An examination of the Census of Agriculture and the Farm Environmental Management Survey on their ability to respond to the growing need for Sustainability data to uphold Canadian agriculture competitiveness

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EXECUTIVE SUMMARY

Many agricultural commodity groups are developing sustainability plans. These plans will require ongoing assessments of economic, environment and social measures. Subsequent evaluation and monitoring through life cycle assessments, social assessments, social license plans and the adoption of Best Management Practices (BMPs) are anticipated moving forward.

The Census of Agriculture (COA) and the Farm Environmental Management Survey (FEMS) provide information that monitors how agriculture is changing over time. The Canadian Cattlemen's Association, Dairy Farmers of Canada, Manitoba Pork Council, and Canadian Canola Growers Association surveyed researchers and industry partners in November 2013 to better understand which questions are the most important for industry to retain to provide the best value given the current increase in sustainability awareness by consumers and to minimize response burden on producers.

As industries data needs are growing, particularly around environmental data the question becomes: do the COA environmental questions and FEMS still fulfill industry's needs in their current form. The benefits of the COA and FEMS are that they provide a nationally consistent set of questions comparable across provinces, and data that can be broken down into smaller census regions. Maintaining existing data series that have historical reference points is important in determining changes in agriculture as new technology becomes available and environmental concerns are addressed. However, the data is not made available to industry in a timely manner, data is difficult to access for research purposes, and data from FEMS questions are not always available to due to quality issues.

As awareness of sustainable agriculture practices and societal interest in sustainable agriculture continue to grow, the importance of environmental indicators that monitor agricultural practices are increasing.

It is important to recognize that the purpose of the COA and FEMS is to cover a broad number of areas at a high level and therefore the limitation is that they do not go deeply into any one area. There will always be a need for more in-depth secondary surveys directed by industry that address current data needs.

The recommendations presented here address the role of secondary surveys, and provide suggested revisions to the existing COA and FEM surveys (all question numbers are from the 2011 COA and FEMS). The recommendations are under seven headings: secondary surveys, land use, nutrient management, water quality, beef, crops and life cycle assessments.

1. Secondary Surveys

There should be a layering of detail and verification between the COA and FEMS with each playing a different role. The COA and FEMS monitor major trends occurring in agriculture by including survey questions on management practice options. More specific questions, targeting specific areas, should be addressed in secondary surveys.

RECOMMENDATION 1: Commodities should be offered the choice to add specific elements to an enhanced FEMS.

RECOMMENDATION 2: That industry identify areas where secondary surveys would provide the most value and a method of consistent delivery if needed to be repeated regularly (e.g. biosecurity practices, animal health and animal care practices).

2. Land Use

The ability to report land use (landscape cover) based on satellite imagery, is an area that could reduce response burden in the future. Something that cannot be captured through satellite imagery is the number of acres under conservation easements. These agreements are growing, but there is no central database tracking how many acres have easements on them. Knowing the number of acres and what type of lands have conservation easements will allow industry to assess if they are successful in preventing land use changes.

RECOMMENDATION 3: COA Step 12 add: How many acres of land were placed under conservation easements or agreements? What kind of land types (e.g. grassland, perennial forage, wetlands or forests) were protected under these agreements? How many acres were seeded to grass/perennial forage under these agreements?

3. Nutrient Management

Canadian farmers have been adopting improved technology to make better use of nutrients (increase utilization by plants), producing more agricultural products with less environmental impact. As agricultural sustainability becomes an increasingly important topic for private industry, governments and the general public, it is important to have information on fertilizer and manure management to better assess the impact on air, water and soil quality.

RECOMMENDATION 4: Expand COA Step 19 to include **source of manure** applied (Beef Cattle, Dairy Cattle, Sheep, Hogs, Chickens, Turkeys, Other). Similar to current questions indicate volume of manure spread and unit of measure used (Imperial Tons, Metric Tonnes, Imperial Gallons, Liters).

A number of questions related to manure management were dropped in the 2011 Census of Agriculture. While it is understood that there was no room for these questions, they provided valuable information to industry. Having access to a historically consistent data series has significant value to industry. As such, it would be deemed appropriate to have these questions either restored in the COA or added to FEMS in such a way as to maintain the integrity of the data series. Recommendations 5 and 6 address these questions.

RECOMMENDATION 5: Expand the current question to include volume and type (e.g beef, pork, dairy, etc.). Indicate unit of measure used: Imperial Tons/ Metric Tonnes / Imperial Gallons / Liters.

	Dry/Solid Manure	Liquid Manure
Manure Sold		
Manure Given		
Manure Bought		

RECOMMENDATION 6: COA Step 19, Q109 For manure applied on this operation (acres), report the area of land for each method of application:

- Manure spread naturally by grazing livestock
- Solid manure(not composted), incorporated into the soil
- Solid manure, not incorporated
- Composted manure, incorporated into the soil
- Composted manure, not incorporated
- Liquid manure, injected or incorporated into the soil
- Liquid manure, not incorporated

RECOMMENDATION 7: COA Step 19, Q109 Somewhere under “Solid Manure” would like to ask: What bedding material was mixed with manure? (Wheat straw, Barley straw, Wood residuals (e.g. shavings, wood chips), Other (Please specify), None).

RECOMMENDATION 8: FEMS #93 just need to ask on how many acres solid, liquid, or semi-solid manure was applied to.

RECOMMENDATION 9: (FEMS #96 – 100) Revise wording to ask what are the sizes and depths of manure storage areas and the storage capacity for each (number of days). Comment on construction of each and if they are covered (if so, with what material)?

RECOMMENDATION 10: In FEMS ask producers if they feed phytase*?*

Current fertilizer questions only ask for the number of acres it has been applied to. This does not address the question of how much fertilizer is applied, the rate it is applied on certain crops and if there is a high or low potential of run off. There are a number of ways that this information can be asked that would be useful to researchers. Recommendations 11a, 11b and 12 address this.

RECOMMENDATION 11a: Expand COA Step 17 Q 106 to include total volume of fertilizer used broken down by nitrogen, phosphorus, potassium and sulfur. Indicate total amount of fertilizer applied (please indicate unit of measure used):

- Total tons (Imperial) (N, P, K, S)
- Total Tonne (Metric) (N, P, K, S)

ALTERNATIVE 11b: COA Step 17 Q 106 What was the corresponding volume for each input applied?

- Anhydrous ammonia (tonnes)
- Urea (tonnes)
- Urea ammonium nitrate solution (Litres)
- Monoammonium phosphate (MAP) (tonnes)
- Diammonium phosphate (DAP) (tonnes)
- Potash (tonnes)
- Ammonium sulphate (21-0-0-24) (tonnes)
- Lime (tonnes)

RECOMMENDATION 12: In FEMS at the very least having a question that asks for the rate of application of nitrogen, phosphorus, potassium and sulfur on the three main crops.

Soil nutrient testing provides valuable information that producers can use to match crop nutrient requirements with nutrient levels in the soil and nutrients supplied through manure and commercial fertilizer. This maximizes productivity while reducing the risk to the environment. Ultimately, the goal is to determine if producers are paying attention to maximum nutrient loading limits, runoff, or volatilization when applying fertilizer or manure.

RECOMMENDATION 13: FEMS Reporting is currently provided on the number of farms that soil test and the frequency (e.g. every 2-3 years). However, what is important is the number of acres under that management. Reporting this data on acres may provide more valuable results in who to target communication information to.

RECOMMENDATION 14: (FEMS Q#29) It would be of value to know what soil parameter tests are used. A check-box could be created for N, P, K, S, soil organic carbon, inorganic N, bulk density, etc.

RECOMMENDATION 15: Expand FEMS Q#29 to ask producers if they conduct soil testing before and after applying fertilizer/manure, and if so, whether they also test the quality (nutrient content) of their manure? And how often they test manure for nutrients?

4. Water Quality

Agricultural land adjacent to surface water (flowing water, permanent or seasonal wetlands) can be contaminated by nutrient or pesticide runoff or by livestock. These water sources provide critical habitat for wildlife as well as drinking water for livestock and downstream for the human population.

RECOMMENDATION 16: Make AAFC data that links COA and FEMS data base on watersheds available to researchers.

