Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada

Evaluation of the Agri-Environmental Science Sub-Activity

Office of Audit and Evaluation

Report

Canada

The AAFC Evaluation Committee recommended this evaluation report (with changes) for approval by the Deputy Minister on November 14, 2012.

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Acronyms

AAFC	Agriculture and Agri-Food Canada
AESB	Agri-environment Services Branch
AES	Agri-Environmental Science
ARS	Agricultural Research Services
BMP	Beneficial Management Practice
BRM	Business risk management
EC	Environment Canada
EU	European Union
FTE	Full-time Equivalent
GF	Growing Forward
GF2	Growing Forward 2
HC	Health Canada
KER	Key Expected Results
NAHARP	National Agri-Environmental Health Analysis and Reporting Program
NCGAVS	National Carbon and Greenhouse Gas Accounting and Verification System
NRCan	Natural Resources Canada
NRC	National Research Council
NSERC	Natural Science Engineering Research Council of Canada
NPO	Non-pay operating
OAE	Office of Audit and Evaluation
OAG	Office of the Auditor General
OECD	Organization for Economic Co-operation and Development
OGD	Other Government Departments
PAA	Program Activity Architecture
PHAC	Public Health Agency of Canada
PMF	Performance Measurement Framework
RB	Research Branch
R&D	Research and Development
SAGES	Sustainable Agriculture Environmental Systems
SSHRC	Social Sciences and Humanities Research Council
TBS	Treasury Board Secretariat
U.S.	United States of America
WEBs	Watershed Evaluation of Beneficial Management Practices

Executive Summary

Agriculture and Agri-Food Canada's (AAFC) Office of Audit and Evaluation (OAE) evaluated the Agri-Environmental Science sub-activity as it was delivered over the period 2009-10 to 2011-12. The purpose of the evaluation was to examine the sub-activity's relevance and performance as required by the Treasury Board (TB) *Policy on Evaluation*. Under relevance, the evaluation assessed whether there is an on-going need for agri-environmental research, and the extent to which the sub-activity is aligned with government priorities, AAFC strategic outcomes and federal roles and responsibilities. With respect to performance, the evaluation assessed the extent of the progress that has been made towards achieving planned outcomes, and the extent to which it demonstrated efficiency and economy.

Agri-Environmental Science (AES) Sub-Activity

Activities under AES focus on conducting basic and applied research to produce new knowledge about the interaction of agriculture and the environment. The results of this research are intended to contribute to the development of policies, practices and technologies that will improve agri-environmental performance. Under AES, there are two sub sub-activities:

- Agri-Environmental Soil, Water, Air and Bioresource Protection is the department's continuing agri-environmental research stream funded from its on-going research and development resources. It comprises research projects that are targeted at enhancing the environmental performance of the Canadian agricultural sector and understanding of Canadian bioresources and protecting and conserving their genetic diversity.
- Sustainable Agriculture Environmental Systems (SAGES) is a four-year initiative funded as part of *Growing Forward* ending in March 2013. It comprises research projects that focus on the agri-environmental challenges related to the quality and use of water, and adaptation to and mitigation of climate change.

From 2009-10 to 2012-13, a total of 91 AES projects were in progress with an estimated expenditure of $104.1 million in salary and non-pay operating costs. The management of AES is shared between the Agri-Environment Services Branch (AESB) and Research Branch, while research projects, with very few exceptions, are carried out by scientists in the Research Branch. As of July 1st, 2012, the AESB and Research Branch have been consolidated into the Science and Technology Branch.

Methodology

The evaluation gathered quantitative and qualitative data using the following lines of evidence: project review; document review; literature review; key informant interviews with program officials, scientists and other government department officials; bibliometric analysis; an analysis of comparable federal research and development programs, surveys of scientists and costing analysis.

Key Findings

The evaluation resulted in the following key findings:

1. There is a continuing need for new and deeper scientific understanding of the interaction between the environment and agriculture as the environment changes and the agricultural sector seeks and adopts new practices and technologies to increase its productivity, profitability, competiveness and sustainability.
2. AES objectives are aligned with the federal government's science and technology, environmental and agricultural priorities, as well as AAFC's strategic outcomes and science priorities.
3. The federal government's roles and responsibilities with respect to the AES sub-activity are consistent with its historical roles and responsibilities, institutional capacity, international practices, and stakeholder thinking about the circumstances where government can, or should, intervene. Going forward, there are opportunities to further strengthen the engagement of provinces and territories in this area.
4. AES projects are targeting research questions that can reasonably be expected to provide scientific knowledge about the interaction of agriculture and the environment.
5. The AES research projects are producing the outputs (peer reviewed scientific publications) required to contribute to the sub-activity's expected outcome of increased understanding of the agriculture-environment dynamic by the science community at or above targeted levels.
6. While collaboration with internal and external partners has increased through SAGES there are opportunities to further promote collaboration among AAFC scientists and managers, other government departments and industry and to strengthen AES knowledge transfer activities.
7. Performance monitoring and reporting on input costs and project outputs could be improved to support more robust assessments of program efficiency and effectiveness. SAGES researchers are funded at levels similar to their peers in the Research Branch and in the federal government as a whole.
8. AES research efficiency is similar to that of public sector research in the U.S. and the EU.

Recommendations

The evaluation recommends that:

1. The Science and Technology Branch should develop an appropriate performance measurement strategy for the Agri-Environmental Science sub-activity, one that is linked to the department's science priorities and strategic outcomes.

2. The Science and Technology Branch should examine ways to improve collaboration on agri-environmental research internally and with other government departments, provinces and territories and industry groups.
3. The Science and Technology Branch should develop and implement a comprehensive knowledge transfer strategy for agri-environmental science based on a broad definition of knowledge transfer as a process that begins in the planning stages and extends through knowledge utilization, and which considers the role and mandate of provinces and territories and industry.
4. The Science and Technology Branch should develop a reporting protocol to track and report program and project level financial and performance information to support more robust performance monitoring and reporting.

1.0 Introduction

Agriculture and Agri-food Canada (AAFC), under the Agri-Environmental Science (AES) sub-activity [Program Activity Architecture (PAA) #1.1.1], conducts basic and applied research to produce new knowledge about the interaction of agriculture and the environment. The results of this research are intended to contribute to the development of policy, practice and technology innovations that will improve agri-environmental performance.[1]

AES research is conducted under two streams (sub sub-activities):

- Agri-Environmental Soil, Water, Air and Bioresource Protection (PAA# 1.1.1.1): This is the department's continuing agri-environmental research stream funded from its on-going research and development (A-base) resources. It comprises research projects that are targeted at AAFC's Science Priorities #5 (Enhancing environmental performance of the Canadian agricultural system) and #6 (Enhancing understanding of Canadian bioresources and protecting and conserving their genetic diversity). The expected results of the knowledge produced by this research include the development of new technologies, tools and beneficial management practices (BMPs); and
- Sustainable Agriculture Environmental Systems (SAGES) (PAA# 1.1.1.2): SAGES is a four-year initiative funded as part of *Growing Forward* ending March 2013. Continuing on the Agricultural Policy Framework (APF), the *Growing Forward Multilateral Framework Agreement* indicates that the initiative is intended to "…focus on the environmental challenges related to the identified priorities of the quality and use of water, and adaptation to and mitigation of climate change..."[2] As is the case for Agri-Environmental Soil, Water, Air and Bioresource Protection research, SAGES targets Science Priority #5 and is expected to produce new knowledge that will contribute to the development of new tools, BMPs and other technologies.

1.1 Evaluation Scope and Methodology

1.1.1 Evaluation Scope

In accordance with the Treasury Board *Directive on the Evaluation Function*, the evaluation examined the sub-activity's relevance, assessing whether there is a continuing need for the research, whether it is aligned with government priorities and departmental strategic outcomes, and whether the federal roles and responsibilities are appropriate. It has also examined the program's performance, the

[1] AAFC 2011-12 Report on Plans and Priorities. pp. 19.

[2] *Growing Forward Multilateral Framework Agreement* (2008). pp. 14.

progress that has been made toward achieving planned outcomes, and the extent to which it demonstrated efficiency and economy.

In terms of measuring performance, the evaluation focused on assessing whether, and to what extent, the department has made progress toward achieving its intended outcomes, as opposed to attempting to measure its impacts because the outcomes of the research done in the period under study will only be measureable in two or more years when research projects will be completed.

1.1.2 Evaluation Approach

The evaluation used a mixed-methods, non-experimental design, incorporating multiple lines of evidence, both qualitative and quantitative, to assess the programs and address evaluation issues and questions. Qualitative data was used to provide context around quantitative data.

1.1.3 Methodology

The evaluation's lines of evidence were:

- Project review: The project review examined the proposals and the 2010-11 annual reports for 32 approved AES research projects (Appendix A List of AES Projects). All active SAGES projects (n:22) were reviewed, and a sample (n:10) of Agri-Environmental Soil, Water, Air and Bioresource Protection projects that were selected based on materiality [largest non-pay operating (NPO) budgets] and commencement date (initiated in 2009-10 or later).
- Key informant interviews: Eight preliminary interviews were conducted during the development of the evaluation scope and design. A total of 19 face-to-face and telephone interviews were completed with senior management (n:7), program officials (n:1), AAFC scientists (n:5) and external collaborators on research projects (n:6). These interviews were conducted using structured interview guides (Appendix B Interview Guides). The sample was selected from lists identified through consultations with program officials and managers. The number of interviews conducted, however, provided sufficient representation, including external collaborators familiar with program delivery. All interview responses are kept anonymous.
- Document and literature review: The evaluators completed a document and literature review to gain an understanding of AES activities and the context in which they are delivered, and to gather information relevant to the evaluation questions. The review examined foundational documents, such as Treasury

Board submissions, as well as branch and departmental planning and performance reports, strategic policy and accountability reports such as the AAFC *Science and Technology Innovation Strategy*, and departmental performance reports. It also reviewed relevant federal policy statements, special studies and reports. The literature review examined publications and reports dealing with issues such as the evaluation of research, the state of agri-environmental research internationally, and national government agri-environmental research programs in other countries. (Appendix C References)

- Survey: A survey was undertaken with AAFC principal investigators and managers (sample=79/responses=44) involved with AES program or project activities. The purpose of the survey was to collect opinion data about the effectiveness, efficiency and economy of the AES sub-activity. The response rate of 56% was considered sufficient representation to support evaluation findings. A copy of the survey questionnaire is attached at Appendix D Appendix D.

- Bibliometric analysis: Bibliometric data is commonly used to measure scientific output, productivity and impact. Data for the bibliometric analysis was collected from two sources. First, the evaluators invited the principal investigators for SAGES (n:25) and Agri-Environmental Soil, Water, Air and Bioresource Protection (n:66) projects to submit lists of the peer reviewed publications, as well as other research products (patents, conference proceedings, books, AAFC reports, etc.) flowing from their projects and dated in 2009 and later. Replies were obtained for 25 SAGES and 49 of 66 Agri-Environmental Soil, Water, Air and Bioresource Protection projects and count and citation data were extracted for peer reviewed articles (n:578). The remaining projects were either in the midst of writing research publications or in the process of conducting research.

  Second, citation data for articles published in 2009 or later where one or more of the authors was affiliated with AAFC was retrieved from Scopus (n=3,583). Then, the publications reported by principal investigators were identified in the Scopus list (n:353) and the citation data extracted for analysis.[3] The analysis included citation counts, calculation of citation (impact) factors for projects individually and type (SAGES and Agri-Environmental

[3] The reasons for the difference between the count of peer reviewed articles reported by principal investigators and the number that appear in Scopus include: Principal investigators reported articles that were “submitted,” “in review,” or “in press” status; Scopus does not index all journals; and Scopus data for some journals is not complete.

Soil, Water, Air and Bioresource Protection), and institutional affiliations.

- Comparable programs analysis: As part of the efficiency and economy assessment, the evaluators used document reviews and interviews to gather information about the goals and objectives, mandates and scope, activities, outputs and costs of federal programs that conduct intramural research on environment-related questions. The information about these comparable programs was used to assess design and delivery aspects of the AES sub-activity and to explore whether more efficient and economic models were available. Selected because of similar environmental focus, the programs were Environment Canada's Lake Winnipeg Basin Initiative (LWBI), Natural Resources Canada's Green Mining Initiative (GMI), and AAFC's Watershed Evaluation of Beneficial Management Practices (WEBs) program.
- Costing analysis: A costing analysis was done to help assess the efficiency and economy of the sub-activity. The analysis used the actual expenditures data as reported by the department's financial management system at the sub-activity and sub sub-activity levels and project-level budget data [NPO and full-time equivalent (FTE) allocations] reported by the Research Branch Project database. Using these data, the evaluators calculated estimated input and output costs to compare with similar data for other research activities in the federal government, United States and Europe.

1.2 Evaluation Constraints and Limitations

The evaluation was constrained by these factors:

- Level of program maturity. About 90% of the 25 SAGES projects and 38% of the Agri-Environmental Soil, Water, Air and Bioresource Protection projects are scheduled to end in March 2013 and many will still be producing outputs (publications and other reports) after the funding ends. The evaluation was based on the data available up to April 2012 and did attempt to incorporate the progress being made in the unfinished projects.
- Return on Investment. It is difficult to determine the return on investments in agri-environmental science, particularly related to funding that was allocated from 2008-09 to 2012-13 under *Growing Forward*. Since the projects are still on-going, data on project outcomes is expected three to four years following the conclusion of the programs. The literature review undertaken as part of this evaluation acknowledges that it is challenging to develop realistic models to explain the direct link between

research and economic performance.[4] In some cases, it takes upwards of 10 or more years for basic scientific research to translate into economic benefits. Furthermore, extrapolating economic impact from individual research projects can be difficult where landscape and farming conditions are highly variable, such as in Canada.

AES research is focused on discovery research, developing scientific knowledge, which is the first phase of the research and development continuum. Discovery scientists carry out their own small scale watershed assessments to test their research, while other AAFC programs, such as WEBs, facilitate BMP implementation. It is challenging to directly link agri-environmental research to economic benefits because there is spillover to other industries, as agri-environmental science includes many agricultural sub-sectors. Notwithstanding these challenges, this evaluation does include a discussion of the potential future return on investment for agri-environmental science activities. The evaluation conducted a review of 32 projects and an analysis of a few individual projects that have continued from previous funding cycles, i.e. funded under the *Agricultural Policy Framework*, to make observations related to the contribution that AES research can make towards the overall return on investment for federal funding in this area.

- Estimated salary costs. While planned staff time allocations are recorded for project management purposes, neither the AESB nor Research Branch track actual project-level staff time allocations. Therefore, estimated salary was used to determine resource utilization at the sub sub-activity level. To determine the efficiency and economy of AES, the evaluation had to cross-reference with project allocation and Corporate Management Branch's financial system to interpret the estimated salary to be able to compare AES with national and international programming. The evaluation team assumed that the financial data at the AES sub-activity level and the project-level staff time allocation was accurate. There was no bias on the interpretation of the evidence on the part of the evaluators.
- No industry stakeholder participation. The evaluation team complied with program management's request that no industry representatives be contacted. There are many external collaborators involved with AES projects, but they have limited understanding of the connection between research projects and

[4] David A. Wolfe, D.A. and Salter, A. (1997) The Socio-Economic Importance of Scientific Research To Canada. A Discussion Paper Prepared for The Partnership Group for Science and Engineering. pp. 13.

the AAFC AES program, as they may or may not be funded collaborators in research projects. These *external collaborators* recognize that they are assisting on an issue of common interest by working with AAFC staff as opposed to a particular program. Therefore, the industry perspective was not captured or analyzed. The evaluation reflects views of industry through secondary sources such as *Growing Forward 2* consultations. As a result, the evaluation findings may not reflect accurate representation of agri-environmental industry issues.

- Limited Access to Key Informants. The interview sample selected for the evaluation was smaller than planned with more key informants at the working level, but it did provide a sufficient representation that was used as evidence, along with survey results, to support evaluation findings. The evaluation team reduced or limited personal bias in the interpretation of the interviews by including two evaluators for every interview and cross-referencing the interview data with survey and document review data.

2.0 Program Profile

AAFC agri-environmental research produces scientific knowledge that contributes to the improved environmental performance of agriculture and minimizes the potential negative impacts of agriculture on the air, water, soil and bioresources. It consists of the basic and applied research[5] done to provide the scientific knowledge needed to characterize and quantify the effects of agricultural production on the environment, develop BMPs, and to advise policy makers, land resource specialists, extension specialists[6] and producers on how to improve agricultural practices and enhance the sustainable management of agricultural resources. Prior to 2009-10, agri-environmental research was undertaken under a number of different programs including Environmental Technology Assessment for Agriculture, Water Quality Surveillance and the National Agri-Environmental Standards Initiative.

As described earlier, AES research is conducted under two streams or sub sub-activities. The first is Agri-Environmental Soil, Water, Air and Bioresource Protection, the department's continuing agri-environmental research stream funded from AAFC's on-going R&D resources. It comprises research projects that are aligned with AAFC's Science Priorities #5 (Enhancing environmental performance of the Canadian agricultural system) and #6 (Enhancing understanding of Canadian bioresources and protecting and conserving their genetic diversity). The expected results of the knowledge produced by this research include the development of new technologies, tools and BMPs.

The second is the Sustainable Agriculture Environmental Systems (SAGES) initiative, which is funded as part of *Growing Forward* for four years ending March 2013. The *Growing Forward Multilateral Framework Agreement* describes SAGES as an agri-environmental initiative designed to "…focus on the environmental challenges related to the identified priorities of the quality and use of water, and adaptation to and mitigation of climate change…"[7] As is the case for Agri-Environmental Soil, Water, Air and Bioresource Protection research, SAGES is expected to produce new knowledge that will contribute to the development of new technologies, tools and BMPs while focusing on the water and climate change priorities.

The SAGES initiative is further distinguished and focused by the fact that this was designed to fund two categories of research:

[5] For definitions of "basic" and "applied" research and related concepts see section 4.2.2 of: Organisation for Economic Co-operation and Development. (2002) Frascati Manual 2002 Proposed Standard Practice for Surveys on Research and Experimental Development. [Paris]: OECD. Retrieved from http://dx.doi.org/10.1787/9789264199040-en.

[6] Extension specialists are those involved in transfer of agriculture knowledge/technology to farms.

[7] *Growing Forward Multilateral Framework Agreement* (2008). pp.14.

- Target: Research done by AAFC scientists and oriented toward the study of nutrients, pathogens, and pesticides in water, as well as carbon and greenhouse gas dynamics in relation to agricultural practices.
- Synergy: Agri-environmental research that addresses water quality or climate variability in a broader multi-sector context and is done in collaboration with other federal organizations such as Environment Canada and the Public Health Agency of Canada (PHAC).

2.1 Governance

During the period covered by the evaluation, the Agri-Environment Service Branch (AESB) and Research Branch each had responsibilities for the management of AES. AESB had overall responsibility to manage SAGES, including planning, and implementing SAGES projects including budget management and resource allocation, while the Research Branch was responsible for the day to day research activities; local science directors and research managers were responsible for including project monitoring and reporting, and the dissemination of research results and findings, in particular. Day to day project management, adjustments to budgets and work plans and resource allocations were under joint responsibility of two directors, one from each Branch.

Given their shared interests and responsibilities, the Branches established the Agri-Environmental Science Steering Committee in 2011 with a mandate to develop branch-level strategies that support the Environment Strategic Plan and the Innovation Strategic Plan. The committee was co-chaired by the Director Generals of Agri-Environmental Knowledge, Innovation and Technology, AESB, and Science Policy and Planning, Research Branch.

In the case of Agri-Environmental Soil, Water, Air and Bioresource Protection projects, the Research Branch was responsible for the management and administrative aspects.

2.2 Program Activities

The activities associated with AES include:

- selecting research projects under Agri-Environmental Soil, Water, Air and Bioresource Protection and SAGES;
- conducting research (collecting and analyzing data to produce findings and conclusions);
- monitoring and reporting on approved projects; and
- disseminating research results.

