



GEORGE MORRIS CENTRE

Canada's Independent Agri-Food Think Tank

An Economic Evaluation of Beneficial Management Practices for Crop Nutrients in Canadian Agriculture

Final Report

Prepared for: Crop Nutrients Council

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EXECUTIVE SUMMARY

Producers realize there is usually some cost involved in adopting beneficial management practices (BMPs), whether the BMPs take up valuable time or cost money for services such as soil testing. In many cases, however, there are offsetting economic benefits. An evaluation of the costs and benefits of BMPs should start with the premise that producers are making decisions they expect will maximize their profits. The federal government has recognized that there are net costs to producers by continuing to review the need for incentives to adopt and/or maintain certain BMPs. Producers need to have a good understanding of the costs and benefits of BMPs when deciding to adopt or continue using them. The purpose of this project was to determine what the economic benefit would need to be to encourage agricultural producers to participate in beneficial management practices, specifically those related to crop nutrients.

Phase I: Literature Review

The purpose of the literature review was to develop a solid understanding of existing research regarding the economics and adoption of crop nutrient beneficial management practices. The literature review focused largely on research from Canada and the United States. In the literature, a number of factors were analyzed that could influence a producer's decision to adopt BMPs. Characteristics of farms and farm operators that appeared to influence adoption were education level, farm size, level of gross sales and whether or not the producer earned off-farm income. Higher levels of education, larger farms, farms with higher levels of gross sales, and producers who earned off-farm income were generally more likely to adopt BMPs. However, these findings were not necessarily consistent across all literature reviewed as some studies did not find significant relationships among these variables.

In assessing why some of these factors were found to influence BMP adoption, Fulgie (1999) suggested that education increased a producer's ability to learn and adapt new technologies to farm operations. Fulgie (1999) and Deloitte and Touche (1992) also suggested that producers with off-farm income were more likely to use reduced tillage systems because of a higher opportunity cost of labour. Larger farms and farms with higher gross sales were more likely to use BMPs because they generally had more financial resources.

With regards to programs in place that encourage the use of BMPs, producer participants in focus groups conducted by Agnew and Filson (2004) mentioned that participation could be improved if there was greater involvement of farm organizations and producers in the design of BMP programs, programs were clear and straightforward, and there was sufficient financial compensation offered. Producers also stated that, in the absence of financial incentives, they would use BMPs if they were cost effective for their farming operation.

In addition, the literature review presented information on adoption levels of BMPs for Canada and data suggested that familiarity with BMPs was lacking in certain provinces. This finding suggests that simply increasing awareness of BMPs may improve adoption levels in these provinces. In other provinces addressing the lack of research conducted pertaining to the economics of BMPs may help increase adoption. Canadian data sources suggested that certain BMPs are more commonly used in the different agricultural regions of Canada. Environmentally sustainable fertilizer application methods such as banding and injecting appear more common in the Prairie provinces. Reduced tillage practices, especially no-till are gaining widespread acceptance not only in the Prairie provinces, but also in Ontario and Newfoundland. Quebec

and Ontario were the provinces most likely to adjust fertilizer applications to account for nitrogen from previous crops and the nitrogen content of manure. These two provinces also had the highest percentages of farms that indicated they had formal Nutrient Management Plans and Environmental Farm Plans.

Also reviewed in the literature were Canadian incentive programs available for the adoption of BMPs. The specific programs included the National Farm Stewardship Program, the Federal-Provincial Environmental Farm Plan Program, the National Water Supply Expansion Program, the Greencover Canada program and assistance programs available for the adoption of manure application BMPs. Payments varied across provinces and programs, but most incentives for BMPs are offered on a cost-share basis with funding caps. The most expansive program offering funding for BMPs was the National Farm Stewardship Program.

Phase 2: Economic Modelling

The purpose of this phase of the work was to estimate farm profitability before and after participation in crop nutrient BMPs using representative farm models for Alberta, Saskatchewan, Manitoba, Ontario, Quebec and Prince Edward Island. The models were developed to represent typical crop rotations in each of the provinces, in order to evaluate beneficial management practices (BMPs) by crop rotation, by province.

A national survey of producers was used to obtain the data required to estimate the economic costs and benefits of participation in BMPs. The George Morris Centre worked closely with Ipsos Reid, a market research company, to identify statistically representative sample sizes and to design questions that would provide the necessary data for this component of the research. The BMPs selected for evaluation in the survey were based on the findings in the literature review and included: soil testing, variable rate fertilization, manure management planning, buffer strips, no-till, minimum till and nutrient management planning.