RECOMMENDATION 17: Add to COA Step 14, Q103 "Off-stream watering" and "Other water developments". Define "streams" as including lakes and rivers as well as streams.

RECOMMENDATION 18: In FEMS ask: How many acres of wetlands were drained (acres) since 2011? Were they permanent or seasonal wetlands? How many acres of wetlands were reestablished since 2011? Were they permanent or seasonal wetlands?

Cover crops reduce erosion but green actively growing vegetation which freezes releases large amounts of dissolved N and P during snowmelt runoff. Green manure crops may be spring seeded and tilled-in later that summer. If the intent of LU04 is to ask about cover or green manure crops which are left over winter and tilled in spring, further clarification is required.

RECOMMENDATION 19: In FEMS clarify that LU01 addresses "Cover, companion, or green manure crops" and LU04 addresses "Winter cover or winter green manure crops".

5. Beef

Beef production management practices have the potential to impact water quality, animal welfare, production efficiencies and the ability of pasture land to sequester carbon. Monitoring adoption of BMPs is useful in informing where environmental risks may occur, and targeting communication. Information on production practices can also be used to educate both the public and government policy makers about the sustainability of beef production.

RECOMMENDATIONS 20: COA Step 14

- Total of choices should equal 100%, e.g. rephrase COA Step 14 to say "What percentage of land managed has: crops rotated, winter cover crops grown, buffer zones, etc…" rather than checking all that apply.
- Break out type of stockpiling (winter grazing) being used on native vs. tame pasture.
- Separate "in-field winter grazing" and "in-field winter feeding". Grazing would apply to stockpiled forage whereas in-field winter feeding would apply more to swathgrazing, balegrazing, crop residue grazing or simply supplying hay out in a field setting. With a strong focus on reducing winter feeding practices it is useful to know how many farms are adopting the practice.
- Add Forage quality testing and use of over-seeding (or other forms of pasture renovation).

6. Crops

Cropping information includes types of crops and agronomic management techniques such as tillage practices, fertilizer application rates, irrigation, and crop rotations. Management practices to reduce soil erosion and increase soil organic matter require integrated approaches that target the combined effectiveness of soil loss by all forms of erosion (water erosion, wind erosion tillage erosion) and manages residue.

We would like to see data collected that would give insight into the frequency of which crops are grown. This would help us understand the crop rotations that are being used on Canadian farms. The current data collected by the COA and FEMS on crop area merely provides a snapshot in time. This snapshot may not accurately represent trends of the last five years in crop rotation due to potential price spikes and other factors.

RECOMMENDATION 21: In FEMS ask: In the last five years, which crop did you plant on the greatest acreage? Which crop did you plant on the 2nd largest acreage? Which crop did you plant on the 3rd largest acreage?

7. Life Cycle Assessments (LCA)

Current information provided in COA and FEMS provide enough information for a general evaluation of agriculture and its impact on the environment as provided in the Agri-Enviornmental Indicators report. However, there is increasing pressure for sector level Life Cycle Assessments (LCAs) that evaluate the impact from each commodity.

Ideally more detailed information would be used in LCAs than is currently available including:

- Which and how much fertilizer is being used at a commodity and field level
- Fertilizer, pesticide and manure use information by crop (application rate, timing of application, placement, and fertilizer type) tillage system and sorted by geographic areas would assist in developing Life Cycle Assessments.
- On-farm fuel use at the commodity and field level.

Accessing data from the FEMS and COA is critical to leveraging the value of these surveys by industry through researchers. Accessing detail on the geographic area or of the actual rate and type of manure / fertilizer application needs to be clearly communicated to these researchers.

For the beef industry, the lack of data is primarily around management of cow-calf operations, including impacts on soil carbon storage from grazing practices.

INTRODUCTION

Many agricultural commodity groups are developing sustainability plans. These plans will require ongoing assessments of economic, environment and social measures. Subsequent evaluation and monitoring through life cycle assessments, social assessments, social license plans and the adoption of Best Management Practices (BMPs) are anticipated moving forward. Currently, the Farm Environmental Management Survey (FEMS) and environmental questions in the Census of Agriculture (COA) are the only sources of nationally consistent environmental indicators across Canada.

The Canadian Cattlemen's Association, Dairy Farmers of Canada, Manitoba Pork Council, and Canadian Canola Growers Association surveyed researchers and industry partners in November 2013 to better understand which questions are the most important for industry to retain to provide the best value given the current increase in sustainability awareness by consumers and minimize response burden on producers. We believe that maintaining the FEMS and environmental questions in the COA will be critical to providing the data needed for sustainability monitoring moving forward.

Consumers domestically and internationally are increasingly aware of the environmental impact of agricultural activities. The global conversation on environmental issues such as climate change, water quality, air quality, wildlife habitat and biological diversity has risen to a new level. Over the last decade public expectations for how their food is produced has changed, placing new demands on the various agricultural sectors to communicate directly to consumers on production practices, animal welfare and environmental stewardship.

There have not only been changes in consumer demands but also in production practices. From the development and adoption of new production methods aimed at enhancing competitiveness, to changes in commodities grown in certain areas as new varieties become available (e.g. lentils, peas, canola, soybeans and corn) which changes crop rotations. Greater farm size and specialization have resulted in more intensive management practices becoming more common. Intensification of agriculture does not necessarily mean increased risk to the environment. Some of these management changes have been a direct result of environmental concerns (e.g. no-till to reduce soil erosion), but others have unknown environmental impacts (e.g. how has increased nutrient use impacted water quality).

Much of the existing questions in FEMS and the COA are useful for agriculture as they cover common production practices as an indication of adoption of Beneficial Management Practices (BMP), land use changes, pesticides, fertilizer, manure and water management – all of which are valuable for sustainability and environmental growth. However, individual sectors (e.g. beef cattle, dairy cattle, hogs, oilseeds and cereals) are increasingly being asked what impacts they (individually) have on the environment and how they are addressing consumer concerns about not just maintaining but enhancing water and air quality, protecting habitat for endangered species and overall biodiversity (fauna and flora).

The Role of the COA and FEMS

It is important to recognize that the purpose of the COA and FEMS is to cover a broad number of areas at a high level and therefore the limitation is that they do not go deeply into any one area. However, they do provide a trend for broad environmental indicators that are valuable to industry in monitoring progress or lack of progress in a number of key areas of concern. Therefore, there will always be a need for more in-depth surveys in certain areas. For example, generating emission inventories requires detailed information on feed rations which are not available in these surveys.

The COA acts as a check for annual livestock inventory surveys. However, that is not the case for the environmental questions. Unlike the annual livestock inventory surveys the duplicate questions in the COA and FEMS act as an administrative check evaluating the robustness of FEMS responses and providing a way to link the two surveys together for researchers. Since both the COA and FEMS are done every five years, in the same year, the value in asking environmental questions in the COA is that the response rate is much higher and more representative than FEMS, thereby providing small scale data (by census region).

The Value of the COA and FEMS

The detail provided in the FEMS crop survey is useful in monitoring the progress that farm operators make in reducing their environmental footprint and maintaining a natural resource. Markets, whether they are international buyers or domestic food companies, are increasingly asking for the level of environment data that FEMS provides.

All of the questions in the FEMS crop survey are relevant to the development and monitoring of environmental sustainability indicators for the cropping sector. Of most relevance are those relating to production of annual crops, and those relating to land use change. A number of the Crop FEM Survey questions results were used for the 2011 report, Application of Sustainable Agriculture Metrics to Selected Western Canadian Field Crops (see www.pulsecanada.com/fieldtomarket). Data from questions 3-6, 19, 20, 27 and some of the manure related questions from 30-56 were all used for this report. Questions 7-9, 26, and 28-29 are valuable in showcasing adoption rates of positive industry practices.

A sustainability initiative called Field to Market Canada, brings together a number of crop groups, and uses FEMS data to produce sustainability indicators based on farm level data. This data could be used in the future to secure access to domestic sustainable sourcing initiatives or regulatory requirements of international markets.

