Social, Economic and Environmental Evaluation of Beneficial Management Practices:

- Improved Manure Storage to Meet Winter Spreading Restrictions (0101)
- Nutrient Management Planning (2401)
- Improved On-Farm Storage and Handling of Agricultural Products (e.g. fuel, pesticides and fertilizers) (0801)

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Executive Summary

Between July 2012 and January 2013 a project team from Yarrow Environmental Consulting was contracted by the British Columbia Ministry of Agriculture (AGRI) to conduct a social, economic and environmental evaluation of agri-environmental beneficial management practices (BMPs) promoted through the *Canada-British Columbia Environmental Farm Plan Beneficial Management Practices Program* (*BMP Program*). The *BMP Program* cost-shares the implementation of agri-environmental practices and technology on British Columbia farms, promoting agricultural sustainability and contributing to a cleaner, healthier environment. This project was supported by *Growing Forward,* a federal-provincial initiative that supports provincial agricultural programs, such as the *Environmental Farm Plan* and *BMP programs*.

This project is the second BMP evaluation project and draws upon the methodology developed in 2011-12 for the previous BMP evaluations. The specific objectives for this project were to:

- Use the BMP evaluation framework created in 2011 to evaluate the social, economic and environmental outcomes of three BMPs on implemented on BC farms and cost-shared through the *BMP Program*; and
- Draw conclusions from the results of the evaluation and make recommendations based on the findings.

The three BMPs reviewed in this report include:

- Improved Manure Storage to Meet Winter Spreading Restrictions (practice code 0101);
- Nutrient Management Planning (practice code 2401); and
- Improved On-Farm Storage and Handling of Agricultural Products (e.g. fuel, pesticides and fertilizers) (practice code 0801).

Three unique BMP evaluation surveys were developed for the evaluation. The surveys collected social, economic and environmental BMP outcome data as well as feedback from *BMP Program* participants. Surveys were administered through personal interviews with producers who implemented the BMPs as well as through paper surveys mailed to *BMP Program* participants across BC in the fall of 2012. *BMP Program* application files submitted by producers were also used for the evaluation. A discounted cash flow (DCF) analysis was conducted to understand the private financial outcomes of BMP implementation. In addition, a cost-benefit analysis (CBA) was conducted for each BMP to understand the societal benefits of BMP implementation. A SWOT analysis framework was used to highlight the strengths, weaknesses, opportunities and threats associated with each BMP and helped to form the basis for recommendations and conclusions made about each BMP.

Results of the project highlight the outcomes of the BMP to individual farm operations and the effectiveness of BMPs at environmental risk mitigation. The results show that, generally, the BMPs evaluated have positive environmental outcomes and can help producers to manage their environmental risk. In some cases BMPs can provide a financial benefit to producers; however, the level of benefit is dependent on the characteristics of the BMP and individual farm operation. Results of the CBAs show that over the expected life of the BMPs, the *Improved Product Storage BMP* and *Nutrient*

Management Planning provide a net benefit to society, whereas the *Improved Manure Storage BMP* does not due to the high implementation costs.

The BMP evaluation results presented in this report will aid in:

- Demonstrating the environmental merits of the BMPs to funding agencies;
- Promoting the on-farm benefits of BMPs to producers; and
- Effectively allocating limited program funding in a means that maximizes the net benefits of the BMP cost-shared programming to the public.

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1.0 Introduction and Background

This project was supported by *Growing Forward,* a federal-provincial-territorial initiative that supports provincial agricultural programs, such as the *Canada-British Columbia Environmental Farm Plan Program* (*EFP*) and *Beneficial Management Practices Program* (*BMP Program*). In British Columbia, the *EFP Program*, launched in 2004, was designed to raise awareness and to complement and enhance the current environmental stewardship practices of agriculture producers. Programs were developed based upon a risk assessment of regional issues concerning air, soil, water, and biodiversity and Beneficial Management Practices (BMPs) needed to address the issues. Encouraging the uptake of BMPs such as those reviewed in this report contributes to improved environmental stewardship. Since 2005, BMP programming, which included the National Farm Stewardship Program, Greencover Canada and more recently the *BMP Program,* has encouraged the uptake of environmentally friendly practices on farms and ranches in BC by cost-sharing the implementation of BMP projects with producers.

An essential aspect of *BMP program* management is to evaluate the process and outcomes of the program. Evaluation and monitoring of a program is a means to discover program strengths, weaknesses, and potential opportunities that could be acted upon as well as threats to the success of the program. Program evaluation delivers valuable feedback to *BMP program* managers and funding partners to allow the program to be adaptively managed and changed over time to meet the needs of BC farms and the changing environment.

In 2011/12, the BC Ministry of Agriculture commissioned the first BMP evaluation project. An evaluation framework was developed to assess the social, economic and environmental outcomes of BMPs with four BMPs evaluated for the initial project. This project is the second BMP evaluation using the evaluation framework that was developed. The three BMPs evaluated in 2012/13 for this project were:

- Improved Manure Storage to Meet Winter Spreading Restrictions (practice code 0101);
- Nutrient Management Planning (practice code 2401); and
- Improved On-Farm Storage and Handling of Agricultural Products (e.g. fuel, pesticides and fertilizers) (practice code 0801).

The objectives of this project were to:

- Use the established BMP evaluation framework to evaluate the social, economic and environmental outcomes of three BMPs cost-shared through the *BMP programs*; and
- Draw conclusions from the results of the evaluation and make recommendations based on the findings.

The specific research questions addressed in this report are:

- What was the uptake of the BMP between 2005 and 2012?
- What were the social, financial and environmental outcomes of each BMP?
- What was the benefit (if any) of the BMP to society?
- Was the BMP effective at mitigating environmental risks?
- Could the BMP be improved in any way?

The BMP evaluation project was conducted by a project team from Yarrow Environmental Consulting and directed by a project steering committee from the BC Ministry of Agriculture (AGRI), BC Agricultural Research & Development Corporation (ARDCorp), and Agriculture and Agri-Food Canada (AAFC). Yarrow Environmental Consulting is a consulting firm with a mandate of helping to create a resilient local agriculture industry in BC. We specialize in agri-environmental resource management, economic analysis and stakeholder engagement.

This evaluation project delivers information to *BMP program* managers regarding how BMPs have been implemented on-farm, their environmental and financial outcomes and the benefits that the BMPs provide to society. The evaluation results presented in this report will aid in:

- Demonstrating the environmental merits of the BMPs to funding agencies;
- Promoting the on-farm benefits of BMPs to producers; and
- Effectively allocating limited program funding in a means that maximizes the net benefits of the *BMP programs* to the public.

The remainder of this report is organized as follows:

- Section 2 describes the evaluation framework and methodology used to conduct the BMP evaluations;
- Section 3 presents the results of each of the three BMP evaluations and discusses recommendations and conclusions specific to each BMP;
- Section 4 presents an additional evaluation question that was evaluated across all three BMPs; and
- Section 5 discusses our recommendations for future BMP evaluations.

1.1 Limitations of the BMP Evaluation Project

The BMP evaluation framework used for this project was developed in response to a desire for more information about the outcomes of BMPs implemented through the *BMP programs.* The methods used for this project were an appropriate means for the evaluation considering time, budget and data constraints associated with the evaluation. Due to the nature and timing of the evaluation and complexities associated with summarizing on-farm outcome data we would like to point out some limitations to the information presented in this report:

- The methods used to determine outcomes are not a true measurement of program impact. To estimate the impact of a program, either baseline data collected prior to BMP implementation or an experimental design procedure where *BMP program* participants are compared to non-program participants is required.
- The BMPs were evaluated separately and therefore results will be reported separately; however, it is important to recognize that BMPs are often implemented as a suite of on-farm projects or improvements. As well, each farm implements environmental improvements within a unique set of operational and environmental circumstances. Thus it is potentially inaccurate to attribute certain environmental and financial outcomes solely to the BMP. It is also possible that a BMP with similar outcomes was funded under a different practice code and this evaluation does not capture the duplication of benefit that may be correlated with those implemented BMPs.

- Certain outcomes of BMP implementation could not be valued within the scope of this report. As a result, the net present values of BMP projects determined by the cost-benefit analyses may be inaccurate. For example, benefits associated with the reduction of nutrient leaching into the environment were not estimated; however, increasing manure storage capacity may have resulted in a reduction in nutrient release into the environment on farms that implemented the *Improved Manure Storage BMP.*
- The conclusions made in this report are not based on statistically significant data.
- The conclusions and recommendations made in this report are based on the results of the BMP evaluations, qualitative information gleaned during the interview process and site visits as well as the authors' opinions and experiences.

2.0 BMP Evaluation Methodology

This project is the second evaluation of BMPs funded through the *Canada-British Columbia Environmental Farm Plan Program*. The methods used for this BMP evaluation project were similar to the previous BMP evaluation project. The remainder of this section outlines the methodology used to conduct the evaluation. For more detailed step-by-step information about the methodology, please consult the *BMP Evaluation Methodology Guide* available through AGRI.

The Evaluation Framework

To evaluate the environmental outcomes of BMPs on farms, environmental indicators were developed based on the specific environmental risk that the BMP is intended to address. Agri-environmental indicators were used as a proxy for the actual environmental impact of a specific BMP, as it was beyond the scope of this project to measure impact directly. Indicators used for each BMP are discussed in detail in the respective BMP sections.

To determine the financial outcomes of the BMP to the average producer, both private costs and private benefits prior to and post BMP implementation were assessed. A discounted cash flow analysis (DCF) was conducted to portray the on-farm financial outcomes of BMP implementation.[1]

To determine the economic outcomes of the BMP to society, a cost-benefit analysis (CBA) was conducted.[2] The CBA framework was developed based on the Canada Treasury Board Secretariat methodology and analyzed according to their generally accepted guidelines.[3] These guidelines were initially developed to evaluate federal regulations but they are also applicable at other levels of government. According to the 'Canadian Cost-Benefit Analysis Guide' five main steps are followed when conducting a cost-benefit analysis:

1. Identify the issues, risks, and the baseline scenario;
2. Set objectives;
3. Develop alternative regulatory and non-regulatory options;
4. Assess the benefits and costs (using a variety of possible techniques); and
5. Prepare an accounting statement.

As an additional step, we added a sensitivity analysis to these five recommended steps.

Data used to conduct the cost-benefit analyses came from both the *BMP programs* data and data collected during the evaluation. In some cases, the sample sizes used to calculate either cost or benefit data were small relative to the overall population of

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[1] Discounted cash flow analyses are used by individuals to determine the financial outcomes of a proposed project over the lifetime of the project. The tool tracks cash flows and discounts them based on a set rate to determine the present value of a project.

[2] Cost benefit analyses are used by governments to determine the economic efficiency of alternative policies (i.e. government intervention) for solving a specific problem (e.g. water pollution). Governments at varying levels around the world have adopted this decision tool for assessing new or existing policies.

[3] Treasury Board of Canada Secretariat. (2007). Canadian Cost-Benefit Analysis Guide: Regulatory Proposals. Ottawa, ON: Government of Canada. Retrieved on January 22, 2012 from: http://www.tbs-sct.gc.ca/ri-qr/documents/gl-ld/analys/analys00-eng.asp

producers who implemented the BMP. Low sample sizes are acknowledged as a potential limitation to the representativeness of the cost-benefit analyses results.[4]

To understand the motivational factors for and barriers to BMP uptake, a set of social evaluation questions were developed. Several semi-structured interviews with non-adopters of the BMPs and industry experts were also conducted to better understand the barriers to uptake of the BMP as well as weaknesses of the BMP.

Data Sources and Data Collection Methodology

The data for this project came from three sources:

1. BMP project application files were supplied by the BC Agricultural Research & Development Corporation (ARDCorp) for each BMP evaluated in this study.

ARDCorp acts as the delivery agent for both the *Environmental Farm Plan* and *BMP programs* in BC. When a farm applies for BMP project funding, they submit an application form to ARDCorp. The BMP project file data was collected from paper archives by photocopying files and entering relevant data into a database. The data that was obtained from the program files included the contact information for adopters, the total number of adopters (N), the specific city/region where the BMP was implemented, the date the BMP was completed, and the total cost of the infrastructure paid by both the agencies and the producer. The data files selected from ARDCorp included all adopters of 0101 (N=116), 2401 (N=147) and 0801 (N=357) or the time period of 2005/06 to 2011/12.

2. Survey instruments were developed to conduct the social, economic and environmental outcome evaluation.

For each BMP, a separate survey instrument was developed to evaluate the social, economic and environmental outcomes. Questions were designed to capture the outcome indicators as well as based on recommendations made by the project team and AGRI steering committee. Data was collected in two ways:

1. Personal interviews with producers, and
2. A mail out to all producers who did not participate in an interview.

A target of 60 interviews (20 for each BMP) was set. Interviews were conducted between September and December 2012 and focused on key areas of BMP uptake across the Province including:

- The Fraser Valley and Metro Vancouver;
- The Southern Interior and Okanagan Regions;
- The Thompson – Nicola Region;
- Vancouver Island; and
- The Peace River Region.

A total of 60 BMP interviews were completed (Table 1). Interviews were arranged by telephone and email prior to visiting the regions. All areas were visited in person with the exception of the Peace River Region. Phone interviews were conducted with producers in the Peace River Region. In most cases, when the producer had time, interviews

[4] Refer to Appendix VII for the detailed cost benefit analysis methodology.

corresponded with a site visit. In addition, targeted interviews were conducted with industry experts and producers who were not captured by the *BMP programs* sample provided by ARDCorp to understand the barriers to uptake and current weaknesses of the BMPs.

Table 1. Summary of Interviews Conducted.

BMP	# Interviews/Site Visits Conducted
Improved Manure Storage	20
Product Storage	20
Nutrient Management Planning	20
Total	**60**

A survey was mailed to the sample of producers who did not participate in an interview. Surveys were sent at the beginning of October with a return deadline of November 1st 2012. A total of 542 surveys were mailed out (some addresses from ARDCorp files were out of date, reducing the sample) and 66 completed surveys were returned. A second survey was sent to all 0101 and 2401 adopters with an extended deadline to December 1st 2012 because of a low response rate for the first survey mail out. Only four surveys were returned from the second mail out. Response rates for each BMP will be discussed in the BMP sections below.

3. Data from relevant literature sources were used, particularly to value environmental benefits for the purposes of the CBA.

Some environmental benefits could not be valued monetarily within the scope and timeframe of this project. In order to conduct the cost benefit analysis, values for environmental benefits were gathered from relevant literature sources. This methodology is termed “value transfer” or “benefit transfer”.

Data Analysis

The data collected through personal interviews and mail surveys was combined and analyzed jointly for each BMP. Average or median values for BMP outcomes were used to demonstrate both the typical case as well as the outcomes of BMP implementation province-wide.

Financial data supplied by respondents was analyzed using a discounted cash flow (DCF) methodology. A DCF allows private costs and on-farm benefits to be compared over the life of the BMP to determine the net present value (NPV) of the BMP project to the producer.

SWOT Analysis, Conclusions and Recommendations

To organize the main findings of the evaluation as well as to present some anecdotal findings from interviews, a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis was conducted for each BMP. Finally, conclusions and recommendations, based on the findings of the BMP evaluation were made for each BMP.

3.0 Social, Economic and Environmental Evaluation of Beneficial Management Practices

This section will report the findings of the social, economic and environmental evaluation of three BMPs evaluated between July 2012 and January 2013. The three BMPs evaluated in this report are *Improved Manure Storage to Meet Winter Spreading Restrictions (*practice code 0101), *Nutrient Management Planning* (practice code 2401) and *Improved On-Farm Agricultural Product Storage and Handling (e.g. fuel, pesticides and fertilizers)* (practice code 0801).

For each BMP, the uptake statistics, environmental and financial outcomes, motivating factors and barriers to uptake as well as the results of the cost-benefit analysis are reported. At the end of each section, the findings of the evaluation are summarized and discussed using a strength, weaknesses, opportunities and threats (SWOT) analysis framework. Finally, conclusions and recommendations based on the findings of the evaluation are discussed for each BMP.

3.1 Improved Manure Storage to Meet Winter Spreading Restrictions

Evaluation Summary

The *Improved Manure Storage to Meet Winter Spreading Restrictions BMP* (the *Improved Manure Storage BMP*) is intended to address environmental risks associated with spreading manure during non-advised times (i.e. the dormant season) by increasing the manure storage capacity of farms that store manure. *BMP programs* have cost-shared the expansion of both liquid and solid manure storage facilities and/or the construction of new manure storage facilities to eliminate the need for farms to spread manure during non-advised periods.

The average implementation cost of an *Improved Manure Storage BMP* project was $102,014. The *BMP programs* provided an average of $20,354 in cost-share dollars to producers per BMP project. Between 2005/06 and 2010/11, producers contributed $9,388,000 and the *BMP programs* contributed $2,361,000 towards *Improved Manure Storage BMPs.*

A total of 116 *Improved Manure Storage BMP* projects occurred across BC between 2005/06 and 2010/11. The dairy industry has implemented the majority of the BMP projects in this category to date (60% of total BMP projects).

Prior to BMP implementation, producers had an average of 3.1 months of manure storage capacity. Implementation of the *Improved Manure Storage BMP* resulted in an increase in manure storage capacity to 7.1 months (holding livestock numbers constant). All respondents indicated that since increasing their manure storage capacity they no longer spread manure during the non-advised times. The majority of respondents also indicated that they had noticed less soil compaction as a result of avoiding the use of heavy equipment on fields during the dormant season.

The on-farm benefits experienced by producers who implemented the *Improved Manure Storage BMP* included but were not limited to:

- Increased flexibility of manure application timing;
- Potential for improvement in crop yields and quality;
- Potential for reduction in soil compaction and erosion;
- Potential for decreased fertilizer usage; and
- Potential for decreased manure application expenditures.

However, the results of the discounted cash flow analyses indicate that generally the implementation costs of the *Improved Manure Storage BMP* outweigh the financial benefits of the BMP to the producer. Similarly, the results of the cost benefit analyses indicate that the net present value of the BMP is negative over the lifetime of the BMP (assumed to be 20 years). It is important to note that not all potential benefits were included in this calculation as they were not able to be valued within the scope of this project.

3.1.1 Introduction to the Improved Manure Storage to Meet Winter Spreading Restrictions BMP

The *Improved Manure Storage to Meet Winter Spreading Restrictions BMP* (herein referred to as the *Improved Manure Storage BMP*) is intended to address environmental risks associated with spreading manure during non-advised times by increasing the manure storage capacity of farms that store manure. In the South Coastal Region, producers are advised to avoid spreading manure between November 16th and January 31st. In the Interior or Northern Regions, producers are advised to avoid to spreading manure between November 1st and February 28th. The environmental risks associated with spreading manure during times when crops are dormant include the potential for nutrient and pathogen losses to the environment, posing risks to surface, ground water and drinking water supply. The application of manure during non-advised times can also result in increased soil compaction and erosion as a result of traffic on wet or saturated fields.[5]

BMP programs have cost-shared the expansion of both liquid and solid manure storage facilities and/or the construction of new manure storage facilities to eliminate the need for farms to spread manure during non-advised periods. Adequate manure storage capacity reduces the risk of nutrient and pathogen losses to the environment and also allows producers to use nutrients more effectively as fertilizer for crops.

3.1.2 Evaluation Survey Response

A total of 20 interviews and site visits were conducted. Six surveys were returned totaling 26 respondents. The survey response rate including interviews and returned surveys was 23%.

3.1.3 Cost-Share Structure and BMP Implementation Costs

Funding for the *Improved Manure Storage BMP* was available between the 2005/06 and 2010/2011 program years. Cost-share funding was eligible for engineering, materials and labour associated with the construction of new solid and/or liquid manure storage facilities and/or the expansion of manure storage facilities including roof construction over new and existing facilities. Eligible items were cost-shared at 30% to a maximum of $30,000. The *BMP programs* funded up to 7 months of storage. Producers who increased the capacity of their storage beyond 7 months, received cost-sharing pro-rated to 7 months storage.

The average implementation cost of an *Improved Manure Storage BMP* project for dairy operations, taking into account only the eligible costs was $140,310. The *BMP programs* provided an average of $24,549 in cost-share dollars to dairy producers per BMP project. The average implementation cost of an *Improved Manure Storage BMP* project for non-dairy operations, taking into account only the eligible costs was $54,688. The *BMP programs* provided an average of $15,205 in cost-share dollars to non-dairy producers per BMP project. Between 2005/06 and 10/2011, producers contributed $9,388,000 and the *BMP programs* contributed $2,361,000 towards *Improved Manure Storage BMPs.*[6]

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[5] National Farm Stewardship Program. (2006). *Beneficial management practices descriptions.* Ottawa, ON: Agriculture and Agri-Food Canada.
[6] Project costs were determined using the ARDCorp BMP programs data.

3.1.4 Improved Manure Storage BMP Uptake Statistics

This section reports the *Improved Manure Storage BMP* implementation and distribution statistics for the period between 2005/06 and 2010/11.

Distribution of BMP Uptake by Region

A total of 116 *Improved Manure Storage BMP* projects occurred across BC between 2005/06 and 2010/11.[7] Figure 1 and Table 2 and display the regional distribution of implementation for this BMP.

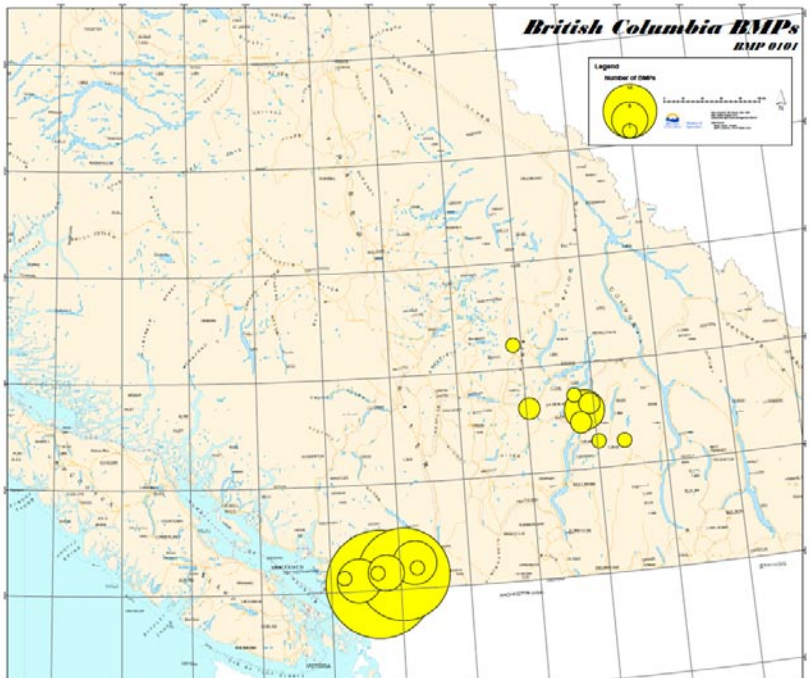

Figure 1. Map of Improved Manure Storage BMP uptake between 05/06 and 10/11.