Insufficient survey data was collected for manure management planning to conduct a complete economic analysis; however, the results obtained from the survey were included as a qualitative assessment for western and central Canada, with specific reference to provinces where appropriate. According to the survey results, the percentage of farmers applying manure is lower in western Canada than in eastern Canada.

Western Canadian producers have been using manure on their farms since the land was first settled. Of the western farmers surveyed by Ipsos Reid, 53% apply manure on their farms (Alberta 64%; Saskatchewan 43%; Manitoba 65%). For producers who use manure (from the survey), approximately 18% of their acres were treated with manure (Alberta 22%; Saskatchewan 15%; Manitoba 22%). Surprisingly, however, only 27% of producers who apply manure use a formal manure management plan (Alberta 34%; Saskatchewan 22%; Manitoba 30%). Approximately half of the producers who use manure in the Prairies use a custom operator to apply manure on their behalf (Alberta 55%; Saskatchewan 42%; Manitoba 41%).

Of the farmers in central Canada surveyed by Ipsos Reid, 76% apply manure on their farms (Ontario 75%; Quebec 78%). For producers who use manure (from the survey), approximately 45% of their acres were treated with manure (Ontario 42%, Quebec 49%), more than double that in western Canada. In Quebec, 90% of producers who used manure followed a formal manure management plan. In Ontario, only 35% of respondents who used manure indicated they used a formal manure management plan. Of those who apply manure, 83% self apply (Ontario 92%; Quebec 65%) rather than hire a custom operator.

A total of 39 models were developed (eight base models of representative farms prior to the implementation of BMPs and 31 iterations of the models after the implementation of BMPs). The farm models were developed using 2006 crop enterprise budgets obtained from the respective provincial¹ governments. The enterprise budgets provided an estimate for revenue, variable costs, fixed costs² and expected net revenue for individual crops on a per acre basis. The enterprise budgets were based on average cost and return estimates (e.g. average provincial crop yields, and average farm prices for a specific crop).

The models were also run with the estimated financial assistance available from federal and provincial programs in Canada. Financial assistance was determined to be available for all of the BMPs evaluated, with the exception of soil testing. Note that financial assistance for the development of a nutrient management plan does include the cost of soil testing. However, for the purpose of this analysis, no financial assistance was incorporated in the soil testing BMP models.

Representative farm models were developed based on specific crop rotations and by using the per acre profitability estimates for the individual crops. The models for central Canada assumed an even distribution of crops across the farm while the models for the western Canada were based on typical crop rotations. Because the crop enterprise budgets were based on per acre data, the representative farms were given an assumed size. The size of each representative farm was based on the mean farm size from the survey for each of the provinces.

The results of the model analysis suggested that soil testing, nutrient management planning, minimum tillage and no tillage were the top-performing BMPs. These practices generally produced increased yields that offset any increases in operating costs. Producers using minimum tillage and no tillage identified fewer increases in yields, although these BMPs typically showed improvements in expected net revenue (ENR) due to reductions in operating costs despite equipment costs (annualized over a 10 year period).

In general, variable rate fertilization and buffer strips were not as profitable. Typically these practices reduced profitability because of increased costs. In all cases buffer strips reduced ENR due to the higher costs for the establishment of the buffers and the lost crop production in the area of the buffer.

The following tables present the whole farm results for all provinces evaluated. What is shown in the tables is the percent change of expected net revenue over the base model when the various BMPs are implemented. The table below illustrates the results without financial assistance. Note that the crop rotations are different across the provinces.

¹ Provinces where enterprise data was unavailable or out dated were left out of the analysis (enterprise data is a serious research gap in the Atlantic provinces and British Columbia). Crop enterprise budgets for Ontario were obtained from the Ontario Ministry of Agriculture, Food and Rural Affairs. Crop enterprise budgets for Quebec were obtained from the Ministère de l'Agriculture, des Pêcheries et de l'Alimentation (MAPAQ). Crop enterprise budgets for the Prairie provinces were obtained from Alberta Agriculture, Food and Rural Development, Saskatchewan Agriculture and Food, and Manitoba Agriculture, Food and Rural Initiatives. Crop enterprise budgets for PEI were obtained from Prince Edward Island Agriculture, Fisheries and Aquaculture and updated by Meyers Norris Penny.