Project Selection: The Research Branch project selection process begins with a call for proposals that identifies the targets, priorities and criteria for each funding round. Interested scientists then develop and submit their proposals which are first subject to management review that rates the proposals against the priorities and criteria. After the initial management screening, the surviving proposals are circulated for examination by an external peer review panel that assesses the proposal's scientific quality. Once the peer review results are known, the proposals are submitted for executive review and decision. The process provides opportunities for modifications to proposals at key planning and approval stages and an appeal in the event a proposal is not approved. The research project selection process diagram can be found in Appendix E.

For SAGES, the competitive process resulted in 73 Letters of Intent, 40 of which were invited to submit 24 integrated full proposals, totalling $30 million. Only 23 principal investigators received funding for SAGES projects, with approximately an annual average of 115 full-time scientists.

Research Projects: The evaluation, however, limited its inquiries to the 91 projects that were active in the three-year period 2009-10 to 2011-12 (25 SAGES projects and 66 Agri-Environmental Soil, Water, Air and Bioresource Protection projects).[8] Table 1 presents data profiling the size of the two groups of AES projects. A list of these projects is presented in Appendix A.

Table 1: AES Project Information

	Agri-Environmental Soil, Water, Air and Bioresource Protection	SAGES
Total Project NPO Budget for the period 2009-2012		
Average	$97,215	$1,062,288
Maximum	$700,000	$3,938,000
Minimum	$15,200	$96,000
Median	$62,900	$770,000

Monitoring and Reporting: The scientists leading each AES project must submit an annual report covering the project's progress, variances and achievements that are reviewed and signed-off by the Research Branch Science Director responsible for that area of research. In the case of SAGES' projects, AESB and Research Branch managers did an additional review of all the projects at the end of the 2010-11 fiscal year to ensure that the initiative, as opposed to individual projects, was proceeding as planned.

[8] The Research Branch project database lists a total of 119 AES projects that were funded for at least one year in the period 2007-08 to 2011-12.

Disseminating Results: AAFC researchers and their collaborators disseminate the results of their research through peer reviewed publications. In addition, they disseminate information through various non-peer reviewed vehicles such as patents, conference proceedings, books and reports.

2.3 Outputs

The primary outputs of AES research are peer reviewed publications that are produced to disseminate the research results within the scientific community. These are augmented by presentations and reports to scientific gatherings. The Research Branch maintains its own database that collects information about peer reviewed publications and patents.

In addition, scientists may produce presentations, reports or other documents to disseminate information about the research and its implications to individuals or groups involved in the development and adoption of agricultural and or environmental policies or practices. While AAFC scientists collaborate in these activities, they are not directly responsible for the knowledge transfer outputs that translate research results into BMPs and other tools, but some do on their own initiative. AAFC scientists generally focus on publishing their research in scientific community publications, that offer highest impact or most appropriate to their work.

2.4 Outcomes

As per the departmental performance measurement framework (PMF), the overall expected outcome for the AES sub-activity is increased understanding by the agri-food sector of the interactions and impact of agricultural practices on the environment (soil, water, air and bioresources) and the potential for using bioresources. That knowledge and understanding forms the scientific basis for development of BMPs and other tools.[9]

2.5 Expenditures

The table below provides a breakdown of the budget and expenditures for SAGES and Agri-Environmental Soil, Water, Air and Bioresource Protection.

[9] Agri-Environmental Science project objectives are linked to Science Priorities 5 and 6.

Table 2: Agri-Environmental Science Expenditures (NPO and Salary) ($million)

Programs	2009-10	2010-11	2011-12	Total
SAGES	10.1	10	10.3	30.4
Agri-Environmental Soil, Water, Air and Bioresource Protection [10]	28.8	25.6	19.3	73.7
Total	38.9	35.6	29.6	104.1

Source: AAFC Corporate Finance, June 2012

The actual expenditures were only available at the AES sub-activity level. The expenditure for 2012-13 will be available at the end of the fiscal year. SAGES project funding began in 2009-10 and is to terminate in 2012-13.

2.6 Performance Measurement

There is no specific or fully developed program logic model and performance measurement framework (PMF) for the AES sub-activity.[11] There are, however, a number of higher-level PMFs that identify a mix of outputs, outcomes and performance indicators for the sub-activity and/or its component parts:

- AAFC`s corporate PMF identifies Agri-Environmental Science sub-activity outputs and outcomes;
- AESB has a performance measurement framework for SAGES;
- The *Growing Forward* PMF has identified outputs and outcomes that do not necessarily include A-base funded programs such as Agri-Environmental Soil, Water, Air and Bioresource Protection; and
- The Research Branch PMF does not deal with named initiatives or sub-activities, but does identify expected outputs, outcomes and performance indicators for each of the key expected results (KERs) aligned with the science priorities.

[10] Agri-Environmental Soil, Water, Air and Bioresource Protection is not a defined program but a research area that is continuously funded as part of one or more of AAFC's science priorities.

[11] Section 6.1.4 and 6.2.3 of the Directive of the Evaluation Function (2009) indicates that program managers are responsible for developing performance measurement strategies for all new and ongoing direct program spending. AES programs were developed prior to the implementation of this policy as there was no requirement to develop a program logic model and performance measurement strategy for Vote 1 funded programs at that time.

3.0 Evaluation Findings

3.1 Relevance

In assessing the relevance of AES, the evaluation examined the current and continuing need for agri-environmental science research; the alignment of such research with federal priorities and departmental objectives; and the appropriateness of the federal roles and responsibilities with respect to developing knowledge to increase the agriculture sector's understanding of its interaction with the environment.

3.1.1 Ongoing Need

There is a continuing need for new and deeper scientific understanding of the interaction between the environment and agriculture as the environment changes and the agricultural sector seeks and adopts new practices and technologies to increase its productivity, profitability, competiveness and sustainability.

Agriculture and Environment Interaction: The demand for scientific knowledge about how agricultural activities affect the environment, and vice-versa, has evolved. The introduction of new agricultural technologies and practices, including larger, more intensive operations, through the latter half of the 20th Century, has increased general concerns about air and water quality, the impacts of agricultural activities on urban environments, possible threats to human health and other factors. By way of illustration, the Organisation for Economic Co-operation and Development (OECD) has reported that the risk of water contamination from agriculture sources has increased since 1981, and the Great Lakes ecosystem is stressed by farm nutrients, pathogens, pesticides and soil sediments from Canadian and U.S. sources.[12] Similarly, phosphorus levels in soil are a concern in Ontario, British Columbia and Quebec.[13]

In one way or another AAFC research has been addressing agri-environmental issues for several decades. The Agriculture Policy Framework (APF), however, was the first injection of targeted funding for agri-environment science. In preparation for the negotiation of an agreement to replace the APF (which expired in 2007-08), AAFC

[12] OECD. (2008) Environmental Performance of Agriculture in OECD countries since 1990, Paris, France. pp. 243.

[13] AAFC. (2006) Environmental and Economic Impact Assessments of Environmental Regulations for the Agriculture Sector: A Case Study of Hog Farming. Prepared by: Cher Brethour, Beth Sparling, Terri-lyn Moore and Delia Bucknell. George Morris Centre. pp.18.

reviewed the state of agri-environmental challenges and concluded that there was a need for better scientific understanding of the interactions between agriculture and the environment, and to inform industry decision-making and national policy development. Building on the APF experience, the department established the SAGES initiative under the *Growing Forward Multilateral Framework Agreement for Agriculture*.

The scope and significance of the need for new agri-environmental knowledge has evolved in response to many factors, including:

- The diversity of Canada's agricultural landscapes: each is a unique soil, water, air and biodiversity resource system. This means, for example, that a particular BMP, such as zero tillage, may work well in one region and be ineffective elsewhere.
- Climate change is altering growing conditions and introducing new agri-environmental risks. For example, the migration of pests into new territories has led to the increased use of pesticides and a greater risk of pesticide residues entering water systems when there is no systematic monitoring for such eventualities. Similarly, climate variability may be leading to increased water usage with higher levels of excess nutrients and pathogens entering the water supply.
- The agricultural sector and governments, responding to the growing global market for food and bio-based products, are encouraging continuing development and adoption of new technologies, crops and agricultural practices to help increase productivity and improve Canada's competitiveness globally, while ensuring environmental health. Growth in Canada's agricultural production was more than double the OECD average between 1990-92 and 2002-04.[14]
- Innovations in agricultural practices and technologies are allowing producers to farm formerly marginal lands. For example, in Alberta, livestock production is being moved to marginal lands by using beneficial management practices to make room for crops such as grains and oilseeds.[15]

[14] OECD. (2008) Environmental Performance of Agriculture in OECD countries since 1990, Paris, France. pp. 243.

[15] Vaisey J.S., Weins T.W., Wettlaufer R.J. (1996) The Permanent Cover Program - Is Twice Enough? Soil and Water Conservation Policies: Successes and Failures, Prague, Czech Republic, September 17-20, 1996, AAFC. http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1187267959357&lang=eng; and, Janzen, H. (2010) Agriculture and the Greenhouse Gases. Prairie Soils and Corps.

Research and development: The document, literature and project reviews, as well as key informant interviews, identified continuing challenges (e.g. climate change, and water quality and quantity issues) and the need to address these in circumstances characterized by constant pressure for increased productivity, and competitiveness, as well as economic and environmental sustainability. The agricultural science and innovation process is iterative and rolls out over relatively long periods of time, in part because the pace of work is often dictated by the seasonal cycles. Key informants indicated that there is an ongoing need to improve the established BMPs, or adapt them to specific regions. For example, water quality monitoring in the Abbottsford-Sumas watershed found that, while BMPs had been in place for several years, water was still being contaminated by livestock waste. This led to additional research and development in this region.

Key informants noted that where research focuses on looking for more efficient and competitive agricultural practices, additional research is needed to ensure a thorough scientific understanding of the impact of these practices on the environment. For example, the adoption of reduced and zero tillage practices have proven to decrease soil erosion, increase soil organic carbon and improve salinity.[16]

The report of the 2010 GF2 stakeholders' consultations noted that farmers identified needs for research that would lead to the development of new applications and uses for agricultural products, new varieties, improved nutrient management, reduced dependence on fertilizers, and lower overall production costs. The key informants indicated that the research - innovation process has yet to generate sufficient scientific understanding to allow the agricultural sector to achieve long-term sustainability, implying the need to continue with agri-environmental science.

In conclusion, based on the document, literature and project file reviews, and key informant interviews, there is considerable evidence of a continuing need for new and deeper scientific understanding of the interaction between the environment and agriculture as the environment changes and the agricultural sector seeks and adopts new practices and technologies to increase its productivity, profitability, competiveness and sustainability.

[16] OECD. (2008) Environmental Performance of Agriculture in OECD countries since 1990, Paris, France. pp. 245.

3.1.2 Alignment with Federal Priorities and Strategic Outcomes

AES objectives are aligned with the federal government's science and technology, environmental and agricultural priorities, as well as AAFC's strategic outcomes and science priorities.

The AES sub-activity's general objective is to conduct intramural basic and applied research to improve scientific understanding of agriculture's interactions with the environment leading to scientific knowledge that contributes to the discovery of technologies, such as BMPs, to improve the agri-environmental performance of the sector.[17] The evaluation reviewed Government of Canada publications and policy documents including Federal Budget statements and AAFC foundational documents that articulate the department's strategic outcomes to assess whether AES objectives and activities are aligned with federal priorities and with AAFC strategic outcomes and science priorities.

Federal science priorities: In the 2007 paper *Mobilizing Science and Technology to Canada's Advantage*, the Federal Government stated that it would focus on research in areas of national interest from a social and economic perspective: environmental science and technologies; natural resources and energy; health and related life sciences and technologies; and information and communications technologies. The document also noted that the Government of Canada would continue to play a role in supporting basic research across a broad spectrum of science, while being more focused and strategic – targeting research in areas of strength and opportunity. The strategy also called for efforts to ensure that federal departments and agencies have access to the science and technology capacity required to fulfill their important policy and regulatory mandates in areas such as environment, health and safety.[18] AES research addresses economic and environmental priorities. Furthermore SAGES is intended to develop AAFC's internal capacity and enhance its collaboration with scientific communities in OGDs, academia and industry to carry out agri-environmental research.

Federal sustainability priorities: In the *Federal Sustainable Development Strategy (2010*), the Government of Canada adopted three themes that are consistently high priorities for Canadians: a) Addressing climate change and air quality; b) Maintaining water quality and availability; and c) Protecting nature. AES research, especially the SAGES projects address the water and climate change priorities.

[17] AAFC. 2011-12 Report on Plans and Priorities. pp.19.

[18] *Mobilizing Science and Technology to Canada's Advantage.* (2007) pp. 11 and 97.

Federal agriculture priorities: The *Growing Forward Multilateral Policy Framework* commits FPT governments to enhancing agri-environmental performance through research. The framework placed an emphasis on improving the sustainability of agricultural production and enhancing the performance and services provided by the agro-system, targeting research on water and climate change.

In Budget 2012, the Government reported that it was working toward a new five-year FPT agricultural policy framework to replace *Growing Forward*. In September 2012, federal, provincial and territorial Ministers of Agriculture reached agreement on the content of the *Growing Forward 2* policy framework for agriculture, which set out several policy directions for the new framework agreement, including a commitment to move toward more targeted, collaborative and results-oriented approaches to address environmental challenges through better integrated and targeted science efforts.[19]

AAFC Strategic Goals: The department's three Strategic Outcomes include "An environmentally sustainable agriculture, agri-food, and agri-food products sector". AAFC's Science and Innovation Strategic Plan identifies seven science priorities, including one, Science priority #5, that is concerned with enhancing the environmental performance of the Canadian agricultural system.

In summary, the document and literature review and key informant interviews found clear evidence that AES objectives and research activities are aligned with the federal government's science and technology, environmental, and agricultural priorities, as well as AAFC's Strategic Outcomes and science priorities.

3.1.3 Roles and Responsibilities

The federal government's roles and responsibilities with respect to the AES sub-activity are consistent with its historical roles and responsibilities, institutional capacity, international practices, and stakeholder thinking about the circumstances where government can, or should, intervene in conducting basic and applied research. However, there are opportunities to further strengthen the engagement of provinces and territories in this area.

The evaluation examined whether the federal government's role in conducting research under the AES sub-activity is appropriate, that is whether its role is reasonable given its jurisdiction and historical responsibilities, its capacity, the approaches to agriculture research

[19] AAFC. (2012) News Release. New Growing Forward Agreement Will Drive Innovation, Market Development and Long-term Growth in Canadian Agriculture.

adopted by other countries, and the expectations and understandings of stakeholders. To address this issue, the evaluation gathered evidence through key informant interviews, a survey of AAFC scientists and program managers, and the document and literature reviews.

A consistent role over time: The federal government has been a central player in agricultural research since the passage of the *Experimental Farm Stations Act* in 1886 when there was little agricultural research capacity in Canada outside of the Ontario Agriculture College at the University of Guelph. The experimental farms were established to do research to discover the methods, breeds, and varieties best suited to the different parts of Canada.[20] Over the intervening century the role of Canadian agricultural research has evolved.

Over the first decades of the 20th Century, the federal government expanded its national capacity to do research to increase and diversify agricultural production. By the 1950's, most provincial governments had created extension divisions and some had established their own research programs. As well, in the post-war era, private industry began supporting both research and extension on a small scale. Today, there are numerous public and private organizations active in agriculture research including university faculties, provincial governments, industry associations and commercial enterprises doing applied research and facilitating the commercialization of new technologies.[21]

Over the last fifty years, federal agricultural research policy has undergone numerous changes. A report by the Canadian Agricultural Innovation Research Network found that reductions in spending in the 1970's and 1980's led to a consolidation of research facilities and an increase in contracted research to private industry and the universities. More recently, these trends have seen the federal government priorities more focused on initiatives like international trade, food quality and safety, the environment, and the development of new technologies.[22] While the federal government's role in agricultural research and development is less dominant than in earlier

[20] Historical series: Agriculture Canada. (2001) Retrieved June 15, 2012, from http://epe.lac-bac.gc.ca/100/205/301/ic/cdc/agrican/pubweb/hs1cover.asp

[21] Forest, B. (n.d.). Agricultural Research and Development. The Canadian Encyclopedia. Retrieved June 18, 2012, from http://www.thecanadianencyclopedia.com/articles/agricultural-research-and-development

[22] Gray, R., & Wessen, S. (2007) The Economic Rationale for Public Agricultural Research in Canada. Canadian Agricultural Innovation Research Network. Retrieved from http://www.ag-innovation.usask.ca/

decades, it remains the largest agricultural research institution in Canada.

Potential for market interference: Political science and economic theory holds that government intervention in the economy may be justifiable where it compensates for conditions, such as the cases of public health and environmental health, that the market does not successfully address (market failure). In the current case, researchers and others tend to characterize government intervention to bring about an optimal amount of agri-environmental research as appropriate, even important.[23] [24] [25]

Low risk of duplication and overlap: The document review and interviews identified a number of organizations having some capacity to conduct research relevant to the achievement of the federal priorities and outcomes related to an environmentally sustainable agricultural sector:

- About ten universities are involved, to some degree, in agri-environmental research. A few, such as McGill's Faculty of Agricultural and Environmental Sciences, have focused on agri-environmental science.
- The Canadian Agri-Science Clusters (AAFC-GF) initiative supports research agendas that include, but do not give priority to, sustainability.
- Environment Canada (EC), Natural Resources Canada (NRCan), Health Canada (HC), the Public Health Agency of Canada (PHAC), and the National Research Council (NRC) conduct and or fund research in related areas (food safety, climate change, water quality, biodiversity, etc.), but none has the capacity or a mandate to deliver research dealing with the interaction of agricultural activity and the environment.

Given the scope and mandates of the other research agencies engaged in related environmental research, the risk that AAFC activities are duplicating the work of others is low. Further, any risk is

[23] Heisey, P. W., King, J. L., Rubenstein, K., Bucks, D. A., & Welsh, R. (2010) Assessing the Benefits of Public Research within an Economic Framework the Case of USDA's Agricultural Research Service (No. 95). Economic Research Report. pp. 82. United States Department of Agriculture, Econ. Res. Serv.

[24] Gray, R., & Wessen, S. (2007) The Economic Rationale for Public Agricultural Research in Canada (p. 40). Canadian Agricultural Innovation Research Network. Retrieved from http://www.ag-innovation.usask.ca/Publications_for%20Download/The%20Economic%20Rationale%20for%20Public%20Agricultural%20Research%20In%20Canada%20-%20Gray%20and%20Weseen.pdf

[25] Productivity Commission. (2007) Public Support for Science and Innovation, Research Report. Commonwealth of Australia. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1615956

mitigated by AAFC's planning and/or project collaboration with these other organizations.

Intramural Research: The AES research is delivered exclusively through intramural activities to carry out agri-environment research.[26] The role of the federal government in intramural research has a number of benefits as indicated by the literature review and key informant interviews, which include:

- providing science expertise, essential for national and international leadership and coordination in agricultural science;
- strengthening the scientific basis of government policies;
- taking on higher-risk and long-term research and global environmental change;
- addressing national and regional research issues where social payoffs are potentially high, like food safety and diet and health;
- maintaining research infrastructure and laboratory capacity that is too expensive for provinces or corporations, such as hydrology labs;
- collaborating in multinational agricultural research partnerships; and
- facilitating technology transfer and commercialization by initiating and coordinating government/industry/university consortia."[27]

Agricultural research is mainly performed on an intramural basis by the U.S. Agriculture Research Services (ARS), with relatively a small extramural research focus. On intramural research the U.S. Congressional Research Services stated that:

- "… maintaining some level of federally funded internal research allows ARS to fill an important niche, not met by industry or other institutions, specifically to address research problems of national and long-term priority such as conservation and improvement or plant genetic resources, surveillance and monitoring of national and regional disease outbreaks, soil and water resource

[26] An intramural delivery model is one where the funding and R&D stay within the federal government and b) an extramural delivery model is where the funding is provided to universities, provinces and/or industry or related non-federal government research institutes to carry out R&D.