Table 2. The number of Improved Manure Storage BMPs implemented in each Regional District.[8]

Regional District	Number of BMP Projects
Fraser Valley	83
Metro Vancouver	19
North Okanagan	9
Columbia-Shuswap	3
Thompson-Nicola	2

[7] A BMP 'project' was defined as a single BMP approved and cost-shared by the BMP programs. Using this definition, an individual farm operation may have implemented one or more distinct BMP projects on one or multiple farm properties.
[8] The regional distribution of BMP uptake was determined using the ARDCorp BMP programs data.

Uptake by Commodity

The dairy industry has implemented the majority of the BMP projects in this category to date (60% of total BMP projects). A total of 69 *Improved Manure Storage BMP* projects have occurred on dairy farms, representing approximately 13% of the current 517 of dairy farms in BC.[9] Other commodities that have implemented this BMP include the poultry industry (32% of total BMP projects collectively) and the hog, horse, nursery, beef, sheep and goats commodities (8% collectively) (Figure 2).

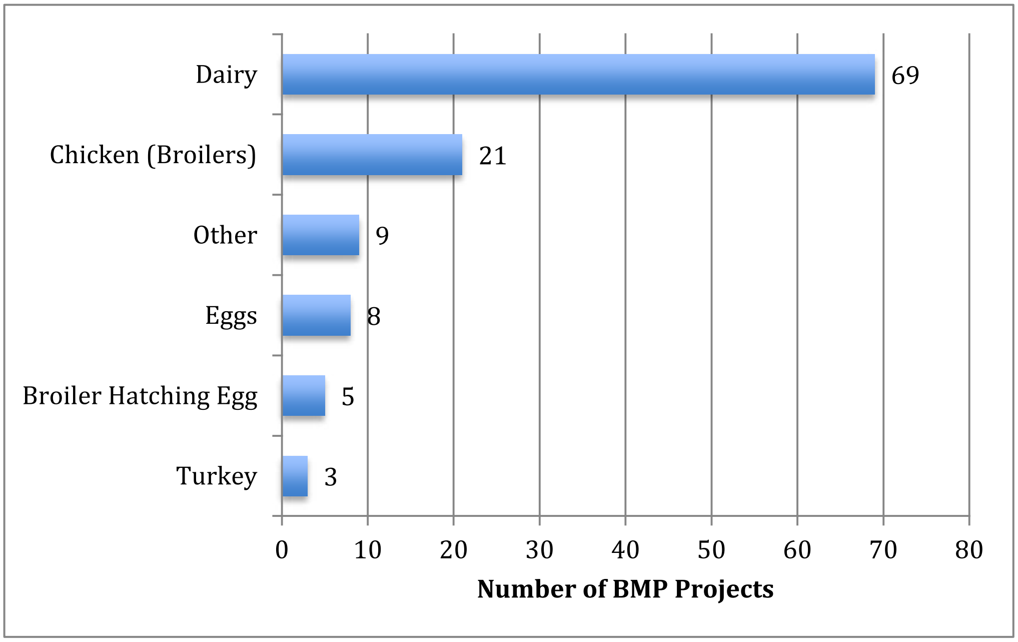

Figure 2. Improved Manure Storage BMP uptake by commodity.[10]

Uptake Over Time

The rate of uptake of the *Improved Manure Storage BMP* peaked in 2008 and declined in the 2009/2010 program year (Figure 3). Although the reasons for the decline in uptake were not explicitly assessed in this project, it is possible that uptake was lower in the 2010/2011 program year due to uncertainty about the availability of funding and that the cost-share rate was initially offered to producers at 15% as opposed to a 30% cost share ratio in which it was offered in previous years.[11] [12]

[9] Statistics Canada (2012). Farm Operator Data Tables. 2011 Census of Agriculture. Source: http://www5.statcan.gc.ca/bsolc/olc-cel/olc-cel?catno=95-640-X&lang=eng
[10] BMP uptake by commodity was determined using the ARDCorp program data files.
[11] At the end of the 10/11 program year, an additional 15% top up was provided to producers who implemented the BMP.
[12] Uptake by year was determined from the ARDCorp BMP programs files.

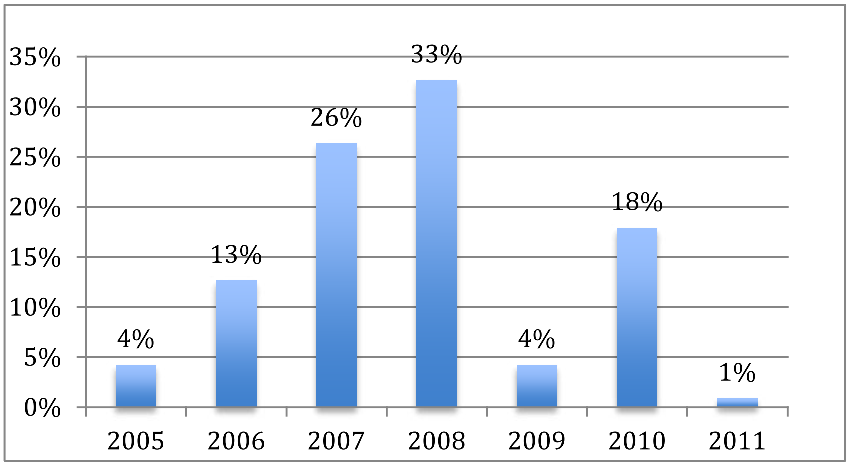

Figure 3. Uptake of the Improved Manure Storage BMP by year.

3.1.5 Characteristics of farms implementing the Improved Manure Storage BMP

The average dairy farm that implemented the *Improved Manure Storage BMP* had 235 milking cows and was 68.2 hectares. The average poultry farm had approximately 47000 birds and was 10 hectares (Table 3).[13] All respondents indicated that the farm operators privately owned the land where the BMP was implemented.

Table 3. Characteristics of the average farm that implemented the Improved Manure Storage BMP.[14]

Type of Livestock	Average Number of Livestock	Median Number of Livestock	Average Area of Farm (Ha)	Median Area of Farm (Ha)
Dairy (Milking Cows)	235	202	68.2	72
Poultry	46575	40000	14.1	10
Other	411	150	34.7	22

[13] The calculations for the average and median number of dairy cows are based on milking cows only. The calculations for average and median area of land is based on owned land and do not include other land that producers may lease.
[14] Farm characteristics were determined from the ARDCorp BMP programs files.

Farm Gate Sales

The majority of respondents to the *Improved Manure Storage BMP* survey had farm gate sales of $500,000 and above (Table 4).

Table 4. Farm Gate Sales of Improved Manure Storage BMP survey respondents.[15]

Farm Gate Sales in 2011	Percentage of Respondents
$9,999 and less	0.0%
$10,000 - $24,000	0.0%
$25,000 - $49,999	0.0%
$50,000 - $99,999	0.0%
$100,000 - $249,000	5.9%
$250,000 - $500,000	11.8%
$500,000 and above	82.4%

Farming Experience

The average number of years that producers who implemented the *Improved Manure Storage BMP* have farmed is 27 years. The average time farmed on the property where the BMP was implemented was 22 years.[16]

3.1.6. The Improved Manure Storage BMP in Practice

This section gives a brief overview of the how the *Improved Manure Storage BMP* has, in general, been implemented on farms. The *BMP programs* funding could have been allocated towards the construction of new solid or liquid manure storage or the expansion of existing solid manure or liquid storage facilities.

Practice Prior to BMP Implementation

Of producers who stored liquid manure on their farms prior to implementing the *Improved Manure Storage BMP,* 68% stored manure in a concrete lined manure pit (Table 5). Of producers who stored liquid manure in a concrete lined pit, 22% had a roof or cover over their pit prior to BMP implementation.[17]

Table 5. Liquid manure storage facilities prior to BMP implementation.

Previous Liquid Manure Storage	Percentage of Producers
Concrete Lined Pit	68%
Earthen Lagoon	10%
Aboveground Tank	6%

[15] Farm gate sales were determined from the BMP evaluation survey.
[16] Farming experience was determined from the BMP evaluation survey.
[17] Manure storage practices prior to BMP implementation were determined by the ARDCorp BMP programs files and verified by the BMP evaluation survey.

Figure 4: Example of liquid manure storage improvement including manure storage expansion and roof.

Of respondents who stored solid manure on their farms prior to implementing the *Improved Manure Storage BMP,* the majority (68%) stored their manure on bare ground with no permanent cover (Table 6). Only one respondent indicated that they had permanent cover over their solid manure storage prior to BMP implementation.

Table 6. Solid manure storage facilities prior to BMP implementation.

Previous Solid Manure Storage	Percentage of Producers
Concrete Slab	32%
Bare ground	68%

Figure 5: Example of solid manure storage improvement including manure storage expansion and roof.

Type of BMP Implemented

Approximately 60% (70 total) of *Improved Manure Storage BMPs* between 2005/06 and 2010/2011 were allocated to improving liquid manure storage capacity, and 40% (46 total) to improving solid manure storage capacity. The majority (57%) of liquid manure storage BMP projects were either covered or uncovered new concrete lined pits (Table 7). The majority (84%) of solid manure storage BMP projects were either covered or uncovered concrete pads to store solid manure (Table 8).[18]

Table 7. Implemented liquid manure storage BMPs.

Liquid Manure Storage BMP	Percentage of Producers	Estimated # of BMP Projects
New Covered Concrete Pit	33%	23
New Uncovered Concrete Pit	24%	17
Cover or Roof Installation	24%	17
Concrete Pit Expansion	16%	11
New Lined Lagoon	3%	2

[18] The type of BMP implemented was determined by the ARDCorp BMP programs files and verified by the BMP evaluation survey.

Figure 6: Liquid manure storage expansion.

Table 8. Implemented solid manure storage BMPs.

Solid Manure Storage BMP	Percentage of Producers	Estimated # of BMP Projects
New Concrete Pad	47%	22
New Concrete Pad with Cover	37%	17
Cover or Roof Only	14%	6
Solid Manure Expansion	2%	1

Figure 7: Compost storage roof installed through the BMP programs.

Change in Manure Storage Capacity

Prior to BMP implementation, producers had an average of 3.1 months of manure storage capacity. Implementation of the *Improved Manure Storage BMP* resulted in an increase in manure storage capacity to 7.1 months.[19]

3.1.7 The Environmental Outcomes of the Improved Manure Storage BMP

The above sections provide insight into how the *Improved Manure Storage BMP* has been implemented in practice, whereas this section provides insight into the environmental outcomes that the BMP has had on farms where it has been implemented.[20]

The indicators used to understand the environmental outcomes of the *Improved Manure Storage BMP* were:

- Change in the frequency of manure spreading during the dormant winter season; and
- Change in the amount of soil compaction experienced by producers.

Change in the Timing of Spreading

Producers were asked to indicate the average amount of days that they spread manure during specific time periods to determine whether the *Improved Manure Storage BMP* has eliminated spreading during the not advised period when crops are dormant.[21] Although the amount of nutrient loss to the environment is dependent on the weather conditions at the time of spreading, research indicates that generally applying manure to dormant cropland during the winter or “non advised” period increases the risk of nutrient loss.

In some cases, producers did not have to spread manure during the non-advised period previously, but did have to spread more manure during the shoulder fall and spring periods. All respondents indicated that they no longer spread manure during the non-advised winter period (Table 9).

Table 9. Change in the timing of manure spreading due to BMP implementation.

	Average # of Spreading Days Prior to BMP	Average # of Spreading Days Post BMP Implementation
Fall	2.4	2.7
Winter – *Not Advised*	1.2	0
Spring	2.3	2.7
Summer	3.5	4
Total Spreading Days	9.4	9.4

[19] Note that the change in capacity was calculated holding the number of livestock constant. Therefore, these numbers reflect the change in storage capacity immediately after the BMP was implemented and do not necessarily reflect the current situation at the farm.

[20] Environmental outcomes were determined by the BMP evaluation survey. This calculation was based on the ARDCorp data files and verified by the evaluation survey.

[21] See the *Canada – British Columbia Environmental Farm Plan Reference Guide Fifth Edition*, pages 6-21 and 6-22 for the exact dates of each spreading period for both the South Coastal and Interior and Northern regions of BC.

Some respondents (15%) indicated that they did not and do not spread manure on their farm. In these cases, the *Improved Manure Storage BMP* has increased the storage capacity of the farm so that manure can be stored with reduced risk of nutrient loss to the environment until it can be shipped off of the farm.

Change in Soil Compaction

Just over half (67%) of respondents indicated that they have noticed less soil compaction, (e.g. a reduction in rutting from heavy equipment and compacted areas around field storage), due to having increased manure storage capacity and not spreading during the non-advised period.

3.1.8 The Financial and Economic Outcomes of the Improved Manure Storage BMP

This section will present the on-farm outcomes experienced by farmers and ranchers that implemented *Improved Manure Storage BMPs* as well as the costs they incur. The financial and economic outcomes are presented for dairy and non-dairy operations.

To evaluate the private financial outcomes of the *Improved Manure Storage BMPs* to the producer, a discounted cash flow (DCF) analysis was conducted. The results of the DCF are presented below in this section. To assess the economic outcomes of the BMP to society a cost benefit analysis (CBA) was conducted. The results of the CBA are presented below in this section as well. The project lifespan of an *Improved Manure Storage BMP* is assumed to be 20 years. The analyses consider the on-farm situation immediately before BMP uptake compared to directly after BMP uptake and does not consider unrelated changes that may have occurred on the farm after BMP uptake.

On-Farm Benefits and Costs of the Improved Manure Storage BMP

A series of survey questions aimed at assessing the costs and benefits experienced by farmers due to the adoption of the *Improved Manure Storage BMP* were asked. The following sections present the results of these survey questions.

Changes in Flexibility of Manure Application Timing

Ninety-three percent of dairy respondents interviewed indicated they had more flexibility in manure application timing as a result of implementing their *Improved Manure Storage BMPs*. Twenty-five percent of non-dairy respondents interviewed indicated that they had more flexibility due to increased capacity.

Reduced Odour and Ammonia Emissions

Implementing an *Improved Manure Storage BMP* can limit spreading during non-advised periods and promote the more efficient use of manure. In some cases, this can lead to benefits including reduced odour and ammonia emissions.

Fertilizer Expenditures

Respondents were asked if their average annual chemical fertilizer expenditures changed as a result of implementing the *Improved Manure Storage BMP*. On average, each dairy farm realized $533.67 per year in fertilizer cost savings as a result of adopting the BMP. Non-dairy farms realized $0 per year per farm in fertilizer cost savings as a result of adopting the BMP.

Manure Application Expenditures

Respondents were asked if their manure application costs and/or labour changed as a result of implementing the manure storage BMP. On average, each dairy farm realized a labour savings of 24.67 hours per year equal to $370 per year or a 48% decrease as a result of adopting the BMP. Additionally, the average dairy farm realized $3054.67 per year in manure application cost savings, a 62% decrease, as a result of adopting the *Improved Manure Storage BMP*. The average non-dairy farm realized a labour savings of 5 hours per year equal to $75 per year or a 29% decrease as a result of implementing the BMP. That average non-dairy farm experienced no change in manure application cost savings, as they were $0 pre-BMP and remained at $0 post-BMP adoption.

Labour Requirements

Respondents were asked if their labour requirements to maintain their manure storage changed as a result of adopting the BMP. On average, dairy farms realized a decrease in labour costs equal to 10.3 hours or $154.50 per year in savings. One average, non-dairy farms realized a decrease in labour costs equal to 26.5 hours or $397.50 per year.

Maintenance and Repair Requirements

Respondents were asked if their maintenance and repair costs differed between the previous manure storage system and the *Improved Manure Storage BMP* they implemented. On average, each dairy farm realized an $8 per year cost savings as a result of adopting the BMP. On average, each non-dairy farm realized a $62.50 per year cost savings as a result of adopting the BMP.

Change in Crop Yield and Quality

Twenty seven percent of dairy respondents indicated they experienced an increase in crop yields as a result of implementing the *Improved Manure Storage BMP*. In many cases, this was due to the increased flexibility of manure application with the new storage system. Thirty three percent of respondents stated they experienced an increase in crop quality as a result of the BMP largely because the manure storage system allowed them to better utilize manure as a fertilizer.

Non-dairy respondents experienced no change in crop yield and quality as a result of adopting the *Improved Manure Storage BMP*. This is likely due to the fact that 75% of non-dairy respondents were poultry operations.

Change in Soil Compaction/Erosion

Fifty percent of dairy respondents experienced a decrease in soil compaction and erosion as a result of implementing the *Improved Manure Storage BMP*. In many cases, farmers were able to spread less often and avoid spreading during non-advised periods, which reduced the amount of heavy equipment use on the fields, particularly during non-advised times.

Non-dairy respondents experienced no change in soil compaction and erosion mainly due to the fact that many were not applying manure to their own farm.

Operational Efficiencies

Implementing *Improved Manure Storage BMPs* in some cases led to on-farm operational efficiencies. For example, for some diary operations, *Improved Manure Storage BMPs* made pumping manure from the pit more efficient. For some poultry operations, covered storage made the manure lighter and easier to handle.

Improved Manure Storage BMP Discounted Cash Flow Analysis

To understand the financial outcomes of the *Improved Manure Storage BMP* to the farmer, a discounted cash flow analysis (DCF) was conducted. The DCF is used to present the private costs and benefits associated with the *Improved Manure Storage BMP* over the life of the BMP to a producer. The project lifespan of an Improved Manure Storage BMP is assumed to be 20 years.

Values included in the DCF included:

- Producer capital contribution to project
- Additional capital expenses incurred by producer
- Repair and maintenance savings
- Labour savings
- Fertilizer savings
- Manure application labour savings
- Manure application savings

Depending on the specification of the discount rate, aggregate benefits for dairy operations ranged from a low of $40,459 to a high of $82,417 while the costs were invariant at $115,811 (Table 10). The net present values at all discount rates were negative. They ranged from a low of -$75,353 in the case of an 8% discount rate to a high of -$33,395 in the case of a 0% discount rate. All NPVs are negative due to the significant capital cost of an *Improved Manure Storage BMP,* which averages $115,811 per farm or $140,310 per farm including the *BMP programs* contribution.

Table 10. Private Benefit, Cost, and NPV of the Discounted Cash Flow Analysis for Dairy Operations[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$82,417	$115,811	-$33,395
3 %	$61,308	$115,811	-$54,504
8 %	$40,459	$115,811	-$75,353

[a] Values are in 2012 Canadian dollars.

Depending on the specification of the discount rate aggregate benefits, for non-dairy operations ranged from a low of $5,253 to a high of $10,700 while the costs were invariant at $40,745 (Table 11). The net present values at all discount rates were negative. They ranged from a low of -$35,493 in the case of an 8% discount rate to a high of -$30,045 in the case of a 0% discount rate.

Table 11. Private Benefit, Cost, and NPV of the Discounted Cash Flow Analysis for Non-Dairy Operations[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$10,700	$40,745	-$30,045
3 %	$7,959	$40,745	-$32,786
8 %	$5,253	$40,745	-$35,493

[a] Values are in 2012 Canadian dollars.

Public Benefits of the Improved Manure Storage BMP

The public benefits of the *Improved Manure Storage BMP* include reduced nutrient leaching and runoff and N_2O emissions due to less winter manure spreading. All respondents felt the *Improved Manure Storage BMP* provided a benefit to society. Reasons provided included:

- Reduced nutrient leaching and runoff;
- Reduced N_2O emissions;
- Better land stewardship practices; and,
- Reduced odour.

Improved Manure Storage BMP Cost Benefit Analysis

To understand the economic outcomes of BMP adoption, a cost benefit analysis methodology was used.[22] The project lifespan of an Improved Manure Storage BMP is assumed to be 20 years.

Public benefits (i.e. reduced nutrient leaching and runoff, reduced N_2O emissions) were not included in the analysis due to uncertainty around estimates. Public costs (i.e. the cost of the *BMP programs* contribution) were included. Appendix III contains a summary of the average costs and benefits used to calculate the *Improved Manure Storage BMP* CBA.

Values included in the CBA included:

- Producer capital contribution to project;
- *BMP programs* cost-share contribution to project;
- Additional capital expenses incurred by producer;
- Repair and maintenance savings;
- Labour savings;
- Fertilizer savings;
- Manure application labour savings; and,
- Manure application savings.

All of the net present values calculated for the *Improved Manure Storage BMP* to date are negative, as are the estimates of net present value over the life of the program (20 years) and for adding a new producer. The negative net present values suggesting that the costs of this BMP are greater than the benefits based on those considered. However, the NPVs could become positive if public benefits such as the values of reduced nutrient runoff and

[22] Refer to Appendix VII for the detailed CBA methodology used for this study.

leaching were included in the CBA. Details of the three net present value calculations are provided below in Tables 12 and 13.

Net Present Value of the Program to Date

Depending on the specification of the discount rate, aggregate benefits for dairy operations ranged from a low of $1,133,229 to a high of $1,324,116, while the costs ranged from a low of $8,561,967 to a high of $12,170,035 (Table 12). The net present values calculated for the program to date were negative. They ranged from a low of -$10,845,919 in the case of an 8% discount rate to a high of -$7,428,738 in the case of a 0% discount rate.

Table 12. Benefit, Cost, and NPV of the Program to Date for Dairy Producers[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$1,133,229	$8,561,967	-$7,428,738
3 %	$1,201,029	$9,789,219	-$8,588,189
8 %	$1,324,116	$12,170,035	-$10,845,919

[a] Values are in 2012 Canadian dollars.

Depending on the specification of the discount rate, aggregate benefits for non-dairy operations ranged from a low of $108,841 to a high of $124,704, while the costs ranged from a low of $3,021,314 to a high of $4,064,635 (Table 13). The net present values calculated for the program to date were negative. They ranged from a low of -$3,939,931 in the case of an 8% discount rate to a high of -$2,912,473 in the case of a 0% discount rate.

Table 13. Benefit, Cost, and NPV of the Program to Date for Non-Dairy Producers[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$108,841	$3,021,314	-$2,912,473
3 %	$114,506	$3,380,566	-$3,266,060
8 %	$124,704	$4,064,635	-$3,939,931

[a] Values are in 2012 Canadian dollars.

Net Present Value over the Expected Life of the Program

Depending on the specification of the discount rate, aggregate benefits for a dairy operation ranged from a low of $3,508,025 to a high of $5,027,417, while the costs ranged from a low of $8,702,327 to a high of $12,397,979 (Table 14). The net present values calculated for the program over its expected lifetime were negative. They ranged from a low of -$8,889,954 in the case of an 8% discount rate to a high of -$3,674,911 in the case of a 0% discount rate.

Table 14. Benefit, Cost, and NPV over the Expected Life of the Program for Dairy Producers[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$5,027,417	$8,702,327	-$3,674,911
3 %	$4,275,812	$9,958,293	-$5,682,481
8 %	$3,508,025	$12,397,979	-$8,889,954

[a] Values are in 2012 Canadian dollars.

Depending on the specification of the discount rate, aggregate benefits for non-dairy producers ranged from a low of $380,844 to a high of $577,800, while the costs ranged from a low of $3,021,314 to a high of $4,056,634 (Table 15). The net present values calculated for the program over its expected lifetime were negative. They ranged from a low of -$3,675,790 in the case of an 8% discount rate to a high of -$2,443,514 in the case of a 0% discount rate.

