri-food sector changing, and if so, how? * Is energy use per unit of agricultural production increasing or decreasing?
	Fertilizer & Pesticide Use	* Are environmental risks associated with use of fertilizers and related soil amendments increasing or decreasing? * Are environmental risks associated with the use of pesticides increasing or decreasing?
USE OF ENVIRONMENTALLY-SUSTAINABLE FARMING PRACTICES	Primary focus on land management practices, but relevant to all environmental issues associated with agriculture.	* To what extent are agricultural practices which conserve resources and which minimize environmental risks being employed?

APPENDIX 2: GENERAL WORK PLAN & SCHEDULE

ACTIVITY	*MILESTONE*
Develop a framework discussion paper for environmental indicators.	* Consultations and development in 4th quarters 92-93 and 1st quarter 93-94.
Distribute discussion paper to stakeholders for information and consultation.	* Distribution through federal-provincial accord committees in 1st quarter 93-94.
Conduct a selected literature review of environmental indicators for agriculture.	* Report completed in 1st quarter 93-94.
Establish Indicator Teams & identify Team Leaders.	* Indicator Teams established in first quarter 93-94.
International workshop on sustainable land management (first quarter 93-94)	* Identification of potential indicators of sustainable land management.
Identification of indicators to be developed in phase one of the project in all relevant areas.	* Preparation of issue-specific papers outlining proposed environmental indicators for agriculture in 2nd quarter 1993-94.
Consultation workshop on development of environmental indicators for agriculture.	* Workshop preparations begin in 2nd quarter 1993-94. * Workshop held in third quarter 93-94. * Preparation of workshop report.
Revision of proposals based on workshop discussion, possible distribution for comment to stakeholders.	* If necessary, proposals revised and distributed following consultation workshop.
Development of indicators in specified areas.	* Indicators development(data, text, graphics, etc) ongoing in second, third & fourth quarters 93-94. * Indicator package assembled in 3rd & 4th quarters 93-94.
Senior management review and preparation of indicator report in 4th quarter 93-94.	* Senior management briefed on indicators early in fourth quarter. * Indicator report prepared in fourth quarter 93-94.
Project status analysis and recommendations for next steps.	* Analysis initiated and completed in fourth quarter.

APPENDIX 3: SUMMARY OF RECENT WORK BY AGRICULTURE CANADA TO DEVELOP ENVIRONMENTAL INDICATORS

This summary identifies recent work carried out in Agriculture Canada to develop formal environmental indicators for the agricultural sector. It does not describe the substantial body of past and ongoing research and development work carried out to investigate various environment-related issues in the sector (such as soil erosion, genetic diversity, etc), much of which can support the development of environmental indicators. However, selected examples of such work are provided.

As is generally the case throughout the federal system, formal work in Agriculture Canada related to environmental indicators began in the late 1980s. The impetus for this was the call by Prime Minister Mulroney at the 1989 G-7 Summit for "new environmental indicators that will allow governments, businesses and private citizens to measure the state of the environment and the relationship of environmental indicators to economic development". Following this, several government departments and other agencies have undertaken work related to environmental indicators.

Agriculture Canada's involvement with the federal indicator effort began in August 1990. The federal initiative is led by Environment Canada (DOE), and was begun early in 1990 and subsequently incorporated into the December 1990 Green Plan under Section VI - Environmentally Responsible Decision-making. In April 1991, DOE released a progress report on the development of national environmental indicators (Environment Canada, 1991). The federal indicator initiative is ongoing, with one environmental indicator "bulletin" released (on stratospheric ozone depletion) and others to follow on a variety of environmental issues.

The 1991 progress report on environmental indicators proposed three environmental indicators for the agricultural sector and one related indicator:

* changes in agricultural land use;
* amount of chemical fertilizer used and its associated nutrient content;
* agricultural pesticide application on cultivated land.
* conversion of prime capability agricultural land, which was proposed under the broader category of Land.

Departmental input to development of the progress report was coordinated by the Research Branch and involved various Branches of the department. The process was as follows:

* A preliminary discussion paper presenting a list of environmental indicators was prepared by DOE;
* Research Branch coordinated a departmental response to the above-mentioned discussion paper. The process involved a review of the paper by members of an

inter-branch committee on the state of the environment;

* To facilitate further technical discussions with Agriculture Canada specialists, Research Branch provided a list of contact persons to DOE;
* Research Branch coordinated a departmental response to a draft of the agriculture component of the progress report on environmental indicators;
* Research Branch coordinated a departmental response to a draft of the full preliminary report on environmental indicators.

Following release of the progress report in April 1991, the following work has been carried out or is in progress:

* In 1992, the Environment Bureau prepared a list of potential environmental performance indicators for the agrifood sector.
* The Centre for Land and Biological Resources Research (CLBRR) is implementing a project to demonstrate the use of indicators of sustainable land management. This work is ongoing and a report is to be released late in 1993. Personnel from the CLBRR have also been involved in an international effort to develop a framework for evaluating sustainable land management.
* In 1993, the department established an interbranch Environmental Indicator Working Group to coordinate the department's work on the development of environmental indicators for the sector. The work of the Group is ongoing, with a first phase focused on developing a set of indicators which make best use of existing data, followed by ongoing work to address gaps and to improve the initial set of indicators developed.
* In June 1993, an international workshop on sustainable land management will be held in Alberta. Agriculture Canada is a major sponsor of the workshop, which will discuss the development of indicators of sustainable land management.

In addition, several programs and initiatives are in place which will increase the department's capacity to monitor and report on the state of agricultural resources using indicators. Selected examples of such initiatives include:

* Work with Statistics Canada to enhance the resource management module contained in the Census of Agriculture. This should yield essential information for developing indicators.
* The Soil Quality Evaluation Program will increase the department's capacity to measure changes in the quality of soil and land resources.
* Ongoing country-wide research and programming supported through the Green Plan, which should lead to the development of information that can support environmental indicator development.
* Work underway to refine the Canadian Regional Agricultural Model (CRAM) to include resource sustainability factors such as soil erosion.

* Development of the Farm Level Data Project (FLDP), which will improve the economic and production data that are available by farm size, type and region. The FLDP is also collecting benchmark Cost of Production data for major crops which includes information on production practices and inputs.