[27] Fuglie, K.; Ballenger, N.; Day-Rubenstein, K.; Klotz, C.; Ollinger, M.; Reilly, J.; Vasavada, U. and Yee, J. (1996, update 2012) Agricultural Research and Development: Public and Private Investments Under Alternative Markets and Institutions. USDA, Economic Research Services.

management, and adaptation to increasing climate variability and extreme events".[28]

From 2005-07, ARS expended $990 million on intramural research; however, in 2012, the U.S. Congressional Research Services stated that new funding mechanisms were being explored due to the constrained federal budget in recent years.[29]

While there are a variety of other approaches that could support federally-funded research and development for agri-environmental science[30], the evaluation noted the following risks associated with extramural or combination of intramural and extramural research:[31]

- ability to effectively coordinate and lead on public good research (national scale);
- ability to shape the policy agenda;
- influence of multiple stakeholders in directing research;
- under-utilization of existing infrastructure and scientific expertise in AAFC; and
- potential underinvestment in basic research and lack of long-term research.

The benefit of some of these other models is the strengthened engagement of industry and end-users in the research and development. It should be noted that other AAFC programs (e.g. Developing Innovative Agri-Products Initiative and Canadian Agri-Science Clusters Initiative) promote collaboration with academia, industry and end-users through the use of contribution agreements. The AES approach has had limited provincial, industry and end-user involvement. In September 2012, federal, provincial and territorial Ministers of Agriculture agreed to increase opportunities for provinces and territories to invest in environmental initiatives as part of the next multilateral framework agreement for agriculture, *Growing Forward 2.* The new multilateral policy framework outlines a commitment to move towards more targeted, collaborative and results-oriented approaches to address environmental challenges through better

[28] Shields, D. A. (2012) Agricultural Research, Education, and Extension: Issues and Background Specialist in Agricultural Policy. pp. 19.

[29] Shields, D. A. (2012) Agricultural Research, Education, and Extension: Issues and Background Specialist in Agricultural Policy. pp. 15.

[30] Programs that were examined for alternative delivery were: EC's Lake Winnipeg Basin Initiative, NRCan's Green Mining Initiative, and AAFC's Watershed Evaluation of Beneficial Management Practices.

[31] AAFC, Office of Audit and Evaluation. (2007) Program Delivery Model (PDM) Formative Evaluation. Final Report.

integrated and targeted science efforts. Collaborating with industry, academia and the public sector is key to achieving this goal, and strengthening capacities in science and innovation in the agriculture, agri-food and agri-based products sector, and maintaining competitiveness.

International comparisons: One way to assess the appropriateness of the federal government's role in the delivery of agri-environmental research is to compare it to the approaches adopted by other countries with similar social, political and economic characteristics. To this end, the evaluation looked at the roles played by the national governments of the United States, the United Kingdom, France, New Zealand and Australia and found that each national government is playing a major role, although using different delivery models.

The U.S. Department of Agriculture (USDA), which has a model most like Canada's, maintains three intramural research agencies and supports a network of state research programs. The largest of the USDA intramural institutions is the Agricultural Research Service (ARS). Australia has a similar approach with a mix of intramural and levy-supported research institutes.

France's agriculture ministry does not have an intramural capacity, but the national government has established an arm's length public research institution, the National Institute for Agricultural Research (INRA), which is under the joint authority of, and 80% funded by, the Ministry of Higher Education and Research and the Ministry of Food, Agriculture and Fisheries. The United Kingdom and New Zealand also have no intramural capacity, but have arm's length government funded research programs. (See Appendix G International Approaches, for further details).

Stakeholder expectations: The document review found little public discussion about the merits of the federal government's role in agricultural research. There was no expressed opposition to its continued participation and some expressions of support. For example, the report of the 2010 GF2 consultations said that participants highlighted a need for governments to support scientific research and development to improve productivity or to reduce environmental impacts, and industry associations, such as the Canadian Fertilizer Institute and BC Cattlemen's Association, have promoted research partnerships with AAFC.

About 80% of the AAFC scientists and managers (n:44) surveyed for the evaluation strongly agreed or agreed with the statement that AAFC was well-placed to be a major centre for agri-environmental research. In the key informant interviews, proponents of a continuing role for AAFC, including AAFC and OGD managers and scientists, argued that the department is well-placed to deliver agri-environmental research because of its capacity (science expertise,

data holdings and regionalized research infrastructure), and its institutional ability to sustain a research agenda that may span decades. At the same time, the key informants emphasized that the department's role is not to be the sole source of agri-environmental research, but a participant and leader in the wider research community.

Provincial Role: Both the agriculture and environment jurisdictions are shared between provinces and territories and the federal government. Provinces and territories have largely relied on AAFC to lead and coordinate agri-environmental research at the national level pursuant to the *Experimental Farm Stations Act*. The *Act* permits the establishment of farm stations across Canada and the conduct of research in a number of specific areas pertinent to agricultural productivity and conservation.

Key informant interview data indicates that most provinces have limited research capacity and infrastructure, but are starting to conduct limited basic and applied agri-environmental research. Most provinces fund agri-environmental research through external organizations. Saskatchewan provides funding for agri-environmental research to the University of Saskatchewan through contracts. Quebec and Ontario have established sustained research capacities with some research and development infrastructure. Ontario has done so through the Agricultural Research Institute of Ontario and a long-term contractual arrangement with the University of Guelph, while Quebec has the Institut de recherche et de développement en agroenvironnement (IRDA), which is a not-for-profit agency created to "…engage in agro-environmental research, development and transfer activities that foster agricultural innovation from a sustainable development perspective."[32]

Throughout the various AAFC regional research centres, scientists work with provinces at the project level as dictated by their research and to field test their research. Provinces and territories supply extension services that help to create awareness and adoption of new knowledge because of their understanding of local environmental conditions and their responsibility for agriculture and the environment at the provincial level. Document review and key informant interview data indicate that to date, provincial and territorial involvement in planning and priority setting for research has been limited.

[32] The IDRA's founding organizations are the Department of Agriculture, Fisheries and Agri-food (MAPAQ), the Union of Agricultural Producers (UPA), the Department of Sustainable Development, the Environment and Parks (MDDEP) and the Department of Economic Development, Innovation and Export Trade (MDEIE). http://www.irda.qc.ca/en/

Going forward, there is increasing recognition of the need for more place-based information, in order to have the greatest influence on agri-environmental outcomes. Currently, there is no formal relationship between AES programs and the provinces and territories, in terms of priority-setting and research planning, despite the fact that provinces and territories are potential users of the information generated by AES research projects, and they can also contribute to the generation of place-based information.[33]

While the federal government's roles and responsibilities for the delivery of agri-environmental research are consistent with its historical roles and responsibilities, capacity, international practices, and stakeholders thinking about the circumstances where government can, or should, intervene, there are opportunities to strengthen the engagement of provinces and territories, and industry in agri-environmental science research.

3.2 Performance – Progress

This section of the report addresses the issue of program effectiveness. The discussion begins with an examination of program logic and performance measures followed by an explanation of the analytical framework used, and concludes with an examination of the available evidence about the program's progress toward achieving its outcomes, including the potential economic return on investment.

3.2.1 Program Logic and Performance Measurement

The evaluation found that the department has not documented a program logic model, nor established an appropriate performance measurement framework for the AES sub-activity.

AAFC's *Science and Innovation Strategic Plan* is specific about the department's expectations for agri-environmental research – it is expected to contribute to achievement of the following results by 2013:

> *Development of new science based tools (concepts, theories, and process models) to assess (understand, describe, measure) soil processes and to understand the impacts of contaminants, and the benefits of agricultural activities, on the environment (soil, air and water quality);*

[33] AAFC, Office of Audit and Evaluation. (2012) Evaluation of Performance Measurement and Reporting Programs – NAHARP and NCGAVS; and Boag, Gemma. (2011) Place-Based Approaches for Agro-Environmental Policy in Canada, prepared by AESB Policy Research Division.

> *Development of Best Management Practices (BMPs) to allow compliance to environmental regulations, to ensure sustainability of production systems, or to add value to the sector in the form of Environmental Goods and Services (EG&S); and,*
>
> *Integrated assessment of long-term environmental effects of agricultural practices at farm, landscape, watershed and regional scales.*[34]

The AES program logic, however, does not explicitly relate the production of new knowledge to the development of new BMPs or other innovations. Instead, it focuses on increasing the scientific community's and, subsequently, the agricultural and agri-food sector's understandings of agricultural-environmental interactions. The indicator chosen for this intermediate-level outcome, as described in the departmental PMF, is a count of the "occurrences of technology (and knowledge) transfers to stakeholders." The AAFC documents and publications available for this evaluation do not provide any indication about what benefits “increased awareness” might deliver, nor how counting activities such as “occurrences of technology transfer” might be a measure of awareness.

To date, AAFC’s performance measures for research have focused on counting the number of peer reviewed publications generated as the measure of productivity or success. Up until recently, this has been the internationally accepted measure for assessing the performance of research activities. Over the past ten years, awareness has been increasing about the need to develop more meaningful measures for innovation, including research. The OECD has undertaken work in this area, as have other government departments. These issues were also noted in the report of the Independent Panel on Federal Support for Research and Development, which noted that “more extensive performance management information is required to ensure an outcome driven and user-oriented approach to federal support for business innovation. This entails regular public reporting on the outcomes both of individual programs and would inform periodic evaluations, not only against the objectives of individual programs, but also of the programs’ relative effectiveness within the overall portfolio.”[35]

Similarly, AAFC acknowledged the challenges associated with measuring the performance of innovation-related programming in its recent Meta-Evaluation of Innovation. Under the leadership of the

[34] AAFC. (2010) The Way Forward: Summary of Agriculture and Agri-food Canada’s Science and Innovation Strategic Action Plan 2010. pp.14. http://www4.agr.gc.ca/resources/prod/doc/pdf/18793_Science_and_innovation_guide_eng_fnl.pdf

[35] Industry Canada. (2011) Innovation Canada: A Call to Action. Review of Federal Support to Research and Development – Expert Panel Report. pp. e12.

Innovation Working Group (chaired by the Science and Technology Branch) AAFC has been developing more meaningful indicators to measure and establish causal linkages between innovation-related outputs and outcomes. Program officials advise that these will be reflected for new AAFC innovation programs under Growing Forward 2.

The document review identified two research organizations that have agri-environmental research objectives that are very similar to those described in AAFC's *Science and Innovation Strategic Plan* have adopted performance indicators that directly relate the production of new knowledge to the development and adoption of particular innovations:

- U.S. Department of Agriculture, Agricultural Research Service (ARS): The ARS strategic plan for 2007-2011 identifies three key outcomes, together with performance indicators and specific targets, for each. Its Strategic Goal 6 is to "Protect and Enhance the Nation's Natural Resource Base and Environment" and one of its key outcomes in this area is "Safe, abundant, and reliable water resources." The performance measure for this outcome is to "Develop technology and practices to reduce the delivery of agricultural pollutants by water on farms and ranches and quantify the environmental benefit of conservation practices in watersheds." The performance target is "Cumulatively, 10 agricultural practices and technologies will have been developed and used by customers to enhance water quality and availability."[36]
- L'Institut de recherche et de développement en agroenvironnement (IRDA): The Québec institute established research and technology transfer goals and performance indicators as part of a 2006-2010 strategy plan.[37] For example, one goal was to propose strategies for the management of the manure produced by the pork sector that would be adaptable to the farm, economically viable and reduce the odor and environmental hazards caused by the spread of nutrients and pathogens. The indicator used to measure the organization's performance in relation to this goal was the number of manure treatment technologies (partial or complete) developed by the IRDA in comparison to the total number of such technologies

[36] Agricultural Research Service, U.S. Department of Agriculture. (2007) Agricultural Research Service: Strategic Plan for FY 2006-2011. Washington, D.C. Retrieved June 22, 2012 (http://162.79.45.195/publications/err36/err36fm.pdf).

[37] Institut de recherche et de développement en agroenvironnement (IRDA). n.d. "Performance measurement-IRDA." Retrieved July 6, 2012 (http://www.irda.qc.ca/en/Performance-measurement).

listed by the technology transfer working group for the Quebec Pork Producers Federation.

In conclusion, the Science and Technology Branch should continue to build on the work that has been done to date, to develop more meaningful performance measures for agri-environmental science.

Recommendation #1:

AAFC's Science and Technology Branch should develop an appropriate program logic model and performance measurement strategy for the Agri-environmental Science sub-activity, one that is linked to department's science priorities and strategic outcomes.

Management Response and Action Plan

Agreed. AAFC has changed recently with the creation of a new Science and Technology Branch (STB) merging (AESB) and Research Branch to bring together all of AAFC's research, development and knowledge and technology transfer functions to facilitate an integrated approach to science delivery.

STB will create a Science and Technology Strategic Plan that will include a performance measurement framework. This framework will be linked to the department's strategic outcomes and the performance measurement framework.

(Target: September 30, 2013; Responsibility: DG, Cross-Sectoral and Director, Integrated Planning and Reporting)

3.2.2 Analytic Framework

In the absence of a full logic model and performance measurement plan for the AES sub-activity, the evaluators analyzed AAFC's PAA performance measurement framework, the Research Branch PMF and SAGES performance measurement plan to identify planned outputs, expected results and performance indicators, as well as some performance targets for the AES sub-activity. From an analysis of these documents, it appears that the AES sub-activity program logic is as follows:

- Activities: Basic and applied research projects are selected and carried out to characterize and quantify the effects of agricultural production on soil, water, air and biodiversity.[38] (In the case of SAGES, the projects target the water and climate change priorities under the *Federal Sustainability Development*

[38] For definitions of "basic" and "applied" research and related concepts see section 4.2.2 of: Organisation for Economic Co-operation and Development. (2002) Frascati Manual 2002 Proposed Standard Practice for Surveys on Research and Experimental Development. [Paris]: OECD. Retrieved from http://dx.doi.org/10.1787/9789264199040-en.

Strategy,[39] as well as emphasizing intramural and extramural scientific collaborations.)

- Outputs: The projects produce new knowledge about agricultural-environmental interactions that is confirmed through peer reviewed publications.
- Immediate outcome: The published research contributes to increased understanding of the interactions and impact of agricultural practices on the environment by the scientific community and, subsequently, the agricultural and agri-food sector (awareness).
- Intermediate outcome: The agriculture and agri-food sector incorporates sound environmental practices (acceptance and adoption).
- Ultimate outcome: An environmentally sustainable agriculture, agri-food and agri-based products sector (AAFC Strategic Outcome 1).[40]

Normally, an evaluation would endeavour to determine whether a program or policy has achieved its intended outcomes. In this instance, however, the evaluation has focused on whether the sub-activity is making progress toward achieving its intended outcomes. This has been done because most SAGES projects and many Agri-Environmental Soil, Water, Air and Bioresource Protection projects were planned to end a year or more after the evaluation finished its data collection phase. Further, given the duration of the research and development continuum (activities - knowledge production – awareness - acceptance - adoption), it will be an additional year or more before progress on intermediate outcomes will begin to become evident.

The evaluation has proceeded from the assumption that AES can be considered to be making progress to the extent that the research projects collectively are delivering appropriate outputs. To assess this, the evaluation sought evidence that the projects are:

- targeting research questions that can reasonably be expected to discover knowledge that will contribute to the development of technologies and practices to help assess, prevent, or mitigate negative consequences of particular agricultural-environmental interactions (the right issues);

[39] Environment Canada. (2010) Planning for a Sustainable Future: A Federal Sustainable Development Strategy for Canada, October 2010. http://www.ec.gc.ca/dd-sd/F93CD795-0035-4DAF-86D1-53099BD303F9/FSDS_v4_EN.pdf

[40] AAFC. 2012-13 Report on Plans and Priorities.

- drawing on the experience and skills of scientists and research institutions inside and outside of AAFC (collaboration);
- producing, or likely to produce, the outputs needed to achieve AES's intended outcomes (demonstrated productivity); and engaging in, or facilitating, technology transfer activities beyond submitting scientific papers for publication (knowledge transfer).

3.2.3 Targeted Activity

AES projects are targeting research questions that can reasonably be expected to provide scientific knowledge about the interaction of agriculture and the environment.

In order to assess whether AES projects are targeting research questions that are immediately relevant to achievement of the sub-activity's outcomes, the evaluation looked at the project selection processes and criteria, examined a sample of project files, and obtained the views of scientists and managers associated with AES.

AAFC research projects are selected through a competitive process that incorporates a call for proposals, a management review to ensure the proposed research aligns with the goals, criteria and priorities identified in the call for proposals and an external peer review that examines the scientific merits of the proposals. An AAFC 2010 evaluation concluded that Research Branch's processes compared favourably to processes of other similar federal science-based departments and agencies, and international organizations.[41]

The project file review conducted for this evaluation found that the process used for SAGES project selection, which was conducted in 2009 and based on specific criteria, was consistent with the Research Branch approach.

More specifically, the evaluation's document and project review found that the SAGES projects addressed the strategic priorities of water or climate change. Specifically, the management review looked at whether the proposals were aligned with sub-priorities that had been developed during the 2008 program planning phase. The sub-priorities for water were nutrient use efficiency, pesticide reduction,

[41] AAFC. Office of Audit and Evaluation. (2010) AAFC Research Branch Research Project Selection Process – Evaluation Report, Agricultural and Agri-food Canada, http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1286463169122&lang=eng. Note: While the evaluation concluded that AAFC's research project selection process was a good model, it did recommend some improvement including steps to increase the clarity around the department's research priorities. In September 2010, the department approved an update to its Science and Innovation Strategic Action Plan which, among other things provided for the further clarity by identifying two or more "key expected results" to be achieved in 2010-2013 for each of the seven science priorities.

and pathogen reduction. The sub-priorities for climate change (CC) were greenhouse gas (GHG) emissions from agriculture, GHG mitigation from agriculture, CC & ecosystem shifts, CC & adaptation, and CC integrated modeling. The SAGES projects were also expected to align with one or more key expected results (KER) under AAFC Science Priority 5: Enhance environmental performance of the Canadian agricultural system. The project and document reviews found that the approved projects were aligned as follows:

- KER 5.1: Science-based tools (concepts, theories, and process models) – 12 projects.
- KER 5.2: Beneficial management practices (BMPs) – 7 projects.
- KER 5.3: Integrated assessment of long-term environmental effects of agricultural practices – 5 projects.
- Science Priority 3 (Enhance security and protection of the food supply) - 1 project.

The Agri-Environmental Soil, Water, Air and Bioresource Protection projects, with four exceptions, targeted KERs 5.1 to 5.3. The exceptions were identified as contributing to Science Priority 6 (Enhance Understanding of Canadian Bioresources and Protecting and Conserving their Genetic Diversity).

In summary, the AES research projects are targeting research questions that can reasonably be expected to lead to new knowledge that will contribute to the development of technologies and practices or to help assess, prevent, and/ or mitigate negative consequences of agricultural-environmental interactions.

3.2.4 Outputs

The AES research projects are producing the outputs (peer reviewed scientific publications) required to contribute to the sub-activity's expected outcome of increased understanding of the agriculture-environment dynamic by the science community at or above targeted levels.

AAFC, like most research organizations, uses peer review publication and, to some extent, patent counts as measures of knowledge outputs. In order to assess this aspect of AES progress toward achieving its outcomes, the evaluation asked project principal investigators of AES projects that were active in 2009-2010 to report the peer reviewed publications dated 2009 and later that were produced by their projects. Noting that publication reports were obtained for only 49 (75%) of the 66 Agri-Environmental Soil, Water, Air and Bioresource Protection projects, the analysis of the

responses indicates that AES projects have met and exceeded the targets for peer reviewed publication targets (Table 3).[42]

Table 3: PR Publications Reported by Principal Investigators (3 years)

AES Initiative (# of projects)	Target	Reported	Average
Soil, Water, Air and Bioresource Protection (53)	300	314	5.9
SAGES (25)	188	262	10.5
Total (78)	488	576	7.4

In addition to the publications, the principal investigator reports identified one project that has registered a patent,[43] two projects that have filed patent applications,[44] another that is preparing such an application, a fifth that had made an invention disclosure, and a sixth that has produced a new BMP.[45] There were no targets for this type of output.