Table 15. Benefit, Cost, and NPV over the Expected Life of the Program for Non-Dairy Producers[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$577,800	$3,021,314	-$2,443,514
3 %	$480,544	$3,377,944	-$2,897,400
8 %	$380,844	$4,056,634	-$3,675,790

[a] Values are in 2012 Canadian dollars.

Net Present Value of Adding one Farmer in 2012

Depending on the specification of the discount rate, aggregate benefits for one dairy operation ranged from a low of $40,459 to a high of $82,417, while the costs were invariant at $140,360 (Table 16). The net present values calculated for adding an agricultural producer today were negative. They ranged from a low of -$99,901 in the case of an 8% discount rate to a high of -$57,943 in the case of a 0% discount rate.

Table 16. Benefit, Cost, and NPV of Adding One Dairy Farmer to the Program in 2012[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$82,417	$140,360	-$57,943
3 %	$61,308	$140,360	-$79,053
8 %	$40,459	$140,360	-$99,901

[a] Values are in 2012 Canadian dollars.

Depending on the specification of the discount rate, aggregate benefits for one non-dairy operation ranged from a low of $5,253 to a high of $10,700, while the costs were invariant at $55,950 (Table 17). The net present values calculated for adding an agricultural producer today were negative. They ranged from a low of -$50,698 in the case of an 8% discount rate to a high of -$45,250 in the case of a 0% discount rate.

Table 17. Benefit, Cost, and NPV of Adding One Non-Dairy Farmer to the Program in 2012[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$10,700	$55,950	-$45,250
3 %	$7,959	$55,950	-$47,991
8 %	$5,253	$55,950	-$50,698

[a] Values are in 2012 Canadian dollars.

3.1.9 The Social and Motivating Factors of Improved Manure Storage BMP Uptake

This section will present the results of a series of questions about various personal and social aspects of BMP adoption to try to understand the following:

- The motivations for uptake of the *Improved Manure Storage BMP*; and
- The barriers to uptake of the *Improved Manure Storage BMP* by other farmers.[23]

[23] Motivations and barriers were determined from the BMP evaluation survey and interviews.

Motivations for Uptake of the Improved Manure Storage BMP

When asked explicitly the main reasons why they decided to implement the *Improved Manure Storage BMP,* respondents indicated that their main reasons were to:

- Avoid the environmental impacts of spreading manure in the dormant season (30% of respondents);
- Improve the timing and flexibility of manure spreading or to use manure nutrients more effectively (30% of respondents);
- Meet environmental regulations and standards (15% of respondents);
- Improve the aesthetics of their farm and improve public perception of their farm (15% of respondents);
- Improve manure or compost control (10% of respondents); and,
- Improve the efficiency of the farm (10% of respondents).

Respondents were also asked to rate on a scale of 1 to 5 (not important to very important), the reasons why they chose to adopt the *Improved Manure Storage BMP* from a list of possible motivations (Table 18). Increasing the flexibility of manure management (i.e. manure spreading) was listed as the largest motivating factor (4.2). Demonstrating stewardship and avoiding environmental impacts were rated as the second highest motivating factors (3.8 and 3.6 respectively). Interestingly, "improving nutrient management on my farm" was rated the lowest motivating factor (2.6), perhaps indicating that increased manure storage capacity is not considered the most important nutrient management tool employed on farms prior to implementing the BMP. For the most part, those who implemented the *Improved Manure Storage BMP* had identified the need to increase their manure storage capacity regardless of the *EFP* and *BMP programs*, and the BMP funding provided the extra incentive to do the project.

Table 18. Motivating factors for uptake of the Improved Manure Storage BMP.

Motivation	Average Score
Increasing the flexibility of manure management	4.2
Demonstrating stewardship	3.8
Limiting the farm's impact on the environment	3.6
Improving the profitability of my operation	3.4
Improving the long-term sustainability of my operation	3.2
Avoiding spreading manure in not advised periods	3.2
Meeting regulatory requirements	3.0
Contributing to a positive industry image	2.8
Improving nutrient management on my farm	2.6

Barriers to Uptake of the Improved Manure Storage BMP

Respondents were asked to indicate what the main barriers to uptake of the *Improved Manure Storage BMP* are for other producers in their industry. Responses included:

- The cost of implementing the project versus small financial returns (65% of respondents);
- Lack of interest in making on-farm improvements (30% of respondents);
- Producers are nearing retirement (10% of respondents);
- The *BMP programs* cost-share levels are inadequate (*while the BMP was funded*) (10% of respondents).

Similar to the motivation question described above, respondents were asked to rate on a scale from 1 to 5 (not a barrier to a large barrier) a set of barriers to *Improved Manure Storage BMP* uptake. The exact wording of the question was “In your opinion, how significant are the following barriers to the adoption of the *Improved Manure Storage BMP* for other producers in your industry?” The perceived cost of BMP implementation was rated as the largest barrier to uptake of the BMP (4.3). A lack of understanding or awareness of the environmental risks and benefits of the BMP appear to be mild barriers to uptake of the BMP (Table 19).

Table 19. Barriers to uptake of the Improved Manure Storage BMP.

Barrier	Average Score
The perceived costs of BMP adoption	4.3
A lack of time or labour	3.5
Inadequate cost-share levels provided by the BMP programs	3.0
Barriers to accessing funding through the BMP programs	2.6
Lack of awareness of risks to the environment from farm practices	2.5
A lack of understanding about how the BMP will benefit their operation	2.5
A lack of understanding about which BMPs will benefit their operation	2.2
No succession plan for their farm	2.2
A lack of public pressure	2.2
A lack of industry pressure	2.0
Other environmental priorities take precedent	2.0
A lack of support from public agencies	1.5

3.1.10 Improved Manure Storage BMP SWOT Analysis

A SWOT Analysis is presented in this section to organize some of the main findings of the BMP evaluation as well as present anecdotal information that may not be presented in the above sections. Note that this section is only the preliminary step in a SWOT analysis and further steps including a detailed analysis and development of an action plan often follows this step in order to direct policy.

Strengths

- The highest utilization of the *Improved Manure Storage BMP* has been by the dairy and poultry sectors.
- The *Improved Manure Storage BMP* has helped reduce the amount of spreading that took place during non-advised periods.

- The BMP has increased the flexibility of manure spreading timing, allowing producers to avoid spreading during poor conditions.
- The BMP has allowed farmers to utilize manure more effectively as a fertilizer.
- On-farm benefits of the BMP include reduced labour and maintenance costs.
- *Improved Manure Storage BMPs* improve the public perception of the farm and help to demonstrate due diligence on the part of the farm.
- In some cases, the BMP funding provided was the incentive to complete the project.
- *Improved Manure Storage BMPs* as well as *NMPs* give a farmer the tools and facilities to effectively manage and apply nutrients.

Weaknesses

- The capital cost of an average *Improved Manure Storage BMP* is a deterrent.
- The results of the financial analysis indicate that the BMP offers little financial benefit to the individual farm operation.
- During the time that BMP funding was offered, manure storage was increased to approximately 7 months capacity (existing industry standard). As standards and regulations change, the BMP may become inadequate.
- Some producers (28%) indicated that they had expanded their herd size since the time the BMP was implemented. In these cases, the manure storage BMP may not be adequate for their operations. When asked if they felt their current manure storage was adequate for their current operations, 21% of respondents indicated they felt their current manure storage was inadequate.
- BMP funding has not been offered since the 2010/2011 program year, therefore producers who did not access funding when it was available do not have the BMP funding incentive to increase their manure storage capacity. Some interviewees indicated that some producers in their industry still do not have adequate manure storage capacity.

Opportunities

- More reliable program funding and more flexible timelines for project approval could help increase uptake.
- A selling feature of the BMP is that adequate manure storage capacity is essential for managing nutrients in a means that maximizes the financial benefits of manure.
- Farmer awareness of the nutrient benefits of manure is increasing, potentially increasing demand for this BMP in the future.
- New technologies such as manure separators and bedding masters can help farms control the amount of manure stored in their current facilities extending the manure storage capacity without having to increase the size of the storage facility.
- The pending introduction of new regulations that govern the storage of manure on farms in BC may create the need for increased manure storage capacity and subsequently increase uptake of the *Improved Manure Storage BMP* if cost-sharing is available.

Threats

- There is a perception that an investment in manure storage will not generate as much revenue as an investment in other parts of the operation such as quota.
- Farms with no succession plan lack the incentive to invest in *Improved Manure Storage BMPs.*

- The manure storage capacity of the farm is linked to livestock numbers. As farms consolidate and increase in size, existing manure storage may become inadequate and the benefits of the BMP may not continue.
- The pending introduction of new regulations that govern the storage of manure on farms in BC may deem current *Improved Manure Storage BMP* projects insufficient, as they may not provide adequate manure storage capacity.

3.1.11 Conclusions and Recommendations for the Improved Manure Storage BMP

This section provides an overview of the main conclusions of the BMP evaluation. Recommendations will also be provided where appropriate. Note that these conclusions and recommendations are based on the authors' opinions and reflect both qualitative and quantitative information collected during the evaluation.

Did the BMP have the outcomes it was designed to have?

The *Improved Manure Storage BMP* is intended to address environmental risks associated with spreading manure in the non- advised period including potential for nutrient loss to the surrounding environment.

The BMP appears, in all cases, to be meeting the environmental objectives that it is intended to. Prior to BMP implementation, the average producer had 3.1 months of storage and post BMP implementation the average producer had 7.1 months of storage. All respondents indicated that they no longer spread any manure during the non-advised period. From these results we assume that the BMP has been effective at reducing nutrient loss to the environment from spreading manure during the not advised period; however, environmental testing to confirm this was beyond the scope of this evaluation.

Did the BMP meet the expectations of producers?

In our opinion, the BMP has met the expectations of producers. All respondents who spread manure on their farm indicated that the implementation of the BMP had increased the flexibility of timing of their manure application. For producers who don't spread manure on their land, but ship manure off the farm, the BMP has allowed the farm to store manure in a manner that minimizes nutrient loss while waiting to be shipped off-farm. It is important to note however that in most cases, the BMP does not provide a financial benefit to the farmer.

The BMP can also help the producer to use manure more effectively as fertilizer by applying it at times where crops can utilize it. The results of the evaluation show that 27% of respondents indicated that crop yields had improved since implementation of the BMP; however in our opinion, it is difficult to attribute the change to increased manure storage capacity only as often producers had made other changes to their nutrient management regime that may have also impacted crop yields.

The criteria used to generate this recommendation was:

Is the BMP effective at mitigating environmental risks?

- Yes the BMP appears to be effective at reducing nutrient loss from manure spreading during the not advised period.

Does the BMP provide the expected outcomes to producers?

- Yes, producers indicate that their expectations were met by the BMP, although there was little financial benefit to the producer.

Does the BMP provide a benefit to society?

- Our analysis shows that over the lifetime of the BMP (20 years), the BMP does not have a positive net benefit to society. However, because we were not able to value the decrease in nutrient loss to the environment and decrease in the N_2O emissions it is possible that the BMP does provide a benefit to society.

3.2 Nutrient Management Planning

Evaluation Summary

The *Nutrient Management Planning Beneficial Management Practice* (*NMP*) is intended to address environmental risks associated with nutrient management (i.e. manure and/or chemical fertilizer) on BC farms. *BMP programs* have cost-shared consulting services to develop nutrient management plans, planning and decision support tools.

The average cost of completing a *NMP* project was $1269. The *BMP programs* provided an average of $1236 in cost-share dollars to producers per Nutrient Management Plan. Between 2009/10 and 2011/2012, producers contributed $4806 and the *BMP programs* contributed a total of $186,467 towards *Nutrient Management Planning.*

In total, 147 *Nutrient Management Plans* were completed across BC between 2009/10 and 2011/12. The dairy industry has accounted for the highest uptake of *NMP* projects in this category to date (57 *NMP*s to date). Other commodities that have completed several *NMP*s include the hog, chicken and beef industries.

Approximately half of respondents indicated they changed their nutrient management practices after completing the *NMP*. Of those who made changes based on their *NMP*, the *NMP* prompted a variety of changes in nutrient management practices. Almost all survey respondents implemented new on-farm technologies after completing an *NMP*. Manure storage was the most popular technology implemented after the completion of the *NMP*, followed by manure application equipment.

The benefits experienced by producers who completed a *NMP* included but were not limited to:

- Increased understanding of nutrient management;
- Access to funding for other manure and nutrient related BMPs;
- Potential for reduced odour and ammonia emissions;
- Potential for increased crop yields;
- Potential for decreased fertilizer usage (and associated costs); and
- Potential for improved livestock health.

The results of the discounted cash flow analyses indicate that generally for producers who crop, the *NMP* provides a financial benefit. However, for producers who do not produce crops, the *NMP* does not provide a direct financial benefit. Similarly, the results of the cost-benefit analyses indicate that the net present value of *Nutrient Management Planning* is positive over a three year lifespan for producers who crop, but negative for producers who do not crop.

3.2.1 Introduction to the Nutrient Management Planning BMP

The *Nutrient Management Planning Beneficial Management Practice* (herein referred to as the *NMP*) is intended to address environmental risks associated with nutrient management (i.e. manure and/or chemical fertilizer use) on BC farms. The environmental risks associated with application of nutrients include the potential for negative impacts on water and air quality if nutrients are over applied or applied in sub-optimal conditions. The nutrients of greatest concern to the environment are nitrogen and phosphorous. When nutrients are properly managed for optimal animal or plant production, impacts to the environment are generally minimized because nutrients are being used efficiently.[24]

BMP programs have cost-shared consulting services to develop nutrient management plans, planning and decision support tools. Proper management of nutrients can minimize risk of water pollution by loss of nitrogen or phosphorous via runoff or leaching, minimize risk of air pollution by loss of nitrogen as ammonia or N_2O, and help achieve optimal crop yields through the appropriate application of nutrients.[25] [26]

3.2.2 Evaluation Survey Response

A total of 20 interviews and site visits were conducted. Eleven surveys were returned totaling 31 respondents. The survey response rate including interviews and returned surveys was 21%.

3.2.3 Cost-Share Structure and BMP Implementation Costs

Funding for the *NMP* was available between the 2009/10 and 2011/12 program years. Cost-share funding was available for consulting services to develop nutrient management plans, planning and decision support tools, soil, manure and compost analyses. Manure, soil, and compost analyses are also funded up to a maximum of $250. Eligible farms could receive up to $1500 towards the completion of a Nutrient Management Plan. Funding for the completion of one follow-up *NMP* was also available, up to 50% of the original *NMP* in subsequent years.

The average cost of a *NMP* project, taking into account only the eligible costs was $1269. The *BMP programs* provided an average of $1236 in cost-share dollars to producers per Nutrient Management Plan. Note a minority of producers (15%) who conducted an *NMP* for their farm operation did not have 100% of the cost of completing the *NMP* funded by the *BMP programs.* Of this 15%, the average cost paid by the producer was $172. Between 2009/10 and 2011/12, producers contributed $4806 and the *BMP programs* contributed a total of $186,467 towards *Nutrient Management Planning.*[27]

3.2.4 *NMP* Uptake Statistics

This section reports the *NMP* implementation and distribution statistics for the period between 2009/10 and 2011/12. The data sources for this section included the ARDCorp program files as well as data collected through the BMP evaluation survey.

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[24] National Farm Stewardship Program. (2006). *Beneficial management practices descriptions.* Ottawa, ON: Agriculture and Agri-Food Canada.
[25] 2012-2013 Growing Forward BMP List.
[26] Consult the *Nutrient Planning Reference Guide* for more information about NMP process.
[27] Project costs were determined using the ARDCorp BMP programs data.

Distribution of NMP Uptake by Region

A total of 147 *Nutrient Management Plans* were completed across BC between 2009/10 and 2011/12. Figure 8 and Table 20 display the regional distribution of implementation for this BMP. [28]

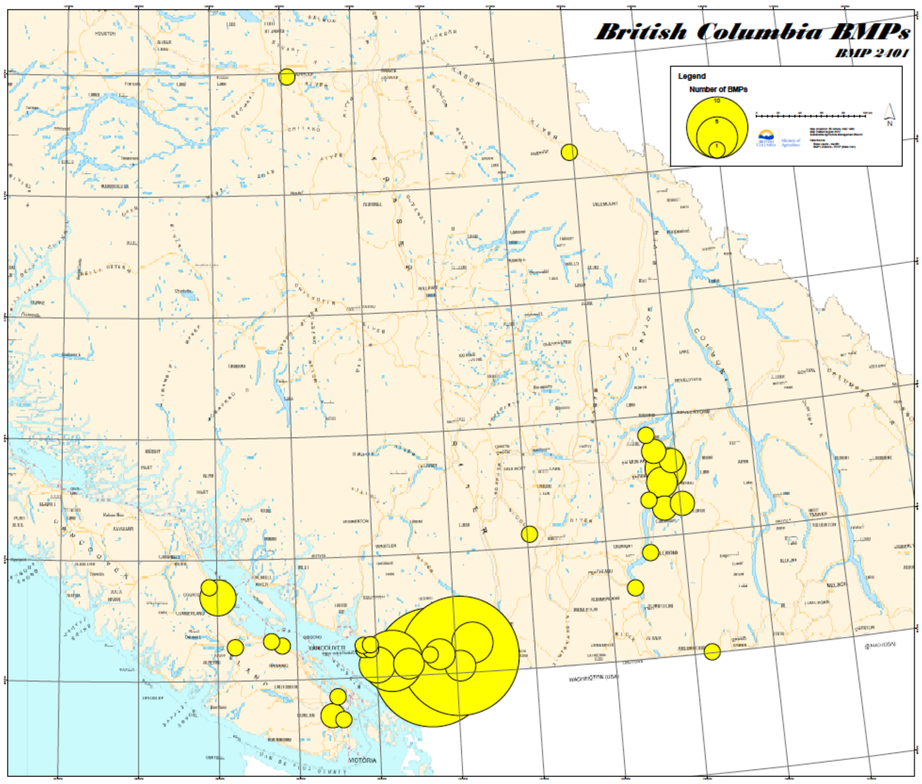

Figure 8. Map of Nutrient Management Planning uptake between 09/10 and 11/12.

[28] The regional distribution of NMP uptake was determined using the ARDCorp BMP programs data.

Table 20. The number of *NMP*s implemented in each Regional District.

Regional District	Number of *NMP* Projects
Fraser Valley	98
North Okanagan	16
Metro Vancouver	12
Comox Valley	5
Capital	3
Columbia Shuswap	3
Cowichan Valley	2
Nanaimo	2
Bulkley Nechako	2
Thompson-Nicola	1
Central Okanagan	1
Kootenay Boundary	1
Okanagan Similkameen	1

Distribution of NMP Uptake by Commodity

The dairy industry has accounted for the highest uptake of the *NMP* projects in this category to date (39% of total *NMP*s). A total of 57 dairy farms have completed a *NMP* through the *BMP programs* (approximately 11% of all dairy farms in the province in 2012) (Figure 9 and Table 21). Other commodities that have implemented this BMP include the poultry, hog and beef commodities.[29]

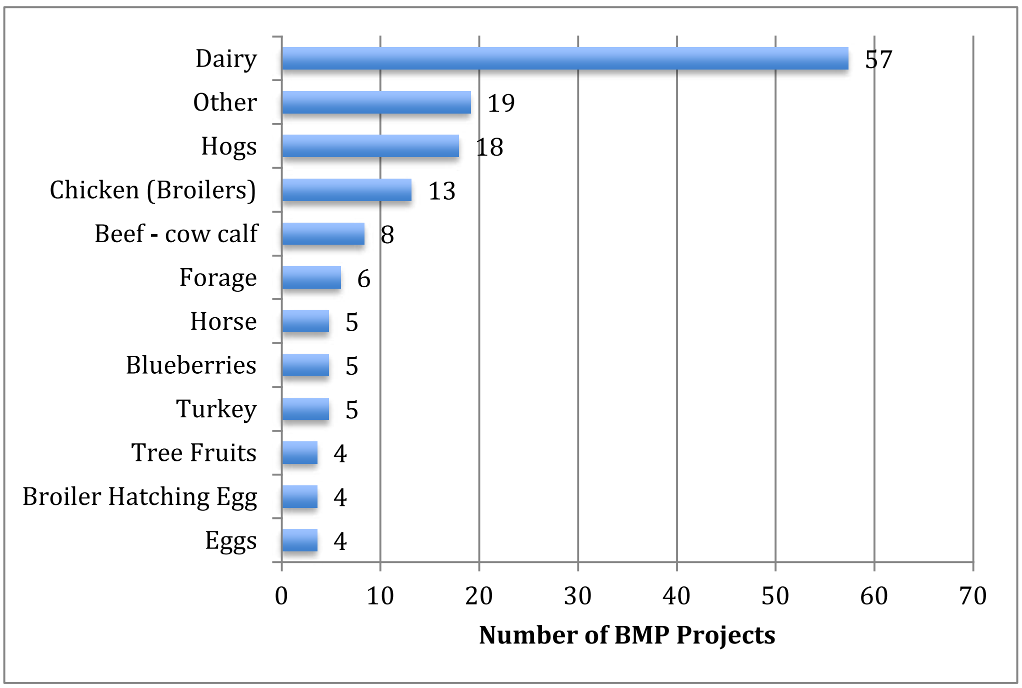

Figure 9. *NMP* uptake by commodity.

[29] NMP uptake by commodity was determined using the ARDCorp program data files.

Table 21. Number of *NMP*s as a percentage of industry.[30]

Commodity	# of *NMP*s	# of Producers in Industry	% of Producers who have completed an *NMP*
Dairy	57	517	11%
Other	19	n/a	n/a
Hogs	18	26	69%
Chicken	13	326	4%
Beef - Cow Calf	8	2500	0%
Forage	6	n/a	n/a
Horse	5	n/a	n/a
Blueberries	5	800	1%
Turkey	5	42	12%
Tree Fruits	4	800	1%
Broiler Hatching Egg	4	58	7%
Eggs	4	208	2%

Uptake Over Time

The rate of uptake of the *NMP* peaked in 2010/2011 and declined in the 2011/12 program year (Figure 9). *NMP* uptake has been positively influenced by the requirement to have a *NMP* to access BMPs related to soil and manure, which began in the 2009/10 program year. Funding for increased manure storage capacity (such as Category 0101) was not available in the 2011/12 program year, which likely impacted the completion of *NMP*s.[31]

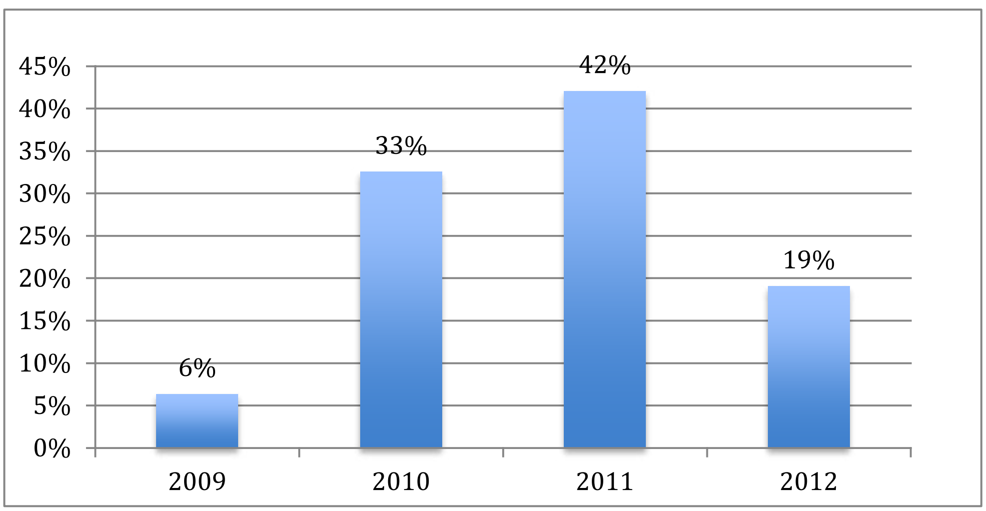

Figure 10. Uptake of the *NMP* by year.