² Although fixed costs do not change with changes in acreage, overall fixed costs, including depreciation, must be covered to maintain long-term profitability.

Provincial Whole Farm Results: % Change in ENR from Base Model with BMP, WITHOUT Financial Assistance

	Soil Testing	VRF	Min-Till	No-Till	NMP	Buffers
Alberta - Black		53%			78%	-10%
Alberta - Brown	19%		34%		33%	
Sask - Black	24%	25%			38%	
Sask - Brown	15%		17%		30%	
Manitoba	12%	-7%	12%	12%	20%	-1%
Ontario	59%	-9%	23%	23%	42%	-3%
Quebec	1%	-6%	12%	8%	13%	-2%
PEI						-0.6%

ENR – expected net revenue
VRF – variable rate fertilization
Min-Till – minimum tillage
No-Till – no tillage
NMP – nutrient management planning

In all cases, the inclusion of financial assistance resulted in greater expected net revenue than the models without financial assistance. However, the magnitude of improvement depended highly on the cost share percentages of available funding and the number of years over which the funding was amortized. In the case of buffer strips, with an assumed life of 10 years, the funding in all provinces evaluated was not sufficient to generate a positive change in ENR over the base model when financial assistance was included. This may suggest that funding for buffer strips under Canadian programs is not sufficient, given the assumptions in the representative models.

Variable rate fertilization was another BMP that demonstrated negative changes in ENR when compared to the base model for many of the provinces. However, producers in Ontario and Quebec indicated that they used custom application services which are ineligible for financial assistance. For the Saskatchewan and Alberta black soil models the change in ENR for variable rate fertilization improved, although it was positive to begin with. Finally, in Manitoba, the financial assistance for variable rate fertilization was not sufficient enough to improve the change in ENR to the point where it was no longer negative. In Manitoba, variable rate fertilization was also the only BMP in which the program payment reached the maximum funding limit based on the estimated costs from the producer survey.

The table below illustrates the results with financial assistance. Note that the crop rotations are different across the provinces.

Provincial Whole Farm Results: % Change in ENR from Base Model with BMP, WITH Financial Assistance

	Soil Testing	VRF	Min-Till	No-Till	NMP	Buffers
Alberta - Black		57%			79%	-8%
Alberta - Brown	19%		35%		33%	
Sask - Black	24%	28%			39%	
Sask - Brown	15%		20%		31%	
Manitoba	12%	-3%	12%	13%	20%	-1%
Ontario	59%	-9%	26%	27%	44%	-2%
Quebec	1%	-6%	13%	9%	14%	-1%
PEI						-0.5%

ENR – expected net revenue
VRF – variable rate fertilization
Min-Till – minimum tillage
No-Till – no tillage
NMP – nutrient management planning

At the individual crop level, spring wheat in western Canada and Quebec and winter wheat in Ontario were the crops that were most responsive to the introduction of crop nutrient BMPs, showing an increase in ENR for all BMPs analyzed (with the exception of buffers in all provinces and VRF in Manitoba) regardless of the province. The results at the individual crop level were the same with the inclusion of financial assistance.

Assessment of BMP Incentives

Although the producers in the survey did not generally access financial assistance (1-7% of respondents received financial incentives depending on the BMPs adopted), this study determined that funding was available for all BMPs (with the exception of soil testing³). The following list from the National Farm Stewardship program and Greencover program ([section 2.5.1](#)) recaps the relevant categories of funding, the cost share amount and maximum available for the BMP. Note that individual provinces may provide ‘top-ups’ in addition to the national funding, as detailed below.

- Manure Land Application - Includes 30% cost share to a maximum of \$10,000.
- Product and Waste Management - Includes 30% cost share for product and waste management to a maximum of \$15,000.
- Riparian Area Management - Includes 50% cost share for establishing buffer strips to a maximum of \$20,000.
- Land Management for Soils at Risk - Includes 50% cost share for establishing forage or annual barrier to a maximum of \$5,000. Top-ups are available in BC (funding provided by Ducks Unlimited Canada). Provincial top-ups are also available in PEI.
- Improved Cropping Systems - Includes 30% cost share for improved cropping systems (including equipment modifications and VRF) to a maximum of \$15,000.⁴

³ Note that financial assistance can be obtained for soil testing with the development of a nutrient management plan.