In order to assess the extent to which the publications have contributed to the dissemination of the research results, the citation data for 360 of the AES articles that are indexed in Scopus were gathered. The data show that the Agri-Environmental Soil, Water, Air and Bioresource Protection publications (n:210) averaged 4.9 citations per paper, and the SAGES publications (n:150) averaged 9.4.[46] The number of citations is an indicator of a publication's research impact – the higher the number of citations the greater the assumed scientific impact. Similarly, the higher the average of citations for a group's or project's publications, the greater their assumed scientific impact. While there is no accepted standard or benchmark for this impact measure, and with the caution that the number of citations per publication tends to increase over time, it is noted that a *Science Watch* examination of productivity of international agricultural research institutions for the period 1996-

[42] Information is based on bibliometric analysis that involved principal investigators' report of list of publications. Only 75% of the projects had a list of publication.

[43] Registered cultivars: McLeod, J.G., Muri, R., Jefferson, P.G., Bittman, S. and McCartney (2009). 'Yellowhead' alfalfa.

[44] Massé, D.I. PCT et US patent application for the low temperature AD biotechnology for prion destruction. US no. 13/292,732 - Notre réf: 05015882-6US;

Masson, L., et al. Provisional Patent Application No. 61/510,221 DNA Probe and Probes against Mitochondrial Sequences. Filed July 21, 2011.

[45] Schroeder W., Kort J., C. Pharo, Simpson J., Silim S., Stefner C., Murray B., Thevathasan N., Vezina A. (2011) Using Willow Riparian Buffer Strips for Biomass Production and Riparian Protection. Agriculture and Agri-food Canada. http://www.shortrotationcrops.org/PDFs/Schroeder_William.pdf

[46] The average number of citations for 3,546 AAFC affiliated publications, inclusive of the AES products, was 2.7.

2006 ranked the University of Guelph 14th with an average of 6.99 citations per publication, suggesting that AES publications are performing reasonably well. [47] [48]

Aside from the publications, a survey of principal investigators and key informant interview data indicates that scientists are making significant progress in generating scientific knowledge but have a long way to go before tangible results are available. For example, a recent SAGES' project assessed the soil, climatic and agricultural management controls on the magnitude and timing of nitrate loading to groundwater in permeable surficial aquifers in order to develop better mitigation strategies. Potential results regarding raspberry production suggest that a significant reduction in irrigation application during the growing season, with a corresponding decrease in the risk of nitrate leaching, can be achieved with minimal effect on crop growth.[49]

The same evaluation data also revealed areas where scientists are developing scientific knowledge, such as on understanding water quality drivers for certain regions; the optimum dose of nitrogen in canola to reduce risk of leaching; the fate of antibiotics used in the feedlot industry and risk to water and soil quality; manure treatment systems; anaerobic digestion for high solids content organic waste; intelligent nano fertilizers to enhance nitrogen use efficiency; prototype tool for in-season crop forecasting; new methods for measuring soil hydraulic conductivity; new technologies and practices relation to riparian (water) protection and GHG mitigation (a new BMP); and research and recommendations to stop the spread of Wooly Cupgrass that affects crop yields.

In conclusion, the AES projects are producing the kind and level of outputs that will be required for the sub-activity to achieve its immediate outcome: an increased understanding of the interactions and impact of agricultural practices on the environment by the scientific community and, subsequently, the agricultural and agri-food sector.

[47] King C. (Editor), Science Watch®, July/August 2006, Vol. 17, No. 4: http://www.sciencewatch.com/july-aug2006/sw_july-aug2006_page1.htm

[48] University of Guelph was the only Canadian organization to make Science Watch's list.

[49] AAFC program document. RBPI project 1459 SAGES Synergy "Mitigating nitrate contamination of vulnerable aquifers by agricultural production" by Dr. Zebarth.

3.2.5 Collaboration

While collaboration with internal and external partners has increased through SAGES there is room to further strengthen collaboration among AAFC scientists and managers, other government departments and industry.

The 2010 AAFC *Science and Innovation Strategic Action Plan* Update notes that knowledge generation and innovation in the agriculture, agri-food and agri-products sector require a blend of scientific disciplines which are seldom available in one organization. Similarly, the 2005 document *In the Service of Canadians: A Framework for Federal Science and Technology* stated that the strong linkages through partnerships, collaboration and integration expand the value and reach of federal science and technology, and enable the government to draw on a broad range of knowledge and experience. These themes are reflected in the emphasis that SAGES has placed on collaboration across AAFC research centres, between AAFC and other federal research institutions, and beyond.

In order to assess whether AES research reflects the expected levels of collaboration, the evaluation assessed the performance of SAGES projects as measured against AESB's targets, and examined the institutional affiliations of the co-authors of the AES-related publications in Scopus.

First, AESB expected that the SAGES initiative would have two benefits in terms of science collaboration and linkages: increased engagement of AAFC internal expertise in knowledge development and networking related to water and climate issues; and increased engagement of external expertise.

Table 4 presents the targets and the results reported by AESB based on a review of annual project reports.

Table 4: Scientist Participation Targets and Results for 2011-12

Target	Performance
90% of eligible AAFC scientists (estimated n:100)	186 AAFC scientists participating
80% of targeted disciplines: nutrient cycling (soil physics and chemistry), environmental management (air quality and water quality), soil microbiology, agro meteorology, nutrient management, hydrology, pathogen microbiology, modeling, remote sensing, land use specialists, environmental management (biodiversity, pest ecology, rangeland), and economics	All targeted disciplines participating
15 external scientist involved as collaborators	142 external scientists
90% of targeted federal research departments agencies	7 involved

These data indicate that SAGES has exceeded AAFC's targets for collaboration and linkages for scientific and research expertise inputs.

To assess whether the AES outputs – peer reviewed publications – reflect the levels and types of linkages expected for the SAGES projects, the bibliometric analysis looked at the institutional affiliations of the co-authors of the Agri-Environmental Soil, Water, Air and Bioresource Protection (n:210) and SAGES (n:150) publications indexed in Scopus. The analysis found:

- Intramural collaborations: On average, AES projects involved authors from at least three AAFC science centres. The largest number for the Agri-Environmental Soil, Water, Air and Bioresource Protection publications was 10 centres, the largest number for SAGES was 9.
- Other federal facilities: 44% of the SAGES projects produced publications that were prepared with the participation of researchers affiliated with other federal research centres, as compared to 12% for Agri-Environmental Soil, Water, Air and Bioresource Protection publications. Research centres maintained by EC, HC and PHAC were the most frequent federal participants.[50]
- Canadian universities and other institutions: The majority of the – SAGES projects (75%) and the Agri-Environmental Soil, Water, Air and Bioresource Protection projects (70%) – produced publications with the participation of scientists affiliated with non-federal Canadian research facilities including universities and provincial organizations. A small number (about 6% of AES projects) appear to have involved researchers affiliated with commercial enterprises.
- International Affiliations: Significant proportions of the Agri-Environmental Soil, Water, Air and Bioresource Protection (61%) and the SAGES (88%) projects produced publications that were prepared with the participation from one or more research institutions in one or more countries. (Appendix H International Affiliations)

The following table identifies the number of external organizations that had one or more scientist co-author an AES publication included in the bibliometric analysis.

[50] The relationship between AAFC and Environment Canada shifted under *Growing Forward* from *Agricultural Policy Framework*. Under APF, AAFC transferred $25 million to EC for agri-environmental science. This ceased under *Growing Forward*.

Table 5: External Collaborating Research Organizations by Type and Number

Organizations Collaborating with AAFC	SAGES	Agri-Environmental Soil, Water, Air and Bioresource Protection
Other Federal Centres* (# of Departments in parentheses)	22 (9)	14 (5)
Provincial Organizations	9	12
Canadian Universities and Other Public Institutions[51]	51	53
Industry Organizations	4	4
Foreign institutions (# of Countries in parentheses)	76 (19)	108 (22)

* A centre is a separate research unit within a department (e.g., the Pacific Environmental Science Centre and the National Water Research Institute (NWRI) are both centres within Environment Canada.

The “Other Federal Centres” data reveal that the publications produced by SAGES projects were far more likely to have scientists from other departments as co-authors. This suggests that the Synergy stream, which was designed to encourage cross-cutting projects jointly led by scientists from AAFC and other departments, had the intended result. Indeed, several key informants expressed the opinion that its provisions for interdepartmental collaboration were one of the more positive features of the SAGES initiative.

By comparison, a survey conducted as part of this evaluation offers conflicting results. The respondents tended to assess AAFC's performance with respect to collaboration as less favourable. The survey asked AAFC scientists to indicate the extent to which they agreed with the statement “AAFC encourages and actively supports project-level collaboration with scientists affiliated with universities and other research institutions in Canada and abroad”. Based on a Likert scale, the average score for their responses was 0.3, where 1 would equal “somewhat agree” and -1 would equal “somewhat disagree”.

In contrast, when asked to report their degree of agreement with other statements about AES performance, the majority responded positively.

[51] Primarily university or university-affiliated organizations along with some not-for-profit and industry-government initiatives such as the Indian Head Agricultural Research Foundation (www.iharf.ca) and Sterile Insect Release Program (www.oksir.org).

Table 6: Principal Investigator Assessment of AES Performance

Statements	Degree of Agreement*
AAFC is very well placed to be the major centre for the conduct of agri-environmental research in Canada.	2.3
The SAGES selection and approval process identified projects that clearly and consistently focus on either the water or the climate change priority.	1.7
Interdepartmental research teams leads to better agri-environmental research outcomes.	1.7
The current Research Branch project selection and approval processes ensure that the AES research is clearly aligned with the Science Priorities.	1.5
Having research teams made up of AAFC scientists from different regions leads to better research outcomes.	1.5
AES research teams routinely interact with people/organizations who will be involved in using new research results to develop BMPs, innovative technologies and/or regulations.	1.0
AES research is informing the development of program priorities and other public policy.	0.9
AAFC encourages and actively supports project-level collaboration with scientists affiliated with universities and other research institutions in Canada and abroad.	0.3

*****A score of 3 would indicate that the respondents, on average, "Strongly agreed" with the statement; 2 would indicate that they "Agreed" and 1 that they "Somewhat Agreed." A negative value would indicate a corresponding degree of disagreement.

The source of the qualified views seen in the survey response is partially explained by comments of survey and key informant participants that acknowledge that while the department encourages scientific collaboration, it fails to fully recognize the need to provide NPO for the travel costs or the external collaborator's NPO costs (e.g. lab access costs and hiring post-graduates), as was done for the Synergy projects under SAGES.

The SAGES performance data and the results of the bibliometric analysis indicate that, overall, AES research projects are successfully engaging AAFC scientists and benefiting from the participation of a significant number of Canadian and international researchers and research organizations. However, the data also indicates that there is very little participation with industry and low levels of collaboration with other federal departments outside of special initiatives, such as Agri-Environmental Soil, Water, Air and Bioresource Protection, which is an on-going departmental program.

While there is good collaboration at the individual project level, there was a lack of coordination and collaboration among AAFC scientists and research centres. In its 2010 audit of scientific research at AAFC, the OAG stated that "in an era of limited research resources in many

science organizations and with even broader challenges facing the sector, collaborative research is seen as a way to ensure that the agricultural sector maintains a competitive edge and to leverage resources".[52] SAGES did foster improvements in this area, but key informant interview data indicates that a culture of competitiveness among AAFC scientists continues to exist and potentially prevents the department from capitalizing on research capacity, producing synergies, complementing internal expertize in areas where scientific capacity is lacking and increasing research efficiency. It should be noted that three key informants did indicate that competitive project proposals sometimes help drive better research proposals.

The document review and key informant interviews suggest that separate agri-environmental science programs have created confusion, decreased collaboration and integration between scientists and external stakeholders and that AAFC should consider and respond to industry associations' request for more research "partnerships" with its centres. For example, it was noted that not many internal AAFC employees understand the overall process of identifying who and what research results to share among SAGES, Watershed Evaluation of Beneficial Management Practices (WEBs), National Carbon and Greenhouse Gas Accounting and Verification System (NCGAVS), National Agri-Environmental Health Analysis and Reporting Program (NAHARP), Agri-Environmental Soil, Water, Air and Bioresource Protection and the Agricultural Greenhouse Gases Program.

The key informant interview data indicates that collaboration was left up to scientists and that management does not get involved partly because managers are too "siloed". The data also suggest that focus should be on eliminating silos and using managers to help with collaboration because scientists do not always feel connected to all the research being conducted at AAFC and to follow through on the process of developing and delivering research results.

To investigate whether there were program design and delivery options that would allow for more collaboration than those designs used for the AES sub-activity, the evaluators gathered information on three federal research programs with environmental mandates, a review of open-source program documents, interviews with program managers and literature review, including literature on the U.S. Department of Agriculture and Canada's Independent Panel on Federal Support for Research Development. The selected programs were:

[52] Office of the Auditor General of Canada. (2010) Report of the Auditor General of Canada to the House of Commons. Chapter 5: Scientific Research – Agriculture and Agri-Food Canada. (p.13)

- Environment Canada's Lake Winnipeg Basin Initiative (LWBI). The science component consisted of research into the nutrient loading of the lake and the stewardship component consisted of mitigation measures;
- Natural Resources Canada Green Mining Initiative (GMI). The GMI, led by NRCan, in close partnership with provincial/territorial governments, industry, academia, NGOs and other interested stakeholders aims to improve the mining sector's environmental performance and create green technology opportunities; and,
- AAFC's Watershed Evaluation of Beneficial Management Practices (WEBs). This program which devotes about half of its budget to intramural research is intended to assess economic and environmental effects of beneficial management practices.

The inquiries found that, while there are variations in the project selection, project reporting and monitoring, and knowledge transfer approaches used by the various programs, there are alternatives for improved collaboration in the delivery of the AES sub-activity.

As an alternative to AES, the delivery models for LWBI, GMI and WEBs were considered in the context of agri-environmental research. The first alternative to AAFC's current approach to funding AES research would be to fund organizations outside the federal government to undertake the needed research. Both WEBs and the LWBI Stewardship component fund extramural environmental research, largely through universities where specialized skills and attention to the needs of target groups are possible, e.g., specific agroclimatic needs. It should be noted that the EU channels substantial funds to universities in member countries for environmental research.

The second alternative delivery approach involves a mix of internal and external research partnerships/collaboration. The Green Mining Initiative of NRCan is an example of sharing resources, leadership and expertize on the program research. The program has core funding along with cost-recovery revenues generated from in-house work such as testing or calibrating samples; however, maintaining the cost-recovery activities was seen as a challenge due to close monitoring and quick turnaround time. Overall, industry involvement helps identify the type of research projects to develop and allows for the immediate use of project results.

A third model for supporting scientific research involves the approach recommended in the Jenkins Report. In the report, the independent panel states that "Canada needs a fundamentally new approach to building public-private research collaborations in areas of strategic importance and opportunity for the economy." To achieve this objective, the report recommended that the National Research

Council (NRC) be transformed into "a constellation of large-scale, sectoral collaborative R&D centres involving business, the university sector and the provinces, while transferring NRC public policy-related research activity to the appropriate federal agencies".[53] Under this model, the report outlined four potential distinct approaches to fund federal R&D:

1) an industry-oriented non-profit research organization mandated to undertake collaborative R&D and commercialization projects and services, funded by amounts drawn against existing NRC appropriations together with revenue earned from collaborative activities;
2) an institute engaged in basic research to be affiliated with one or more universities and funded by an amount drawn against existing NRC appropriations together with contributions from university and/or provincial partners;
3) part of a non-profit organization mandated to manage what are currently NRC major science initiatives and potentially other such research infrastructure in Canada; and
4) an institute or unit providing services in support of a public policy mandate and to be incorporated within the relevant federal department or agency. [54]

The NRC is currently implementing the recommendations from the Jenkins Report following Budget 2012 decisions. Moving to an arm's length R&D approach is another model that could potentially provide opportunities to improve collaboration closely with academia and industry in key agriculture and agri-food sectors.

In conclusion, while collaboration with internal and external partners has increased through SAGES there is room to further strengthen collaboration among AAFC scientists and managers, OGDs and industry on agri-environmental concerns.

Recommendation #2:

The Science and Technology Branch should examine ways to improve collaboration on agri-environmental research internally, with other government departments, provinces and territories, industry groups.

Management Response and Action Plan

Agreed. Science at AAFC includes a collaboration dimension. In fact, SAGES was a program designed to promote/enhance scientific

[53] Industry Canada. (2011) Innovation Canada: A Call to Action. Review of Federal Support to Research and Development – Expert Panel Report. pp. e12.

[54] Industry Canada. (2011) Innovation Canada: A Call to Action. Review of Federal Support to Research and Development – Expert Panel Report. pp. e12.

collaboration and, as recognized in the evaluation report, was highly successful in that regard, even exceeding expected results.

STB recognizes the need to continue to improve collaboration both internally and with all external partners.

- STB agrees to examine ways to enhance the exchange of science information and ideas internally.
- STB agrees to explore ways to improve collaboration with external stakeholders.

(Target: March 31, 2014; Responsibility: DG, Prairie Boreal Plains)

3.2.6 Knowledge Transfer

AES research teams are participating in knowledge transfer activities; however, there are opportunities for improvements at all stages of the research and development cycle.

A key assumption in the logic model for AES programming developed as part of this evaluation is that reliable knowledge transfer processes are in place.

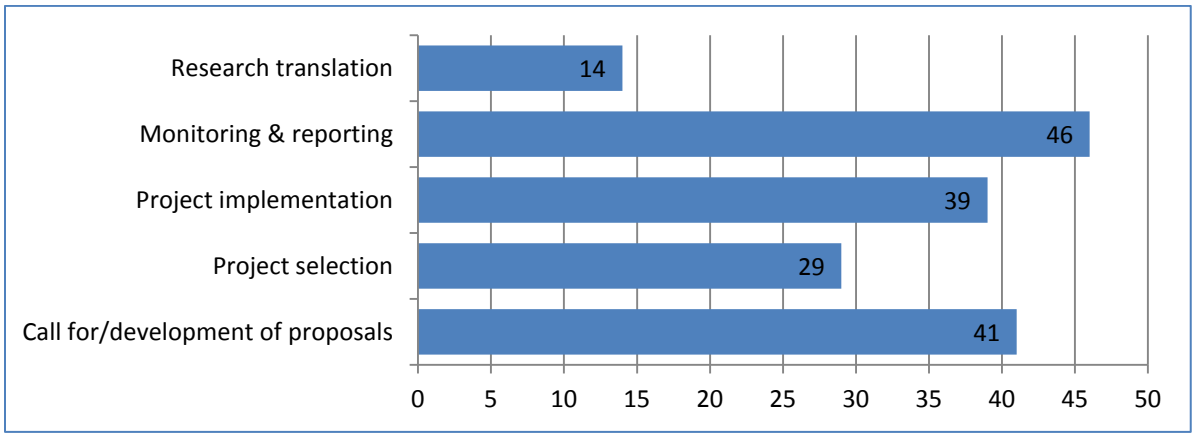
In practice, the only processes that are consistently used, monitored, and reported on are peer reviewed publications and various forms of intellectual property protection such as patents. As noted earlier, the department's PMF includes an indicator that refers to "occurrences" of technology/knowledge transfer, but there is no guidance given to explain what activities might be accepted as an occurrence of technology transfer and no mechanisms are in place to capture information about them.