[30] Statistics Canada. (2011). Census of Agriculture Data. Retrieved from http://www29.statcan.gc.ca/ceag-web/eng/data-type-selection-type-donnees?geoId=590000000
[31] Uptake by year was determined from the ARDCorp BMP programs files.

3.2.5 Characteristics of Farms Completing Nutrient Management Plans

The average dairy farm that implemented the *Nutrient Management Planning BMP* had 341 cows and was 135.3 hectares. The average poultry farm had approximately 49000 birds and was 22.8 hectares (Table 22). The average hog farm had 1353 hogs and was 37.5 hectares. All respondents indicated that the farm operators privately owned the land where the BMP was implemented.[32]

Table 22. Characteristics of the average farm that conducted a *NMP*.

Type of Livestock	Average Number of Livestock	Median Number of Livestock	Average Area of Farm (ha)	Median Area of Farm (ha)
Dairy (Milking Cows)	341	295	135.3	70
Poultry	49171	34813	22.8	8
Hogs	1353	1100	37.5	29
Other	146	38	95.7	14

Farm Gate Sales

The majority of respondents to the *Nutrient Management Planning BMP* survey had farm gate sales of $500,000 and above (Table 23).[33]

Table 23. Farm Gate Sales of *NMP* survey respondents.

Farm Gate Sales in 2011	Percentage of Respondents
$9,999 and less	0.0%
$10,000 - $24,000	0.0%
$25,000 - $49,999	0.0%
$50,000 - $99,999	6.9%
$100,000 - $249,000	3.4%
$250,000 - $500,000	20.7%
$500,000 and above	69.0%

Farming Experience

The average number of years that producers who implemented the *NMP* have farmed is 28 years. The average time farmed on the property where the *NMP* was conducted was 22 years.[34]

3.2.6. The Nutrient Management Plan in Practice

This section gives a brief overview of the how the *NMP* has, in general, been implemented on farms. The *BMP programs* funding went towards the completion of an *NMP* and the producer had the option to implement any part or the entire plan. The following section discusses the changes that occurred on-farm after conducting an *NMP*.[35]

[32] Farm characteristics were determined from the ARDCorp BMP programs files.
[33] Farm gate sales were determined from the BMP evaluation survey.
[34] Farming experience was determined from the BMP evaluation survey.
[35] The on-farm outcomes of NMP completion were determined by the BMP evaluation survey.

Changes in Nutrient Management Practices on Farms

Approximately half (55%) of respondents indicated they changed their nutrient management practices after completing the *NMP*. Table 24 summarizes the on-farm changes that occurred after completion of the *NMP*.

Table 24. Changes in nutrient management practices as a result of *NMP* completion.

Changes in Nutrient Management Practices	Percentage of Respondents
Manure or Fertilizer Application Rates	55%
Method of Manure or Fertilizer Application	27%
Manure or Fertilizer Application Timing	19%
Other	6%
Livestock Numbers	3%
Spreading Setback Distances	3%
Application of Other Nutrient Sources	3%

Changes in On-Farm Technologies

Almost all (97%) of survey respondents went on to implement new on-farm technologies after completing their *NMP*. Manure storage was the most popular technology implemented after the completion of the *NMP* followed by manure application equipment. Other on-farm technologies not listed included bedding makers, in vessel mortality composters, and wash water recirculation.

Table 25. On-farm technologies implemented after *NMP* completion.

On Farm Technologies	# Implemented
Improved Manure Storage (volume or cover)	61%
Manure Application Equipment	17%
Other	10%
Manure Treatment Facilities	7%
Manure Separators	3%

Follow Up Nutrient Management Plans

Sixteen percent of respondents indicated that they had conducted a follow up Nutrient Management Plan.

3.2.7 The Environmental Outcomes of the Nutrient Management Plan BMP

The above sections provide insight into how the *Nutrient Management Plan* has been implemented in practice, whereas this section provides insight into the environmental outcomes that the BMP has had on farms where it has been implemented.[36]

The indicators used to understand the environmental outcomes of the *NMP* were:

- Change in nutrient application rates; and
- Change in the setback distances associated with manure/fertilizer application.

Change in Nutrient Application Rates

When asked explicitly what aspects of their *NMP* they implemented, a quarter (27%) of respondents indicated that they changed their nutrient application rates as a result of *Nutrient Management Planning*. However, when asked to indicate their average manure application rates prior to conducting their *NMP* and after conducting their *NMP*, respondents indicated that very little actual change in application rates had occurred. There is a chance that respondents did not remember what their application rates were or were not aware of their application rates prior to *NMP* completion and therefore survey responses were not accurate.

Change in Spreading Setbacks

Ten percent of respondents indicated that they increased their manure spreading buffer due to the completion of their *NMP*. The average buffer width between nutrient application areas and surface water (e.g. ditches, streams, ponds), well and buildings has increased slightly as a result of completing the *NMP* (Table 26).

Table 26. The change in manure application buffer widths.

	Average Spreading Setback	Median Spreading Setback
Setback Pre-BMP	14.51 m	5.33 m
Setback Post-BMP	16.50 m	7.05 m

3.2.8 The Financial and Economic Outcomes of the *NMP*

This section will present the on-farm benefits that farmers and ranchers experienced after completing *NMPs* as well as the costs that they incur when doing so. The financial and economic outcomes were analyzed and are presented for dairy and non-dairy operations.

To assess the private financial outcomes of the *NMP* to the average farmer a discounted cash flow (DCF) analysis was conducted. The results of the DCF are presented below in this section. To assess the economic outcomes of the *NMP* to society a CBA was conducted. The results of the CBA are presented below in this section as well.

On-Farm Benefits and Costs of the Nutrient Management Planning BMP

A series of survey questions aimed at assessing the costs and benefits experienced by farmers due to the completion of the *NMP*. The following sections present the results of these survey questions.

[36] Environmental outcomes were determined by the BMP evaluation survey.

Increased Understanding of Nutrient Management

Eighty-five percent of respondents who crop indicated that the completion of the *NMP* increased their understanding of nutrient management on their farm. Ninety three percent of respondents who crop also stated that they found the *NMP* useful for their operation. In general, respondents found that the *NMP* provided them with information about the state of their operation and nutrient management on their farm. Respondents indicated that the *NMP* gave them a better understanding of a variety of areas of nutrient management including:

- Better utilization of manure as a fertilizer;
- Land stewardship practices;
- Appropriate manure application practices;
- Appropriate soil nutrient levels and the influence of fertilizers (i.e. manure, chemical) on those levels; and
- Soil testing and monitoring.

Completing NMPs to Access Funding for other BMPs

The *BMP program* now requires that producers complete a *NMP* to gain access to funding for a variety of other manure and nutrient related BMPs including the *Improved Manure Storage BMP*. Thus, completing the *NMP* allowed producers to potentially access additional BMPs. For some respondents, accessing other BMP funding was the primary reason for completing the *NMP*.[37]

Reduced Odour and Ammonia Emissions

The completion of a nutrient management plan can limit spreading during non-advised periods and promote the more efficient use of manure. In some cases, this can lead to benefits including reduced odour and ammonia emissions.

Change in Crop Yields

Respondents were asked if they experienced an increase in crop yields as a result of completing their *NMP*. Twenty-six percent of respondents who crop indicated that they experienced an increase in crop yields. On average, respondents who crop experienced a $361.53 per year increase in crop yields per farm ($27/hectare). Respondents who do not crop did not experience a change in crop yields.

Change in Fertilizer Usage

Twenty-two percent of respondents who crop indicated that their *NMP* resulted in a decrease in annual fertilizer costs equal to $6333.33 on average per farm. Seven percent of respondents who crop indicated that their *NMP* led to an increase in fertilizer costs

[37] Note that the analysis presented in the *NMP* section considers only the changes that resulted from the NMP and does not include changes that occurred as a result of the implementation of other BMPs. The survey stated that respondents should report changes resulting from the *NMP* specifically. However, it is possible that some respondents may have attributed on-farm changes resulting from other BMPs to the NMP.

equal to $400 on average per farm. Finally, 74% of respondents who crop indicated that there was no change in fertilizer costs as a result of the *NMP*.

On average across all respondents who crop, the *NMP* led to $459.26 per year in fertilizer savings.[38] Note that this calculation does not take into account the change in the price of fertilizer. Respondents who do not crop did not experience a change in fertilizer costs.

Improved Livestock Health

In some cases, *NMPs* identified high levels of potassium, which have the potential to lead to livestock health issues. When the potassium levels were reduced through the implementation of the *NMP*, these producers indicated livestock health improved.

NMP Discounted Cash Flow Analysis

To understand the financial outcomes of *NMPs* to the average farmer, a DCF was conducted to present the private costs and benefits associated with the *NMP* over the life of the *NMP*. The project lifespan of an *NMP* is assumed to be 3 years.

Values included in the DCF included:

- Producer capital contribution to *NMP*;
- Fertilizer savings; and,
- Increased crop yields.

Depending on the specification of the discount rate, aggregate benefits for producers who crop ranged from a low of $2,115 to a high of $2,462, while the costs were invariant at $38 (Table 27). The net present values at all discount rates were positive. They ranged from a low of $2,077 in the case of an 8% discount rate to a high of $2,425 in the case of a 0% discount rate. All NPVs are positive due to the minimal cost of the *NMP* to the farmer compared to the fertilizer cost savings and increase in crop yields that resulted from implementing the *NMP*.

Table 27. Private Benefit, Cost, and NPV of the Discounted Cash Flow Analysis for Producers who Crop[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$2,462	$38	$2,425
3 %	$2,322	$38	$2,284
8 %	$2,115	$38	$2,077

[a] Values are in 2012 Canadian dollars.

For producers who do not crop, the *NMP* provides no benefits and has a minimal cost of $2 to the operation (Table 28). Irrespective of the discount rate, the net present values were equal to -$2. These findings demonstrate that the *NMP* provides limited private benefits to producers who do not crop directly related to the *NMP*.

[38] One respondent experienced a $45,000 decrease in annual fertilizer costs, while another respondent experienced a $40,000 increase in annual fertilizer costs. These two cases were considered outliers and were excluded from the calculation of averages. However, they were counted as having experienced either a decrease or increase in annual fertilizer costs.

Table 28. Private Benefit, Cost, and NPV of the Discounted Cash Flow Analysis for Producers who Do Not Crop[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$0.00	$2	-$2
3 %	$0.00	$2	-$2
8 %	$0.00	$2	-$2

[a] Values are in 2012 Canadian dollars.

Public Benefits of Nutrient Management Plans

Public benefits of *NMPs* occur where the *NMP* is implemented and improves nutrient management practices that may have been causing a negative environmental impact. For example, *NMPs* can increase setbacks for manure application in instances where buffers were insufficient or nonexistent prior. *NMPs* can also modify nutrient (i.e. manure or chemical fertilizer) application timing and rates to avoid the application of nutrients, during times of increased potential for nutrient runoff and leaching as well as N_2O emission generation. Eighty one percent of respondents indicated they felt the *NMP* provided a benefit to society. Reasons provided by respondents included:

- Reduction in nutrient runoff and leaching;
- Reduction in N_2O emissions;
- Better land stewardship practices;
- Producers have more information to make better on-farm decisions; and,
- Reduced odour and ammonia emissions.

NMP Cost Benefit Analysis

To understand the economic outcomes of *NMP* uptake, a cost benefit analysis methodology was used. The project lifespan of a *NMP* is assumed to be 3 years.

Public benefits (i.e. reduced nutrient leaching and runoff, reduced N_2O emissions) were not included in the analysis due to a lack of reliable data and uncertainty around estimates. Public costs (i.e. the cost of the *BMP programs* contribution) were included. Appendix III contains a summary of the average costs and benefits used to calculate the *NMP* CBA.

Values included in the CBA included:

- Producer capital contribution to *NMP*;
- *BMP programs* cost-share contribution to *NMP*;
- Fertilizer savings; and,
- Increased crop yields.

All of the net present values calculated for the *NMP* to date are positive, as are the estimates of net present value over the life of the program (3 years) and for adding a new producer. The positive net present values suggesting that the benefits of the *NMP* are greater than the costs. These results suggest that the *NMP* has economic justification. Details of the three net present value calculations are provided below in Tables 29 to 34.

Net Present Value of the Program to Date

Depending on the specification of the discount rate, aggregate benefits for producers who crop ranged from a low of $129,685 to a high of $133,935 while the costs ranged from a low of $159,786 to a high of $176,473 (Table 29). The net present values calculated for the program to date were all negative. They ranged from a low of $-$42,539 in the case of an 8% discount rate to a high of -$30,101 in the case of a 0% discount rate.

Table 29. Benefit, Cost, and NPV of the Program to Date for Producers who Crop[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$129,685	$159,786	-$30,101
3 %	$131,267	$165,919	-$34,652
8 %	$133,935	$176,473	-$42,539

[a] Values are in 2012 Canadian dollars.

For producers who do not crop, there is no benefit associated with the *NMP*. Depending on the specification of the discount rate aggregate costs ranged from a low of $24,577 to a high of $26,909 for producers who do not crop (Table 30). The net present values calculated for the program to date were all negative. They ranged from a low of -$26,909 in the case of a 8% discount rate to a high of -$24,577 in the case of a 0% discount rate.

Table 30. Benefit, Cost, and NPV of the Program to Date for Producers who Do Not Crop[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$0	$24,577	-$24,577
3 %	$0	$25,435	-$25,435
8 %	$0	$26,909	-$26,909

[a] Values are in 2012 Canadian dollars.

Net Present Value over the Expected Life of the Program

Depending on the specification of the discount rate, aggregate benefits for producers who crop ranged from a low of $292,020 to a high of $307,796, while the costs ranged from a low of $159,786 to a high of $176,473 for producers who crop (Table 31). The net present values calculated for the program over its expected lifetime were all positive. They ranged from a low of $115,547 in the case of an 8% discount rate to a high of $148,010 in the case of a 0% discount rate.

Table 31. Benefit, Cost, and NPV over the Expected Life of the Program for Producers who Crop[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$307,796	$159,786	$148,010
3 %	$301,351	$165,919	$135,432
8 %	$292,020	$176,473	$115,547

[a] Values are in 2012 Canadian dollars.

For producers who do not crop, there is no benefit associated with the *NMP*. Depending on the specification of the discount rate aggregate costs ranged from a low of $24,577 to a high of $26,909 for producers who do not crop (Table 32). The net present values calculated for the program to date were all negative. They ranged from a low of -$26,909 in the case of a 8% discount rate to a high of -$24,577 in the case of a 0% discount rate.

Table 32. Benefit, Cost, and NPV over the Expected Life of the Program for Producers who Do Not Crop[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$0	$24,577	-$24,577
3 %	$0	$25,435	-$25,435
8 %	$0	$26,909	-$26,909

[a] Values are in 2012 Canadian dollars.

Net Present Value of Adding one Farmer in 2012

Depending on the specification of the discount rate, aggregate benefits for producers who crop ranged from a low of $2,115 to a high of $2,462, while the costs were invariant at $1,278 for producers who crop (Table 33). The net present values calculated for adding an agricultural producer today were all positive. They ranged from a low of $837 in the case of an 8% discount rate to a high of $1,184 in the case of a 0% discount rate.

Table 33. Benefit, Cost, and NPV of Adding One Farmer to the Program in 2012 for Producers who Crop[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$2,462	$1,278	$1,184
3 %	$2,322	$1,278	$1,043
8 %	$2,115	$1,278	$837

[a] Values are in 2012 Canadian dollars.

The addition of one farmer who does not crop to *BMP programs* results in an NPV of -$1,229, irrespective of the discount rate (Table 34).

Table 34. Benefit, Cost, and NPV of Adding One Farmer to the Program in 2012 for Producers who Do Not Crop[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$0	$1,229	-$1,229
3 %	$0	$1,229	-$1,229
8 %	$0	$1,229	-$1,229

[a] Values are in 2012 Canadian dollars.

3.2.9 The Social and Motivating Factors of *NMP* Uptake

This section will present the results of a series of questions about various personal and social aspects of BMP uptake to try to understand the following:

- The motivations for uptake of the *NMP*; and
- The barriers to uptake of the *NMP* by other farmers.[39]

[39] Motivations and barriers were determined from the BMP evaluation survey and interviews.

Motivations for Uptake of the NMP

When asked explicitly in an open-ended format, the main reasons why they decided to complete the *Nutrient Management Plan BMP,* respondents indicated that their main reasons were to:

- Complete the *NMP* requirement to gain access to other BMP funding (48% of respondents);
- Understand how the farm is performing regarding nutrient management and where they can improve nutrient management on their farm (31% of respondents);
- Learn about better stewardship and environmental practices for nutrient management (24% of respondents);
- Address public perception of their operation and ensure due diligence regarding nutrient management (17% of respondents); and
- Reduce fertilizer costs and more effectively utilize manure as a nutrient (7% of respondents).

Respondents were also asked to rate on a scale of 1 to 5 (not important to very important), the reasons why they chose to complete a *Nutrient Management Plan* from a list of possible motivations (Table 35). Improving nutrient management on my farm was listed as the largest motivating factor (3.7). Demonstrating stewardship, improving the long-term sustainability of the farm and contributing to a positive industry image were rated as the second highest motivating factors (3.6, 3.4 and 3.4 respectively).

Table 35. Motivating factors for uptake of the *NMP*.

Motivation	Average Score
Improving nutrient management on my farm	3.7
Demonstrating stewardship	3.6
Improving the long-term sustainability of my operation	3.4
Contributing to a positive industry image	3.4
Limiting the farm's impact on the environment	3.2
Improving the profitability of my operation	3.1
Meeting regulatory requirements	2.8

Barriers to Uptake of NMPs

Respondents were asked, in an open-ended format, to indicate what the main barriers to uptake of the *NMP* are for other producers in their industry. Responses included:

- The cost of the BMP (24% of respondents);
- Lack of awareness of BMP funding and the *NMP* (24% of respondents);
- Paperwork required to complete the *NMP* (14% of respondents);
- Lack of interest in *Nutrient Management Planning* (14% of respondents);
- Concern that the *NMP* will reveal they are doing something wrong (14% of respondents);
- Time required to complete the *NMP* (10% of respondents);
- Poor advertising of the *BMP programs* and *NMP* (3% of respondents);

- Producers that do not crop (e.g. poultry farms) have little need for *NMP*s (3% of respondents);
- Lack of penalties for those that do not properly manage nutrients (3% of respondents); and,
- Lack of incentives for producers once the *NMP* is completed (3% of respondents).

Similar to the motivation question described above, respondents were asked to rate on a scale from 1 to 5 (not a barrier to a large barrier) a set of barriers to *Nutrient Management Planning* uptake. The exact wording of the question was "In your opinion, how significant are the following barriers to the adoption of the *Nutrient Management Planning BMP* for other producers in your industry?" Interestingly, the perceived cost of *NMP* completion was rated as the largest barrier to uptake of the BMP (3.8). This finding indicates that although the cost of completing an *NMP* is generally 100% funded by the *BMP programs*, producers either still perceive the cost of the process to be a barrier or are taking into account the cost of implementing measures associated with *Nutrient Management Planning* when answering this question. A lack of understanding about how the BMP will benefit their operation appears to be a mild barrier to uptake of the BMP (Table 36).

Table 36. Barriers to uptake of *NMP*s.

Barrier	Average Score
Perceived costs associated with *NMP* completion	3.8
A lack of understanding about how the BMP will benefit their operation	3.3
A lack of time or labour	3.2
A lack of awareness of risks to the environment from farm practices	3.1
A lack of understanding about which BMPs will benefit their operation	3.0
Inadequate cost-share levels provided through the BMP programs	2.9
Barriers to accessing funding through the BMP programs	2.8
No succession plan for their farm	2.5
Other environmental priorities take precedent	2.2
A lack of public pressure	1.9
A lack of support from public agencies	1.8
A lack of industry pressure	1.5

3.2.10 Nutrient Management Planning SWOT Analysis

A brief SWOT (Strength, Weaknesses, Opportunities, Threats) Analysis is presented in this section to organize some of the main findings of the *NMP* evaluation as well as present anecdotal information that may not be presented in the above sections. Note that this section is only the preliminary step in a SWOT analysis and further steps including a detailed analysis and development of an action plan often follows this step order to direct policy.

Strengths

- The requirement for producers to complete *NMP*s to access BMP funding for manure and soil related BMPs has increased uptake levels.
- The requirement to complete *NMP*s to access BMP funding has captured producers who may have otherwise not have completed an *NMP*. Of these producers, some indicated that they found the *NMP* to be informative and useful for their operation.
- *Nutrient Management Planning* generally resulted in on-farm financial benefits.
- Respondents indicated that soil testing of individual fields provided useful information about how to manage each field.
- Respondents indicated that manure analysis informed them about the nutrient value of manure, some of who were unaware previously.

Weaknesses

- There are no requirements to implement changes based on the *NMP*s findings and in some cases, respondents indicated that they had no plan to change their practices based on findings.
- There is no clear process for producers to monitor or track nutrient management on the farm after the initial *NMP*. Producers indicated that this was a weakness of the current program.
- The majority of producers who did an *NMP* did not complete the process on their own in subsequent years due to a variety of reasons including lack of awareness of ongoing monitoring processes, lack of ability to use *NMP* software and lack of information regarding how to conduct appropriate follow up activities (e.g. where to send a soil sample).
- For producers that do not apply nutrients on their property, or apply very little of their total manure production, the *NMP* process is perceived to be unnecessary and costly.
- In some cases the current *NMP* does not capture the "end-user" of the nutrients. For example, some poultry producers ship all of their manure off-farm and have no control over how those nutrients are managed past the farm gate.
- Producers perceive a high risk associated with changing nutrient application practices or rates on cropland. This perception may act as a barrier to implementation of *NMP*s.
- There has been relatively low uptake in sectors other than dairy, poultry and hog indicating that perhaps the *NMP* is not being targeted effectively to other commodities.
- Currently *NMP*s are not being targeted to priority areas (such as vulnerable watersheds or other areas). By not targeting priority areas, *NMP* benefits are not being maximized across the province.
- A lack of on-farm record keeping reduces the accuracy and effectiveness of the *NMP*.
- Accessing producers not interested in completing *NMP*s to access other BMP funding is a challenge. For example, crop producers who apply manure and other nutrients but do not produce or store manure are currently not being targeted.