FEMS is a key contributor of data to several AAFC products that industry uses:

- Soil erosion – FEMS contributes key data used to build Canada's NAHARP soil erosion indicator, and soil loss indicators have all been built from the same databases
- Energy use and climate impact – Canada's UN FCCC reporting uses FEMS data in the area of farm energy use, and this was the source of data for Canada's energy use and climate impact indicators in 2011 (also for the present comparators in the Western Canada Fieldprint Calculator)
- Soil organic carbon – FEMS provides data for NAHARP's soil organic carbon indicator, which is the basis for the present comparator for soil organic carbon in the Western Canada Fieldprint Calculator

The purpose of FEMS is to gather information on farming practices on Canadian crop and livestock operations. The survey focuses on crop and nutrient (fertilizer and manure) management, pesticide use, grazing, and adoptions of BMPs. In general, the crop section of FEMS has proven to be extremely valuable in providing information that is not found anywhere else and is particularly useful in creating crop life cycle assessments. However, the livestock portion of FEMS has many repeating and unnecessary questions (e.g. housing) and is formatted so poorly that it discourages many producers from filling it out. Livestock related FEMS questions could be of comparable value to those on the crop side, if appropriate changes were made.

The Importance of Consistent Measurement

Baseline data is integral to the development of sound public policies and programs around livestock production, to support valuable work being undertaken by the research community and to educate the general public about beef production. It is important that baseline data is secured and updated over time, particularly as new policies and programs are being developed by various levels of government. Therefore maintaining existing data series that have historical reference points is important in determining changes in agriculture as new technology becomes available and environmental concerns are addressed. This has been an issue in the past when certain parameters have not been consistently measured or surveyed or because data have been suppressed to protect producer confidentiality. Alternative approaches can be used to estimate the missing values, but the best policy is to maintain a consistent data series.

Consistent information on agricultural land use and management practices is critical to assessing agriculture's environmental performance. The COA and FEMS monitor these changes over time, identifying broad changes in land use which may present environmental risks and which Beneficial Management Practices (BMPs) are being adopted to address these environmental risks. There is considerable value in the questions being asked in areas such as fertilizer, manure, land, water and wetlands management practices, grazing, land use changes, energy usage and Environmental Farm Plans. Some provinces have extensive regulation around fertilizer, manure management and riparian area protection so access to sound baseline data within the province and across provinces is very important for monitoring these policy issues.

Where Improvements could be made

A limitation of the FEMS and the COA is that they are aligned to political boundaries and cannot easily be linked to biophysical information. Consequently, the Agri-Environmental Indicators (AEI) Reporting series uses a combination of FEMS and the COA, as well as a second framework based on watershed boundaries, the National Scale Frameworks Hydrology – Drainage Areas[1]. This framework integrates soil and farm management information with surface drainage to assess risk to water quality. In addition, representative information on the soils and landscapes based on the Soil Landscapes of Canada (SLC) framework are calculated and the census data is reassigned based on the SLC polygons. A number of researchers noted in the survey that the data from FEMS and the COA would be more widely used if it was available by watershed as the AEI has done.

Industry recognizes government concern about response burden and encourages data sharing between jurisdictions wherever possible (taking into account privacy considerations) to maximize the resources available. The ability to report land use (landscape cover) based on satellite imagery would reduce response burden and potentially increase the frequency of data available to industry for analysis. This type of technology would improve over time as comparisons were made available on both a large and small geographic scale. The changes in land management may be another area where satellite imagery could be used. However, it would need mapping support.

Data that is collected by Statistics Canada needs to be released in a timely manner in a format readily understood by potential users, be that industry, government or the general public. The 2011 Census of Agriculture had a very limited release of data onto the website in May 2012 (after a one year delay as is

[1] See the "Environmental Sustainability of Canadian Agriculture: Agri-Environmental Indicator Report Series" for more details on how these data series are used.

typical of the census). As a result, data that many partners in Agriculture had used historically was not made available to them until special requests had been made and fulfilled. These special requests took as much as a year to be processed, making the data two years old before it was available to industry partners and researchers. Many researchers were not made aware of the opportunity to even access the data through these special requests and found the limited data on the website inadequate for their work.

A number of researchers noted that the existing FEMS questions would be useful, but accessing the data is an issue. The publically available data summary reports on the FEMS are not useful in their current form. Not all of the data collected is summarized. Accessing more detailed data is necessary for researchers to leverage this survey. The addition of table fields to CANSIM that would allow for drill down would be helpful. Currently some researchers cannot find the data broken down into geographical areas small enough to allow for analyses. The last published report "Manure Management in Canada 2004 Vol.1 no.2" provided interesting data, but did not break it down into groups small enough to be used on a provincial level (e.g. R.M. level data).

Since FEMS excludes data from active farms with agricultural sales in 2010 of less than $10,000, it is questioned whether some useful environmental data is being lost. For example, are all smaller operators adhering to the same kinds of environmental standards expected of larger operations? Are there programs and services that should be targeted at these smaller operations to ensure that they are environmentally sustainable?

Having the flexibility to access the data on a timely basis and in a manner useful to researchers is key to leveraging the value of the investment in these surveys. While some are looking for information on smaller operations, others are looking only for information that is the most representative of the number of animals and not necessarily the number of farms, and therefore would like to target large operations. This flexibility can only be provided through a special request service which needs to be timely and which users are made aware of. The current time lag of several months to get data from a special request is unacceptable. In addition, due to the quality of the data, Statistics Canada will not release a number of variables from the FEMS livestock survey. Increasing response numbers and data quality must be a priority to make this data available and valuable to industry in the future.

THE IMPORTANCE OF SECONDARY SURVEYS DONE BY INDUSTRY

There should be a layering of detail and verification between different surveys with each playing a different role. The COA and FEMS monitor major trends occurring in agriculture by asking high level questions such as whether they practice certain management options. More specific questions that vary significantly between producers should be included in industry surveys (e.g. Types of diets fed to the animals and how much). There is currently a proposal to break FEMS into five commodity specific surveys with one done each year and each commodity survey repeated every five years.

RECOMMENDATION 1: Commodities should be offered the choice to add specific elements to an enhanced FEMS.

If FEMS goes to five commodity specific surveys there should be steps taken to ensure that mixed operations are only contacted for one FEM survey and not multiple surveys. For example, if they are contact for a beef FEM survey, they should not be contacted for a crop FEM survey and vice versa. While the move to commodity specific surveys would provide the opportunity for more questions to be asked, they also have the potential of increasing not decreasing the response burden on producers.

The only way for a commodity to find out about specific producer practices is by conducting secondary surveys. In general these surveys are limited in size because of the cost for the infrastructure. The use of the infrastructure developed for the COA assists in developing larger samples and more relevant information that can be used to measure continuous improvement.

Researchers who conduct more in-depth surveys are frequently approached for data so obviously there is a need for more detailed information. There needs to be industry partners who support and guide these more in-depth surveys. Those who will want access to the data will need to participate, on both development and funding.

RECOMMENDATION 2: That industry identify areas where secondary surveys would provide the most value and a method of consistent delivery if needed to be repeated regularly (e.g. biosecurity practices, animal health and animal care practices).

There are a number of areas that the COA and FEMS do not take into account: **biosecurity practices** being employed by producers that help **protect** not only **animal health** but human health. There are no questions related to **animal care practices** that would evaluate adoption levels of BMPs in this area outside of the rudimentary housing questions. There is room for robust industry surveys that answer these and other questions.

Example of potential secondary survey questions:

- Indicators of **economic efficiency** so better and more progressive farming practices can be identified (e.g. inputs per unit of production).
- **Environmental Monitoring**, how many producers do any kind of periodic monitoring:
    1) Water quality testing (surface or groundwater)
    2) Riparian health assessments
    3) Range health assessments (native grassland)
    4) Wildlife counts
- Gauge **producer perceptions** of agriculture-environment interactions:
    1) Do you think the environment is under threat from agriculture?
    2) How does agriculture positively impact the environment?

3) Would you alter management/production system to accommodate environmental goods and services, provided a market mechanism existed?

Regardless if the survey is national (FEMS or COA) or private it is very important to get endorsement from the industry to encourage the producers to respond.

There is also a matter of who is conducting the survey, as there are pros and cons with any survey provider. For example, Statistics Canada probably has a better data base of producers. However they are very limited to the length of questionnaire because their participants may be somewhat reluctant to complete if too time-consuming. IPSOS pays the respondents a nominal fee and this allows for a somewhat longer survey questionnaires before fatigue. This is very important in terms of what can be accomplished, but there needs to be safeguards to ensure that the surveys are representative of the target group.