This is not to say that knowledge transfer does not occur. The project file review found that principal investigators are invited to identify project achievements including "…innovations, publications/conferences, technology transfer, capacity building, success stories, media, recognition and other outputs." However, a review of the 2011-12 SAGES reports found only two that had explicitly identified technology transfer events or documents, although a scan of the lists in other reports suggest that they had been involved in similar activities. Further, key informants, while cautioning that it takes a long time for the research findings to be understood, then integrated in public policy or translated in new practices or

technologies, did offer several examples of research that led to new BMPs and other innovations.[55]

Several respondents, however, felt that the department was not doing a good job around knowledge transfer, at least with respect to agri-environmental science. They observed that AAFC was producing quality research and effectively disseminating the results within the science community, but having less success reaching policy makers, industry stakeholders and producers. In this regard, when asked to rate the efficiency of a number AES processes, the survey participants scored the procedures and services supporting the knowledge transfer (also referred to as "research translation") to innovations and new technologies the lowest of the AAFC processes they were invited to rate (Figure 1).

Figure 1: Overall Efficiency Rating of AES Processes



The document review found that concerns about AAFC's knowledge transfer measures are not isolated to agri-environmental science. For example, a 2009 Research Branch gap analysis stated that there was need for "better translation of science to commercial applications via more progressive policies and programs, and better integration between branches."[56] Similarly, the Office of the Auditor General, in 2010, reported:

> *5.29 Consistent with standard practices within the scientific community, the Department's scientists continue to share research results through scientific conferences. The Department also communicates with research users through open houses at*

[55] Some examples technologies include: a) improvements to manure management BMP's to reduce adverse water quality affects; b) technique for accurately measuring greenhouse gases from cattles; and c) potential fertilizer nitrogen recommendations for raspberry production in BC.

[56] AAFC, Research Branch. (September 2010) 2010-2011 Update: Science and Innovation Strategic Action Plan - 2009-2013. pp. 55.

> *research centres and by publishing internal and external newsletters. However, it has no systematic process for identifying who to share the research results with or for determining when and how to share those results. A frequent comment made by the stakeholders we interviewed was the need for the Department to improve its communication of research results.*[57]

The document review did find that AAFC gives strategic priority to knowledge transfer. For example, one of the seven goals of its Science and Innovation Strategy is: Accelerating adoption and commercialization of scientific knowledge. Also, the commercialization of research is an element of the R&D and innovation initiatives it supports. However, beyond the policies and procedures relating to patents, licencing and other intellectual property matters, the department's knowledge transfer expectations and policies are vague, especially at the project level and the department's expectations of scientists in this area.

In their comments, survey participants and key informants advanced a number of suggestions for improvements including a call for strategies that would allow researchers to obtain a better understanding of what is happening "on the ground" through ongoing engagement with local stakeholders, and procedures to encourage research teams to include the people who are driving the outreach and decision making in the areas that are likely to benefit from the research.

The document and literature review found that most federal research organizations have knowledge/technology transfer policies and practices that, like AAFC policies, focus on research dissemination though peer reviewed publications, commercialization and intellectual property management.[58] However, the Canadian Institutes of Health Research (CIHR), which has a statutory mandate to promote the dissemination of knowledge and the application of health research, has adopted a somewhat broader approach, one that includes a Knowledge Translation Strategy.[59]

CIHR describes knowledge translation as including "…knowledge dissemination, communication, technology transfer, ethical context, knowledge management, knowledge utilization, two-way exchange between researchers and those who apply knowledge,

[57] Office of the Auditor General of Canada, Report of the Auditor General of Canada to the House of Commons SPRING 2010 Chapter 5, Scientific Research— Agriculture and Agri-Food Canada

[58] See: Federal Partners in Technology Transfer, http://www.fptt-pftt.gc.ca/, an organization that fosters the development of professional capacity within the Canadian government to enhance the effectiveness and efficiency of technology and knowledge transfer and commercialization.

[59] See: CIHR, Knowledge Translation & Commercialization:www.cihr-irsc.gc.ca/e/29529.html.

implementation research, technology assessment, synthesis of results within a global context, development of consensus guidelines and more."[60] This theme is also seen in the findings of research examining European and North American approaches to the dissemination of environmental research. The guidelines produced by this research emphasize end-user involvement beginning with project planning, the use of intermediaries/brokers and other engagement strategies.[61]

The document review, survey responses and key informant interviews suggest that AAFC could develop its policies and strategy recognizing that "knowledge/ technical transfer" is a broad and complex concept.[62] In developing its policies, AAFC could give consideration to improvement opportunities such as:

- Program planning and priority setting: Consulting sector stakeholders in program planning and periodic reviews to more effectively target agri-environmental research programs/initiatives to address demonstrated industry needs and capacity, which would encourage scientists to develop BMPs. Timely engagement of the sector (including provinces) would help with the strategic direction, identify gaps and eliminate policy barriers to implementing the science being recommended.
- Project planning and activities: Requiring project proponents to identify the likely end users of the proposed research, and including an integrated knowledge transfer plan (including implementation) in their submissions that would support research closer to farms.
- Internal communication: Increase opportunities for collegial sharing of project experience and progress.

[60] Canadian Institutes of Health Research. (2004) Innovation in Action: Knowledge Translation Strategy 2004-2009.

[61] Bielak, A. T., Holmes, J., Savgård, J., and Schaefer, K. (2009) A comparison of European and North American approaches to the management and communication of environmental research. Swedish Environmental Protection Agency Report 5958. http://www.naturvardsverket.se/en/ /

[62] For discussion of some of the complexities associated with planning and measuring knowledge transfer activities see: Bozeman, B. 2000 Technology transfer and public policy: a review of research and theory, Research Policy, 29, 627-655; and Sudsawad, P. 2007. Knowledge translation: introduction to models, strategies and measures. Austin, TX: Southwest Educational Development Laboratory, National Center for the Dissemination of Disability Research. Retrieved April 14:2008. Retrieved April 8, 2012.

Recommendation #3:

The Science and Technology Branch should develop and implement a comprehensive knowledge transfer strategy for agri-environmental science based on a broad definition of knowledge transfer as a process that begins in the planning stages and extends through knowledge utilization, and which considers the role and mandate of provinces and territories and industry.

Management Response and Action Plan

AAFC will be implementing a Knowledge Transfer strategic initiative under *Growing Forward 2*. Knowledge Transfer (KT) is a key component of the innovation agenda within *Growing Forward 2*, and the KT Initiative aims to facilitate the transfer of innovative ideas, tools, and practices covering the full range of innovation efforts. Regionally relevant and commodity specific KT approaches will be informed by advice from industry users to ensure knowledge will be transferred according to local circumstances and needs to intended users, farms and firms, thereby enhancing sector competitiveness, profitability, sustainability and adaptability.

(Target: March 31, 2014; Responsibility: DG, Cross-Sectoral)

3.3 Performance – Efficiency and Economy

This section of the report examines the efficiency and economy of agri-environmental science activities, which includes the assessment of resource acquisition and utilization in relation to the production of outputs in support of outcomes. In line with this definition, an efficiency measure was developed by AAFC's OAE by relating inputs to outputs based on similar measures from other jurisdictions. In assessing economy, this report examined the potential return on investment of AES research activities based on project reviews and case studies that have been carried on from previous agri-environmental initiatives, such as Environmental Technology Assessment for Agriculture, Water Quality Surveillance, and the National Agri-Environmental Standards Initiative.

AES research, which is conducted on an intramural basis, is partly "basic" and partly "applied". The key input to AES activities is the funding provided to researchers (Figure 2). The primary measure of output is peer reviewed scientific publications. As a consequence, the efficiency measure used for the purposes of this evaluation is cost per publication, one that is also used by international organizations to determine economy and efficiency in the absence of direct economic impact data of research.

Figure 2: AES Input/Outputs

3.3.1 Efficiency - Program Costs

AAFC does not have any system or reporting protocol that permits program managers to monitor input costs and project outputs below the sub-activity level or at the project level with the result that managers are unable to routinely assess the effectiveness of program resource allocations, or the efficiency of particular initiatives.

The key inputs to the program are non-pay operating (NPO) and salary costs associated with AES research activities. Even though SAGES received NPO from *Growing Forward,* the evaluation examined both NPO and salary associated with AES as part of efficiency and economy.[63] AES expenditures on NPO and salary at the sub activity level appear in Table 2, page 14. Consequently, this section provides information at the sub sub-activity level and below (SAGES and Agri-Environmental Soil, Water, Air, and Bioresource Protection), as required.

Non-Pay Operating Costs: NPO is used to acquire the goods and services necessary for the execution of AES projects. For example, the largest categories of SAGES NPO expenditures are materials and supplies (e.g. chemical, fertilizer, and related products), professional and special services (e.g. scientific services), and students to help with research tasks (Table 7).

[63] SAGES was developed with the following NPO allocation: 2009-10: $8,100,000; 2010-11: $7,436,000; 2011-12: $6,641,000. Salary for SAGES was available from departmental A-base.

Table 7: SAGES NPO 2010-11

Goods and Services	Expenditure ($)
Students	1,217,117
Travel	537,307
Professional & Special Services	1,824,190
Materials and Supplies	2,231,352
Scientific/Technical equipment	144,048
Other	518,064
Total	**6,472,077**

Source: AAFC Corporate Finance, SAP, June 2012

NPO funding for Agri-Environmental Soil, Water, Air and Bioresource Protection is significantly less than for SAGES research on a per project and per full-time equivalents (FTE) basis (Table 8). On a per project basis, 2010-11 NPO funding for the former was $49,446, and $247,474 for the latter. On a per FTE basis, the figures were respectively $23,170 and $52,412.

Table 8: AES Research NPO Costs (excluding salary)

Agri-Environmental Soil, Water, Air and Bioresource Protection

	2009-10	2010-11	2011-12
NPO	$2,968,013	$2,142,532	$890,025
FTEs	122.5	105.1	38.4
Projects	56	45	18
NPO per FTE	$24,229	$20,386	$23,170
NPO per Project	$53,000	$47,612	$49,446

SAGES

	2009-10	2010-11	2011-12
NPO	$7,054,051	$6,474,794	$5,691,912
FTEs	127.6	119.1	108.6
Projects	25	23	23
NPO per FTE	$55,164	$54,364	$52,412
NPO per Project	$281,555	$281,513	$247,474

Notes: i) Funding and FTEs of OGD collaborators in SAGES projects are excluded; ii) FTEs are based on annual planned allocations rather than actual.
Source: AAFC Corporate Finance as of June 2012.

Salary Costs: According to AAFC's Corporate Financial reporting system - Systems Applications and Products in Data Processing (SAP) - salary, including benefits, over the period 2009-10 to 2011-12 for AES activities was $78.8 million.

There was no salary attributed to AES activities in 2008-09 even though it is known that scientists that eventually had projects approved were devoting their time to project development in that

year. This highlights the fact that salary dollars devoted to AES projects may not be fully accounted for in current financial reporting structures.

Table 9: Salary Costs at the Sub Sub-Activity Level ($ million) (excluding NPO)

	2009-10	2010-11	2011-12	Total
Agri-Environmental Soil, Water, Air and Bioresource Protection	$25.8 (89%)	$23.5 (87%)	$18.4 (80%	$67.7 (86%)
SAGES	$3.1 (11%)	$3.5 (13%)	$4.6 (20%)	$11.1 (14%)
Total	$28.9 (100%)	$26.9 (100%)	$23.0 (100%)	$78.8 (100%)

Note: Salary data is the sum of source funds *Growing Forward* and general salary.
Source: AAFC Corporate Finance, SAP and OAE, as of June 2012.

AES sub-program salaries in SAP (Table 9) do not accord well with planned FTEs in the Research Branch database. On average, 14% of AES salaries are attributed to SAGES over 2009-2012 (Table 9). In contrast, 57% of planned AES FTEs were attributed to SAGES over the same period (Table 10).

Table 10: Planned FTEs at the Sub Sub-Activity Level

	2009-10	2010-11	2011-12	Total
Agri-Environmental Soil, Water, Air and Bioresource Protection	122.5 (49%)	105.1 (47%)	38.4 (26%)	266 (43%)
SAGES	127.6 (51%)	119.1 (53%)	108.6 (74%)	355.3 (57%)
Total	250.1 (100%)	224.2 (100%)	147 (100%)	621.3 (100%)

Source: RBPI Staff Allocation database and OAE, as of June 2012.

Due to this apparent anomaly a costing exercise was undertaken, with the help of Corporate Management Branch. A total salary estimate for SAGES was developed based on the planned allocation of FTEs prepared in the project selection process and reported on the Research Branch database. This exercise found that many of the personnel working on SAGES projects were coded for salary purpose to the Research Branch rather than specifically to GF activities.

Based on the evaluation analysis, the estimated salary costs for SAGES were $8.2 million in 2011-12, well above the amount appearing in the SAP system.[64]

[64] SAGES' salary of $8.2million is based on planned FTE time allocated to SAGES projects for fiscal year 2011-12. See Appendix F for planned FTE data.

In conclusion, AAFC's financial reporting system was not able to accurately identify actual program salary costs below the sub-activity level, with the result that the evaluation had to rely on estimated salary costs for SAGES.

Funding Allotment: Under AES, SAGES is funded through time-limited Vote 1, NPO as part of *Growing Forward*, while the Agri-Environmental Soil, Water, Air and Bioresource Protection program is funded through AAFC's Vote 1 – A-base resources.[65] Salary for AAFC scientists is managed at the program sub-activity level, not tied directly to lower level programs.

In the OAE's evaluation of NHRAP and NCGAVS, program officials and scientists noted that there are challenges in trying to determine the allocation of time spent by AAFC scientists on specific Vote 1 programs. These challenges include:[66]

- A "common elements" challenge, where some portion of a researcher's time will be spent undertaking activities that are associated with keeping a lab up and running. This could include developing or refining lab methods, ordering supplies, or building specialized equipment. These activities support multiple programs.
- A "project overlap" challenge. Research scientists often receive funding from a variety of program sources, as well as from external funding sources. The research supported through this funding arrangement often supports multiple program objectives. As a result, it is difficult to allocate funding to specific program-related activities.

Notwithstanding these challenges, AAFC does not have any system or reporting protocol that permits program managers to monitor input costs and project outputs below the sub-activity level or at the project level with the result that managers are unable to routinely assess the effectiveness of program resource allocations, or the efficiency of particular initiatives. To some extent, the issue will be addressed going forward through the requirement to develop formal performance measurement strategies for Vote 1 (operating) programs.

[65] A-Base refers to the department's on-going annual operating budget.

[66] AAFC. (2012) Evaluation of Performance Measurement and Reporting Programs (NHARP and NCGAVS). Office of Audit and Evaluation.

Recommendation #4:

The Science and Technology Branch should develop a reporting protocol to track and report program and project level financial and performance information to support more robust performance monitoring and reporting.

Management Response and Action Plan

Research Branch has established the Science Management Systems Program (SMSP) to develop a system that will document and standardize business processes, improve quality and repeatability of monitoring and performance reporting, and provide a level of automation which enables better aggregation of research results. A pilot project to develop a monitoring and reporting prototype was successfully completed. The prototype would now require some enhancements to provide linkages to existing AAFC data and reporting mechanisms and to ensure it reflects the change in structure with the new Science and Technology Branch. A project is currently being considered to proceed with these enhancements and implement SMSP across the new Branch.

STB will also collaborate with Corporate Management Branch and Programs Branch to study and present options on how to capture the efforts of AAFC scientists related to program activities

(Target: September 30, 2014; Responsibility: DG, Cross Sectoral Strategic Direction, Science and Technology Branch)

3.3.2 Efficiency - Comparison to Other Government Departments

SAGES researchers are funded at levels similar to their peers in the Research Branch and the federal government as a whole.

The Research Branch accounted for about 15% of the federal government's intramural R&D expenditures in 2011-12. AES funding of $30 million in the same year accounted for 11% of the Research Branch intramural research.

Intramural R&D expenditures per FTE for SAGES were $139,000 in 2011-12, which is close to the corresponding figure for the Research Branch at $136,000. Both of these figures are moderately higher than the federal government intramural research expenditures per FTE at $124,000 (Table 11).

Table 11: Comparison of Intramural Research and Development, 2011-12

	Federal Gov't	Research Br.	SAGES
In-house R&D*	$1,770,000,000	$257,000,000	$14,000,000***
Other R&D	$44,000,000	$ 13,000,000	
Total Intramural R&D**	$1,814,000,000	$270,000,000	$14,000,000
R&D FTEs	14,636	1,984	108****
Funding/FTE	$124,000	$136,000	$130,000

* Includes research and development and research fellowships.

**Excludes administration of extramural programs, capital expenditures and supporting contracts.

***Based on 2011-12 SAGES` salary and NPO.

****Based on planned FTE for 2011-12.

Source: Statistics Canada, Federal Scientific Activities, Catalogue 88-204, AAFC Corporate Finance and OAE estimates as of June 2012.

3.3.3 Efficiency - International Comparison

AES research efficiency is similar to average public sector research efficiency in the U.S. and the EU.

In order to assess the efficiency of AES research, an international comparison of cost per publication was undertaken. A number of sources were consulted including the OECD Main Science and Technology Indicators, the *United Nations Economic, Scientific and Cultural Organization (UNESCO) Science Report 2010* and the *European Commission's Innovation Union Competitiveness Report*, 2011 edition.

The most appropriate data for making a comparison of efficiency was found in the *Innovation Union Competitiveness Report* which presents statistics on R&D expenditures and scientific publications for both the U.S. and the EU, including funding per FTE and average number of publications per FTE (Table 12). This information was used to make an indicative calculation of cost per scientific publication for the public sector.

Table 12: Cost per Scientific Publication in the EU and U.S.

	EU (2007 and 2008)	U.S. (2007)
Funding per FTE *	CAD $162,640 [67] (EUR €107,000)	CAD $351,764 (EUR €231,424)
Publications per FTE *	0.7	1.54
Cost per publication **	CAD $232,000	CA$D 225,000

* Innovation Union Competitiveness Report p.150-151, OECD
** OAE calculations.

The bibliometric analysis done for the evaluation estimated that there were a minimum of 576 peer reviewed publications attributable to the AES sub-activity during the period 2009-2012.[68] Hence, the AES cost per publication over a three year period is estimated to be $180,000 ($104.1M / 576 publications), less than the average costs for the EU and the U.S., as seen in the table above.

The comparison, of course, must be treated with caution for several reasons including that the salary costs for scientists developing SAGES projects in 2008-09 may not be fully accounted for, AES is agri-environment research while the EU and U.S. data relate to all forms of scientific research, and the time periods covered by the AES and the Innovations Union data do not match. Nevertheless, taking these limitations into account, it is reasonable to conclude that the efficiency of AES research activities is similar to average public research in the other jurisdictions considered.

[67] For the EU and the U.S., cost/publication = (funding/FTE) * (FTE/publications). Euros are converted to Canadian dollars using a PPP exchange rate for 2007 published by the OECD of CAD 1.52 = EUR 1.0. This is very close to the market exchange rate in that year.

[68] Note: This count of AES peer reviewed publications was based on a report for only 75% of the Agri-Environmental Soil, Water, Air and Bioresource Protection projects and, therefore underestimates the level of AES productivity. The remaining 35% of the projects were either in amidst of writing research reports for publications or in the process of conducting research.

3.3.4 Economy – Potential Return on Investment

Much of the evidence from past research indicates that AAFC's agri-environmental science can bring enormous benefits once the information has been translated into beneficial management practices. For example, beneficial management practices related to crop rotation "have the potential to increase or maintain the quantity and quality of soil organic matter, and improve soil chemical and physical properties"[69], and increase agriculture production over time.

Based on previous case studies, beneficial management practices, such as minimum tillage have significantly reduced the costs of production (e.g., time, fuel consumption, use of fertilizer etc.) and have increased outputs. [70] They have also led to development of new machinery, an indication of research benefits spilling over to other agricultural sub-sectors. Currently 60% of producers on the Prairies have adopted minimum tillage practices.[71]

AAFC program officials have provided a number of examples that demonstrate that investments in research and innovation have the potential to provide significant economic returns over time:

Canola gave the world a new food-grade oil; it contributes $15.4 billion to the economy (2011)	The 'carrot trimmer' has reduced yield losses due to schlerotina rot by 80% since 2008. The cost of one pass of the trimmer is $5 per acre compared to $20 per application of pesticide
Genetics for livestock created a $248 million export industry (2011)	The University of Guelph collaborated with producers, processors and government to develop DHA-enriched milk, which commands a 15-30% premium in dairy cases across Canada

Source: AAFC Strategic Policy Branch (based on studies, news articles)

[69] X. Liu, S.J. Herbert, A.M. Hashemi, X. Zhang1, G. Ding (2006). Effects of agricultural management on soil organic matter and carbon transformation – a review. Plant Soil Environment, *52*, (12): pp. 531–543.