Opportunities

- Field trials and demonstrations of the benefits may help to effectively reduce the perception of risk among producers.

- Demonstrating the business case for and financial benefits of completing a *NMP* could increase uptake.
- Establishing an on-going monitoring component to the *NMP* (e.g. nutrient application calendar, soil testing) that could be self-administered could help promote on-going nutrient management on farms.
- Developing a simple tool to manage nutrient record keeping on-farms may help to increase the usefulness and accuracy of *NMP* activities.
- Promoting the low cost to producers of completing an *NMP* could increase uptake levels.
- Making the *Nutrient Management Planning* spreadsheet tool accessible online and more user friendly could help producers apply the *NMP* in subsequent years, extending benefits.
- Targeting *NMP*s towards priority areas will help to maximize the benefits of the BMP as well as to use *BMP programs* funding most effectively.
- There may be an opportunity to increase the uptake of *NMP*s by administering them through industry associations, thereby capturing producers who have not completed the *EFP*. Administering *NMP*s through industry may also help to gain the trust of potential adopters.
- General increasing awareness of the value of manure as fertilizer amongst producers may help to increase uptake of *NMP*s.

Threats

- Limited understanding of nutrient value and the importance of nutrient management could limit uptake in some instances.
- In some cases, although an *NMP* indicates a deficiency in nutrient management, the producer has no feasible options to change their practices due to operational or financial constraints.
- Producers in some cases receive conflicting information about nutrient management from sources other than their planning advisor.
- Distrust of how *NMP* data and information that is collected from the farm is used may act as a barrier to uptake.

3.2.11 Conclusions and Recommendations for the Nutrient Management Planning BMP

This section provides an overview of the main conclusions of the *NMP* evaluation. Recommendations will also be provided where appropriate. Note that these conclusions and recommendations are based on the authors' opinions and reflect both qualitative and quantitative information collected during the evaluation.

Did the NMP have the outcomes it was designed to have?

Nutrient Management Plans are intended to address environmental risks associated with manure and fertilizer nutrients, including negative impacts on water and air quality by identifying issues with nutrient management practices and identifying potential solutions. It is also intended to increase producer understanding and awareness of appropriate nutrient management practices and the nutrient value of manure.

The *NMP* appears to have been effective at identifying problems with nutrient management practices, particularly on farms where excess nutrients were being applied. It has also been effective at increasing producers' knowledge and understanding of nutrient management. However, in some cases the *NMP* has not been effective at identifying feasible solutions for farms to improve their nutrient management practices. In about half of the cases, respondents indicated that their *NMP* did not lead to any changes on the farm due to financial constraints, lack of feasible solutions and in some cases no identified need for the producer to change practices. There also appears to be little nutrient management monitoring and follow-up activities occurring on-farm, indicating that producers are not using the *NMP* as an ongoing tool for nutrient management.

As with all BMPs cost-shared through the *BMP programs,* it is possible that the *NMP* has not addressed all priority farms or areas (e.g. sensitive watersheds or areas of high concentration of livestock), where the need for *Nutrient Management Planning* is the greatest. Because of this, in our opinion, the *NMP* is not currently having the outcomes that it was designed to have on a province-wide basis.

Did the NMP meet the expectations of producers?

In some cases, the *NMP* appears to be meeting certain expectations of producers. For example, 90% of respondents indicated that the *NMP* was useful for their farm operation, mostly because it helped to identify deficiencies in their nutrient management practices or verified that their practices were appropriate. However, in some cases it appears that the *NMP* has not met the expectations of producers who identified a need to change their practices but are not able to do so due to operational or financial constraints. In other cases, producers did not see the need for the *NMP* and did not see the value in the information received through the process.

Some producers indicated that they would appreciate more financial incentives and emphasis put towards monitoring and follow-up activities so that the *NMP* is useful beyond completion of the initial plan. For example, some producers indicated that they would like to continue to conduct ongoing soil and manure analyses, but were not currently doing so due to lack of awareness of the proper process. Many producers currently do not feel that they are able to complete the *NMP* process on their own to make ongoing management decisions on their farm in subsequent years.

Is the NMP effective at mitigating environmental risks?

- The *NMP* is useful mostly for identifying environmental risks; however, it is difficult to attribute changes to the tool itself. In our opinion, other nutrient management related BMP projects (e.g. improved manure application equipment and increased manure storage capacity) that farms have implemented are responsible for mitigation of environmental risks. The *NMP* has potential to mitigate environmental risks if used as an ongoing tool to help producers make decisions regarding nutrient management.

Does the NMP provide the expected outcomes to producers?

- In some cases the *NMP* has provided positive outcomes on farm. In other cases, as discussed above, producers indicated that the *NMP* was not useful for their farm operation as they do not crop or use manure as nutrients on their farm.

Does the NMP provide a benefit to society?

- Although we were not able to value the benefit of the *NMP* to society, it is likely that overtime, increased understanding and awareness of appropriate nutrient management practices and the value of manure will result in benefits to society in the form of environmental risk mitigation.

3.3 Improved On-Farm Storage and Handling of Agricultural Products (e.g. fuel, pesticides and fertilizers) BMP

Evaluation Summary

The *Improved On-Farm Storage and Handling of Agriculture Products (e.g. fuel, pesticides and fertilizers) BMP* (*Product Storage BMP*) is intended to address risks to the environment posed by inadequate or ineffective fuel, pesticide or fertilizer storage and handling facilities. *BMP programs* have cost-shared the modification or construction of new fuel, pesticide and fertilizer storage facilities that reduce the risk of spills or leaks of agricultural product into the environment.

The average cost of a *Product Storage BMP* project was $7474. The *BMP programs* provided an average of $2182 in cost-share funding to producers per BMP project. Between 2005/06 and 2011/12, producers contributed $1,889,000 and the *BMP programs* contributed $778,000 towards *Product Storage BMPs.*

A total of 357 *Product Storage BMP* projects occurred in BC between 2005/06 and 2011/12. Of the 357 BMP projects that were implemented between 2005/06 and 2011/12, 55% were fuel storage BMPs, 31% were pesticide storage BMPs and 18% were fertilizer storage BMPs. The majority of BMP projects have occurred in the Lower Mainland (156) and the Southern Interior of BC (112). A range of commodity producers have implemented the *Product Storage BMP*.

Respondents indicated that prior to BMP implementation they generally experienced one noticeable spill event of agricultural product per year. The implementation of the *Product Storage BMP* has generally eliminated agricultural product spills while product is in storage. The results of the risk assessment for fuel storages show that prior to BMP implementation, 85% of fuel storage facilities were at a high risk of environmental contamination. After BMP implementation, 4.1% of fuel storage facilities were at a high risk and 78% of fuel storage facilities were at a medium risk of environmental contamination.

The on-farm benefits experienced by producers who implemented the *Product Storage BMP* included but were not limited to:

- Avoided loss of product;
- Avoided spill response costs;
- Environmental risk reduction and associated peace of mind; and
- Operational efficiency gains.

However, the results of the discounted cash flow analyses indicate that generally the costs of implementing the *Product Storage BMP* outweigh the financial benefits to the producer over the life of the BMP (assumed to be 15 years). The results of the cost-benefit analyses indicate that the net present value of nutrient management planning is positive over the life of the BMP indicating that the BMP is a net benefit to society.

3.3.1 Introduction to the Improved On-Farm Storage and Handling of Agricultural Products (e.g. fuel, pesticides and fertilizers) BMP

The *Improved On-Farm Storage and Handling of Agriculture Products (e.g. fuel, pesticides and fertilizers) BMP* (herein referred to as the *Product Storage BMP*) is intended to address risks to the environment posed by inadequate or ineffective fuel, pesticide or fertilizer storage and handling facilities.[40] Agricultural products can negatively impact soil, water and air quality if spilled, emitted or leaked into the environment.

BMP programs have cost-shared the modification or construction of new fuel, pesticide and fertilizer storage facilities that reduce the risk of spills or leaks of agricultural product into the environment. Improved agricultural product storage may also reduce the amount of agricultural product lost to freezing, saturation, leaks, evaporation, spills and theft, reducing financial losses to the farm as well as avoiding the cost of cleaning up spilled product.

3.3.2 Evaluation Survey Response

A total of 20 interviews and site visits were conducted. Forty-nine surveys were returned totaling 69 respondents. The survey response rate including interviews and returned surveys was 19%.

3.3.3 Cost-Share Structure and BMP Implementation Costs

Funding for the *Product Storage BMP* was available between the 2005/06 and 2012/13 program years. Cost-share funding was eligible for:

- Fuel Storage: A roof and containment for a single walled fuel tank or the cost of a double walled tank. Concrete slabs, bollards, electrical hook-ups are eligible items for double walled tanks. Spill kits and fire extinguishers are also eligible items if purchased with other fuel storage upgrades.
- Pesticide Storage: Storage structures that meet the requirements of federal and provincial legislation.[41]
- Fertilizer Storage: Storage structures and in the Peace River region, bulk hoppers.

Eligible items were cost-shared at 30% to a maximum of $10,000 per product.

The average total cost of a *Product Storage BMP* project was $7474. The *BMP programs* provided an average of $2182 in cost-share funding to producers per BMP project. Between 2005/06 and 2011/12, producers contributed $1,889,000 and the *BMP programs* contributed $778,000 towards *Product Storage BMPs.*[42]

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[40] Note that BMP programs have cost-shared *Product Storage BMPs* related to storing silage as well as flail mowers for mulching woodwaste. These BMP projects were not included in the evaluation.

[41] BC Ministry of Agriculture and Lands. (1994). *On-Farm Pesticide Storage and Handling Facility.* Retrieved from *www.agf.gov.bc.ca/resmgmt/publist/300Series/373130-2.pdf*

[42] Project costs were determined using the ARDCorp BMP programs data.

3.3.4 Product Storage BMP Uptake Statistics

This section reports the *Product Storage BMP* implementation and distribution statistics for the period between 2005/06 and 2011/12.

A total of 357 *Product Storage BMP* projects occurred across BC between 2005/06 and 2011/12. The majority of BMP projects have occurred in the Lower Mainland (156) and the Southern Interior of BC (112). Figure 11 and Table 37 display the distribution of *Product Storage BMP* uptake across the province.[43]

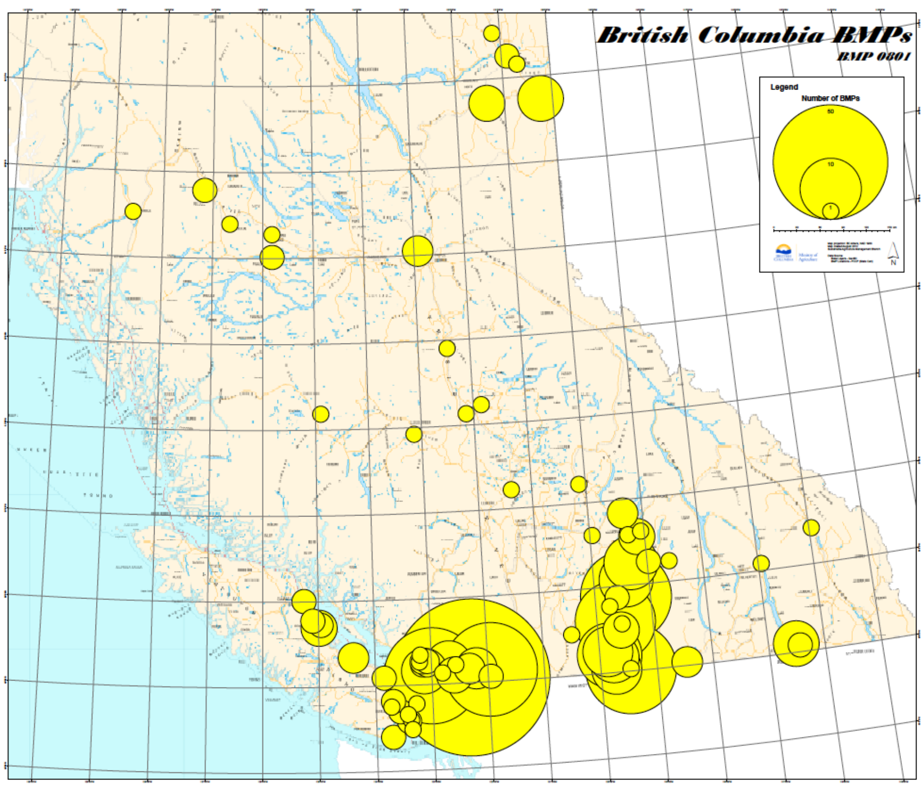

Figure 11. Map of Product Storage BMP uptake between 05/06 and 11/12.

[43] The regional distribution of BMP uptake was determined using the ARDCorp BMP programs data.

Table 37. The number of *Product Storage BMPs* implemented in each Regional District.

Regional District	Number of BMP Projects
Okanagan-Similkameen	86
Fraser Valley	85
Metro Vancouver	71
Peace River	26
Comox Valley	18
North Okanagan	15
Central Kootenay	11
Central Okanagan	11
Capital	6
Cariboo	6
Bulkley Nechako	5
Cowichan Valley	5
Columbia-Shuswap	3
Fraser-Fort George	3
Kootenay-Boundary	3
East Kootenay	1
Thompson-Nicola	1

Uptake by Commodity

The *Product Storage BMP* has been implemented by a range of commodity producers across BC. Tree fruit growers have implemented the most *Product Storage BMPs* of all commodities with 71 projects between 2005/06 and 2011/12. The blueberry and dairy industries have implemented 40 BMPs each (Figure 12).[44]

[44] BMP uptake by commodity was determined using the ARDCorp program data files.

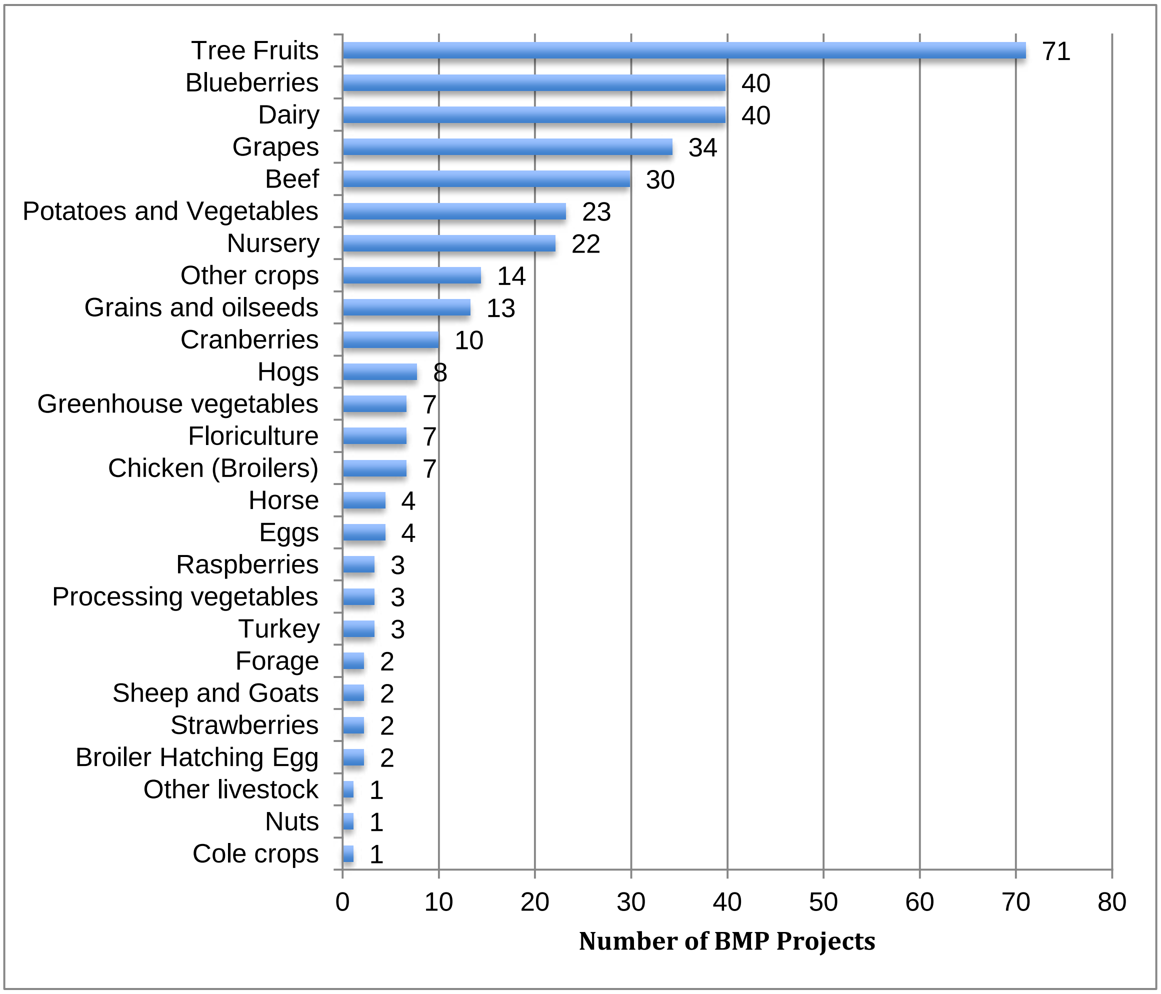

Figure 12. Product Storage BMP uptake by commodity.

Uptake Over Time

The rate of uptake of the *Product Storage BMP* peaked in 2008 and declined in the 2009/2010 program year (Figure 13). Uptake has remained constant since 2009. Reasons for rates of uptake were not explicitly assessed in this project; however, the decline in uptake after the 2008/09 program year may be explained by one or more of the following reasons:

- The BMP has reached all early adopters and is not effectively targeting other potential adopters;
- Increased scrutiny of BMP project applications;
- Change in program delivery model has resulted in less communication between the *EFP/BMP programs* and other potential adopters; and/or
- Lack of awareness of the BMP and benefits of the BMP amongst other adopters.[45]

[45] Uptake by year was determined from the ARDCorp BMP programs files.

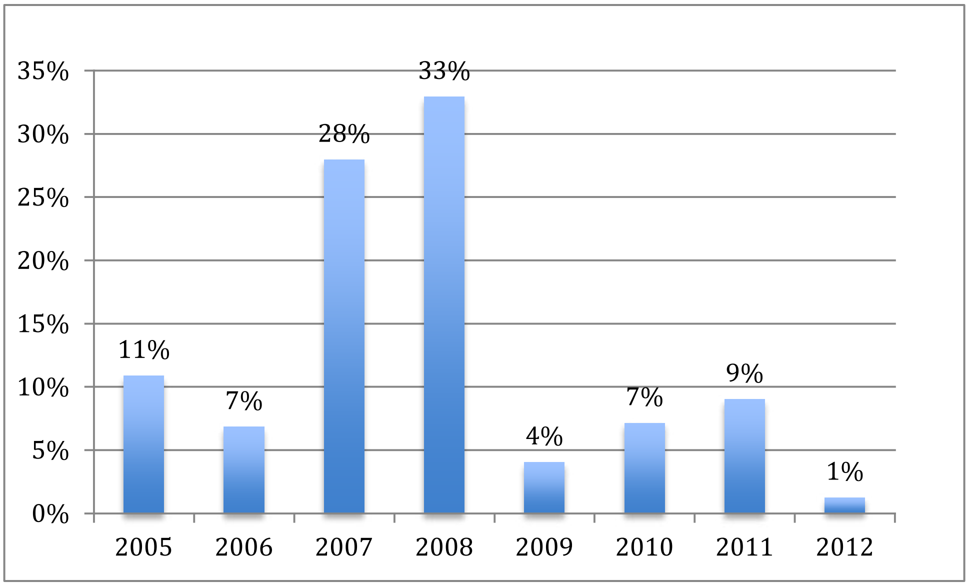

Figure 13. Uptake of the Product Storage BMP by year.

3.3.5 Characteristics of Farms Implementing the Product Storage BMP

The average size of farm that has implemented the *Product Storage BMP* was 176 hectares and the median size of farm that has implemented the BMP was 23 hectares. Thirty-five percent of farms that implemented the BMP have some livestock. All respondents indicated that the farm operators privately owned the land where the BMP was implemented.[46]

Farm Gate Sales

The majority of respondents indicated that their farm had over $100,000 in farm gate receipts in 2011 (62%). Respondents most frequently indicated that their farm gate receipts were $500,000 and above in 2011 (Table 38).[47]

Table 38. Farm Gate Sales of Product Storage BMP survey respondents.

Farm Gate Sales in 2011	Percentage of BMP Adopters
$9,999 and less	8.2%
$10,000 - $24,000	3.3%
$25,000 - $49,999	18.0%
$50,000 - $99,999	8.2%
$100,000 - $249,000	13.1%
$250,000 - $500,000	9.8%
$500,000 and above	39.3%

[46] Farm characteristics were determined from the ARDCorp BMP programs files.
[47] Farm gate sales were determined from the BMP evaluation survey.

Farming Experience

The average number of years that producers who implemented the *Product Storage BMP* have farmed is 30 years. The average time farmed on the property where the BMP was implemented was 21 years.[48]

3.3.6 The Product Storage BMP in Practice

This section gives a brief overview of the how the *Product Storage BMP* has, in general, been implemented on farms. The *BMP program* funding could have been allocated towards the installation, construction or modifications to fuel storage systems, pesticide storage facilities and fertilizer storage BMPs.

Of the 357 BMP projects that were implemented between 2005/06 and 2011/12, 55% were fuel storage BMPs, 31% were pesticide storage BMPs and 18% were fertilizer storage projects (Table 39).

Table 39. Product Storage BMP by product type.

Type of BMP	Percentage of Projects	Total # of Projects
Fuel Storage	55%	196
Pesticide Storage	31%	111
Fertilizer Storage	18%	64

Characteristics of Storage Facility Prior to and Post BMP Implementation

Respondents were asked to describe their storage practices prior to and post BMP implementation. The following tables describe the specifications of fuel, pesticide and fertilizer storage facilities prior to and post BMP implementation. These specifications were used to calculate the change in environmental risk in Section 3.3.7 below.[49]

<u>Fuel Storage</u>

Fuel storage BMP projects generally fit into the category of either installing a new double walled tank (65% of projects) or installing secondary containment and a roof over a single walled tank (33% of projects). Generally, respondents indicated that they improved their fuel storage safety precautions including installing locking facilities (48%), creating a spill clean up kit (42%) and installing a fire extinguisher nearby (35%). Prior to BMP implementation, only 2% of respondents indicated that they had secondary containment (either a double walled tank or concrete floor with berm) to catch leaks and spills. Post BMP implementation, all respondents indicated they had secondary containment of fuel (Table 40).

[48] Farming experience was determined from the BMP evaluation survey.
[49] Characteristics of product storage facilities prior to and post BMP implementation were determined by the BMP evaluation survey.

Table 40. Summary of fuel storage specifications prior to and post BMP implementation.