LAND USE

Agricultural land covers 8% of Canada's landscape and is made up of cultivated land, hay land, and grazing land with associated riparian, wetlands, woodlands and natural grassland. Within this mosaic 588 species of birds, mammals, reptiles and amphibians live and each species has unique habitat requirements. Producers are not only in the food business, but are stewards of biodiversity and managers of multifunctional agricultural landscapes that support wildlife habitat.

Different agricultural crops and land uses have different propensities for maintaining or degrading the environment[2]. The Census of Agriculture (COA) monitors Land use (Step 12, Q 94-101) reporting the acres of land in various field crops, permanent pasture (tame, seeded or natural), woodlands and wetlands. Natural and semi-natural land cover (e.g. woodland, wetland and riparian areas and unimproved pasture) have high wildlife habitat value and benefits to supporting biodiversity. However, land use does not tell the entire story; producer management decisions can have a significant impact on wildlife habitat capacity including: tillage (conventional, conservation, and no-till), summerfallow (tilled, chem-fallow, or combination) and management of wetlands (buffer zones, fencing, off-site water sources). These must also be considered when looking at the environmental impact of land use changes.

The public is largely uninformed about agriculture, but are interested in the extent and types of wildlife habitat available (e.g. rangeland, wetlands, woodlands, etc.). Hence, there is a social value of various management options.

What it's used for:

- With climate change and commodity price pressures crop rotations and land management practices are changing significantly. Crop varieties that were formerly grown in only minor corners of agricultural landscapes are now, or may become, a significant component of these landscapes. Data representing these landscape changes contribute to understanding driving industry trends.
- The proportion of land for pasture, summerfallow, and cultivation assists in scientific aspects of carbon, nitrogen and phosphorus recycling and are needed to estimate the ability of farm land to sequester carbon and evaluate whether organic matter is being gained or lost.
- Areas of summerfallow, reduced tillage, rotational grazing, winter cover crops and buffer zones around water bodies provide an indication of industries adoption of BMPs.
- The "Environmental Sustainability of Canadian Agriculture: Agri-Environmental Indicator Report Series" uses land use data to calculate a Wildlife Habitat Capacity on Farmland Indicator to assess broad trends in the ability of Canada's agricultural landscape to provide suitable habitat.

Data collected on land use evaluates major trends over time and identifies concerns an industry needs to address.

Industry recognizes government concern about response burden and encourages data sharing between jurisdictions wherever possible (taking into account privacy considerations) to maximize the resources available. The ability to report land use (landscape cover) based on satellite imagery, is an area that could reduce response burden in the future. The changes in land management may be another area where satellite imagery could be used. However, it would need mapping support.

[2] AAFC, 2010. Environmental Sustainability of Canadian Agriculture: Agri-Environmental Indicator Report Series. Report #3.

Something that cannot be captured through satellite imagery is the number of acres under conservation easements. These agreements are growing, but there is no central database tracking how many acres have easements on them. Knowing the number of acres and what type of lands have conservation easements will allow industry to assess if they are successful in preventing land use changes.

RECOMMENDATION 3: COA Step 12 add: How many acres of land were placed under conservation easements or agreements? What kind of land types (e.g., wetlands or forests) were protected under these agreements? How many acres were seeded to grass/perennial forage under these agreements?

NUTRIENT MANAGEMENT

Canadian farmers have been adopting improved technology to make better use of nutrients (increase utilization by plants), producing more agricultural products with less environmental impact. As agricultural sustainability becomes an increasingly important topic for private industry, governments and the general public, it is important to have information on fertilizer and manure use (COA Step 17 & 19, FEMS) to better assess the impact on air, water and soil quality. Excess nitrogen (N) can volatilize into the air contributing to greenhouse gas emissions and poor air quality. Both N and phosphorus (P) can be transported out of the soil to ground or surface water potentially causing overgrowth of algae or other plant material resulting in eutrophication. Although some loss is inevitable, there are BMPs that reduce the risk of nutrient loss. Nutrient management is covered in two areas: Manure and Fertilizer.

MANURE

Manure storage and application can represent environmental challenges for livestock producers. Sub-optimal storage and application of manure can lead to nutrient loss through volatilization into the air, through runoff or leaching into the soil. Optimal storage for solid manure is on a covered, impermeable pad with runoff containment. Optimal storage for liquid/semi-solid manure is a covered tank. However, this is not always feasible and monitoring the environmental risk, particularly to water and air quality, is important when evaluating proposed recommendations. The rate, method, and timing of manure application and incorporation can influence the total nutrient loss from run-off or through volatilization[3].

Manure management practices (COA Step 19): land area applied to, method of application, timing of application, and rates are useful in understanding 'on –farm' manure management practices, and how they are changing over time. There are stringent regulatory frameworks related to manure management in some provinces and having access to sound baseline data better equips industry to work with governments on this issue.

What it's used for:

- This information is important in understanding the nutrient balance by municipality.
- It is also beneficial to be able to monitor manure application practices and how these are changing over time.
- Information on manure application methods have been used to assess relevance of technologies developed or being considered for development.
- This information is useful in assessing adoption of beneficial management practices for land application of manure.

[3] AAFC, 2010. Environmental Sustainability of Canadian Agriculture: Agri-Environmental Indicator Report Series. Report #3.

- Questions related to soil testing, manure and fertilization application practices are used when evaluating the impact of certain regulations, as well as adoption rates of BMPs.

COA Step 19 – Manure Production

The "Environmental Sustainability of Canadian Agriculture: Agri-Environmental Indicator Report Series" (Report #3 page 22) says that typically beef and poultry operations store solid manure, while hog and dairy operations store liquid or semi-solid manure. This is complicated in provinces where some beef producers also utilize hog manure on their operations due to availability. This high level assumption is adequate for estimating the overall impact of agricultural activities. However it is of limited value in a life cycle assessment where the environmental impact of one species is being evaluated.

RECOMMENDATION 4: Expand to include source of manure applied (Beef Cattle, Dairy Cattle, Sheep, Hogs, Chickens, Turkeys, Other). Similar to current questions indicate volume of manure spread and unit of measure used (Imperial Tons, Metric Tonne, Imperial Gallons, liters).

A number of questions related to manure management were dropped in the 2011 Census of Agriculture. While it is understood that there was no room for these questions, they provided valuable information to industry. As noted above, having access to a consistent data series historically has significant value to industry. As such, it would be deemed appropriate to have these questions either restored in the COA or added to FEMS in such a way as to maintain the integrity of the data series. Recommendations 5 and 6 address these questions.

COA STEP 19, Q 108 - Value of Manure

Information collected on how much beef manure is being bought or sold, provides an indication of the value of the product, not only to producers, but also to government regulators and the general public. However, this should also indicate volume of manure sold or given to others to determine the size of the market.

RECOMMENDATION 5: Expand the current question to include volume and type (e.g beef, pork, dairy, etc.). Indicate unit of measure used: Imperial Tones/ Metric Tonnes / Imperial Gallons / Liters.

	Dry/Solid Manure	Liquid Manure
Manure Sold		
Manure Given		
Manure Bought		

COA STEP 19, Q 109 - **Method of application**

The method of application for manure affects the risk of nutrient loss, sub-surface application with seed lowers the risk of runoff and volatilization. Reduced trips over the field, by incorporating fertilizer at seeding time also helps reduce GHG emissions.

The most beneficial application is immediately incorporating manure into the soil which reduces the risk of surface runoff, nutrient loss to the air, odour, and places nutrients in immediate proximity to the root for effective utilization and uptake. The least beneficial is spread on the surface with no incorporation, leaving the manure exposed to nutrient loss[4].

It is important to separate "injected" and "incorporated" as separate application methods for manure. The risk of phosphorus loss in spring runoff can be significantly different for the two methods.

[4] AAFC, 2010. Environmental Sustainability of Canadian Agriculture: Agri-Environmental Indicator Report Series. Report #3.

Composted manure should be separated from fresh manure as their chemical composition is very different. Also stockpiling manure prior to land application (a common practice) is not currently captured, but combined under solid manure. The following question was in the 2006 COA but removed from the 2011 COA. These questions are important for tracking changes in management practices over time.