[70] U.S. Department of Agriculture. Natural Resources Conversation Services. Integrated Cropping Systems and Water Management Handbook (AGRO-76). http://www.nm.nrcs.usda.gov/technical/handbooks/iwm/NM_IWM_Field_Manual/Section10/10a-Benefits_Conservation_Tillage.pdf

[71] AAFC Policy Branch documentation.

Based on project review data, an example of agri-environmental research that has led to the development of a BMP (initiated under the APF period and continued under GF) is the Controlled Tile Drainage (CTD) BMP.[72] With this BMP, the flow of water drainage is controlled with structures that are installed on tile headers. Based on WEBs economic and environmental performance data on a 480 hectare test watershed over a four-year time period, the CTD increases crop yields by an average of 3% for corn and 4% for soybeans. The cost of installing CTD is approximately $208/hectare and each structure has a lifespan of 25 years. Using a five-year corn and three-year soybean model of net revenues for a typical crop operation, this BMP would amount to an annual benefit of $5,700 ($55/hectares) for corn and $1,200 ($21/hectares) for soybeans. Aside from potential economic returns, in terms of environmental benefits, overall nitrogen loads were reduced by 50-100% as compared to uncontrolled drainage.

A second example of AAFC-funded agri-environmental research that has led to the development of a BMP is the Water Demand Model.[73] While a specific estimate of the economic value of this research is not yet available, it has the potential to generate economic and social benefits related to reduced costs of production, and water usage. While it is too early to understand the full benefits of the Water Demand Model, research indicates that the Model can be used to determine current and future water requirements for regional agriculture, which will assist in supporting an ongoing, guaranteed water supply. This is important as competition for the resource is high and agriculture in certain regions cannot operate without water irrigation, thereby offering security to agricultural producers. The Model can determine the impact on water demands as changes to the efficiency of irrigation practice are implemented; producers who have efficient systems can save money on water supply and be drought-proofed against future shortages.

The combination of the Water Demand Model with a hydrology model (water supply/demand study) could help determine the relationship between agricultural demand and the provision of ecological goods and services (i.e. in-stream flows for fish; water quality, temperature for fish habitat, etc.). The Model is being used in water planning for a large number of regional water purveyors in British Columbia to assess future risks for Agriculture water supply in the Okanagan. It is

[72] AAFC, Watershed Evaluation of Beneficial Management Practices (WEBs). http://www4.agr.gc.ca/resources/prod/doc/pdf/webs_epbh_fs3_drainage-eng.pdf. David Lapen was the leading scientist.

[73] Neilsen, D., Smith, S., Taylor, B., Fretwell, R. (2006). Modeling regional water demand for current and future climate in the Okanagan Basin, British Columbia, Canada.

also being used to develop a prototype for an Agricultural Water reserve in British Columbia.

In conclusion, while difficult to quantify and attribute, over the long-term, AAFC investments in agri-environmental science have the potential to generate considerable economic and social returns on investment. The challenge going forward will be to develop the measures and systems required so that these benefits can be tracked and reported over time to demonstrate value for money.

4.0 Conclusions and Recommendations

4.1 Conclusions

There is a continuing need for new and deeper scientific understanding of the interaction between the environment and agriculture as the environment changes and the agricultural sector seeks and adopts new practices and technologies to increase its productivity, profitability, competiveness and sustainability.

AES objectives are aligned with the federal government's science and technology, environmental and agricultural priorities, as well as AAFC's strategic outcomes and science priorities. The next agricultural policy framework outlines a commitment to move towards more targeted, collaborative and results-oriented approaches to address environmental challenges through better integrated and targeted science efforts.

The federal government's roles and responsibilities with respect to the AES sub-activity are consistent with its historical roles and responsibilities, institutional capacity, international practices, and stakeholder thinking about the circumstances where government can, or should, intervene. However, there are opportunities to further engage provinces and territories. Further, there is little risk of duplication or overlap, as AAFC is the only Canadian-research based organization with a national agri-environmental research capacity.

AES projects are targeting research questions that can reasonably be expected to provide scientific knowledge about the interaction of agriculture and the environment. Based on evaluation evidence, AES projects address AAFC's science priority 5, to enhance environmental performance of the Canadian agricultural system.

The AES research projects are producing the outputs (peer reviewed scientific publications) required to contribute to the sub-activity's expected outcome of increased understanding of the agriculture-environment dynamic by the science community at or above targeted levels. Due to the level of maturity of the programs, many more peer reviewed scientific publications will continued to be produced after *Growing Forward* expires.

While collaboration with internal and external partners has increased through SAGES, more work needs to be done to promote collaboration among AAFC scientists and managers, other government departments and industry. The evaluation

evidence indicates that outside of special initiatives, collaboration is at low levels, and there is a lack of coordination and collaboration that takes away from capitalizing on research capacity, producing synergies, and increasing research efficiencies. Other program research delivery models exist that may enable more collaboration with other government departments and industry.

AES research teams are participating in knowledge transfer activities; however, there are opportunities for improvements at all stages of the research and development cycle. The document review, survey responses and key informant interviews suggest that AAFC's knowledge transfer expectations and policies are vague, especially at the project level, as well as the department's expectations of scientists in this area.

AAFC does not have any system or reporting protocol that permits program managers to monitor input costs and project outputs below the sub-activity level or at the project level with the result that it is unable to routinely assess the effectiveness of program resource allocations, or the efficiency of particular initiatives. It was a challenge to assess the salary costs for AES in relation to the planned FTEs based the research project database and financial management system because salaries were recorded at the PAA sub-activity level rather than the program level.

AES research projects have the potential to generate considerable economic and social benefits over time. The challenge going forward will be to develop the measures and systems required so that these benefits can be tracked and reported over time to demonstrate value for money.

4.2 Recommendations

1. The Science and Technology Branch should develop an appropriate performance measurement strategy for the Agri-Environmental Science sub-activity, one that is linked to the department's science priorities and strategic outcomes.
2. The Science and Technology Branch should examine ways to improve collaboration on agri-environmental research internally and with other government departments, provinces and territories and industry groups.
3. The Science and Technology Branch should develop and implement a comprehensive knowledge transfer strategy for agri-environmental science based on a broad definition of knowledge transfer as a process that begins in the planning stages and extends through knowledge utilization which considers the role and mandate of provinces and territories and industry.

4. The Science and Technology Branch, should develop a reporting protocol to track and report program and project level financial and performance information to support more robust performance monitoring and reporting.

Appendix A List of AES Projects

Agri-Environmental Soil, Water, Air and Bioresource Protection Projects ** projects included in the project file review*							
ID	**Project Title**	**KER**	**2009-2010**	**2010-2011**	**2011-2012**	**2012-2013**	**Total**
7	Managing carbon and nitrogen to sustain productivity and preserve environmental health in a changing world	5.1	$38,000	$38,000			$76,000
19	Effect of crop management practices on denitrification, nitrous oxide emissions and denitrifier populations.	5.1	$22,400	$30,400			$52,800
21	Managing plant-associated microorganisms in efficient and sustainable cropping systems	5.1	$48,000	$34,400			$82,400
25	Environment impacts of intensive potato production and effectiveness of beneficial management practices in agricultural watersheds	5.2	$32,000	$28,800			$60,800
31	Managing phosphorus and potassium for environmentally sustainable crop production	5.1	$48,000	$48,000			$96,000
36	Understanding the impacts of agronomic practices on soil organic carbon dynamics and sequestration for fine-textured soils in Southwestern Ontario	5.1	$24,000	$24,000			$48,000
51	Adapting cropping systems to climate change. Phase 1: developing capabilities for monitoring crop growth in response to weather conditions using verified crop growth models, agrometeorology and remote sensing.	5.3	$20,000	$20,000			$40,000
53	Understanding, Predicting and Managing Nitrogen Processes in Soils to Reduce Environmental Losses to Air and Water		$196,000				$196,000
54	Integrated management of liquid manure	5.2	$24,000	$24,000			$48,000
56	The impact of agricultural management practices and abiotic factors on the turnover and storage of soil carbon and nitrogen		$48,000				$48,000
68	Nutrient and water management of horticultural crops in an era of uncertain water supply	5.2	$35,200	$35,200			$70,400
69	Landscape-scale assessment of hydrology, water quality and aquatic biota in surface waters as a function of agricultural intensity	5.3	$20,000	$20,000			$40,000

Agri-Environmental Soil, Water, Air and Bioresource Protection Projects ** projects included in the project file review*							
ID	**Project Title**	**KER**	**2009-2010**	**2010-2011**	**2011-2012**	**2012-2013**	**Total**
70	Phosphorus cycling in agri-eco-systems and development for risk assessment tools and BMPs to improve water quality while maximizing crop productivity	5.2	$20,000	$20,000			$40,000
76	Isotopic tracing of biogeochemical cycling in agriculture	5.1	$20,000	$20,000			$40,000
80	Microbial source tracking and modeling tile drain management at watershed scales to assess and manage the risk of agricultural derived pollution to water courses	5.2	$160,000	$160,000			$320,000
82	Enhancing best-management-practices to mitigate environment and crop production risks associated with salinization.	5.2	$12,000	$3,200			$15,200
93	Étude du comportement de recherche d'hôte et de la réponse aux extrèmes de température des parasitoïdes	6.2	$24,000	$24,000			$48,000
94	Sediment, phosphorus and heavy metal fate in first-order agricultural watersheds: sources, temporal transport and P bioavailability	5.1	$57,600	$57,600			$115,200
106	Quantifying and reducing greenhouse gas, ammonia and particulate matter emissions from agroecosystems.	5.1	$80,000	$80,000			$160,000
122	Detection and fate of recombinant DNA from selected genetically modified crops and feed with respect to their long term environmental sustainability.		$33,600				$33,600
135	Supporting Agricultural Risk Management and Long Term Sustainability Through the Use of Satellite Imaging	5.3	$52,000	$52,000			$104,000
137	Developing knowledge and technology to assess and simulate agricultural land use and land management change in support of environmental and economic modeling.	5.3	$28,000	$28,000			$56,000
156	Reducing pesticide contamination from point- and diffuse sources	5.2	$16,000	$16,000			$32,000
163	Integrated Nutrient Management for Improved Productivity and Environmental Sustainability		$180,000				$180,000

Agri-Environmental Soil, Water, Air and Bioresource Protection Projects ** projects included in the project file review*							
ID	**Project Title**	**KER**	**2009-2010**	**2010-2011**	**2011-2012**	**2012-2013**	**Total**
166	The Impact of Farm Improvements Implemented from Environmental Farm Planning though the Application of Beneficial Management Plans and the Investigation of Pathogen Levels in Wildlife and Livestock Populations in Watersheds.		$46,800				$46,800
170	Impact de la gestion des sols sur la dynamique des éléments nutritifs	5.1	$20,000	$20,000			$40,000
182	Improving the Environmental and Economic Performance of Agriculture by Enhancing Soil Quality	5.1	$44,000	$44,000			$88,000
183	Impact de systèmes de production contrastés - transgénique, biologique et conventionnel - sur les composantes de la biodiversité de l'agroécosystème	6.2	$43,760	$40,400			$84,160
194	Long-Term Sustainability of Soil and Crop Management Practices for Canadian Prairie Agriculture	5.3	$64,042	$54,236			$118,278
205	Impact of straw harvest for biofuel feedstock and other uses on soil quality and crop production	5.1	$18,286	$24,206			$42,492
213	Feedlot manure nutrient management: fine-tuning the process and optimizing end use	5.2	$28,000	$28,000			$56,000
214	Development of physico-chemical treatment systems for the separation and concentration of manure nutrients and the production of reusable water	5.2	$40,000	$40,000			$80,000
223	Effectiveness of controlled tile drainage with sub-surface irrigation recycling for mitigating the impacts of three manure sources on water quality and crop production.	5.2	$38,400	$38,320			$76,720
226	Advanced pesticide application technologies for reduced environmental impact.	5.2	$16,000	$16,000			$32,000
227	Biological interactions fundamental to the environmentally sustainable production of high-quality blueberries	6.2	$40,000	$40,000			$80,000
815	Mitigation of nitrate contamination of vulnerable groundwater aquifers by agricultural production	5.1	$72,000	$90,000	$90,000		$252,000
820	Watershed-based assessment of the impacts of intensive potato production on nitrate levels of groundwater	5.1	$32,000	$28,000	$5,000		$65,000

Agri-Environmental Soil, Water, Air and Bioresource Protection Projects ** projects included in the project file review*							
ID	**Project Title**	**KER**	**2009-2010**	**2010-2011**	**2011-2012**	**2012-2013**	**Total**
823	Assessment and management of on-farm fate of microbial and chemical contaminants carried in human and animal wastes used as organic fertilizers		$200,000	$250,000	$250,000		$700,000
834	Impact de la variabilité climatique sur les dynamiques de l'hôte et ses bioagresseurs		$40,000				$40,000
839	Assessing the impacts of climate change and climate variability on the production of annual crops: risks, opportunities and adaptation strategies		$28,000				$28,000
1108	Microbial symbionts of insects: detection, identification, and novel applications for pest control	6.2	$48,000	$48,000			$96,000
1278	Advanced Remote Sensing Methods for Assessing Crop Acreages in Canada		$30,000				$30,000
1282	Characterizing Forms and Dynamics of Soil Phosphorus in Long-Term Prairie Crop Rotation Plots		$47,000				$47,000
1296*	The molecular compounds of root exudates associated with soil nitrogen mineralization and its crop uptake are the basis for increasing fertilizer-nitrogen use efficiency	5.1	$87,500	$87,500	$87,500		$262,500
1312	Diversity of Bacillus thuringiensis and its position in the B. cereus sensu lato group - Improving the Safety of Animals, Humans and the Environment		$25,000				$25,000
1319*	For the soil surface layer, define enhanced taxonomic protocols and model framework to characterize and predict the agri-environmental impacts from land use and tillage on the soil structure fingerprint.	5.3	$30,000	$30,000	$40,500	$40,500	$141,000
1322	Adapting Nitrogen (N) Fertilization to Rainfall Conditions, Soil Characteristics and Climate Variations		$65,000				$65,000
1325	Persistence and genomic dynamics of emerging human pathogens in soils		$48,000				$48,000
1347	Use of electronic monitoring of insect pest movement in the agricultural landscapes to develop improved best management practices.	5.1	$45,000	$45,000			$90,000
1358*	Invasive plants of agro-ecosystems: distribution, dynamics involved and potential management strategies.	5.1	$45,000	$45,000	$45,000	$45,000	$180,000

Agri-Environmental Soil, Water, Air and Bioresource Protection Projects ** projects included in the project file review*							
ID	**Project Title**	**KER**	**2009-2010**	**2010-2011**	**2011-2012**	**2012-2013**	**Total**
1375	Environmental nutrient management tools and recommendations for intensive cropping systems	5.2	$35,000	$35,000			$70,000
1378*	Root diseases of perennial fruit crops: Influences of climate change and sustainable water management strategies	5.1	$50,000	$50,000			$100,000
1392*	The effect of elevated CO2, temperature and drought on life cycle shifts in annual weeds.	5.1	$35,000	$35,000	$35,000	$35,000	$140,000
1432*	Developing Earth Observation Tools to Measure the Current and Future Spatial Extent and Productivity in Grasslands of Western Canada	5.3	$183,800	$93,500			$277,300
1483	Atténuation des pointes de crues (APC)	5.2	$10,000	$10,000			$20,000
1599	BARD PHASE II - Dissolved organic matter fractionation and pollutant interactions in soils irrigated with reclaimed wastewater	5.1		$19,000	$17,000	$17,500	$53,500
1630*	Agricultural Impacts and BMPs in Thomas Brook, Nova Scotia WEBs	5.2	$74,250	$144,100	$116,600	$100,100	$435,050
1720	Characterizing the Relationships Among Essential Soil Functions and Dynamic Soil Physical Properties	5.3			$25,000		$25,000
1722*	Walking movement patterns of agricultural insect pests: field boundary dynamics.	5.3			$40,000	$40,000	$80,000
1768*	Long-term experiments as historical records of microbial community adaptation in evolving agroecosystems: utilizing soil archives to establish a chronosequence of soil microbial biodiversity	5.1			$50,000	$50,000	$100,000
1782	Managing Phosphorus and Water in Soils Long-term Continuously Amended with Animal Manures and Inorganic Fertilizers to Increase Crop Use Efficiency and Reduce Adverse Impacts on Water Quality in the Great Lakes Region	5.2			$25,000	$25,000	$50,000
1788*	Further investigations into the impact of pesticide use on crop diseases, microbial populations, plant nutrition and long-term sustainability	5.3			$40,000	$40,000	$80,000
1795	Sustainability of Alternative Crop Production Systems for the Canadian prairies	5.3			$25,000	$25,000	$50,000

Agri-Environmental Soil, Water, Air and Bioresource Protection Projects ** projects included in the project file review*							
ID	**Project Title**	**KER**	**2009-2010**	**2010-2011**	**2011-2012**	**2012-2013**	**Total**
1854	Quantifying particulate matter emission factors associated with crop production in Canada	5.3			$13,500	$5,500	$19,000
1855	Long-Term Sustainability of Soil and Crop Management Practices for Canadian Prairie Agriculture	5.3			$25,000	$25,000	$50,000
1889	Net impact of cattle grazing grasslands on methane and carbon dioxide balance	5.2			$25,000	$25,000	$50,000
Agri-Environmental Soil, Water, Air & Bioresource Protection Total			**$2,868,638**	**$2,118,862**	**$955,100**	**$473,600**	**$6,416,200**

SAGES ** projects included in the project file review*							
ID	**Project Title**	**KER**	**2009-2010**	**2010-2011**	**2011-2012**	**2012-2013**	**Total**
177	Dynamique de la matière organique du sol : impact des pratiques agricoles et pertes environnementales associées.	5.1	$168,000	$168,000			$336,000
193	Emissions from Animal Agriculture - Livestock and Livestock Facilities	5.1	$48,000	$48,000			$96,000
906	Integrated management of buffers for sustainable nutrient management		$60,000	$60,000	$53,000	$53,000	$226,000
1260	Unlocking Soil Processes and Nutrient Cycling Using a Heritage of Long-Term Field Experiments	5.3	$81,600	$81,600	$81,600	$81,600	`$326,400
1277	Linking Soil Nitrogen Dynamics to Gaseous (N2O and NH3) Emissions in Agricultural Soils	5.1	$75,000	$75,000	$75,000	$75,000	$300,000
1352	Development of an environmentally-sound dry anaerobic digestion bioprocess to reduce odours, pathogens, and organic pollutants and recover usable green energy and value added by-products from farm solid wastes and energy crops.	5.3	$60,000	$60,000	$71,000	$71,000	$262,000
1458	Improving the resilience of Canadian agro-ecosystems to climate change and variability	5.2	$444,700	$$460,000	$391,000	$460,000	$1,755,700
1459	Mitigating nitrate contamination of vulnerable aquifers by agricultural production	5.1	$400,000	$400,000	$340,000	$400,000	$1,540,000

SAGES ** projects included in the project file review*							
ID	**Project Title**	**KER**	**2009-2010**	**2010-2011**	**2011-2012**	**2012-2013**	**Total**
1461	Understanding and predicting nitrogen dynamics in Canadian cropping systems to improve efficiency of nitrogen utilization and reduce environmental losses	5.1	$1,000,000	$1,000,000	$938,000	$1,000,000	$3,938,000
1462	Assessment and management of water and air quality risks associated with the use of organic fertilizers	5.1	$1,000,000	$1,000,000	$850,000	$1,000,000	$3,850,000
1463	Assessment and management of risk to water from emerging organic contaminants in agroecosystems	5.1	$290,000	$290,000	$247,000	$290,000	$1,117,000
1464	AeroNet: Aerobiota Monitoring and Forecasting Network	3.3	$180,000	$180,000	$153,000	$180,000	$693,000
1465	Understanding the impact of manure management practices on pathogen survival and transport in tile drained agricultural soils.	5.2	$100,000	$100,000	$85,000	$100,000	$385,000
1467	Integrated Earth Observation Information on Crops and Soils for Agri-Environmental Monitoring in Canada	5.3	$388,500	$366,000	$332,000	$355,500	$1,442,000
1468	Development of gene expression indicators and genetic markers to improve nitrogen use efficiency and water use efficiency and accelerate adaptation to climate change in potatoes.	5.1	$200,000	$200,000	$170,000	$200,000	$770,000
1469	Investigations of land use change and BMP implementation scenarios through the application of non-point source water quality modeling to reduce nutrient loadings to tributaries in the Red-Assiniboine Basin	5.1	$100,000	$100,000	$85,000	$100,000	$385,000
1470	Herbicide use reduction by inter-row weed emergence stimulation and detection.	5.2	$50,000	$50,000	$43,000	$50,000	$193,000
1471	Sustaining Grassland Systems in the Face of Climate Change	5.2	$420,000	$400,000	$357,000	$420,000	$1,597,000
1472	Assessing biological community shifts, and nitrogen and carbon transformations during winter in Canadian agricultural soils	5.2	$450,000	$450,000	$383,000	$450,000	$1,733,000
1473	Soil organic matter dynamics in a warming world	5.1	$125,000	$420,000	$414,000	$473,000	$1,432,000
1474	Development of ecological performance standards for sediments, nutrients and pesticides in streams across gradients of agricultural intensity	5.3	$100,000	$100,000	$80,000	$100,000	$380,000

SAGES ** projects included in the project file review*							
ID	**Project Title**	**KER**	**2009-2010**	**2010-2011**	**2011-2012**	**2012-2013**	**Total**
1475	Soil and plant phosphorus assessment and modeling in Canadian agro-ecosystems	5.1	$340,000	$340,000	$289,000	$340,000	$1,309,000
1476	Exploring new farming systems that promote environmental health and enhance ecosystem services	5.1	$65,000	$173,000	$148,000	$180,000	$566,000
1477	The future Canadian agriculture system in a changing world: environmental and economic adaptation, impacts, and risks	5.2	$250,000	$250,000	$213,000	$250,000	$963,000
1478	Determining interactions between land use and climate to evaluate impacts and adaptations to climate variability and change	5.3	$224,600	$257,000	$213,000	$267,500	$962,100
SAGES Total			**$6,620,400**	**$7,028,600**	**$6,011,600**	**$6,896,600**	**$26,557,200**
AES Total			**$9,489,038**	**$9,147,462**	**$6,966,700**	**$7,370,200**	**$32,973,400**

Source: Research Branch Project Database and AESB.