Fuel Storage Specifications		Prior to BMP Implementation	Post BMP Implementation
Average size of Tank(s)		2522 L	4104 L
Type of ground/base	Highly or Semi-Permeable	67%	35%
	Impermeable	33%	65%
Type of tank	Single Walled	98%	33%
	Double Walled	2%	67%
Average age of tank		24 years	6 years
Median distance from well or surface water		61 m	91 m
Median distance from closest building		15 m	30 m
Cover over tank	No	80%	42%
	Yes	20%	58%
Secondary containment	No	98%%	0%
	Yes	2%	100%
Fire extinguisher	No	70%	35%
	Yes	30%	65%
Spill clean up kit	No	81%	39%
	Yes	19%	61%
Locked or secured	No	66%	18%
	Yes	34%	82%

Figure 14: *Fuel Storage BMP* including double-walled tank and roof

Pesticide Storage

Prior to BMP implementation the majority of respondents indicated that they stored their pesticides in a temporary or permanent wooden shed. In some cases, no pesticide storage facilities existed and pesticides were stored outdoors. To improve pesticide storage, producers generally built new storage structures or created a room in a previously existing structure, specifically to store pesticides.

Prior to BMP implementation, 33% of respondents indicated that they were storing pesticides on a permeable base (Table 41). All respondents indicate that pesticides are now stored in a structure with an impermeable base. Prior to BMP implementation, 17% of respondents indicated that their storage area had secondary containment to catch pesticide leaks and spills and now all respondents have secondary containment in their storage facilities. Generally, respondents indicated that they improved their pesticide storage safety precautions including installing locking facilities (42%) and creating a spill cleanup kit (50%).

Table 41. Summary of pesticide storage specifications prior to and post BMP implementation

Pesticide Storage Specifications		Prior to BMP Implementation	Post BMP Implementation
Size of Facility		9.3 m^2	11.3 m^2
Volume of Product Stored	Liquid	99 L	110 L
	Dry	135 Kg	213 Kg
Type of ground/base	Highly or Semi Permeable	33%	0%
	Impermeable	66%	100%
Distance (m) from well or surface water		13 m	55 m
Distance (m) from closest building		8.7 m	18.2 m
Secondary containment in storage area	No	83%	0%
	Yes	17%	100%
Secondary containment in mixing area	No	82%	38%
	Yes	18%	62%
Structure ventilated	No	42%	8%
	Yes	58%	92%
Structure insulated	No	67%	17%
	Yes	33%	83%
Spill clean up kit	No	83%	33%
	Yes	17%	67%
Locked or secured	No	42%	0%
	Yes	58%	100%

Figure 15: Pesticide shed funded through the BMP programs

Fertilizer Storage

Prior to BMP implementation, respondents indicated that they either did not have a fertilizer storage facility or that they were storing their fertilizer in a wooden shed that provided inadequate protection against leaks, spills and the elements. To improve fertilizer storage facilities, producers either installed fertilizer hoppers (3 respondents) or constructed fertilizer storage sheds. One respondent indicated that a shipping container is now used for fertilizer storage.

Prior to BMP implementation, only 20% of respondents indicated that their fertilizer storage facility had secondary containment to contain fertilizer leaks and spills (Table 42). Post-BMP implementation, 71% of respondents indicated that their storage facility had secondary containment. Generally, respondents indicated that they improved their fertilizer storage safety precautions including installing locking facilities (40%) and creating a spill clean up kit (38%).

Table 42. Summary of fertilizer storage specifications prior to and post BMP implementation

Fertilizer Storage Specifications		Prior to BMP Implementation	Post BMP Implementation
Size of Facility		23.2 m^2	13.4 m^2
Volume of Product Stored	Liquid	n/a	n/a
	Dry	24837 Kg	48782 Kg
Type of ground/base	Highly or Semi Permeable	0%	0%
	Impermeable	100%	100%
Distance (m) from well or surface water		269 m	304 m
Distance (m) from closest building		40 m	30 m
Secondary containment in storage area	No	80%	29%
	Yes	20%	71%
Secondary containment in filling area	No	100%	57%
	Yes	0%	43%
Structure ventilated	No	50%	0%
	Yes	50%	100%
Structure insulated	No	100%	71%
	Yes	0%	29%
Spill clean up kit	No	67%	29%
	Yes	33%	71%
Locked or secured	No	83%	43%
	Yes	17%	57%

3.3.7 The Environmental Outcomes of the Product Storage BMP

The above sections provide insight into how the *Product Storage BMP* has been implemented in practice, whereas this section provides insight into the environmental outcomes that the BMP has had on farms where it has been implemented.

The indicators used to understand the environmental outcomes of the *Product Storage BMP* were:

- Change in the risk of spill or leak events due to inadequate product storage (fuel only)[50]; and,
- Change in actual spill events reported by survey respondents.[51]

Change in the Environmental Risk Associated with On-Farm Fuel Storage

To estimate the change in risk associated with the storage of fuel, a risk assessment framework was developed based on the fuel storage specifications reported in section

[50] A risk assessment was not conducted for pesticide and fertilizer facilities due to a lack of comparable literature. Pesticide and fertilizer risk assessments in the literature focus mainly on application whereas our focus was storage.
[51] The environmental outcomes of the product storage BMP were assessed by the BMP evaluation survey and fuel risk assessment framework described in Appendix IV.

3.3.6. The results of the risk assessment show that prior to BMP implementation, 85% of fuel storage facilities were at a high risk of environmental contamination. After BMP implementation, 4.1% of fuel storage facilities were at a high risk and 78% of fuel storage facilities were at a medium risk of environmental contamination. The risk assessment results are summarized in tables 43, 44 and 45 and the risk assessment framework is described in Appendix IV.[52]

Table 43. Risk assessment summary for fuel storage practices prior to BMP implementation.

	Low Risk (Rank 3)	Moderate Risk (Rank 2)	High Risk (Rank 1)
The distance separating the well from surface water or tank	55%	6%	39%
The distance separating the tank from the closest building	57%	20%	23%
The characteristics of the ground around the fuel tank	31%	29%	40%
Tank type and age	2%	21%	77%
Was the tank covered or shaded?	20%	80%	
Was secondary containment present?	0%		100%
Was an overfill prevention device present?	11%		89%
Was spill response equipment kept nearby?	19%		81%
Was a fire extinguisher present?	34%	66%	
Was the storage secure?	30%		70%

[52] The fuel risk assessment was developed based upon the 2009 University of Georgia Cooperative Extension publication "Petroleum Storage and Handling", the 2002 BC Ministry of Environmental publication "A Field Guide to Fuel Handling, Transportation and Storage" and the recommended standards and regulatory requirements for storing fuel described in the *Canada-British Columbia Environmental Farm Plan Reference Guide 5th Edition.*

Table 44. Risk assessment summary for fuel storage practices post BMP implementation.

	Low Risk (Rank 3)	Moderate Risk (Rank 2)	High Risk (Rank 1)
The distance separating the well from surface water or tank	72%	6%	21%
The distance separating the tank from the closest building	82%	8%	10%
The characteristics of the ground around the fuel tank	63%	14%	22%
Tank type and age	63%	16%	18%
Is the tank covered or shaded?	94%	6%	
Is secondary containment present?	100%		0%
Is an overfill prevention device installed?	60%		40%
Is spill response equipment kept nearby?	61%		39%
Is a fire extinguisher kept nearby?	65%	35%	
Is the storage secure?	82%		18%

Table 45. Fuel storage risk assessment summary.

Level of Risk	Prior to BMP Implementation	Post BMP Implementation
Low (2.34 - 3)	0.0%	18.4%
Medium (1.67 - 2.33)	14.6%	77.6%
High (1 - 1.66)	85.4%	4.1%
Average Score	1.41	2.14

Change in Actual Spill Events

Respondents indicated that prior to BMP implementation they experienced 0.72 noticeable spill events per year. Respondents have experienced an average of 0.06 spill events per year since the *Product Storage BMP* was implemented. For fuel storage specifically, respondents experienced 0.84 noticeable spill events prior to BMP adoption versus 0.04 noticeable spills events since the *Fuel Storage BMP* was implemented. One spill event was considered to be a distinct occurrence of agricultural product spill that was *noticed* by the producer. The average volume of *fuel* spilled per spill event was 3.69 L.

3.3.8 The Financial and Economic Outcomes of the Product Storage BMP

This section will present benefits that farmers and ranchers experience when they implement *Product Storage BMPs* as well as the costs that they incur when doing so. The *Product Storage BMP* and the *Fuel Storage BMP* subsample are presented.

To assess the private financial outcomes of the BMP to the average farmer a discounted cash flow (DCF) analysis was conducted. The results of the DCF analysis are presented below in this section. To assess the economic outcomes of the BMP to society a cost-benefit analysis (CBA) was conducted. The results of the CBA are presented below in this section as well. The DCF and CBA were conducted for the *Product Storage BMP* as a whole as well as for the *Fuel Storage BMP* subsample. The analyses consider the on-farm situation immediately before BMP uptake compared to directly after BMP uptake and does not consider unrelated changes that may have occurred on the farm after BMP uptake.

On-Farm Benefits and Costs of the Product Storage BMP

A series of survey questions were posed to respondents to assess the costs and benefits experienced by farmers as a result of implementing the BMP. The following sections present the results of these survey questions.

Avoided Loss of Product Due to Spills, Saturation, Freezing or Theft

Producers lost an average of $99.44 in product with previous product storage systems due to spills, saturation, freezing or theft. With the adoption of the *Product Storage BMP*, producers lost $12.54 on average representing 87% decrease equal to an $86.90 savings in avoided product loss. In terms of fuel storage specifically, producers lost $42.52 in fuel prior to implementing the BMP compared to $3.96 with the BMP representing a 91% decrease or $38.56 in savings.

Avoided Spill Response Costs

Producers experienced 0.72 spills per year for all products prior to implementing the *Product Storage BMP*. Producers experienced 0.06 spills per year after implementing the BMP representing a 92% decrease. For fuel storage in particular, producers experienced 0.84 spills per year previously compared to 0.04 spills after implementing the BMP representing a 95% decrease.[53] With a reduction in instances of product spills, producers experienced reduced spill response costs.

Reduced Fuel Evaporation Losses

Evaporation losses vary with the type of storage, fuel and management practices to prevent evaporation.[54] Fuel Storage BMPs involve changes to on-farm fuel storage that can reduce evaporation losses. Some characteristics of fuel storage facilities that can limit evaporation losses include painting the tank with a reflective paint, locating the tank in shade, using a pressure ventilated cap, or installing a double-walled tank. Some respondents indicated that they noticed reduced evaporation losses associated with their *Fuel Storage BMP*.

[53] Spills over 100 liters are required to be reported to the Ministry of Environment. No spills events greater than the 100 liter threshold were captured in the survey sample.
[54] Beneficial Management Practices: Environmental Manual for Alberta Farmsteads - Chapter 6 Fuel Storage and Handling. Source: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex11148

Environmental Risk Reduction and Peace of Mind

Producers noted that the *Product Storage BMP* significantly reduced the environmental risk of product spills, which gave them peace of mind. Confidence in the security and safety of the new system compared to the old system was an important operational change and a primary driver for uptake.

Labour Requirements

Respondents were asked to indicate how many hours of labour annually they spent maintaining the product storage system that was replaced, and how many hours annually they spend maintaining the *Product Storage BMP*. For respondents that implemented the *BMP*, they spent 2.57 hours ($38.61 in labour[55]) maintaining the system compared to 0.72 hours ($10.82 in labour) with the *Product Storage BMP*. For respondents that implemented the *Fuel Storage BMP*, they spent 1.23 hours ($18.41 in labour) maintaining the system compared to 0.41 hours ($6.13 in labour) with the fuel storage BMP. Reasons for the decrease in labour included:

- More organized and efficient system for storing, accessing and using products;
- Easier facility to clean and maintain; and
- Ability to store larger volume of product.

Maintenance Costs

Respondents were asked to indicate how much the spent to maintain the product storage system that was replaced, and how much they spent maintaining the *Product Storage BMP*. Respondents who implemented the *Product Storage BMP*, they spent $134.62 maintaining the system compared to $8.77 with the *Product Storage BMP* representing a 72% decrease. For respondents that implemented the *Fuel Storage BMP*, they spent $44.47 maintaining the system compared to $7.11 with the *Fuel Storage BMP* representing a 67% decrease.

Operational Efficiency Gains

Producers noted that the *Product Storage BMP* increased the efficiency of certain aspects of their operation. For instance, pesticide and fertilizer sheds were more organized than the previous systems making them easier to use. Another example was new fuel tanks with electric pumps that filled tractors much faster than previous gravity-fed systems and were also easier to resupply.

Product Storage BMP Discounted Cash Flow Analysis

To understand the financial outcomes of BMP uptake to the average farmer, a DCF analysis was conducted to present the private costs and benefits associated with the *Product Storage BMP* over the life of the BMP (15 years). The analyses are presented for the *Product Storage BMP* and the *Fuel Storage BMP* subsample.

[55] The ARDCorp value of $15 per hour for in-kind labour was used to value labour inputs.

Values included in the DCF included:

- Producer capital contribution
- Clean-up cost savings
- Product loss savings
- Maintenance savings
- Labour savings

Depending on the specification of the discount rate aggregate benefits for the *Fuel Storage BMP* ranged from a low of $2,149 to a high of $3,765, while the costs were invariable at $5,915 (Table 46). The net present values at all discount rates were negative. They ranged from a low of -$3,767 in the case of an 8% discount rate to a high of -$2,150 in the case of a 0% discount rate.

Table 46. Private Benefit, Cost, and NPV of the Discounted Cash Flow Analysis For Product Storage BMP[s].

Discount Rate	Benefit	Cost	Net Present Value
0 %	$3,765	$5,915	-$2,150
3 %	$2,997	$5,915	-$2,919
8 %	$2,149	$5,915	-$3,767

[a] Values are in 2012 Canadian dollars.

Depending on the specification of the discount rate aggregate benefits for the *Product Storage BMP* ranged from a low of $820 to a high of $1,436, while the costs were invariable at $5,141 (Table 47). The net present values at all discount rates were negative. They ranged from a low of -$4,321 in the case of an 8% discount rate to a high of -$3,704 in the case of a 0% discount rate.

Table 47. Private Benefit, Cost, and NPV of the Discounted Cash Flow Analysis for Fuel Storage BMP[s].

Discount Rate	Benefit	Cost	Net Present Value
0 %	$1,436	$5,141	-$3,704
3 %	$1,143	$5,141	-$3,998
8 %	$820	$5,141	-$4,321

[a] Values are in 2012 Canadian dollars.

All DCF NPVs for the *Product Storage BMP* and *Fuel Storage BMP* subsample are negative due to the relatively higher capital cost of the BMP compared to the annual benefits associated with the BMP. While benefits such as maintenance and labour savings, lost product savings, and clean up savings exist, they are not sufficient to offset the initial capital cost of the BMP to the average farmer over the life of the BMP.

Public Benefits of Product Storage BMPs

Product Storage BMPs result in a reduction in the risk of product spills and the associated environmental costs of those spills. Product spills can impact habitat and wildlife, surface and groundwater, as well as soil quality. Society benefits from a reduction in the risk of these product spills.

Ninety-two percent of respondents felt the *Product Storage BMP* was a benefit to society for reasons including:

- The BMP was an aspect of better land stewardship;
- The BMP reduces the environmental risk of spills; and
- The BMP improved the aesthetics of the farm.

Product Storage BMP Cost-Benefit Analysis

To understand the economic outcomes of BMP uptake, a cost-benefit analysis methodology was used. [56] The project lifespan of an *Improved Manure Storage BMP* is assumed to be 15 years.

Public benefits (i.e. reduced risk of product spills) were included in the analysis. Public costs (i.e. the cost of the *BMP programs* contribution) were included in the analysis as well. Appendix III contains a summary of the average costs and benefits used to calculate the *Product Storage BMP* and *Fuel Storage BMP* CBAs.

Values included in the CBA included:

- Producer capital contribution
- *BMP programs* contribution
- Clean-up cost savings
- Product loss savings
- Maintenance savings
- Labour savings
- Environmental cost of product spill[57]

All of the net present values calculated for the *Product Storage* and *Fuel Storage BMPs* to date are negative due to the capital cost of the BMP and the limited number of years in which the benefits of the BMPs have accrued. All NPVs over the life of the program and for adding one farmer in 2012 are positive because they consider all of the benefits over the life of the BMP as well as the capital cost of the BMP. The positive net present values suggest that when public benefits and costs are considered in addition to private benefits and costs, the benefits of this BMP are greater than the costs over the life of the BMP. These results suggest that the *Product Storage BMP* has economic justification. Details of the three net present value calculations are provided below in Tables 38 to 43.

Net Present Value of the Program to Date

Depending on the specification of the discount rate, aggregate benefits ranged from a low of $1,965,727 to a high of $2,301,733, while the costs ranged from a low of $2,890,638 to a high of $4,039,743 for the *Product Storage BMP* (Table 48). The net present values calculated for the program to date were negative. They ranged from a low of -$1,738,010 in the case of an 8% discount rate to a high of -$924,911 in the case of a 0% discount rate.

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[56] Refer to Appendix VII for the detailed CBA methodology used for this study.

[57] Environmental cost of fuel spills was calculated and included in the analyses. The Environmental cost of pesticide and fertilizer spills in storage could not be calculated due to data limitations.

Table 48. Benefit, Cost, and NPV of the Program to Date for Product Storage BMPs[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$1,965,727	$2,890,638	-$924,911
3 %	$2,084,724	$3,280,925	-$1,196,201
8 %	$2,301,733	$4,039,743	-$1,738,010

[a] Values are in 2012 Canadian dollars.

Depending on the specification of the discount rate, aggregate benefits ranged from a low of $1,570,496 to a high of $1,827,731, while the costs ranged from a low of $1,419,041 to a high of $1,949,586 for the *Fuel Storage BMP* (Table 49). Certain net present values calculated for the program to date were negative while others were positive. They ranged from a low of -$121,855 in the case of an 8% discount rate to a high of $151,455 in the case of a 0% discount rate.

Table 49. Benefit, Cost, and NPV of the Program to Date for Fuel Storage BMPs[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$1,570,496	$1,419,041	$151,455
3 %	$1,661,774	$1,599,930	$61,844
8 %	$1,827,731	$1,949,586	-$121,855

[a] Values are in 2012 Canadian dollars.

Net Present Value over the Expected Life of the Program

Depending on the specification of the discount rate, aggregate benefits ranged from a low of $5,540,975 to a high of $6,948,164, while the costs ranged from a low of $2,890,638 to a high of $4,039,743 for the *Product Storage BMP* (Table 50). The net present values calculated for the program over its expected lifetime were all positive. They ranged from a low of $1,501,232 in the case of an 8% discount rate to a high of $4,057,526 in the case of a 0% discount rate.

Table 50. Benefit, Cost, and NPV over the Expected Life of the Program for Product Storage BMPs[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$6,948,164	$2,890,638	$4,057,526
3 %	$6,276,401	$3,280,925	$2,995,476
8 %	$5,540,975	$4,039,743	$1,501,232

[a] Values are in 2012 Canadian dollars.

Depending on the specification of the discount rate aggregate benefits ranged from a low of $4,599,066 to a high of $5,866,325, while the costs ranged from a low of $1,419,041 to a high of $1,949,586 for the *Fuel Storage BMP* (Table 51). The net present values calculated for the program over its expected lifetime were all positive. They ranged from a low of $2,649,480 in the case of an 8% discount rate to a high of $4,447,384 in the case of a 0% discount rate.

Table 51. Benefit, Cost, and NPV over the Expected Life of the Program for Fuel Storage BMPs[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$5,866,325	$1,419,041	$4,447,284
3 %	$5,263,932	$1,599,930	$3,664,001
8 %	$4,599,066	$1,949,586	$2,649,480

[a] Values are in 2012 Canadian dollars.

Net Present Value of Adding one Farmer in 2012
Depending on the specification of the discount rate aggregate benefits ranged from a low of $11,106 to a high of $19,463, while the costs were invariant at $8,097 for the *Product Storage BMP* (Table 52). The net present values calculated for adding a producer today were all positive. They ranged from a low of $3,009 in the case of an 8% discount rate to a high of $11,366 in the case of a 0% discount rate.

Table 52. Benefit, Cost, and NPV of Adding One Farmer to the Program in 2012 for Product Storage BMPs[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$19,463	$8,097	$11,366
3 %	$15,490	$8,097	$7,393
8 %	$11,106	$8,097	$3,009

[a] Values are in 2012 Canadian dollars.

Depending on the specification of the discount rate aggregate benefits ranged from a low of $16,992 to a high of $29,778, while the costs were invariant at $7,203 for the *Fuel Storage BMP* (Table 53). The net present values calculated for adding an agricultural producer today were all positive. They ranged from a low of $9,789 in the case of an 8% discount rate to a high of $22,575 in the case of a 0% discount rate.

Table 53. Benefit, Cost, and NPV of Adding One Farmer to the Program in 2012 for Fuel Storage BMPs[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$29,778	$7,203	$22,575
3 %	$23,699	$7,203	$16,496
8 %	$16,992	$7,203	$9,789

[a] Values are in 2012 Canadian dollars.

3.3.9 The Social and Motivating Factors of Product Storage BMP Uptake

This section will present the results of a series of questions about various personal and social aspects of BMP uptake to try to understand the following:

- The motivations for uptake of the *Product Storage BMP*; and
- The barriers to uptake of the *Product Storage BMP* by other farmers.[58]

Motivations for Uptake of the Product Storage BMP

When asked explicitly, the main reasons why they decided to implement the *Product Storage BMP,* respondents indicated that their main reasons were to:

[58] Motivations and barriers were determined from the BMP evaluation survey and interviews.

- Reduce the environmental risks associated with agricultural product storage (32%);
- Reduce the human health risks associated with agricultural product storage (21%);
- Meet regulatory and industry requirements for product storage (18%);
- Increase efficiency on the farm (15%); and
- Demonstrate environmental stewardship (10%).

Other motivations included a desire to upgrade storage facilities, food safety, livestock safety, avoiding theft and demonstrating due diligence. Some respondents (7%) indicated that the need to implement the product storage was identified by the *EFP Program* and the BMP funding was the motivation for completing the project.

Respondents were also asked to rate on a scale of 1 to 5 (not important to very important), the reasons why they chose to adopt the *Product Storage BMP* from a list of possible motivations (Table 54). Avoiding environmental risks and demonstrating environmental stewardship were rated as the top motivating factors for producers who implemented the BMP. Improving efficiency on the farm and financial motivations are slightly less important than environmental motivations among those who have implemented the *Product Storage BMP.*

Table 54. Motivating factors for uptake of the Product Storage BMP.

Motivation	Average Score
Reducing the risks to the environment from product spills	4.5
Limiting my farm's impact on the environment	4.3
Demonstrating stewardship	4.1
Improving the long-term sustainability of my operation	4.1
Avoiding the cost of cleaning up product spills	4.0
Meeting regulatory requirements	4.0
Contributing to a positive industry image	4.0
Improving efficiency on my farm	3.8
Improving the profitability of my operation	3.2

Barriers to Uptake of the Product Storage BMP

Respondents were asked to indicate what the main barriers to uptake of the *Product Storage BMP* are for other producers in their industry. Responses included:

- The implementation cost of the project (37%);
- Barriers associated with *BMP programs* process and timing (13%);
- Lack of awareness of *BMP programs* funding (11%); and
- Lack of awareness of risks to the environment (10%).