RECOMMENDATION 6: For manure applied on this operation (acres), report the area of land for each method of application:

- Manure spread naturally by grazing livestock
- Solid manure(not composted), incorporated into the soil
- Solid manure, not incorporated
- Composted manure, incorporated into the soil
- Composted manure, not incorporated
- Liquid manure, injected or incorporated into the soil
- Liquid manure, not incorporated

Bedding material can make up about 20% of the mass of feedlot manure. Traditionally this has been cereal straw, but there have been efforts by the forest and lumber industry to promote wood residuals as bedding. Research indicates that wood residuals instead of straw, can alter manure properties (e.g. pH, carbon and nitrogen content) and therefore GHG emissions.

RECOMMENDATION 7: Somewhere under "Solid Manure" would like to ask: What bedding material was mixed with manure? (Wheat straw, Barley straw, Wood residuals (e.g. shavings, wood chips), Other (Please specify), None).

FEMS Manure Storage Type

This section is repetitive and poorly organized. These questions could be asked once (not multiple times), with details for the three largest storage areas. Relative size of manure storage areas, the largest and second largest (FEMS #91 and #92) are not needed.

RECOMMENDATION 8: FEMS #93 just need to ask on how many acres solid, liquid, or semi-solid manure was applied to.

RECOMMENDATION 9: (FEMS #96 – 100) Revise wording to ask what are the sizes and depths of manure storage areas and the storage capacity for each (number of days). Comment on construction of each and if they are covered (if so, with what material)?

FEMS Time and Frequency of Spreading

Ideally, nutrients are added to the soil when crops need them most and nutrient uptake is the highest (just before growth). Spreading manure on frozen ground should be avoided, and is regulated in many provinces. Results are used to identify potential for switching from fall to spring applications.

There is a prohibition on winter spreading of manure in many provinces. Questions related to winter spreading in the FEMS provide an indication on how prevalent it is in areas without regulations.

Feed Ration impact on manure

Surface runoff, deep drainage and soil erosion by water on agricultural land contribute to the risk of phosphorus (P) contamination of surface water in eastern Canada. In western Canada, surface runoff seems to be a major factor contributing to P transport. Local implementation of nutrient management plans, regulations, conservation practices and BMPs can significantly decrease the P surplus in some areas. Appropriate use of the enzyme phytase in monogastric animal feed enables producers to reduce the quantities of P supplement they introduce in the animal ration and consequently, reduce P

concentration of manures. As the proportion of hogs and poultry fed with phytase increase nationally the quantities of P in manure will decrease.

RECOMMENDATION 10: Ask producers if they feed phytase*?*

FERTILIZER & PESTICIDE USE

The COA asks for the acreage herbicide, fertilizer, insecticide, fungicide or lime is applied to. FEMS asks questions on soil and manure testing, land area fertilizer was applied to, method and timing of application.

Maintaining fertilizer use questions is important because it gives insight into the use of key inputs to crop production. Furthermore this question also is used in life cycle analysis as the production of these products is energy intensive which will be accounted for in some life cycle analysis models. At a time when consumers are asking questions about the sustainability of food production, we need to continue collecting this data. The industry has used this time series to evaluate efficiency of fertilizers. It is essential that this data set is maintained to provide historical comparability.

It is important that questions related to pesticide application practices be retained, as policy makers/regulators face increasing public pressure to make changes to laws governing the use of pesticides which may not necessarily be based on sound science. The Manitoba government has already signaled its intention to restrict the use of pesticides and this could have serious consequences for the agricultural sector.

What it's used for:

- Provides a database from which the agricultural industry can track fertilizer use and efficiency
- Assesses the role agriculture plays in environmental issues (e.g. such as pollution in Lake Winnipeg and other sensitive areas).

COA STEP 17, Q106 PESTICIDE and FERTILIZER

More detailed information on the type of fertilizers that are being applied to agricultural land would be useful including total tonnes applied of each product and outlined by crop if possible. Manitoba's phosphorus balance is estimated by municipality. The 'weak link' is having data on the amount of phosphorus in commercial fertilizer that is applied by municipality throughout the province.

RECOMMENDATION 11a: Expand COA Step 17 Q 106 to include total volume of fertilizer used broken down by nitrogen, phosphorus, potassium and sulfur. Indicate total amount of fertilizer applied (please indicate unit of measure used) and code breakdown (e.g. 12-40-0-10):

- Total Tonnes (Imperial) (N, P, K, S)
- Total Tonnes (Metric) (N, P, K, S)

An alternative, but less desirable, way of collecting this information may be to ask the tonnage of major fertilizer types (anhydrous ammonia, urea, monoammonium phosphate) that were applied. The question would have to be worded carefully, though done correctly it would provide a great data set for the industry.

ALTERNATIVE 11b: What was the corresponding volume for each input applied?

- Anhydrous ammonia (tonnes)
- Urea (tonnes)
- Urea ammonium nitrate solution (Litres)
- Monoammonium phosphate (MAP) (tonnes)
- Diammonium phosphate (DAP) (tonnes)
- Potash (tonnes)

- Ammonium sulphate (21-0-0-24) (tonnes)
- Lime (tonnes)

COA & FEMS Land area fertilizer is applied to (acres)

Both the COA and FEMS ask about the acres fertilizer is applied to, which provides an anchor point to tie the two surveys together. However, there is not enough information to calculate the **rate applied**, as the tonnage applied would also be needed**.** In addition, the data also needs to be separated by nutrient sources (N,P,K,S) as well as the level of application, frequency of application and removal rates (crop specifics for area of spread).

This would provide a key piece of information going forward, as fertilizer is a major factor for several environmental sustainability indicators, including greenhouse gas emissions, energy use, water quality and nutrient balance. One way or the other the industry must get accurate information related to crop specific use of fertilizers (rate, fertilizer type, timing, and placement).

RECOMMENDATION 12: At the very least having a question that asks for the rate of application of nitrogen, phosphorus, potassium and sulfur on the three main crops.

FEMS Nutrient Testing

Soil nutrient testing provides valuable information that producers can use to match crop nutrient requirements with nutrient levels in the soil and nutrients supplied through manure and commercial fertilizer. This maximizes productivity while reducing the risk to the environment. Ultimately, the goal is to determine if producers are paying attention to maximum nutrient loading limits, runoff, or *volatilization* when applying fertilizer or manure. FEMS currently asks the frequency (e.g. every 2-3 years) that producers do nutrient testing.

RECOMMENDATION 13: FEMS Reporting is currently provided on the number of farms that soil test and the frequency. However, what is important is the number of acres under that management. Reporting this data on acres may provide more valuable results in who to target communication information to.

The increased use of N fertilizer, increased N fixation by legume crops and an increased application of manure to agricultural land intensifies the risk of high Residual Soil Nitrogen (RSN) in soils. Methods to use N inputs more efficiently include testing soil for inorganic N, splitting fertilizer applications over the growing season to reduce losses, and analyzing the nutrient content of manure.

RECOMMENDATION 14: (FEMS Q29) It would be of value to know what soil parameter tests are used. A check-box could be created for N, P, K, S, soil organic carbon, inorganic N, bulk density, etc.

While soil testing is a common decision making tool utilized by producers, nutrient testing of manure is less so. In particular, solid manure is less likely to be tested. Measuring the manure nutrient content prevents excess P from being applied, particularly if a crop uses large amounts of N but very little P, leaving P in the soil year after year.

RECOMMENDATION 15: Expand FEMS Q#29 to ask producers if they conduct soil testing before and after applying fertilizer/manure, and if so, whether they also test the quality (nutrient content) of their manure.

WATER QUALITY

Agricultural land adjacent to surface water (flowing water, permanent or seasonal wetlands) can be contaminated by nutrient or pesticide runoff or by livestock. These water sources provide critical habitat for wildlife as well as drinking water for livestock and downstream for the human population.

What it's used for:

- Water quality and risks are evaluated with wetland management questions (buffer zones) and are used when evaluating the impact of certain regulations, as well as adoption rates of BMPs
- Irrigation use is used to evaluate agricultural use of water

Questions related to agriculture's impact on water quality would be more valuable if the information could be sorted according to watershed. This would allow more groups to leverage the existing data. Currently COA and FEMS data is available by census region, based on political boundaries. The Environmental Sustainability of Canadian Agriculture: Agri-Environmental Indicator Report reassigns information based on watersheds. Having this data available to researchers would eliminate duplication of work, and increase usefulness of the existing data.