Appendix B Interview Guides

Agri-Environmental Science Evaluation

Key informants Interview Guide

Name	
Position / Affiliation	
Date	
Place	
Interviewer(s)	

AAFC's Office of Audit and Evaluation (OAE) is conducting an evaluation of Agri-Environmental Science (AES). This sub-activity comprises research delivered by the Research Branch under Sustainable Agriculture Environmental Systems (SAGES), a *Growing Forward* initiative administered by AESB, and research in the area Agri-Environmental Soil, Water, Air and Bioresource Protection.

As part of the evaluation, OAE is interviewing AAFC officials and others who have been involved in planning, managing, conducting and using AES research.

Your participation in these interviews is much appreciated.

Your responses to the following questions will be held in confidence; responses will be reported in aggregate form only and without attribution.

- ✴ Please note that we would welcome receiving any documentation that elaborates on any of the issues covered in the interview.

Introduction

1. Could you describe your involvement with Agri-environmental Science activities?

Program Progress and Need

2. AES research is done to increase knowledge about the interactions between agriculture and the environment and contribute to the development of BMPs and other technologies to protect Canada's soil, air, water and bioresource. Some of the research is funded from A-based resources, while about 25 projects have been funded through the SAGES (Sustainable Agriculture Environmental Systems) initiative that focuses on agri-environmental water and climate issues.

   a. Which of the following statements best summarizes your assessment of the progress made in advancing understanding of the agriculture-environment interaction and establishing the scientific basis for new technologies over the past three to four years:

   <u>On water issues</u>:

   ☐ No progress has been made; ☐ Very little progress has been made; ☐ There have been some promising developments; ☐ There have been major gains.

   <u>And, progress on climate issues</u>:

   ☐ No progress has been made; ☐ Very little progress has been made; ☐ There have been some promising developments; ☐ There have been major gains.

   Comment:

b. What are the important knowledge gaps, if any?

c. Has there been enough progress made in some areas to allow for a shift of emphasis to other agricultural research issues? If so, what issues should be targeted?

d. Has the agri-environmental research that has been done, or that is still underway, had any significant, but unexpected impacts?

Approach to Planning and Delivering Research

3. Under the Agricultural Policy Framework, agri-environmental research was done through a number of research programs, each with different priorities, clients, delivery agents and processes. Building on lessons from that experience, AAFC designed the SAGES initiative to consolidate related research into one program, focus on water and climate change, and encourage national collaboration within AAFC and interdepartmental collaboration federally.

   a. Has this approach been an appropriate and credible response to agri-environmental research needs as you understand them?

   b. If not, what other approach would you recommend?

   c. On a scale of 1 to 6, where 1 means that you "Strongly Agree" and 6 means you "Strongly Disagree," please indicate the extent to which you agree or disagree with the following statements:

      i. The SAGES selection and approval process identified projects that clearly and consistently focus on either the water or the climate change priority!

Strongly Agree	2	3	4	5	Strongly Disagree	No opinion

      Comment:

      ii. Having research teams made up of AAFC scientists from different regions leads to better agri-environmental research outcomes!

Strongly Agree	2	3	4	5	Strongly Disagree	No opinion

      Comment:

      iii. Having interdepartmental research teams leads to better agri-environmental research outcomes!

Strongly Agree	2	3	4	5	Strongly Disagree	No opinion

      Comment:

      iv. AES research teams routinely collaborate with people who will be involved in using new research results to develop new BMPs and other technologies!

Strongly Agree	2	3	4	5	Strongly Disagree	No opinion

      Comment:

Alignment with the AAFC Science and Innovation Strategy

4. Using the same scale, please indicate the extent to which you agree with the following statements:

   a. The current project **selection and approval processes** ensure that all AES research is clearly aligned with the Science Priorities.

Strongly Agree	2	3	4	5	Strongly Disagree	No opinion

   Comment:

   b. The current project **reporting and review processes** ensure that the AES research scientists and managers know when project re-alignment occurs or should be considered.

Strongly Agree	2	3	4	5	Strongly Disagree	No opinion

   Comment:

Who Should Do Agri-Environmental Research

5. Program evaluations are expected to address questions about whether the programs they are assessing are delivered by the most appropriate organization.

   a. To what extent do you agree that AAFC is very well-placed to be the major centre for agri-environmental research in Canada?

Strongly Agree	2	3	4	5	Strongly Disagree	No opinion

   b. If you tend to disagree with the proposition, what other departments or organizations outside of the federal government would be better placed to plan and conduct some or most of the research in this area?

   c. What factors do you think have to be considered when a decision has to be made about whether AAFC should do research itself, fund external organizations to do it, or simply leave it to the private sector?

   d. Do you know of other research organizations that devote a significant proportion of their resources to agri-environmental research?

From Discovery to Delivery

6. Agri-environmental research activities are intended to provide the scientific basis for the development and implementation of beneficial management practices and other technologies.

   a. Has the current AES research made a direct contribution to the development of new or improved tools or processes, beneficial management practices, environmental assessment and protection processes, public policy or other innovations?

      If not, is it likely to do so in near future?

   b. Do you have examples that show how the process of translating agri-environmental science discovery into new technologies should or could work?

Are there references or citations that we could use to get more information about these examples?

Research Project Planning, Administration and Delivery

7. The decision-making and project administration processes used for SAGES projects are somewhat different than those used for A-based projects, and both may differ from practices in other research organizations.
   a. From your perspective what were the key features of the SAGES approach and were they implemented in the way you originally expected?
   b. What aspects of the SAGES approach are working well?
   c. What aspects of the A-base process and approach are working well?
   d. Are there improvements you would like to see in the planning, administrative or delivery processes used for AES projects, whether SAGES or A-base?
   e. Do you know of federal research programs or initiatives dealing with environmental issues that have funding levels similar to AES ($6-8 million a year)? We are interested in learning about programs that do their research internally, as well as those that fund external research.

Wrap up

8. Are there other comments or observations that you would like to see considered in the evaluation of the agri-environmental science function?

Thank you very much for your time and insights!

Appendix C References

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Appendix D Survey Questionnaire

Agri-Environmental Science Evaluation
Principal Investigators Survey

Office Of Audit & Evaluation, Agriculture and Agri-food Canada

Thank you for participating in this survey. Please note that your responses will be reported in aggregate form only, without attribution.

First name	*Enter your first name.*
Surname	*Enter your surname.*
Affiliation	*Identify the centre or other division where you work*

Progress

AAFC invests in AES research to increase scientific knowledge about the interaction between agriculture and the environment, and to contribute to the development of BMPs and other technologies to protect Canada's soil, air, water and bioresource.

Please rate the progress that has been made over the past three to four years with respect to:

1. Advancing understanding of the interaction of agriculture and **water.**

   ☐ No progress has been made; ☐ Little progress has been made; ☐ There have been promising advances; ☐ There have been significant advances

2. Advancing understanding of the interaction between agriculture and **climate.**

   ☐ No progress has been made; ☐ Little progress has been made; ☐ There have been promising advances; ☐ There have been significant advances

3. Producing knowledge that leads to **new technologies and agricultural innovations?**

   ☐ No progress has been made; ☐ Little progress has been made; ☐ There have been promising advances; ☐ There have been significant advances

4. If there have been significant achievements, please identify/describe them.

   Enter text here!

5. Please identify/describe any significant knowledge gaps.

   Enter text here!

6. Please use the space below to add any additional comments you may wish to make about the state of agri-environmental science.

Enter text here!

Please indicate the extent to which you agree or disagree with the following statements:

Alignment with Priorities

7. The SAGES selection and approval process identified projects that clearly and consistently focus on either the water or the climate change priority!

☐ Strongly disagree; ☐ Disagree; ☐ Somewhat disagree; ☐ Somewhat agree; ☐ Agree; ☐ Strongly agree

8. The current Research Branch project selection and approval processes ensure that the all AES research is clearly aligned with the Science Priorities!

☐ Strongly disagree; ☐ Disagree; ☐ Somewhat disagree; ☐ Somewhat agree; ☐ Agree; ☐ Strongly agree

Research Linkages

9. Having research teams made up of AAFC scientists from different regions leads to better research outcomes!

☐ Strongly disagree; ☐ Disagree; ☐ Somewhat disagree; ☐ Somewhat agree; ☐ Agree; ☐ Strongly agree

10. Interdepartmental research teams leads to better agri-environmental research outcomes!

☐ Strongly disagree; ☐ Disagree; ☐ Somewhat disagree; ☐ Somewhat agree; ☐ Agree; ☐ Strongly agree

11. AAFC encourages and actively supports project-level collaboration with scientists affiliated with universities and other research institutions in Canada and abroad!

☐ Strongly disagree; ☐ Disagree; ☐ Somewhat disagree; ☐ Somewhat agree; ☐ Agree; ☐ Strongly agree

Knowledge Transfer

12. AES research is informing the development of program priorities and other public policy!

    ☐ Strongly disagree; ☐ Disagree; ☐ Somewhat disagree; ☐ Somewhat agree; ☐ Agree; ☐ Strongly agree

13. AES research teams routinely interact with people/organizations who will be involved in using new research results to develop BMPs, innovative technologies and/or regulations!

    ☐ Strongly disagree; ☐ Disagree; ☐ Somewhat disagree; ☐ Somewhat agree; ☐ Agree; ☐ Strongly agree

14. AAFC is very well placed to be the major centre for the conduct of agri-environmental research in Canada!

    ☐ Strongly disagree; ☐ Disagree; ☐ Somewhat disagree; ☐ Somewhat agree; ☐ Agree; ☐ Strongly agree

Program efficiency

Please rate the efficiency of the following AES management and administrative activities (A process or activity is efficient where it produces the best results.)

15. The processes involved in the call for and development of proposals for AES research projects.

    ☐ Very efficient; ☐ Efficient; ☐ Somewhat efficient; ☐ Inefficient

16. The project review and selection procedures.

    ☐ Very efficient; ☐ Efficient; ☐ Somewhat efficient; ☐ Inefficient

17. Project implementation

    ☐ Very efficient; ☐ Efficient; ☐ Somewhat efficient; ☐ Inefficient

18. Project monitoring, change management and reporting

    ☐ Very efficient; ☐ Efficient; ☐ Somewhat efficient; ☐ Inefficient

19. The procedures and services support the translation for research results to innovations and new technologies.

    ☐ Very efficient; ☐ Efficient; ☐ Somewhat efficient; ☐ Inefficient

Program Economy

Please rate the overall economy of the following AES management and administrative activities (An economic activity is one that achieves its results at the least cost.)

20. The processes surrounding the call for and development of proposals for AES research projects.

    ☐ Very economical; ☐ Economical; ☐ Somewhat economical; ☐ Not economical

21. The project review and selection procedures.

    ☐ Very economical; ☐ Economical; ☐ Somewhat economical; ☐ Not economical

22. Project implementation

    ☐ Very economical; ☐ Economical; ☐ Somewhat economical; ☐ Not economical

23. Project monitoring, change management and reporting

    ☐ Very economical; ☐ Economical; ☐ Somewhat economical; ☐ Not economical

24. The procedures and services that support the translation of research results into innovations and new technologies.

    ☐ Very economical; ☐ Economical; ☐ Somewhat economical; ☐ Not economical

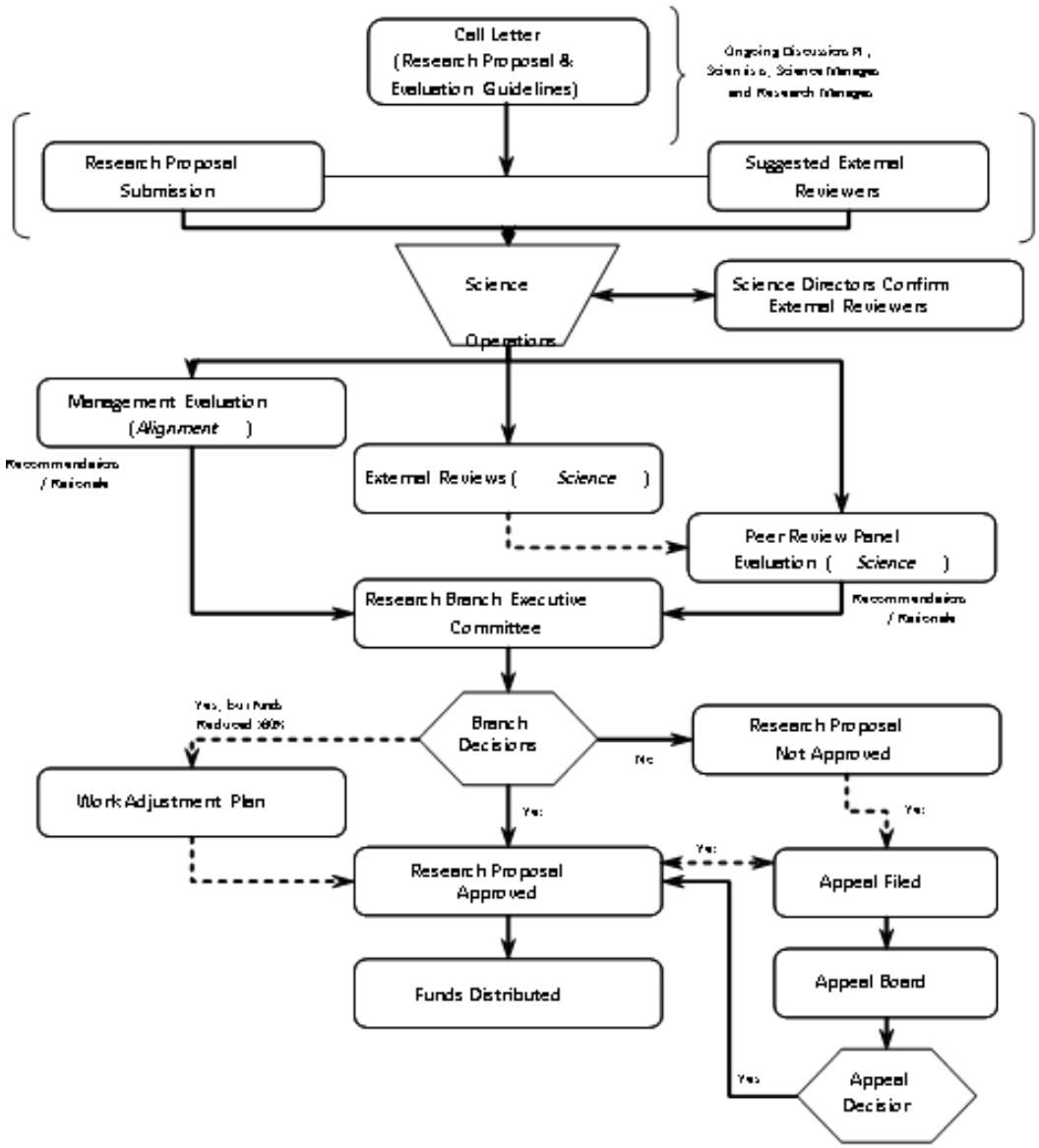
General Comments

25. Please add any comments you wish about the planning, management, and reporting practices for AES research.

Enter text here!

Thank you very much!