Other responses included a lack of financial benefit provided by the BMP, inadequate cost-share levels and a belief that their current product storage facility is adequate. Some respondents (8%) indicated that there are no barriers to uptake of the BMP and that their industry has generally accepted the BMP as standard practice.

Similar to the motivation question described above, respondents were asked to rate on a scale from 1 to 5 (not a barrier to a large barrier) a set of barriers to *Product Storage BMP* uptake. The exact wording of the question was "In your opinion, how significant are the following barriers to the adoption of the *Product Storage BMP* for other producers in your industry?" The perceived cost of BMP implementation was rated as the largest barrier to uptake (3.9). Barriers to accessing funding through the *BMP programs* and lack of understanding of the benefits of the BMP were the second largest barriers to uptake of the BMP (Table 55).

Table 55. Barriers to uptake of the Product Storage BMP.

Barrier	Average Score
The perceived costs of BMP adoption	3.9
Barriers to accessing funding through the BMP programs	3.2
A lack of understanding about how the BMP will benefit their operation	3.2
A lack of time or labour	3.0
A lack of understanding about which BMPs will benefit their operation	3.0
Inadequate cost-share levels provided by the BMP programs	3.0
No succession plan for their farm	2.8
A lack of industry pressure	2.8
Other environmental priorities take precedent	2.8
A lack of support from public agencies	2.8
Lack of awareness of risks to the environment from farm practices	2.7
A lack of public pressure	2.4

3.3.10 Product Storage BMP SWOT Analysis

A brief SWOT (Strength, Weaknesses, Opportunities, Threats) Analysis is presented in this section to organize some of the main findings of the BMP evaluation as well as present anecdotal information that may not be presented in the above sections. Note that this section is only the preliminary step in a SWOT analysis and further steps including a detailed analysis and development of an action plan often follows this step order to direct policy.

Strengths

- There has been high uptake of fuel storage BMPs potentially due to the applicability of the BMP to a wide range of agriculture sectors.
- There are annual labour and maintenance cost-savings associated with the BMP.
- The BMP funding provided the incentive to improve product storage practices that might have otherwise not occurred.
- The *Product Storage BMP* gave producers peace of mind regarding the safety of their products in storage (e.g. from an environmental and human health risk perspective).

- *Product Storage BMPs* provided efficiency gains for some operations (e.g. easier to refuel tractors, more storage capacity, more organized storage).
- The BMP resulted in a reduction of product lost due to theft, freezing, saturation, evaporation and leaks and spills.
- The BMP helped producers to maintain the quality of their product in storage.

Weaknesses

- There has been lower uptake of pesticide and fertilizer storage compared to fuel storage possibility due to the relatively limited applicability of the BMP to a wide range of agriculture sectors.
- The timing of program funding makes it difficult to plan and complete projects.
- Cost of BMP and other priorities represent barriers to BMP uptake.

Opportunities

- Extending the time available to implement projects could increase uptake.
- A more aggressive marketing campaign including success stories as well as public and private benefits could increase uptake.
- Applicability of the BMP to other on-farm programs such as food-safety and organic certification may help to increase uptake.

Threats

- Inconsistency of program funding and limited timeframe to implement projects could limit uptake.
- Existing facilities may be relatively new and therefore there is little incentive to implement the *Product Storage BMP* although the existing facilities have a high environmental risk.

3.3.11 Conclusions and Recommendations for the Product Storage BMP

This section provides an overview of the main conclusions of the BMP evaluation. Recommendations will also be provided where appropriate. Note that these conclusions and recommendations are based on the authors' opinions and reflect both qualitative and quantitative information collected during the evaluation.

Did the BMP have the outcomes it was designed to have?

The *Product Storage BMP* is intended to address environmental risks associated with agricultural products (e.g. fuel, pesticides and fertilizers) in storage.

The BMP is effective at reducing the risk of agricultural products in storage by improving storage facilities and increasing safety precautions (e.g. spill equipment and anti-theft devices). The effectiveness of the BMP was demonstrated both by a reduction in the average amount of spills experienced by producers as well as by a change in the level of risk associated with fuel storage facilities.

Did the BMP meet the expectations of producers?

In our opinion, the BMP generally has met the expectation of producers. Producers indicated that the improved facilities helped to increase efficiency on their farm, improve environmental and human safety and gave them peace of mind.

Is the BMP effective at mitigating environmental risks?

- Yes the BMP appears to be effective at mitigating environmental risks associated with stored agricultural product.

Does the BMP provide the expected outcomes to producers?

- Yes the BMP provides the expected outcomes to producers.

Does the BMP provide a benefit to society?

- Results of the CBA show that the NPV of the BMP is positive over the lifetime of the BMP (assumed to be 15 years), demonstrating that the BMP is a benefit to society.

4.0 Additional Evaluation Questions

Preferred Information Channels

Respondents were asked to indicate which information channels they prefer to receive information about environmental farm programming and practices from. Approximately half of respondents (48%) indicated that that they prefer to receive information via newsletters (Table 56). Many interviewees indicated that they preferred to receive information about the *EFP* and *BMP programs* via their industry association communications.

Table 56. Information channels for environmental program information preferred by producers.

Information Channel	Percentage of Respondents
Newsletters	48%
Agricultural magazines	41%
Peers	34%
Internet/websites	32%
Newspapers	28%
Classes/workshops	24%
Farm demonstrations and field trials	21%
Government publications	20%
Agricultural supply companies	18%
Books	4%
Mobile media	3%
Television	3%
Social media websites	0%

5.0 Recommendations for Future BMP Evaluations

Program evaluation is an important aspect of program process that can deliver valuable feedback to program managers. In our experience, the evaluation process also shows *BMP programs* participants that the projects they completed on their farm are beneficial to society and that their feedback is valued. The project team from Yarrow Environmental Consulting has conducted two BMP evaluation projects using the methodology developed in 2011. Based on our experiences conducting evaluations and speaking with evaluation participants, we have compiled the following recommendations for ongoing BMP evaluations. Recommendations for future evaluations made in the previous BMP evaluation report also remain relevant.

1. ***Develop a regular evaluation component for the BMP programs.***
   We see an opportunity to make evaluation a regular part of the *BMP program* process for a relatively low cost and with minimal additional labour for program staff and producers. For example, a simple self-evaluation and feedback survey to understand environmental and on-farm outcomes could be made a mandatory aspect of program participation. In order for this type of evaluation to be successful, it is critical that baseline information be collected at the time the BMP Project application is submitted.

   Ongoing feedback and outcome data from program participation will strengthen program delivery, help to communicate the environmental achievements of the agriculture industry and demonstrate the benefits of environmental programming on farms.

2. ***Collect baseline environmental and on-farm financial data either through the BMP application form or through a separate form completed by the Planning Advisor.***
   For this evaluation, baseline data was collected at the same time that outcome data was collected by asking respondents to indicate what their practices were like prior to BMP implementation. Although this method allows some estimation of prior conditions, respondents have difficulty recalling exactly what the previous conditions and practices were which results in less reliable data and potentially a lower survey response rate. Collecting baseline data prior to BMP implementation would result in a more accurate estimate of on-farm outcomes and more reliable evaluation results.

3. ***Continue to conduct some BMP evaluations on-farm and in-person.***
   The knowledge and feedback gained through in-person discussions with program participants and viewing BMP projects, we feel, is invaluable. In person evaluations help to understand the regional conditions and needs of producers, bring context to the evaluation results, and validate survey data gained through mailed surveys. Most interviewees seemed appreciative of the opportunity to show the projects that they completed through the *BMP programs* and give their feedback about the work they did.

4. ***Store BMP application, baseline and outcome data in an electronic database.***
   Currently much of the *BMP programs* data is stored in paper archives. Storing data electronically will greatly reduce the effort required to monitor BMP uptake progress and to conduct simple BMP evaluations.

5. ***Communicate the program progress and successes to program participants and potential participants.***
   Some interviewees indicated that they would appreciate an occasional *EFP/BMP programs* “update” newsletter so they could learn about what other producers have done on their farms. There is also an opportunity to communicate the results of evaluations to past and potential *BMP programs* participants to promote the benefits of the program.

Appendices

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II. Cost-Benefit Analysis Assumptions and Limitations

Key Assumptions

1. We assumed that the initial infrastructure costs occurred in the first time period and that annual benefits and costs started to occur in the following time period.

2. We assumed that the annual benefits and costs were constant throughout the life of each program. This may not be the case. For example, maintenance and labour costs may increase over the life of a BMP as infrastructure may begin to deteriorate at a faster rate.

3. We assumed that the baseline and BMP scenarios were not impacted by changes in key variables (e.g. population or technological changes). We did not complete a detailed forecast of the baseline or scenario.

4. We assumed that enrolment in the BMP programs would not change from current levels when completing the cost-benefit analysis over the program's lifetime.

5. We assumed that transitional and government regulatory costs were zero. In the case of transitional costs it is likely safe to assume that they are "small and can be ignored"[59]. However, government regulatory costs are likely not zero (e.g. administration costs associated with the EFP Program). However, we did not have any information on these costs.

6. We assumed that the information obtained from the survey and ARDCorp used to determine benefits and costs was representative of the larger population of BMP adopters. For example, average maintenance costs calculated from survey responses were applied to the population of BMP adopters.

Key Limitations

1. We could not quantify all of the benefits or costs. This is especially evident in the case of BMP 0101 and 2401 as we were only able to capture private benefits and costs. There may be other benefits of this BMP that we're not assessed. For example, a change in nutrient leaching and runoff could not be calculated because of inadequate data. The public benefits from reduced nutrient leaching and runoff, but this could only be captured qualitatively in this study.

2. We were not able to complete a rigorous analysis of the impacts of each BMP on the environment on or near each farm. This is especially difficult to complete for a program such as the Environmental Farm Plan since agricultural producers are distributed throughout the province. This makes monitoring difficult as information on the change in environmental characteristics such as soil erosion or water quality is difficult and costly to obtain. An additional complication is that it may be difficult to link changes in management practices to any changes observed in the environment. A further issue is

[59] Treasury Board of Canada Secretariat. (2007). Canadian Cost-Benefit Analysis Guide: Regulatory Proposals. Ottawa, ON: Government of Canada. Retrieved on January 22, 2012 from: http://www.tbs-sct.gc.ca/ri-qr/documents/gl-ld/analys/analys00-eng.asp

that the environmental impacts of management practices on one farm may be negligible, but cumulative impacts of implementing BMPs on many farms may be substantial.

3. We did not complete a dynamic risk assessment that linked into the CBA.

4. We did not complete a detailed stakeholder impact analysis.

III. Data Sources for Benefits and Costs Used in the Cost-Benefit Analysis

- All values are per farm (or per farm per year)
- Negative cost indicates a benefit.
- All values are in 2012 Canadian dollars.

Table 57. Values and Data Sources for Nutrient Management Planning – Producers who Crop (2401)

BMP	Impact	Amount	Source
Benefits	Reduction in Nutrient Runoff (N + P)	N/A	
	Reduction in N_2O emissions	N/A	
	Increase in Crop Yields	$361.53 per year	Survey
	Fertilizer Costs	$459.26 per year	Survey
Costs	Infrastructure:		
	Provided by the EFP program	$1,240.50	ARDCorp
	Provided by the farmer	$ 37.79	ARDCorp

Table 58. Values and Data Sources for Nutrient Management Planning – Producers Who Do Not Crop (2401)

BMP	Impact	Amount	Source
Benefits	Reduction in Nutrient Runoff (N + P)	N/A	
	Reduction in N_2O emissions	N/A	
	Increase in Crop Yields	$0 per year	Survey
	Fertilizer Costs	$0 per year	Survey
Costs	Infrastructure:		
	Provided by the EFP program	$1,226.62	ARDCorp
	Provided by the farmer	$2.24	ARDCorp

Table 59. Values and Data Sources for Improved Manure Storage – Dairy Operations (0101)

BMP	Impact	Amount	Source
Benefits	Reduction in Nutrient Loss (N + P)	N/A	
	Reduction in N2O Emissions	N/A	
Costs	Infrastructure:		
	Provided by the EFP program	$24,548.66	ARDCorp
	Provided by the farmer	$115,761.46	ARDCorp
	Additional infrastructure cost	$50 .00	Survey
	Maintenance	-$8.00 per year	Survey
	Labour	-$154.50 per year	Survey
	Manure Application Costs	-$3,054.67 per year	Survey
	Fertilizer Costs	-$533.67 per year	Survey
	Manure Application Labour	-$370.00 per year	Survey

Table 60. Values and Data Sources for Improved Manure Storage – Non-Dairy Operations (0101)

BMP	Impact	Amount	Source
Benefits	Reduction in Nutrient Loss (N + P)	N/A	
	Reduction in N_2O Emissions	N/A	
Costs	Infrastructure:		
	Provided by the EFP program	$15,204.96	ARDCorp
	Provided by the farmer	$39,482.83	ARDCorp
	Additional infrastructure cost	$1,262.50	Survey
	Maintenance	-$62.50 per year	Survey
	Labour	-$397.50 per year	Survey
	Manure Application Costs	-$0.00 per year	Survey
	Fertilizer Costs	-$0.00 per year	Survey
	Manure Application Labour	-$75.00 per year	Survey

Table 61. Values and Data Sources for Product Storage (0801) CBA

BMP	Impact	Amount	Source
Benefits	Savings due to reduced environmental risk of a product spill	$1,046.50 per year	Survey, Etkin et al. (2004) – See Appendix VI for Calculations
Cost			
	Infrastructure:		
	Provided by the EFP program	$2181.86	ARDCorp
	Provided by the farmer	$5291.83	ARDCorp
	Additional infrastructure cost	$623.33 per year	Survey
	Lost Product	-$86.90 per year	Survey
	Maintenance	-$125.85 per year	Survey
	Labour	-$27.79 per year	Survey
	Spill Remediation Costs	-$10.47 per year	Survey

Table 62. Values and Data Sources for Product Storage (0801) – Fuel Storage CBA

BMP	Impact	Amount	Source
Benefits	Savings due to reduced environmental risk of fuel spill	$1889.46 per year	Survey, Etkin et al. (2004) – See Appendix VI for Calculations
Cost			
	Infrastructure:		
	Provided by the EFP program	$2,062.40	ARDCorp
	Provided by the farmer	$4,788.35	ARDCorp
	Additional infrastructure cost	$362.50	Survey
	Lost Product	-$38.56 per year	Survey
	Maintenance	-$37.35 per year	Survey
	Labour	-$12.27 per year	Survey
	Spill Remediation Costs	-$7.57 per year	Survey

IV. Fuel Storage Risk Assessment Summary

A fuel storage risk assessment was developed for the purposes of the BMP evaluation project using comparable fuel storage risk assessment frameworks from:

- BC Ministry of Environment; and
- The University of Georgia, Georgia Farm-A-Syst Farm Assessment System.[60] [61]

The framework that was developed includes 10 characteristics of on-farm fuel storage facilities and three levels of risk associated with each characteristic (Table 63). The specific levels assigned to each category were determined using BC's standards for on-farm fuel storage.[62]

Table 63. Fuel Storage Risk Assessment Framework

Characteristics of Fuel Storages	Levels of Risk		
	Low Risk (Rank 3)	Moderate Risk (Rank 2)	High Risk (Rank 1)
The distance separating the well from surface water or tank	50 m and further	49.9 m - 30.5 m	30.4 m and closer
The distance separating the tank from the closest building	12 m and further	11.9 m-6 m	5.9 m and closer
The characteristics of the ground around the fuel tank	Impervious (i.e. concrete)	Clay soil	Sandy soil
Tank type and age	Double walled	Single walled (younger than 15 years)	Single walled (older than 15 years)
Was the tank covered or shaded?	Double Walled or Yes Shaded	Not shaded	
Was secondary containment present?	Double Walled or curbs	[redacted]	Nothing
Backflow device present?	Yes	[redacted]	No
Was spill response equipment kept nearby?	Yes		No
Was a fire extinguisher present?	Yes	No	
Was the storage secure?	Yes		No

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[60] BC Ministry of Water, Land and Air Protection. (2002). A field guide to fuel handling, transportation and storage. 3rd Edition. Retrieved from www.env.gov.bc.ca/epd/industrial/oil_gas/.../fuel_handle_guide.pdf on August 2, 2012.

[61] University of Georgia. (2009). Georgia Farm-A-Syst: Petroleum storage and handling. Factsheet B 1152-07. Retrieved from http://www.caes.uga.edu/publications/pubDetail.cfm?pk_id=6260 on August 2, 2012.

[62] BC Ministry of Agriculture and Lands. (2005). Farm Mechanization Factsheet: Farm Storage and Handling of Petroleum Products. Order No. 210.510-1. Retrieved from www.agf.gov.bc.ca/resmgmt/publist/200Series/210510-1.pdf on August 2, 2012.

Respondents were asked to indicate the characteristics of their on-farm fuel storages before BMP implementation and post BMP implementation. Using the data provided by survey respondents a level of risk was assigned to producers' fuel storage prior to BMP implementation and post BMP implementation using the following steps:

1. The assessor assigned a level of risk, low (3), medium (2) or high (1), to each of the 10 categories for each respondent.
2. Each respondent's total risk score was summed and then divided by the total number of responses. For example, if a producer answered all 10 questions, the total score was divided by 10. If a producer answered 9 questions, the total score was divided by 9.
3. The level of risk associated with producers' fuel storage was categorized using the ranges indicated in Table 64.

Table 64. Fuel Risk Assessment Scoring.

Risk Rankings	Risk Score
Low	2.34 and higher
Medium	1.67 - 2.34
High	1 - 1.66

V. Summary of Respondent Comments

Respondents were asked to provide any comments about their experience adopting the BMP or any comments and suggestions about the BMP programs in general:

Improved Manure Storage BMP

- My first grant was with AARDSA in 1998 when I roofed a pit and in 2007 for an under barn pit.
- Everything was relatively easy and went smoothly.
- Please conduct the review closer to the time BMP was implemented. The planning advisor was a pleasure to work with. If the papers I read are correct, the government is thinking of expanding the recommended storage from 7 months to a whole year. It would be easier for the farmer to only have to upgrade once, rather than in stages, more hassle. We like to be lazy too!
- Funding makes these projects financially viable for the farm. However, approval late in the season makes projects hard to complete.
- Everyone involved was very helpful and informative.
- Manure storage improves farm's image.
- Happy we did it.
- Good program, however funding levels should be pro-rated to gross sales of business.
- We would like to access funding over time. It is currently unreliable.
- The program has been a success, so it makes sense to continue it.
- Good program but for large operations the funding program is never going to be enough. EFP was the best thing as a learning tool. The BMP program was good for getting the work done on the farm. The BMP work helped to get insurance. Funding is really just enough to tip producer into doing it.

Nutrient Management Planning

- My advisor was very helpful and easy to work with.
- Payment of cost sharing funds are often slow in coming.
- Livestock operations should be audited to prove they have sufficient manure storage facilities. There needs to be fixed dates when manure cannot be spread. There is too much interpretation on current recommendations.
- Planning advisor is good for promotion.
- Would like to be able to access funding over time. It tends to come in fits and spurts. Doesn't allow for the producer to plan long term.
- The timing of BMP projects is always too late in the season. Ends up being bad weather. Changes in the BMP list year to year is very hard for producers to plan. Have one master list that doesn’t change much. Paperwork is a barrier.
- We value the information and just want to express appreciation for the program. We use the manure nutrient values. The *NMP* has been very useful for other application processes.
- Avoid caps, trim the fat of program so farmers get more.
- *NMP* is not practical for small operations.
- There should be a simple tracking program for manure management (e.g. a calendar). The *NMP* should be used for education and industry driven.

- There needs to be more funding available so that you can access some of the improvements needed for completing the *NMP*.
- The *NMP* is critical because of increase in fertilizer prices. We did it to access funding.

Product Storage BMP

- The BMP program is an excellent program. It gave me the incentive to improve.
- I feel that a major problem is the paperwork that is required.
- The BMP grant was easier to obtain than expected.
- Our consultant was excellent, very helpful and supportive.
- The application was too involved. We wouldn't have done it if the planning advisor hadn't spent the day help us to understand it.
- There is a push coming down to the farm from the retailer regarding sustainability putting pressure on the farmers. Ocean spray is doing a sustainability survey. BMPs and the environment are being pushed onto the producers and farmers are being forced to pay. Prior to the BMP program I had tried to find the guidelines for fuel storage - not easy to do. The EFP book brought together the rules and BMP to one comprehensible spot. Having a consultant work through the book meant the review got done and some actions took place. It is time for another review but time and energy are an issue. There should be a revitalization of the consultant side of the program and/or the funding as a motivator.
- Program needs to be consistent, on again off again always.
- Lots of time invested with no financial return.
- Farmers should understand that they own the process and can decide what to do based on their priorities.
- Unaware of additional programs.
- Need to convince farmers there is value in doing the project, need to sell benefits.
- Water quality is paramount so fuel storage and riparian fencing bring peace of mind.
- Approval process should have guaranteed timeframe for better planning, funding should be in place throughout the entire fiscal year.
- BMP needs expansion, more marketing to farmers, should advertise success stories, project completion, awareness or recognition beyond financial.
- Local planning adviser was excellent.
- The representative was easy to work with.
- The time to implement the project needs to be extended.
- Program seems to be directed at big farms with secretaries.
- Planning advisor was good.
- Assistance is woefully lacking in groundwater pollution solutions. Lots of old historical garbage sites on farms that need to be cleaned up.
- Uncertainty around funding approval, too much paperwork.
- Storage and handling BMPs should be increased because they are the most important BMPs to grain producers.
- Wouldn't have done it without cost-share.
- Difficult to keep track of changing BMP programs, hard to get answers from advisor.
- Learned a lot about what other successful farmers were doing, no real return for cost.

- Good way to promote innovative ideas to industry.
- Most people aren't interested because of cost and they are afraid the government will be "spying" on them.
- Excellent program, much needed especially for new farmers.
- Timing of the program makes it almost impossible to do projects. The program wasn't able to recognize best equipment.
- More verification of EFP on farms, seems that there are some farms that don't comply.
- Spent more money going through program on fuel storage than if he just did the project on his own. Recommends that ARDCorp do a mailout to producers to tell them what is available to proactively promote the program.
- The program is geared more towards livestock and less towards berries and intensive agriculture.
- No negative comments. Continue with program.
- Straightforward program.
- I like the program and want to do more work though it including fuel and fertilizer storage and wood chipper.