⁴ Note that category 14 provides cost share on the specialized components of conservation equipment. Therefore, in some cases, the cost share may not apply to the entire implement, but only the specialized components. However, for GPS, the 30% cost share can be applied on the entire unit, up to the category cap of \$15,000.

- Shelterbelt Establishment - Includes 50% cost share for shelter belt establishment (similar to buffer strips) to a maximum of \$10,000. Provincial top-ups are available in Quebec and PEI.
- Enhancing Wildlife Habitat and Biodiversity - Includes 50% cost share for buffer strip establishment to a maximum of \$10,000. Top-ups are available in BC (funding provided by Ducks Unlimited Canada).
- Species at Risk - Includes 50% cost share for plant species establishment to a maximum of \$10,000. Top-ups are available in BC (funding provided by Ducks Unlimited Canada).
- Preventing Wildlife Damage - Includes 30% cost share for forage buffer strips to a maximum of \$10,000. Top-ups are available in BC (funding provided by Ducks Unlimited Canada).
- Nutrient Management Planning - Includes 50% cost share for consultant fees to establish a nutrient management plan and for planning and decision tools to a maximum of \$4,000 (including costs for soil sampling and analysis). Provincial top-ups are available in Manitoba.

Sources: AAFC 2005e; AAFC 2006b.

It is worth noting that funding for certain BMPs (e.g. buffer strips) is available through several categories of the National Farm Stewardship Program and Greencover program. Therefore, program administrators and producers can select various categories from which funding can be accessed.

Conclusions

Producers have lacked information on the economic viability of BMPs. The goal of this study was to provide a framework for producers to assess the benefits and costs of BMPs for their farm operations. It is important to note that changes in farm profitability due to the adoption of BMPs for individual farms may vary from the results of this study. This is because the research is based on producer perceptions, representative farm models that are based on industry averages, and additional assumptions for modelling purposes. Therefore, individual producers may experience different effects on farm profitability from the adoption of BMPs due to factors such as the site specific nature of their property (resulting in varying yield changes from BMPs), as well as revenues and expenses which are different from those used in provincial enterprise budgets (due to different management styles).

Based on producer perceptions and the assumptions used in this analysis, the results of this study indicated that the majority of the selected BMPs, including soil testing, minimum tillage, no tillage and nutrient management planning, improved profitability for the representative farms. The profitability of farms using variable rate fertilization depended on the crop grown and the province in which the BMP was practiced. In all cases, the models suggested that buffer strips reduced expected net revenue. Although many of the BMPs evaluated in this study were found to be profitable, these results are not meant to suggest that financial assistance programs are not required. As stated above, results will vary, thereby impacting profitability and the need for financial assistance.

Another goal of this research was to assess the incentives currently available for producers to adopt BMPs. The study found that funding was available for all the BMPs evaluated except soil testing (unless obtained through the development of a nutrient management planning). Despite this, respondents in the Ipsos Reid survey indicated they were not taking advantage of the funding programs. Only 1-7% of respondents received financial incentives depending on the BMPs adopted on their farms. The National Farm Stewardship Program administrators were

contacted to understand current uptake levels in the national program. As of September 30, 2006, approximately 6,000 producers had applied and received funding for 9,623 BMPs (Snell, 2006). This represents 3% of all Canadian producers (6,000 of approximately 200,000 producers). For this reason, it would seem there are additional barriers to adoption that need to be addressed.

The results of the survey suggested that the greatest barriers to adoption were cost and not understanding the need for the BMP. One observation made while doing this analysis was that many producers did not recognize that the BMP could have an economic net gain for their farm. While financial assistance deals with the cost barrier, not understanding the need for the BMP or recognizing the economic viability of the practice implies that future work needs to include communication and education regarding the environmental and economic benefits of the BMPs.

Transition costs, real or perceived, may also be barriers preventing further adoption by producers. The capital costs (e.g. equipment) required for no-tillage and VRF may prevent producers from establishing these practices. Transition costs may also include costs dedicated to learning about BMPs (e.g. time, education) and perceived risks of adopting new practices versus continuing reliable methods. There may also be transition costs involved in accessing financial assistance for BMPs such as costs of paperwork and meeting program requirements (e.g. completion of Environmental Farm Plan). Overall, transition costs may hinder producers from adopting BMPs despite the economics of the practices after adoption is established.