RECOMMENDATION 16: Make AAFC data that links COA and FEMS data base on watersheds available to researchers.

COA STEP 14, Q 103 Production Practices *(Buffer zones around water bodies)* – check mark question

Watersheds at moderate to high risk generally correspond to areas with high rates of coliform input due to intensive animal production and consequently high volumes of manure. On the national scale, manure excreted by pastured animals was the largest source of coliform potentially available for transport to surface water. Therefore, understanding extensive livestock management around surface water bodies (wetlands, streams) is important. In addition, the application of ecosystem service approaches to grazing systems make this type of information valuable to future research that can inform management and policy initiatives.

Maintaining set back distances around surface water, stabilizing shorelines and planting riparian buffer areas can reduce the risk of water contamination as the vegetation captures excess soil, nutrients, and pesticides before they enter the stream. Controlling livestock access to surface water prevents stream bank degradation and protects water quality. This can be accomplished through alternative water sources (e.g. a trough), limited access, or in sensitive area elimination of access.

RECOMMENDATION 17: That "Off-stream watering" and "Other water developments" be added to COA Step 14. Define "streams" as including lakes and rivers as well as streams.

COA STEP 18 Acres under Irrigation

This section only asks about the acres under irrigation (separated by crop type). This provides an indication of water use on those acres that is relevant in assessing the water footprint of those crops. It also gives an indication of the most profitable crops under irrigation practices.

FEMS Water Management

FEMS asks if all, some or no water bodies (seasonal and permanent wetlands and waterways) have buffer zones and what type of vegetation is in the buffer zone (trees, shrubs, grass/legume, other) and if it was harvested or idled.

Practices that result in significant land cover changes such as consolidation, removal of wetlands through draining and native vegetative cover show up in land use data. LU25 asks about Restoration of previously drained wetlands (acres). However, the larger concern is the acres of wetlands being lost through changes in production practices. While producers are supposed to apply to the Rural Municipality to drain a wetland, making the data available through administrative sources, many producers do not. Having some source of data with no repercussions for the producer reporting is necessary to evaluate what is happening on the landscape.

RECOMMENDATION 18: Ask: How many acres of wetlands were drained (acres) since 2011? Were they permanent or seasonal wetlands? How many acres of wetlands were reestablished since 2011? Were they permanent or seasonal wetlands?

Wastewater management (WM09) applies to feedlots and holding ponds for manure runoff. This is a useful BMPs indicator particularly for smaller lots.

FEMS Cover Crops

From the aspect of risk of nutrient loss during spring runoff it would be extremely useful to know the area of cover crops which were actively growing at the onset of winter. Cover crops reduce erosion but green actively growing vegetation which freezes releases large amounts of dissolved N and P during snowmelt runoff. Green manure crops may be spring seeded and tilled-in later that summer. If the intent of LU04 is to ask about cover or green manure crops which are left over winter and tilled in spring, further clarification is required.

RECOMMENDATION 19: In FEMS clarify that LU01 addresses "Cover, companion, or green manure crops" and LU04 addresses "Winter cover or winter green manure crops".

BEEF

Beef production management practices have the potential to impact water quality, animal welfare, production efficiencies and the ability of pasture land to sequester carbon. Monitoring adoption of BMPs is useful in informing where environmental risks may occur, and targeting communication. Information on production practices can also be used to educate both the public and government policy makers about the sustainability of beef production.

What it's used for:

- All of the questions have been used to assess adoption levels of various management practices. It is useful to know which types of production practices are being used by producers, especially as the provincial government enacts policies and regulations in some areas.
- Identifying which practices exceed a 40% threshold set by Alberta Environment and Sustainable Resource Development is used to define 'Business As Usual', on a provincial basis. Adoption levels beyond this threshold would generally not qualify as carbon offset.
- Population distribution of livestock animals (by census region) is important for development of agricultural production models.
- The information is used in support of the agricultural document for the Integrated Watershed management Plans.

COA STEP 14, Q 103 Production Practices *(In-field winter feeding or grazing, rotational grazing, windbreak/shelterbelt)*

We see considerable value in the data gleaned from information on production practices (COA Step 14) that can be used to educate both the public and government policy makers about the sustainability of beef production. However, this question only provides check boxes to give an indication of adoption of various management practices. This would be more useful if the producers were asked about the changes in these practices and land features on the operation over the recent past.

RECOMMENDATIONS 20: COA Step 14

- Total of choices should equal 100%, e.g. rephrase COA Step 14 to say "What percentage of land managed has: crops rotated, winter cover crops grown, buffer zones, etc…" rather than checking all that apply.

- Break out type of stockpiling (winter grazing) being used as native vs. tame pasture.
- Separate "in-field winter grazing" and "in-field winter feeding". Grazing would apply to stockpiled forage whereas in-field winter feeding would apply more to swathgrazing, balegrazing, crop residue grazing or simply supplying hay out in a field setting. With a strong focus on reducing winter feeding practices it is useful to know how many farms are adopting the practice.
- Add Forage quality testing and use of over-seeding (or other forms of pasture renovation).

FEMS Production Practices (Livestock Module)

Similar to the COA it would be useful for all production practices to specify what percentage of each practice was used so total = 100% rather than checking all that apply. An alternative that would be even better would be to specify what area (acres), but that is only useful if total area is also noted so percentage can be calculated.

FEMS Animal management practices (Livestock Module)

FEMS #24-48 on housing of beef cattle are excessive for the information provided. Questions 25, 30, 35, 40 and 45 provide an indication if animals are housed. But the size of housing (largest, second largest and third largest) is of no value as they have no indication of square footage per head. It is not critical to link how many animals are in each building, as much as the quality and quantity of space provided from an animal welfare perspective.

FEMS Grazing Management (Livestock Module)

Current research into carbon sequestration by pasture systems is still fairly new and highly controversial. Some studies have shown that net carbon flux ranges from positive to negative. So pastures may act as a net sink or a net source of carbon emissions depending on the state of several variables including: photosynthetic uptake (plants), ecosystem respirations (plants, micro-oganisims, herbivores), and net biome productivity (losses from fire, export of harvested biomass, inputs from manure)[5]. In turn these processes are dependent upon many other variables: climate, species present, grazing days, and stocking rates. In order to do more than assume that pasture is net neutral in an LCA, more research will be needed on grazing acres, forage type, and management practices on that land.

FEMS Wildlife Damage (Crop Module)

It is known that wildlife affect the financial health and stability of beef producers. However, it is questionable whether Statistics Canada needs to collect data on wildlife damage. The few questions asked are not broad enough to take into account losses related to baled hay or silage, making them of limited value to industry.

There is currently a private study being done by Dr. Kim Good (partnered with the Alberta Beef Producers and Miistakis Institute) that will provide better information on the "Cost of Co-existence: Economic Impact of Wildlife to Beef Producers" (www.beefsurvey.ca). Study objectives include: (1) Identify species most involved with conflict with beef producers; (2) Evaluate economic costs to beef producers by region from ungulates, carnivores and birds co-existing on agricultural lands; and (3) Develop comprehensive lists of costs associated with animal and feed loss, property damage, prevention

[5] Skinner, R. Howard. High Biomass Removal Limits Carbon Sequestration Potential of Mature Temperate Pastures. J. Environ. Qual. 37:1319-1326 (2008).
Soil Conservation Council of Canada. Global Warming and Agriculture Livestock. Volume 1, Number 6, May 2001.

and management activities. In addition, provincial agencies involved in crop insurance may have better data than what FEMS can provide.

HOGS

There are no hog specific production practice questions in the COA, but there are some in the livestock module of FEMS. Most of those questions focus on ventilation in barns as an indicator of air quality for both the hogs and humans in surrounding areas. Of most value are the questions around nutrient management (methods of manure storage, storage capacity, times of application, synthetic applications to fields with manure type and amount, nutrient profile of soils, manure and fertilizer application methods, land use, crop types, amount of feed grown). ***Information is needed on the mixed use of synthetic fertilizer and manure***. Crop type and amounts of feed grown; is important to record the nutrient removal and recycling that takes place on soils fertilized with both manure and or synthetics. It can be used to determine if the soil will remain balanced or begin to accumulate nutrients.