VI. Fuel Spill Environmental Cost Valuation Based on Etkin et al. (2004) Formula

Table 65. Values for Fuel Spill Environmental Cost Calculation using Etkin et al. (2004)

Category	Value	Source
Fuel type	Diesel	Common agricultural fuel
Fuel Price	$1.16/L	Average price of diesel between 2010 and 2011[63]
Volume	3.69 L/spill	Survey, $1.16/L diesel
# of Spills Pre BMP	0.84/year	Survey
# of Spill Post BMP	0.04/year	Survey
Location Modifier	0.55	Etkin et al. (2004), Average of pavement/rock (0.5) and soil/sand (0.6)
Freshwater (Wildlife use) Multiplier	0.9	Default value in Etkin et al. (2004)
Habitat and Wildlife Use Multiplier	2.2	Agricultural land multiplier value in Etkin et al. (2004)

Notes:
1) Etkin et al. (2004) was used to calculate environmental costs. Clean-up costs (referred to as mechanical costs in Etkin et al. 2004) were not calculated used the Etkin et al. (2004). Rather, actual clean up costs stated by survey respondents were used to determine average clean-up costs.
2) Socio-economic costs, as presented in Etkin et al. (2004) were not calculated for fuel spills in the BMP analysis.

[63] http://www2.nrcan.gc.ca/eneene/sources/pripri/prices_byyear_e.cfm?ProductID=5

VII. Detailed Cost-Benefit Analysis Methodology

The methodology presented here was adapted from the CBA methodology developed for the initial Socio-economic and Environmental Assessment of BMPs conducted by Amy Kitchen (Suess) and Ryan Trenholm.[64]

STEP 1: IDENTIFY THE ISSUE, RISKS, AND THE BASELINE SCENARIO

The first step involves documenting the details of the issue or problem and any related risks. This step also involves identifying and projecting what may happen given the status quo situation (i.e. the baseline scenario with no policy intervention).

1.1 Issue

The important details of the issue should be clearly identified and defined. The general issue addressed by the BMPs that are part of our review are environmental impacts associated with agricultural operations in British Columbia. However, each BMP is targeted at specific issues.

Table 66. The issues targeted by each BMP

BMP	Issues
Improved Manure Storage	Risk of nutrient loss to the environment when spreading of manure during off-season due to inadequate manure storage
Nutrient Management Planning	Risks of nutrient loss to the environment associated with the application of nutrients
Product Storage	Risk of contamination of soil, water and air due to improper fertilizer, fuel or pesticide storage

1.2 Baseline Scenario

The benefits and costs of a policy are determined by contrasting the baseline scenario with the scenarios that include government intervention. As such, correctly identifying and projecting the baseline scenario is of utmost importance. Projection of the baseline scenario should attempt to account for any changes that might be expected to occur without the policy intervention. This may include the adoption of environmentally friendly farming practices due to changes in the market (e.g. consumer preferences), innovation, or advances in technology.

For the purposes of our study we assumed that agricultural producers in British Columbia would not have adopted a BMP without the help of the Canada-British Columbia Environmental Farm Plan Program. We also assumed that agricultural producers would not have adopted practices that would cause further environmental degradation. Therefore, the baseline scenario reflects the situation before each farmer adopted their BMP. We determined the baseline scenario using a survey of participating farmers, as well as farm site visits.

[64] The complete report and methodology can be located at:http://www.agf.gov.bc.ca/resmgmt/EnviroFarmPlanning/AGRI_BMP_Report_FINAL.pdf

1.3 Risk Assessment

A dynamic risk assessment is often required when dealing with environmental issues. Such an assessment involves identifying and evaluating any risks and uncertainties associated with the issue and baseline scenario.

A risk assessment for each agricultural operation was not used for the CBA as this was beyond the scope of our resources.

STEP 2: SETTING OBJECTIVES

This step involves setting objectives for the policy intervention. For example, are the goals of the proposed policy intervention purely economic or do they include social and environmental factors? Consulting with the stakeholders can be helpful at this stage. The goals of the proposed policy should be clearly identified and defined in such a way so that progress toward the goal can be evaluated. As such some level of measurability, such as a set of criteria, should be identified as part of the policy-making process.

The overall objective of the Canada-British Columbia Environmental Farm Plan Program is to help agricultural producers in British Columbia manage environmental risks associated with their farming operations by enhancing their stewardship practices. However, each BMP has specific objectives.

Table 67. The objectives of each BMP

BMP	Objectives
Improved Manure Storage	1) Reduction of the loss of nutrients to surface and ground waters by minimizing spreading during the off-season 2) Reduction of the generation of N_20 by minimizing spreading during saturated conditions 3) Reduction in the risk of soil compaction and erosion due to use of equipment in fields during periods of saturation (both on-farm and off-farm benefits).
Nutrient Management Planning	1) Minimized risk of water pollution by loss of nitrogen or phosphorus via run-off or leaching. 2) Minimized risk of air pollution by loss of nitrogen as ammonia or N_20
Product Storage	1) Reduction in the risk of contamination of soil, water and air due to improper fuel, pesticide or fertilizer storage

STEP 3: DEVELOPING ALTERNATIVE REGULATORY AND NON-REGULATORY OPTIONS

This step involves identifying the alternative policy interventions that may be used to address the issue. Several tools can be used for this purpose, including regulatory and non-regulatory instruments or a combination of these approaches. These instruments seek to change consumer or producer behaviour in order to achieve a policy's objective.

Regulatory instruments involve the government setting mandatory standards that stakeholders are required to meet. They seek to change stakeholder behaviour using a command and control approach. On the other hand, non-regulatory instruments are voluntary tools. They generally rely on market forces (i.e. market-based instruments) to modify a stakeholder's behaviour, but may also involve education and information campaigns, or voluntary standards. Several market-based instruments have been developed, including: tradable permits; taxes or charges; subsidies or tax incentives; and deposit-refund schemes. When initially selecting among alternative tools a preliminary analysis should be conducted based on the characteristics of each instrument. It may also be useful to examine experiences with the alternative options in other jurisdictions. A chief concern when selecting among alternative instruments is their efficiency or cost-effectiveness. Additional concerns include: stringency; stakeholder compliance; timing; international and regional issues; size of stakeholders; and enforcement.

The Canada-British Columbia Environmental Farm Plan Program is a non-regulatory market-based instrument since the program provides subsidies to agricultural producers for adopting certain BMPs. The subsidy covers a certain percentage of eligible costs associated with the BMP up to a certain level of funding (i.e. it's a cost-share program). The BMPs that are part of this evaluation are described in Table 3.

Table 68. Details of each BMP

BMP	Description	Cost-Share	Program Life[65]
Improved Manure Storage	Funding the expansion of manure storage facilities.	30% up to $30K	20 years
Nutrient Management Planning	Consulting services to develop nutrient management plans, planning and decision support tools.	100% up to $1500	3 years
Product Storage	Modification or improvement of fuel, fertilizer or pesticide storage facilities.	30% up to $10K	15 years

STEP 4: ASSESS THE BENEFITS AND COSTS

The main part of a cost-benefit analysis is assessing the benefits and costs of each alternative policy. This step involves identifying the impacts of the policy and then measuring the associated benefits and costs.

4.1 Identification of significant impacts

Identifying the significant impacts involves defining and quantifying the impacts of each alternative policy and then projecting these impacts over the policy's expected life. Consulting with experts at this stage can be helpful. Three activities are involved in identifying and projecting the impacts: 1) identifying the potential direct or indirect impacts of each alternative; 2) relating these potential impacts to variables, such as economic growth or technological change, that may modify an impact's magnitude over time; and 3) using projections of these variables to forecast the impacts over the life of each

[65] The program life was estimated based on the nature of the BMP, depreciation of equipment and input from the Project Steering Committee.

alternative policy. Often this proceeds by using an environmental impact assessment or life cycle analysis.[66] The forecasted impacts of each alternative are then contrasted with the baseline scenario in order to determine the incremental impact of each policy. To facilitate the CBA, the identified impacts should be classified by stakeholder. Qualitative descriptions should be provided for any impacts that cannot be quantified.

General descriptions of the potential impacts of each of the BMPs that are part of our analysis are provided below in Tables 69 to 71.

Table 69. The potential impacts of the Improved Manure Storage BMP

Impact Category	Specific Impacts
Environmental risk addressed	1. Loss of nutrients to surface and groundwater by spreading during the off-season
	2. Generation of N_20 by spreading during saturated conditions
	3. Soil compaction and erosion due to use of equipment in fields during periods of saturation
Additional benefits	1. More effective use of manure
	2. Change in crop yields
	3. More flexibility in manure application timing
	4. Reduced odour and ammonia emissions
	5. Reduced manure application expenditures
	6. Change in fertilizer usage
Cost	1. Implementation costs
	2. Ongoing maintenance costs
	3. Ongoing labour costs

Table 70. The potential impacts of the Nutrient Management Planning

Impact Category	Specific Impacts
Environmental risk addressed	1. Loss of nutrients to surface and groundwater by spreading during the off-season
	2. Generation of N_20 by spreading during saturated conditions
Additional benefits	1. Increase in crop yields
	2. More efficient use of nutrients
	3. Reduced odour and ammonia emissions
	4. Change in fertilizer expenditures
Cost	1. Completion of *NMP*

[66] Pearce, D.W., G. Atkinson, and S. Mourato. (2006). Cost-benefit analysis and the environment: recent developments. Paris: Organisation for Economic Co-operation and Development.

Table 71. The potential impacts of the Product Storage BMP

Impact Category	Specific Impacts
Environmental risk addressed	1. Contamination of water, ground and air due to improper fuel, pesticide or fertilizer storage
Additional benefits	1. Operational efficiencies 2. Security of product and peace of mind 3. Avoided loss of product and remediation costs
Cost	1. Ongoing labour and maintenance costs 2. Implementation costs

While environmental impact assessments and life-cycle analyses are the preferred means of identifying and projecting the impacts of each BMP we did not have sufficient resources to complete them. Instead, since the Canada-British Columbia Environmental Farm Plan Program has existed for several years we were able to use a survey, sent to a sample of program participants, along with visits to farms to help determine the impacts of each BMP. The survey was developed in consultation with the literature, farmers, and ministry experts. Surveys have been used to identify the impacts (i.e. costs) imposed on agricultural producers. However, surveying farmers has rarely been used to help ascertain the benefits of BMPs. The survey we developed was used to determine the impacts of each BMP on an agricultural producer's management of their farm (e.g. change in soil compaction/erosion associated with Improved Manure Storage BMP). These impacts were then used to determine the relevant benefits and costs. A more rigorous approach to assessing benefits would have been to determine the impacts of changing management practices on indicators of water quality, habitat, etc. This, however, was beyond the scope of our resources as it would have required modeling or linking any changes in the environment that have occurred directly to each BMP. However, the information that was gathered can be used to get an estimate of some of the relevant benefits. Note that the impacts were not related to key variables when making projections over the life of the program — annual impacts were assumed to remain constant.

4.2 Measurement of benefits and costs

After identifying the incremental impacts of each alternative policy it is possible to determine the associated benefit and cost in monetary terms, which provides a common metric. There are several different types of benefits and costs to consider when analyzing agricultural beneficial management practices (see Table 72). A monetary value is assigned to each benefit and cost by estimating the maximum willingness to pay or minimum willingness to accept of stakeholders. Willingness to pay is the amount of money a stakeholder would pay in order to obtain an increase — or avoid a decrease — in the quantity or quality of a good or service, while willingness to accept is the amount that they would require to forgo an increase — or to endure a decrease — in quantity or quality. These measures are capable of capturing the total economic value of a policy's impacts.

Table 72. Different types of costs and benefits[a]

Costs	Benefits
• Compliance costs e.g. new equipment • Government regulatory costs[b] e.g. monitoring • Transitional social costs[b] e.g. unemployment	• Environmental improvements e.g. ecosystem services • Commodity quality e.g. Livestock health • Reduction in operating expenses e.g. irrigation efficiencies

[a] Double counting of costs or benefits should be avoided. Caution is advised when dealing with transfers between stakeholders. For example, if producers increase prices to cope with an increase in farming costs they are passing on these costs to consumers. These costs should only be counted once.
[b] Information on government regulatory and transitional costs was not available and were assumed to be zero.

Several techniques can be used to determine willingness to pay or accept. For impacts that affect marketed goods or services (e.g. agricultural output), it is possible to use market prices as inputs into the cost-benefit analysis. However, in many cases it is not possible to use prices since the impacts of a policy affect goods and services whose values are not reflected in the market (i.e. there is no price). As such, economists have developed a series of non-market valuation techniques to elicit willingness to pay or willingness to accept. These techniques can be classified into three main groups: 1) revealed preferences; 2) stated preferences; and 3) value transfer. Revealed preference techniques use information obtained indirectly from observing stakeholder choices in markets related to the good or service being valued. Several techniques are part of this group, including: hedonic pricing; travel cost; averting behaviour; replacement cost; cost of illness; and production function approaches. Stated preference techniques use information obtained directly from stakeholders by asking about their willingness to pay or accept using surveys. These techniques include contingent valuation and choice experiments. The choice of which technique to use depends on many factors. For example, stated preferences are able to capture a wider range of values than revealed preferences, though they are subject to several biases.

When the resources required for eliciting willingness to pay or accept using revealed or stated preferences are prohibitive, it is possible to use value transfer (a.k.a. benefit transfer). Value transfer, which is a commonly used technique, involves assigning monetary values to non-market goods and services using estimates from previous studies in similar contexts. Values can either be transferred as unit values (i.e. means or medians) or functions (i.e. a function relating WTP or WTA to certain independent variables). Three basic guidelines should be followed when conducting a value transfer: 1) the context of the studies that are the source of the transferred values should be similar to the context of the current study; 2) the source studies should be of good quality; and 3) the source studies should use the same welfare measure as the current study (i.e. WTP or WTA).

While it is possible to monetize many benefits and costs, it is likely not possible to monetize all of them. In these cases it is still important to qualitatively document the features of these benefits and costs. An additional concern is double counting which occurs when a benefit or cost is counted twice. Double counting should be avoided. Also, financial transfers among stakeholders or between stakeholders and the government should not be counted as either benefits or costs.[67]

We used a mix of techniques for our analysis (see Table 9). Where possible, market prices were used. However, incremental impacts to non-market goods and services for fuel spills were assigned a value using unit value transfer based on the formula presented in Etkin et al. (2004). Parameter values used for the Etkin et al. (2004) calculation are presented in Appendix VI.

Table 73. Monetizing costs and benefits

BMP	Costs	Benefits
Improved Manure Storage	▪ Infrastructure (Market price)	▪ Reduction in nutrient runoff and leaching (Not Included in Analysis) ▪ Reduction in N_2O emissions (Not Included in Analysis ▪ Change in crop yield (Market price) ▪ Change in fertilizer expenditures (Market Price) ▪ Savings due to less labour required (Market price) ▪ Savings due to less maintenance required (Market price)
Nutrient Management Planning	▪ Completion of Plan (Market price)	▪ Change in crop yield (Market Value) ▪ Change in fertilizer expenditures (Market Price)
Product Storage	▪ Infrastructure (Market price)	▪ Avoided environmental cost of spill (Value transfer) ▪ Avoided remediation costs of spill (Market Price) ▪ Savings due to less labour required (Market price) ▪ Savings due to less maintenance required (Market price)

4.3 Aggregating Benefits and Costs

The present values of each policy intervention can be calculated once benefits and costs are estimated in each time period for individual stakeholders. This involves aggregating individual average values across the population of stakeholders as well as aggregating values across time.

4.3.1 Across Stakeholders

Aggregating average estimates of benefits or costs over the relevant populations is fairly straightforward. A simple approach is to multiply the mean or median estimates of benefits and costs calculated for individual stakeholders by the total number of

[67] However, we used the transfer of funds from the government to agricultural producers to determine the costs of constructing infrastructure related to implementing each BMP.

stakeholders. More complicated approaches involve accounting for differences in stakeholders (e.g. location, producer type, etc.) using adjustments or functions.[68]

We used the simple approach to aggregate average estimates to the relevant population of agricultural producers.

4.3.2 Across Time: Discounting

Aggregating benefits and costs over time can be complicated. It requires discounting benefits and costs to account for the effect that time has on the value of money, as well as accounting for any future changes in unit benefits or costs (e.g. if a good becomes more scarce in the future, then the price will increase). Discounting involves converting future values of benefits and costs into present monetary values[69] using a discount rate. This rate reflects the time value of money (return on private investment or the rate at which individuals are willing to trade consumption over time). Values that occur in future time periods are essentially weighted less than values that occur in — or nearer to — the current time period. The formula for calculating the present value is:

$$PV = \frac{FV}{(1+r)^t} \quad [\mathbf{1}]$$

Where: *PV* is the present value
FV is the future value
r is the discount rate
t is the number of time periods

Since discounting essentially weights the future less than the present it is the somewhat controversial. As such several approaches to discounting have been developed, including: using one positive discount rate (the common approach); using a discount rate of zero; and using time declining discount rates. The Treasury Board of Canada Secretariat[70] advises the use of one positive discount rate. The selection of a discount rate is also controversial since higher discount rates weight the future less than lower rates. Three approaches to calculating discount rates are common: 1) the social time preference rate; 2) the opportunity cost of forgone investments; or 3) a combination of these approaches. Regardless, the Treasury Board of Canada Secretariat recommends the use of an 8% discount rate. However, they suggest that the social time preference rate is closer to 3%. The same rate should be used for discounting both benefits and costs.

Since the Environmental Farm plan has been operating for several years there are benefits and costs that have occurred in the past time periods. In this case these past values were converted into future values using the discounting process. The same formula used to calculate the present value was used for this process. However, the time period was set as a negative number. For example, if the year of a benefit was 2005, then

[68] Bateman IJ, Carson RT, Day B, Hanemann M, Hanley N, Hett T, Jones-Lee M, Loomes G, Mourato S, Özdemiroğlu E, Pearce DW, Sugden R, Swanson J. (2002). Economic Valuation with Stated Preference Techniques: A Manual, Edward Elgar, Northhampton, MA.
[69] The reference year for our analysis is 2012 as farmers were surveyed at this time.
[70] Treasury Board of Canada Secretariat. (2007). Canadian Cost-Benefit Analysis Guide: Regulatory Proposals. Ottawa, ON: Government of Canada. Retrieved on January 22, 2012 from: http://www.tbs-sct.gc.ca/ri-qr/documents/gl-ld/analys/analys00-eng.asp

t was set at -7 (i.e. 2005-2012). This process brings costs and benefits occurring in past years to the current time period and is consistent with the approach taken by the Environmental Protection Agency in the United States in their cost-benefit analysis of the Clean Air Act.[71] Doing so will have the effect of magnifying past cost and benefit values (similar to future values being weighted less when calculating the present value of future benefits or costs).

We used discount rates of 0%, 3%, and 8%. We assumed that the BMP implementation costs occurred in the first year, with annual costs and benefits occurring each following year until the end of the BMP's life. The stream of benefits and the stream of costs were separately converted into present values using Equation 1.

4.4 Criteria / Decision Rule

Once the values are estimated for the benefits and costs and they have been discounted to present values the decision rule can be applied. There are three criteria that are often used: 1) net present value rule; 2) benefit-cost ratio; and 3) internal rate of return. Net present value is calculated by subtracting the present value costs from the present value benefits. For this criterion, a policy intervention should proceed if the net present value is larger than zero. If choosing among several different policy interventions the most efficient alternative has the largest net present value (i.e. select the alternative with the largest NPV). The benefit-cost ratio is calculated by dividing the present value costs by the present value benefits. A policy intervention should proceed if the benefit-cost ratio is larger than 1. If choosing among several different policy interventions the most efficient alternative has the largest benefit-cost ratio. The internal rate of return is calculated by determining the discount rate at which the net present value equals zero. The internal rates of return calculated for competing policy interventions can then be contrasted.

We used the net present value criterion since the Treasury Board of Canada Secretariat recommends this criterion as the benefit-cost ratio and internal rate of return are problematic. Among the issues are that the benefit-cost ratio conceals the scale of benefits and costs, while several internal rates of return can be calculated from the same set of data.

Three different net present value analyses were performed for each BMP:

1. Determining the net present value of the program to date (until 2012);
2. Determining the net present value over it's expected life; and
3. Determining the net present value of adding one farmer to the program in 2012.

4.5 Annualizing net present value

Annualizing net present values involves adjusting the overall net present value so that it is expressed as a constant annual amount. Annualizing net present values can be helpful when comparing policies that have different lifetimes. For example, BMP A has a large net present value and a long lifetime, while BMP B has a smaller net present value and shorter lifetime. Comparing these two BMPs without adjusting for the differing time periods is problematic and the net present values should be annualized. The following equation is used to annualize net present values:

[71] United States Environmental Protection Agency. (1997). The Benefits and Costs of the Clean Air Act, 1970 to 1990. Retrieved on January 22, 2012 from: http://yosemite.epa.gov/EE/epa/eerm.nsf/vwRepNumLookup/EE-0295?OpenDocument

$$AV = \frac{NPV \times r}{1-(1+r)^{-n}} \quad [2]$$

Where: *AV* is the annualized value
NPV is the net present value
r is the discount rate
n is the policy's lifetime

4.6 Cost-effectiveness analysis
If an economic value cannot be determined for the benefits of a policy intervention it may be possible to conduct a cost-effectiveness analysis instead of a cost-benefit analysis. This type of analysis can be used to identify the least cost approach (i.e. most efficient) for solving a particular problem. It proceeds by dividing the present value costs of a policy intervention by a quantitative measure of the related present value benefits. The resulting ratio represents the cost to achieve a unit of benefit. Lower ratios indicate more efficient policy alternatives.

We did not complete a cost-effectiveness analysis as part of our study.

4.7 Impacts on stakeholders
Economic efficiency is likely one of several criteria being used to evaluate a policy intervention. Equity is another common criterion and a policy's distributional impacts can also affect the success of its implementation. Therefore, it is important to identify the impacts of a policy intervention on each of the stakeholders involved. These stakeholders include impacts on industry, employment groups, consumers and individuals, governments, and others. Distributions between regions and generations may also be of concern.

We did not complete a stakeholder impact analysis as part of our project.

STEP 5: SENSITIVITY ANALYSIS

Sensitivity analysis is an important step in any cost-benefit analysis as it provides an opportunity to deal with uncertainty. Though mentioned in the 'Canadian Cost-Benefit Analysis Guide', sensitivity analysis is not presented as an explicit step in this guidebook. However, following Hanley and Barbier[72], we included sensitivity analysis as a distinct step in this document. Uncertainty is incorporated into the cost-benefit analysis as part of this step by first modifying the values of certain parameters (e.g. the variables that help predict impacts over time or the discount rate) and then recalculating benefits, costs, and decision criteria. Thus, we get an idea of how varying key parameters impacts the conclusion of the cost-benefit analysis.

For our analysis, we completed a sensitivity analysis by examining the effect of varying the discount rate (0%, 3%, and 8%).

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[72] Hanley, N. and E. B. Barbier. (2009). Pricing Nature: Cost-Benefit Analysis and Environmental Policy. Northhampton, MA: Edward Elgar.

Step 6: Prepare an accounting statement

The results of the cost-benefit analysis should be presented in an accounting statement. The intention of an accounting statement is to present all of the relevant details of the exercise, including: monetized and non-monetized benefits and costs; criteria; as well as impacts on stakeholders. Accounting statements should also incorporate the results of the sensitivity analysis. The 'Canadian Cost-Benefit Analysis Guide' provides templates that can be used to prepare an accounting statement.