According to the survey, the following types of resources would assist producers in adopting and using beneficial management practices:

- Written material on how to adopt/implement the practice
- Workshops or seminars
- More financial assistance
- Agricultural extension assistance
- More information

One final conclusion that can be drawn from this research is that at least some types of BMPs (e.g. variable rate fertilization and buffer strips) were not affordable to many farms without incentives, regardless of the environmental benefits gained from the practice. Even though some incentive programs already exist to address these low profit BMPs, it is key that governments ensure that:

- producers are aware of the programs;
- there is sufficient compensation from the programs; and
- the application processes are simple (as found in the literature review).

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1.0 INTRODUCTION

Producers realize that there is usually some cost involved when adopting beneficial management practices (BMPs), whether the BMPs take up valuable time or cost money for services such as soil testing. In many cases, however, there are also offsetting economic benefits. An evaluation of the costs and benefits of BMPs should start with the premise that producers are making decisions they expect will maximize their profits. The federal government has recognized that there are net costs to producers by continuing to review the need for incentives for certain BMPs. Producers need to have a good understanding of the costs and benefits of BMPs to decide whether to adopt them. Governments also need to understand that some BMPs primarily benefit the public. Analysis of BMPs should enable governments to develop policies that encourage producers to adopt such practices.

Since BMPs often require producers to alter their current production practices, they may need to acquire new skills or equipment to adopt them. Canada also has a very diverse landscape, and farms across Canada have significant differences. Varying soil conditions, climate, crops, livestock, topography, and a host of other factors all influence whether implementing various BMPs is beneficial for a particular farm. There is also continuing scientific debate about the value of BMPs to producers and society.

In general, the intent of crop nutrient BMPs are to:

- Balance application rate to meet crop needs
- Time nutrient availability with crop needs
- Minimize nutrient losses into the environment (i.e. watercourses)
- Maintain the profitability of farm operations
- Leverage the expertise of knowledgeable professionals

There is no one-size-fits-all BMP manual. Producers may need assistance in determining the right BMPs for their operation. Successful approaches will require flexibility and leveraging resources such as research, professional extension services (government and private sector) and nutrient management planning systems.

Producers need a framework to assess the benefits and costs of BMPs for their operations and to evaluate the impact of government policy decisions. This kind of framework would also be an important tool for government policy analysis. Evaluation of BMPs through a benefit-cost analysis will be important to ensure that nutrients are utilized in a manner that is both environmentally and economically sustainable.

1.1 Purpose and Objectives

The purpose of this project was to determine what the economic benefit would need to be to engage farm producers to participate in BMPs, specifically those related to crop nutrients. The specific objectives of the project were:

- To estimate farm profitability before and after participation in BMPs.
- To assess the incentives currently available for producers to adopt BMPs.
- To assess the need for additional incentives for producers to adopt BMPs (i.e. what incentive is required to overcome the short-term costs for a BMP that will provide long-term benefits).

- To assess the need for additional incentives to agricultural operators for participation in BMPs.

1.2 Report Outline

The following is an outline of the report: Section 2.0 is a synopsis of the literature reviewed for this research. Section 3.0 describes the methods used to determine the specific economic costs and benefits of the BMPs through the development of representative farm models for Western and Eastern Canadian farm operations. Section 4.0 presents the results of the economic evaluation of BMP and assesses the incentives available for BMP adoption in the context of the model. Section 5.0 summarizes the research results, presents conclusions about the profitability of BMPs and lists recommendations for improving adoption of the BMPs evaluated (i.e. soil testing, nutrient management planning, variable rate fertilization, buffer strips, minimum tillage and no tillage).

2.0 LITERATURE REVIEW

Section 2.0 is a synopsis of the literature reviewed for this research. The section clarifies the definition of a beneficial management practice (section 2.1), identifies factors that affect producer decisions when deciding whether to adopt BMPs (section 2.2), provides an overview of barriers to adoption and current adoption rates (section 2.3), provides a review of the academic literature that investigates the economic implications of adopting these practices (section 2.4) and presents the incentives in Canada that are currently available for producers to adopt BMPs (section 2.5). The focus of the literature review is on BMPs which are specifically related to crop nutrients.

2.1 Definitions of Beneficial Management Practices (BMPs)

As the literature was reviewed, a number of definitions of ‘best’ or ‘beneficial’ management practices were identified. Commonalities across these definitions were the protection of the environment and economic sustainability at the farm level. The following paragraphs are a summary of the definitions obtained from industry, government and academia.