In the livestock module of FEMS there are an excessive number of questions and that are repeated. For example, FEMS asks how many barns there are on the property and how many livestock in the largest and second largest, and third largest barn neither of which is useful. For ventilation, only need to ask how each building on the farm is ventilated. The current format is not attractive for producers to fill it out.

Similar to beef, there are no questions around biosecurity measures for animal health practices or adoption of BMPs around animal care. Ontario Pork regularly conducts its own benchmarking survey of pork producers that details farm operations; however, environmental information is not detailed.

DAIRY

The dairy industry has access to number of data bases on production related to milk recording and genetic improvement; however a large part of the information depends on other sources like FEMS and the Census. Producers need access to the data generated by FEMS and the COA in a timely manner. This is becoming more and more important at time when all commodities are addressing issues related to environment and the socio-economic aspects agricultural production.

Dairy Farmers of Canada is in the process of implementing a program incorporating milk quality, milk safety, animal health, animal welfare, traceability and environment under a single program validation system using the platform developed for on-farm food safety program called Canadian Quality Milk. The element dealing with environment depends on provincial farm environmental plans, which relies on information from FEMS and the COA, particularly for data related to manure, fertilizers, water quality, soil management, pasture management, and pesticide usage.

Data generated by FEMS and the COA are unique. No one else can generate as robust information for crops and livestock productions. There is a need to maintain and improve FEMS and the COA questions. The lack of information will weaken the entire livestock and crop industries if they are unable to measure progress in improving management practices.

CROPS

Cropping information includes types of crops and agronomic management techniques such as tillage practices, fertilizer application rates, irrigation, and crop rotations. Management practices to reduce soil erosion and increase soil organic matter require integrated approaches that target the combined

effectiveness of soil loss by all forms of erosion (water erosion, wind erosion, tillage erosion) and manages residue.

What it's used for:

- Most data is used to determine producer uptake of 'sustainable' practices.
- Data from COA Steps 13, 15 and 19 have been used to help develop and track key sustainability indicators like soil erosion, energy use and greenhouse gas emissions for Canadian field crops (Western Canada). See www.pulsecanada.com/fieldtomarket for report which used this data.
- To assess tillage practices and overall acres planted, harvested. Tillage data pertains to soil organic carbon profile and is a critical number in determining the carbon intensity of crop-based biofuels. Information related to tillage system (e.g. no-till), summerfallow and crop type area are compiled over several census periods to model trends.
- Data about summerfallow are used to determine overall arable utilization
- Data from COA Steps 13 and 15 have also been used in presentations to food companies and others, in order to showcase improvements in practice of Canadian farmers.

COA STEP 13, Q102 SUMMER or CHEM FALLOW

This data is key for demonstrating the impact from agricultural land use change. The continued reduction in summerfallow demonstrates how Canadian farmers are managing their land sustainably and being more productive as a whole. This data is used in certification schemes to facilitate international trade where regulatory requirements exist. For example, the canola industry used this data to determine aggregate land use change for the United States Environmental Protection Agency to be considered as a sustainable feedstock for biodiesel production. Moreover, the tillage/chemfallow component of this question explains to what extent our fallow is managed sustainably[6]. Many LCA model results will change depending on tillage practices on summerfallow. Continued access to this data will be a valuable tool moving forward for market access and market development.

We would like to see data collected that would give insight into the frequency of which crops are grown. This would help us understand the crop rotations that are being used on Canadian farms. The current data collected by the COA and FEMS on crop area merely provides a snapshot in time. This snapshot may not accurately represent trends of the last five years in crop rotation due to potential price spikes and other factors.

The frequency of crops in a rotation is becoming more important as profitability favours certain crops such as canola more than others – potentially impacting sustainability and yields. The data is important to assess the impacts and risk of such rotations on yield and variability to draw conclusions and correlations with other data.

RECOMMENDATION 21: In the last five years, which crop did you plant on the greatest acreage? Which crop did you plant on the 2nd largest acreage? Which crop did you plant on the 3rd largest acreage?

COA STEP 14, Q103 Production Practices *(Crop rotation, Winter Cover crops, Plow down green crop)*

[6] It would useful to know 'fallow' acres that were that way because of excess moisture (i.e. too wet to seed). It is not necessary to ask this in a survey that is only asked every five years. There are other tools that can provide this information on an annual basis that would be more valuable to industry.

As noted above this question is of extremely limited value without a qualifier (e.g. how many acres of cover crop, what percentage of crops are in rotation, etc.). Having typical crop rotations for regions would be more valuable.

COA STEP 15, Q104 NO-TILLAGE

The shift to using conservation tillage practices is a tremendous agricultural success story across Canada. Supporting these practices will prove crucial to maintain and continue to build soil health, as well as prevent severe soil erosion. Information regarding tillage practices can also be used in nutrient runoff calculations. Stubble in fields can produce more phosphorus runoff than fields that have been tilled. This can be used in determining the origin of increased nutrient runoff. Tillage data is used extensively in life cycle analysis models internationally to show carbon sequestration. Having this data gives Canadian agriculture a competitive advantage because of the high uptake of Canadian farmers. This data will prove especially important in market driven initiatives for sustainable sourcing. Food companies and retailers are beginning to set goals that bring them in line with a more environmentally driven consumer. This data shows a favourable trend over time and the ability to maintain the data from this question is an invaluable resource to draw from for Canadian agriculture.

FEMS Crop Residue

Crop residue management results are used to identify adoption levels of use for biomass feedstock. Note that a negative approach had to be used (e.g. if other uses specified in survey, then assumed none were used for biomass feedstock). Of course it is difficult to prove that a new practice is not used, although the FEMS data is helpful in establishing that other practices were common.

For bioenergy applications, the percentage of **crop residue** left on the land is an important data point if residues are feedstock for bioenergy/biofuels. The number of acres where residue was removed and the portion of residue (%) on that land – would allow for the assessment of the overall retention of residue.

LIFE CYCLE ASSESSMENTS

The current level of information provided in COA and FEMS is adequate for a general evaluation of agriculture and its impact on the environment as provided in the Agri-Enviornmental Indicators report. However, there is increasing pressure for sector level Life Cycle Assessments (LCAs) that evaluate the impact from each commodity.

A LCA will require specific data on energy use in the crop and livestock sector as well as nutrient stocks and flow (are there accumulations of nutrients). Information on all inputs and processes is required, so amounts of inputs are needed, not just whether inputs are used or not. Another aspect of LCA data that would be essential is water use and water constraints to crop and livestock production. As part of this, data on the value of water would be useful to understand water tradeoffs under water scarce scenarios.

Many assumptions and extrapolations are made particularly around identifying boundaries around what's included in an LCA or not, and generalizing to represent "average" scenarios. Most studies have excluded inputs of less than 1% or that were determined as negligible within the life cycle by expert opinion.

Typical LCA Data Requirements*	COA	FEMS	Secondary Surveys	Statistics Canada, Canfax, Experts	Currently Unavailable
Nutrient Sources					
Production System Information				√	
Crop and forage acres by species	√	√			
Land use changes (acres from pasture to cultivation, summerfallow, tame and native pasture)	√				
Fertilizer/pesticide use (by crop, acres, timing and method of application)		√			
Manure Use (by species, crop, acres, timing and method of application)		√			
Livestock inventories (by species & class)	√			√	
Live cattle movement (auction markets, exports, interprovincial)				√	
Feedlot Demographics and locations				√	
Provincial Slaughter number & beef production				√	
Livestock rations (at every production phase)			√		
Energy use (fuel consumption)			√		√
Nutrient Uses					
Crop harvest acres, yield, residue		√		√	
Livestock outputs – pounds of beef sold				√	
Grazing – acres in forage and type, amount harvested		√			√
Winter grazing management – swath grazing, stock-piling			√		√
Bedding use			√		√
Socio-Economic					
Employee working conditions					√
Biosecurity/Animal Care & Health					√
Biodiversity/ Habitat quality/wildlife counts					√
Riparian & Range health					√

*This table is incomplete

In general, data requirements for a cereal or oilseed LCA are: crop yield, fertilizer, agricultural chemicals, direct energy, agronomic practices (varieties, N_2O Emissions, tillage practices, irrigation) and transportation. For livestock, production system information, rations, energy use, and production levels are needed (the below table summarizes some of these broad categories and where they can be sourced from currently in Canada). Obviously, more detailed information is better for LCAs.