Appendix E Research Selection Process



Appendix F Planned FTE Data

Table 13: Planned FTEs: Agri-Environmental Soil, Water, Air and Bioresource Protection Research Projects

	2009-10	2010-11	2011-12	2012-13
Principal Investigator	27.9	23.6	10.2	8.0
Co-Principal Investigator	3.7	3.9	3.7	2.7
Participant	22.8	21.8	7.0	4.6
Support	68.2	55.9	17.6	11.2
Total	122.5	105.1	38.4	26.4
Source: Research Branch Staff Allocation database and OAE				

Table 14: Planned FTEs: SAGES Research Projects

	2009-10	2010-11	2011-12	2012-13
Principal Investigator	10.5	9.5	8.6	9.7
Co-Principal Investigator	4.4	4.3	3.4	3.6
Participant	41.3	40.6	39.0	39.7
Support	71.4	64.8	57.6	59.2
Total	127.6	119.1	108.6	112.2
Note: Data is for active projects in 2011-12 Source: Research Branch Staff Allocation database and OAE				

Appendix G International Approaches

United States: The U.S. Department of Agriculture mandate includes expanding markets for agricultural products, support for international economic development, rural development, food safety, providing food assistance and nutrition education and promotion, and managing and protecting America's public and private lands working cooperatively with other levels of government and the private sector. In pursuit of these ends, it provides funding to states and maintains three in-house research agencies the Economic Research Service, the Forest Service's Research & Development program and the Agricultural Research Service (ARS). ARS is intended to develop scientific knowledge to "… help solve problems in crop and livestock production and protection, human nutrition, and the interaction of agriculture and the environment." It has a large research capacity is large, with some 2,200 scientists and post docs, 6,200 other employees, 90 plus research locations and a $1.1 billion budget for 2012.[74]

France: The National Institute for Agricultural Research (INRA), which was founded in 1948, is a public research institution under the joint authority of, and 80 % funded by, the Ministry of Higher Education and Research and the Ministry of Food, Agriculture and Fisheries, which does not have an in-house research capacity. The Institute is governed by a government appointed board. It does research that concerns agriculture, food, nutrition, food safety, and environment and land management with emphasis on sustainable development. INRA also has a large research capacity with 1,837 researchers, 2,590 engineers, and 4,061 technicians and administrative staff located 19 regional centres comprising 213 research units and 49 experimental units. The organization has fourteen divisions, including one focusing on issues that parallel those covered by the AES sub-activity.[75]

United Kingdom: The UK's Department for Environment, Food and Rural Affairs (Defra) is responsible for that countries food and agriculture policies "… ensuring a thriving farming and food sector with an improving net environmental." The department does not have an intramural research capacity, although some of its "executive" agencies, such as the Food and Environment Research Agency, do. Rather, it commissions research through requests for proposal and non-competitive contracts.[76] In 2010–11, Defra spent approximately [$172M] for

[74] Agricultural Research Service, USDA. (n.d.). Retrieved June 18, 2012, from http://www.usda.gov/wps/portal/usda/usdahome?contentid=ARS_Agency_Splash.xml&contentidonly=true

[75] National Institute for Agricultural Research (INRA), France. (n.d.). Retrieved June 18, 2012, from http://www.inra.fr/l_institut/l_inra_en_bref

[76] A Defra online database lists 330 current projects covering natural and social sciences, economic analysis, and monitoring, testing and surveillance activities, Defra, UK, Science and Research Projects. (n.d.). Retrieved June 19, 2012, from http://randd.defra.gov.uk/

natural and physical sciences and operational research.[77] The department also or addresses its science and research needs through collaboration with its network of executive and arms-length agencies, national research council's and other government organizations, as well as the Agriculture and Horticulture Development Board, a statuary, levy-funded organization.[78]

New Zealand: New Zealand's governmental research capacity is located in Crown Research Institutes. The institutes are governed structured as for-profit companies, although they are wholly state owned and governments Cabinet-appointed directors and annually negotiate "statements of internet" with the government.[79] The institute for the agricultural sector is AgResearch, which has a mandate "to enhance the value, productivity and profitability of New Zealand's pastoral, agri-food and agri-technology sector value chains to contribute to economic growth and beneficial environmental and social outcomes for New Zealand." It has four research sites and about 850 staff, 625 of who are identified as researchers. The organization's Agriculture & Environment Science Group is doing research around issues similar to those undertaken by under AES: soils & land use; greenhouse gas emissions and mitigation; nutrient management; climate change and adaptation; water quality; and environmental foot printing.[80]

Australia: Australia has an intramural research capacity, as well as a six commodity-specific research "corporations" that are established under statute and partially funded from producer levies: cotton; fisheries; grains; grape and wine; rural industries and sugar. The intramural service is the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) within the Department of Agriculture, Fisheries and Forestry.[81] All of the agencies associated with the department do some agri-environmental science. It should be noted that the Commonwealth Scientific and Industrial Research Organisation (CSIRO) appears to be the more important source of Australian agricultural

[77] U.K. House of Commons. (2011). Department for Environment, Food and Rural Affairs Annual Report and Accounts 2010–11. Retrieved from http://www.defra.gov.uk/publications/files/defra-annual-report2011.pdf

[78] United Kingdom, Department for Environment, Food and Rural Affairs. (2011). Defra's Evidence Investment Strategy: 2010-2013 and beyond (2011 update) (p. 51). Retrieved from http://www.defra.gov.uk/publications/files/pb13471-eis-110427.pdf

[79] New Zealand, Crown Research Institutes Act 1992 No 47 (as at 01 February 2011), Pub. L. No. 1992 No, 47. Retrieved from http://www.legislation.govt.nz/act/public/1992/0047/latest/whole.html#DLM265147

[80] AgResearch Limited. (2011). AgResearch Annual Report Financials 2010/2011. New Zealand. Retrieved from http://www.agresearch.co.nz/publications/annualreport/annual-report-2010-2011/docs/Annual%20Report%202010-2011%20(PDF,%202.29MB).pdf

[81] ABARES was established through the merger of the Australian Bureau of Agricultural and Resource Economics (ABARE) and the Bureau of Rural Sciences (BRS) in 2010. ABARE's history dates back 65 years (from 1945) and BRS's 24 years (from 1986). About ABARES - Department of Agriculture, Fisheries and Forestry. Retrieved June 19, 2012, from http://www.daff.gov.au/abares/about

research, including environmental research, both in terms of capacity and productivity.[82]

[82] http://www.csiro.au/en/Portals/About-CSIRO.aspx

Appendix H International Affiliations

	Number of Research Institutions	
Country	**Agri-Environmental Soil, Water, Air and Bioresource Protection**	**SAGES**
Argentina	1	
Australia	7	14
Austria		2
Belgium		2
Brazil	1	
Chile	1	1
China	35	11
Columbia	1	
Cuba	2	
Denmark	1	1
Finland		2
France	4	10
Germany	9	
Iran		1
Ireland		1
Italy		2
Japan	1	
Netherlands	1	1
New Zealand	1	3
Norway		4
Pakistan		1
Poland		1
South Africa	1	
South Korea	5	
Sweden	4	2
Switzerland	7	
Tunisia	1	
United Kingdom	2	6
Ukraine	1	
Uruguay	1	
United States	21	11
Number of Institutions	**108**	**76**
Number of Countries	**22**	**19**

Appendix I Other Government Department Programs

The objective of the Lake Winnipeg Basin Initiative Science component is to provide scientific results to the province of Manitoba that will allow the setting of appropriate targets for nutrient levels in the lake. This activity relies on research projects carried out by Environment Canada scientists with funding of $12 million from total LWBI funding of $17.7 million over 4 years.

The objective of the Lake Winnipeg Basin Initiative Stewardship component is to reduce nutrient loading in Lake Winnipeg. It is a G&Cs program with typical recipients including conservation districts for BMPs and universities for research. Phase I had a budget of $2.1 million and Phase II of the program will have $7.5 million ($5.5 million for projects and $2 million for governance).

The objective of WEBS is to assess economic and environmental effects of beneficial management practices (BMPs). BMPs are typically developed in small plot settings while WEBS tests them in larger settings - at the watershed level. WEBS Phase I started under the APF with $5 million in NPO funding ($1.25 million contributed by Ducks Unlimited). A G&Cs component was introduced as the program progressed. Currently, the funding is $14.5 million and is delivered through a mix of G&Cs and NPO (40%-60% split but shifts back and forth year by year and averages about 50%- 50%).

The objective of the Green Mining Initiative is to improve environmental performance and promote innovation in the mining industry. The initiative, led by Natural Resources Canada, in close partnership with provincial/territorial governments, industry, academia, NGOs and other stakeholders aims to improve the mining sector's environmental performance and create green technology opportunities. There are four pillars under the program with Ecosystem Risk Management, Mine Closure and Rehabilitation and Mine Waste Management that seem most relevant to AES type activities. Footprint Reduction is the fourth pillar of GMI. The total budget is about $16 million. A-base "core" research projects make up 10-20% of the total. Cost recovery projects account for $6-$7 million and it is a challenge to maintain this level of activity. Approximately half of the cost recovery revenue is service provision (e.g. lab analyses) and half is R&D. Some funding (currently $1 million per year for next 3 years) is received from other areas of NRCan to carry out projects.

Appendix J Evaluation Matrix

#.#	Evaluation Question	#.#.#	Sub question	#.#.#.#	Indicator	Data Source	Method
Relevance							
1.1	Is there a demonstrable ongoing need for the research related to the interaction between agriculture and environment that Agri-Environmental Science (AES) is intended to produce?	1.1.1	What was the original need that the program was intended to address, and does this need continue to exist?	1.1.1.1	The original need for the initiative remains current and credible.	AAFC documents	Document Review
				1.1.1.2	Views about unmet and emerging needs for new knowledge / research about the interaction of agricultural practices and environmental health.	Key informants	Interviews
						Scientific, industry, and similar publications, reports and submissions; popular media;	Document Review
		1.1.2	Is the AES initiative an appropriate response to the identified needs?	1.1.2.1	Views about the potential for AES to respond to the identified need.	Key informants	Interviews
						Scientific, industry, and similar publications, reports and submissions; popular media;	Document Review
						Principle investigators	Email survey
1.2	Are the Agri-Environmental Science objectives fully aligned with federal government priorities and departmental strategic outcomes?	1.2.1	To what extent are AES's objectives and activities aligned with federal government priorities?	1.2.1.1	AES's objectives are clearly linked to, and supportive of, government priorities as set out in Federal Government policy statements, including throne speeches, budgets	Government of Canada, AAFC and AES documents; national agriculture policies; etc.	Document Review

#.#	Evaluation Question	#.#.#	Sub question	#.#.#.#	Indicator	Data Source	Method
					and similar documents.		
		1.2.2	To what extent are AES's objectives and activities aligned with AAFC's strategic outcome?	1.2.2.1	AES's objectives are clearly linked to, and supportive of, the department's strategic outcomes.	AAFC documents	Document Review
				1.2.2.2	Project goals and objectives are aligned with the AAFC and Growing Forward priorities.	Project management systems; individual project files.	Project review
						Project management systems; individual project files.	Document Review
		1.2.3	To what extent are AES's objectives and activities aligned with AAFC Science and Innovation Strategy?	1.2.3.1	AES's objectives and activities are clearly linked to the Science and Innovation Strategy and its key expected results.	Key informants	Interviews
						AAFC documents	Document Review
1.3	Are the federal government's roles and responsibilities for delivery of Agri-Environmental Science research appropriate?	1.3.1	Is the research being conducted under AES appropriate to AAFC, or should all or part of the research be done by another department or organization.	1.3.1.1	AAFC's roles and responsibilities for agri-environmental research are consistent with well-established policies and practices in relation to Canadian agriculture.	AAFC and AES foundational documents; national agriculture policies; etc.	Document Review
				1.3.1.2	Agricultural sector stakeholders, particularly in the research community, are of the view AAFC is the appropriate organization to lead/deliver AES research.	Scientific, industry, and similar publications, reports and submissions; popular media;	Document Review
						Key informants	Interviews

#.#	Evaluation Question	#.#.#	Sub question	#.#.#.#	Indicator	Data Source	Method
		1.3.1	To what extent is there overlap or duplication with other programs/research within and outside government?	1.3.2.1	Other public and private research organizations have committed resources / are conducting research in the areas where AES is active. (Possible duplication/overlap).	Key informants	Interviews
						Scopus	Document Review
Performance							
2.1	To what extent have the AES activities and outputs contributed to progress toward the achievement of intended outcomes?	2.1.1	What progress has been made to-date on research contributing to the development or modification of science-based tools?	2.1.1.1	# of projects x priority area x type x findings x funding source that made a demonstrable contribution to the development or modification of a science-based tool; # of tools	Project management systems; individual project files.	Project review
						RD program records: Performance measurement reports	Document review
2.1	To what extent have the AES activities and outputs contributed to progress toward the achievement of intended outcomes?	2.1.2	What progress has been made to-date on research contributing to the development or modification of BMPs?	2.1.2.1	# of projects x priority area x type x findings x funding source that made a demonstrable contribution to the development or modification of a BMP	Project management systems; individual project files;	Project review
				2.1.2.2	# of projects x priority area x type x findings x funding source that made a demonstrable contribution to the development or modification of a BMP	RD program records; Performance measurement reports.	Document review
		2.1.3	What progress has been made to-date on contributing to the development or modification of the integrated assessment of agricultural practices?	2.1.3.1	# of projects x priority area x type x findings x funding source that made a demonstrable contribution to the development or modification of the integrated assessment of an agricultural practice	Project management systems; individual project files;	Project review

#.#	Evaluation Question	#.#.#	Sub question	#.#.#.#	Indicator	Data Source	Method
						RD program records; Performance measurement reports.	Document review
		2.1.4	What progress has been made to-date contributing to the understanding and protection of Canadian bioresources?	2.1.4.1	# of projects x priority area x funding source x type that made a demonstrable contribution to the understanding and protection of Canadian bioresources	Project management systems; individual project files;	Project review
						RD program records; Performance measurement reports.	Document review
2.1	To what extent have the AES activities and outputs contributed to progress toward the achievement of intended outcomes?	2.1.5	Has the knowledge produced by AES research been effectively disseminated to contribute to the innovation chain?	2.1.5.1	# of reports accepted for publication in peer reviewed media x project /researcher	Project management systems; individual project files.	Project review
						Commercial citation services and publications databases	Bibliometric Analysis
						Departmental publication monitoring system	Bibliometric Analysis
						RB activity reports; Performance measurement reports	Document Review
						Principle investigators	Email survey
				2.1.5.2	# of presentations to scientific gatherings x type x project. (knowledge dissemination/ translation)	Project management systems; individual project files; Performance measurement reports.	Project review
						RB activity reports	Document Review
						Principle investigators	Email survey
				2.1.5.3	# of citations x peer reviewed publication x indicator of scientific	Commercial citation services and publications databases	Bibliometric Analysis

#.#	Evaluation Question	#.#.#	Sub question	#.#.#.#	Indicator	Data Source	Method
					impact.		
				2.1.5.4	# of external collaborators/partners x project	Project management systems; individual project files.	Project review
						Principle investigators	Email survey
				2.1.5.5	# of awareness events/activities for external stakeholders undertaken x type x project.	Project management systems; individual project files;	Project review
2.1	To what extent have the AES activities and outputs contributed to progress toward the achievement of intended outcomes?					RD program records; Performance measurement reports.	Document review
		2.1.6	To what extent are the AES research results been useful? For example, have the results been used in strategic and policy documents?	2.1.6.1	Views about the extent to which AES research results are used and referenced by the scientific community, influence agricultural practices, or contribute to technological innovation, etc.	Key informants	Interviews
						Project management system	Project review
				2.1.6.2	Views about the extent to which AES has facilitated synergies across program areas and departments.	Key informants	Interviews
				2.1.6.3	Views about the extent to which AES research have contributed to environmental (air, water, and soil) health.	Key informants	Interviews
				2.1.6.4	Views about the extent to which AES research have contributed to policy development.	Key informants	Interviews

#.#	Evaluation Question	#.#.#	Sub question	#.#.#.#	Indicator	Data Source	Method
		2.1.7	What other results, intended or unintended, have AES activities produced?	2.1.7.1	Reports of outcomes/ results other than those clearly identified in AES and related documentation.	Scientific, industry, and similar publications, reports and submissions; popular media;	Document Review
						Key informants	Interviews
2.2	Is the Agri-Environmental Science initiative delivered in an efficient and economical way, or are there better delivery models available?	2.2.2	Has the AES initiative been delivered as planned?	2.2.1.1	The a-based AES projects were selected, approved, monitored and reported in a manner consistent with RB policies and practices.	AAFC documents	Document Review
						Project management systems; individual project files; Performance measurement reports.	Project review
						Key informants	Interviews
				2.2.1.2	SAGES projects were selected, approved, monitored and reported in a manner consistent with documented plans.	AAFC documents	Document Review
						Project management systems; individual project files; Performance measurement reports.	Project review
						Key informants	Interviews
		2.2.1	What is the cost of these programs?	2.2.1.3	AES project selection and management costs x year x type x funding proposal / project	AAFC documents	Document Review
				2.2.1.4	RD research project selection and management costs x year x funding proposal / project	AAFC documents	Document Review
				2.2.1.5	Project budgets x year x line item	Project management systems	Document Review

#.#	Evaluation Question	#.#.#	Sub question	#.#.#.#	Indicator	Data Source	Method
		2.2.2	Are the program activities designed and delivered in the most efficient and economical way?	2.2.2.1	AES project management processes and costs are similar to those other research initiatives of comparable scope and reach x delivery model.	Publically-available program descriptions, annual and other reports, OAG and evaluations reports, etc	Document Review
		2.2.3	Are more cost-effective delivery models available for these programs?	2.2.3.1	AES project management processes and costs are similar to those other federal research initiatives of comparable scope and reach.	Managers of the AES and comparable programs	Interviews
				2.2.3.2	Views on the strengths/weaknesses, efficiencies/inefficiencies of the AES project selection and management process	Key informants (internal and external)	Interviews
		2.2.4	Is the external knowledge being captured and used efficiently by AAFC scientists?	2.2.4.1	Views on the strengths/weaknesses, efficiencies/inefficiencies of the AES project selection and management process	Principle investigators	Email survey

Appendix K Management Response and Action Plan

Evaluation of Agri-Environmental Science Sub-Activity (SAGES and Agri-Environment Soil, Water, Air and Bioresource Protection)			
RECOMMENDATION	**MANAGEMENT RESPONSE AND ACTION PLAN (MRAP)**	**TARGET DATE**	**RESPONSIBLE POSITION (S)**
	Please provide a "**SMART**" MRAP that is **S**uccinct, **M**easurable, **A**chievable, **R**elevant and **T**imely (refer to instructions provided below)	*Insert the day, month and year that the action plan will be completed by management*	*Insert position title of responsible executive*
1. The Science and Technology Branch should develop an appropriate performance measurement strategy for the Agri-Environmental Science sub-activity, one that is linked to the department's science priorities and strategic outcomes.	AGREE • AAFC has changed recently with the creation of a new Science and Technology Branch (STB) merging (AESB) and Research Branch to bring together all of AAFC's research, development and knowledge and technology transfer functions to facilitate an integrated approach to science delivery. • STB will create a Science and Technology Strategic Plan that will include a performance measurement framework. This framework will be linked to the department's strategic outcomes and the performance measurement framework.	September 30, 2013	Rick Butts, DG, Cross-Sectoral John Sharpe, Director, Integrated Planning and Reporting
2. 2. The Science and Technology Branch should examine ways to improve collaboration on agri-environmental research internally and with other government departments, provinces and territories and industry groups	AGREE • Science at AAFC includes a collaboration dimension. In fact, SAGES was a program designed to promote/enhance scientific collaboration and, as recognized in the evaluation report, was highly successful in that regard, even exceeding expected results. • STB recognizes the need to continue to improve collaboration both internally and with all external partners. o STB agrees to examine ways to enhance the exchange of science information and ideas internally. o STB agrees to explore ways to improve collaboration with external stakeholders.	March 31, 2014	DGs, Prairie Boreal Plains

Evaluation of Agri-Environmental Science Sub-Activity (SAGES and Agri-Environment Soil, Water, Air and Bioresource Protection)			
RECOMMENDATION	**MANAGEMENT RESPONSE AND ACTION PLAN (MRAP)**	**TARGET DATE**	**RESPONSIBLE POSITION (S)**
3. The Science and Technology Branch should develop and implement a comprehensive knowledge transfer strategy for agri-environmental science based on a broad definition of knowledge transfer as a process that begins in the planning stages and extends through knowledge utilization, and which considers the role and mandate of provinces and territories and industry.	AGREE • AAFC will be implementing a Knowledge Transfer strategic initiative under Growing Forward 2. Knowledge Transfer (KT) is a key component of the innovation agenda within GF2, and the KT Initiative aims to facilitate the transfer of innovative ideas, tools, and practices covering the full range of innovation efforts. Regionally relevant and commodity specific KT approaches will be informed by advice from industry users to ensure knowledge will be transferred according to local circumstances and needs to intended users, farms and firms, thereby enhancing sector competitiveness, profitability, sustainability and adaptability.	March 31, 2014	Rick Butts, DG, Cross-Sectoral
4. The Science and Technology Branch should develop a reporting protocol to track and report program and project level financial and performance information to support more robust performance monitoring and reporting	AGREE • Research Branch has established the Science Management Systems Program (SMSP) to develop a system that will document and standardize business processes, improve quality and repeatability of monitoring and performance reporting, and provide a level of automation which enables better aggregation of research results. A pilot project to develop a monitoring and reporting prototype was successfully completed. The prototype would now require some enhancements to provide linkages to existing AAFC data and reporting mechanisms and to ensure it reflects the change in structure with the new Science and Technology Branch. A project is currently being considered to proceed with these enhancements and implement SMSP across the new Branch. • STB will also collaborate with Corporate Management Branch and Programs Branch to study and present options on how to capture the efforts of AAFC scientists related to program activities.	September 30, 2014	Director General, Cross Sectoral Strategic Direction, S&T Branch