The data that is missing or lacking for a cereal or oilseed LCA are around energy and fertilizer use:

- Which and how much fertilizer is being used at a commodity and field level
- Fertilizer, pesticide and manure use information by crop (application rate, timing of application, placement, and fertilizer type) tillage system and sorted by geographic areas would assist in developing Life Cycle Assessments.
- On-farm fuel use at the commodity and field level.

Estimates for energy use (fuel consumption from transportation, natural gas, electricity) currently rely heavily on expert opinion and small sample secondary surveys.

Fertilizer - Ancillary data and research are needed for context. Although farmer's rates of P application are needed to assess runoff, the context needed to complete comprehensive LCAs is missing (e.g. rates of phosphorus runoff, particularly in spring conditions). We recognize that this type of data goes beyond FEMS mandate. Current and detailed information from the fertilizer industry on the energy required to manufacture chemical fertilizers in Canada is currently unavailable. Up to date information for crop inputs (energy use/ carbon footprint of pesticides, fertilizers) may require information from manufacturers and cooperation from groups like Crop Life and the Canadian Fertilizer Institute.

The information related to manure and fertilizer application would be useful to a broader group of researchers if it could be sorted according to watersheds.

Geographic details - Accessing data from the FEMS and COA is critical to leveraging the value of these surveys by industry through researchers. Accessing detail on the geographic area or of the actual rate and type of manure / fertilizer application needs to be clearly communicated to these researchers.

- General production information for specific geographic areas – yields, crop rotations, etc.
- Geographic distribution of cropland and the areas in specific crops – at the census region level
- Geographic distribution of crop delivery points – shipping volumes by point, grain catchment areas etc.

For the **beef** industry, the lack of data is primarily around the question of management of cow-calf operations, including impacts on soil carbon storage from grazing practices. Previous LCAs completed in Canada have strongly recommended that a more detailed and complete assessment of carbon sequestration on pasture land be done and included in future beef LCAs. To do this more comprehensive information on grazing practices is needed.

Also to be able to show improvement over current conditions, more research is needed that evaluates the effectiveness of BMPs.

APPENDIX A

These are the questions used most by industry for environmental monitoring. Please note that questions not listed here do not mean that they are not used by industry but that these listed are specifically needed for Environmental Indicators.

Census of Agriculture (2011)	Industry Priority			Needs Change	Industry Uses
	High	Med	Low		
Step 12 Q94-101 **Land Use** (acres in summerfallow, tame or seeded pasture, natural pasture, woodlands, wetlands, other)	√				√
Step 13 Q102 **Summerfallow Management** (weed control)	√				√
Step 14 Q103 **Land Management** (check mark question)		√			√
Step 15 Q104 **Tillage Practices**	√				√
Step 16 Q105 **Crop Residue practices**		√			
Step 17 Q106 **Herbicide, Insecticide, Fungicide, Commercial Fertilizer and Lime Use** (acres only, need N,P,S,K details for main crops)				√	√
Step 18 Q107 **Irrigation** (acres under alfalfa, field crops, vegetables, fruit)			√		√
Step 19 Q108-109 **Manure**	√				√
Farm Environmental Management Survey (2011)	Industry Priority			Needs Change	Industry Uses
Crop Module	High	Med	Low		
Q3-8 Crop acres, tillage practices	√				√
Q9 Crop Residue management	√				√
Q10-16 Perennial forages (acres, age of stand, and rotations)	√				√
Q17-18 Fruit/Nut production					
Q19-25 Commercial Fertilizer Application & Timing (on annual & perennial crops)	√				√
Q26-29 Soil Testing	√				√
Q30-56 Liquid or semi-solid manure	√				√
Q57-67 Pesticide application practices	√				√
Q68 (LU01-33) Land and Water management practices (BMPs)	√				√
Q69-70 Technology Use			√		
Q71-75 Land Use changes	√				√
Q76-89 Wetland and water management (BMPs)	√				√
Q90-91 Alternative Energy production			√		
Q91-93 Wildlife Damage			√		
Q94-102 Waste management and hazardous materials (storage)		√			√
Q103-105 Environmental Farm Plan uptake		√			
Q106-108 Reasons for not adopting BMPs		√			
Livestock Module					
Q3-90 Livestock inventories and buildings (relative building size is irrelevant – see comments on page 20)			√	√	
Q91-179 Manure & nutrient management (overlaps with crop module questions, building size questions can be removed)	√			√	√
Q 95, 97 – 101, 103, 104, 105, 106, 107, 108, 109, 117, 118, 119, 145 – 152, 164 – 175					√
Q180-194 Grazing management on tame and natural pasture (fencing, average days grazed in each field, number of rotations, residue left)		√			√

APPENDIX B

Frequently Asked Questions

Q: How to access detailed FEMS data?

A: Special Requests can be sent to Stewart Deyell (Stewart.Deyell@statcan.gc.ca) at Statistics Canada. This service is provided for a fee.

Q: How to access detailed Census of Agriculture data?

A: To obtain more information on the data, products and services available from the Census of Agriculture, please contact Statistics Canada's National Contact Centre, the Census of Agriculture Data and Subject Matter Consulting Unit (toll-free at 1-800-465-1991). Special requests can be sent to Leon Laborde (leon.laborde@statcan.gc.ca) at the Census of Agriculture. This service is provided for a fee.

Q: A limitation of the FEMS and the COA is that they are aligned to political boundaries and cannot easily be linked to biophysical information. The Agri-Environmental Indicators (AEI) Reporting series uses a combination of FEMS and the COA, as well as a second framework based on watershed boundaries, the National Scale Frameworks Hydrology – Drainage Areas. This framework integrates soil and farm management information with surface drainage to assess risk to water quality. In addition, representative information on the soils and landscapes based on the Soil Landscapes of Canada (SLC) framework are calculated and the census data is reassigned based on the SLC polygons. A number of researchers noted in the survey that the data from FEMS and the COA would be more widely used if it was available by watershed as the AEI has done. How would a researcher go about getting access to the AEI data?

A: Because the Census of Agriculture includes all producers – it is a census and not a survey – it can be analyzed at various biophysical scales, limited only by strict producer confidentiality criteria: data must always represent an aggregate of producers. FEMS, on the other hand, is a survey of a sub-set of producers, and as such it has the inherent limitations of any survey. The main one is that it is "coarse" data, and therefore can't be sliced up to fine spatial resolutions. It does include non-political spatial subdivisions, though, based on eco-zones and eco-districts. Agriculture Canada is currently working on analysis of FEMS data to these scales, and we will make the numbers available to the public, via the web, soon.

Agriculture Canada is working hard to make its Agri-Environmental indicator data, and census data, available to the public at finer resolutions, within the limits of confidentiality restrictions, and our license agreements with Statistics Canada. Currently all agri-environmental indicator data are available "on the web" at the scale of the Soil Landscape of Canada polygons, for example. David Lee is the head of the unit focusing on this work. Contact David Lee (David.Lee@AGR.GC.CA) for more direction on where to find publicly available data.

Q: Is there potential for greater industry collaboration?

A: The Agriculture Canada (AAFC) research branch wants to work more closely with science experts representing the interests of commodity groups such as the Canadian Cattlemen's Association (CCA), Dairy Farmers of Canada (DFC), Manitoba Pork Council, and Canadian Canola Growers Association, to help address sustainability monitoring and certification needs. If we engage in closer dialogue, to understand better what questions industry needs answers to, we can explore the data that is currently available from government, to find the pieces that most directly address industry's needs.

Q: Is there value in differentiating between how producers manage private lands versus Crown lands? Is there value in attempting to identify the sound beneficial management practices producers provide when managing leased Crown lands?

A: In the FEMS Crops and Livestock Module, it states that participants should include rented land, as well as crown or public land used for agricultural operations. Beef producers make extensive use of leased agricultural Crown lands for grazing, hay and some cropping. In general, production practices are similar on both.