According to the Crop Nutrients Council (2005), a beneficial management practice considers the balance of nutrients for agricultural production with the goal of protecting environmental resources and ensuring profitable crop production.

Other definitions of BMPs include:

- “Management practices can be qualified as “beneficial” if they are economically sustainable for farmers while contributing to food quality and/or quantity and the protection of environmental resources (Canadian Fertilizer Institute, 2005).”
- “A farming method that minimizes risk to the environment without sacrificing economic productivity (Hilliard et al., 2002).”
- “A practice or combination of practices that are determined by an appropriate agency to be the most effective and practicable (including technological, economic and institutional considerations) means of controlling point and non-point source pollutants at levels compatible with environmental quality goals (SWCS, 1982).”
- “A practical, affordable approach to conserving a farm’s soil and water resources without sacrificing productivity (OMAF, 2003).”
- “Any agricultural management practice that mitigates or minimizes negative impacts and risk to the environment, ensures the long term health of land related resources used for agriculture and does not negatively impact the long term economic viability of producers (McGarry, PFRA, 2004).”

The environmental, economic and social objectives of BMPs are also important to note as these aspects are generally inherent to BMP definitions. These objectives, as defined by the Canadian Fertilizer Institute (2005) are as follows:

- Environmental
 - Sustain soil quality
 - Avoid the need for additional farmland, especially production on marginal lands
 - Maintain nutrient levels consistent with the sustainability of natural ecosystems
- Economic
 - Produce sufficient returns to sustain farm operations

- Enable investment in BMPs
- Preserve quality of life
- Make efficient use of crop nutrients
- Social
 - Produce nutritious, abundant and affordable food
 - Support programs for strong and caring communities
 - Help meet global food needs
 - Provide ongoing employment opportunities in agriculture and related services

For the purpose of this research, the Crop Nutrients Council's definition of BMPs will be used, which considers balancing the use of nutrients with the goal of protecting environmental resources and ensuring profitable crop production⁵. This definition was chosen since it is specific to crop nutrient BMPs, which are the focus of this study.

2.1.1 Types of BMPs

There are a number of BMPs that have been developed for Canadian agriculture and many of them have monetary incentives to encourage adoption. The following is a list of BMPs that are applicable to crop nutrients and their associated definitions.

1. Nutrient management planning – “involves careful attention to meeting crop nutrient needs, using cost-effective and environmentally responsible management practices” (Lane, 1998, p.3). It includes accounting for nutrients from other sources like manure and previous crops and utilizing crop response data to determine economically efficient application rates to maintain a balance between nutrient applications and removals (Bruulsema, 2004).
2. Soil testing – “used to estimate the fertility of the soil. In soil testing, chemicals that remove nutrients from the soil are used to estimate the nutrients that plants will be able to take up. The soil test is an index of the likelihood of crop response to applied nutrients” (Lane, 1998, p. 13; Morris, 1994, p. 39).
3. Manure testing – involves analysing a representative manure sample to determine nutrient levels, which helps determine total nutrient application rates. A manure analysis is necessary because the quantity of nutrients and ratio of nitrogen (N), phosphorus (P) and potassium (K) in the manure varies greatly from farm-to-farm, depending on the diet of the animals and the amount of bedding and liquid added to the manure (Lane, 1998).
4. Foliage testing/plant tissue analysis - Foliage testing/plant tissue analysis helps producers determine the adequacy of fertilization practices. It provides the producer with information regarding the nutrient content of a crop that can be used during the growing season or from year-to-year. In combination with soil test information, fertilization practices can be adjusted to specific soil characteristics and plant needs (Flynn et al., 1999).
5. Yield goal analysis - analyzing various yield scenarios to help make appropriate nutrient decisions (Bruulsema, 2004).
6. Application method - Inorganic (commercial) and organic (e.g. manure) fertilizers are applied as solids or liquids using broadcast, band or injection methods. Combinations of fertilizer type and method differ in the amount of risk they present to the environment. Of these methods, McRae et al. (2000) indicate that in general, injecting and banding are the most environmentally sustainable fertilizer application methods, with injecting being the preferred application method with respect to environmental sustainability. On the

⁵ In other words, the management of crop nutrients for maximum economic, social and environmental benefits.

other hand, broadcasting is identified as generally the least environmentally sustainable, but may be appropriate for certain situations (e.g. topdressing winter wheat in cool spring weather).

7. Application timing – “the timing of nutrient application, whether from a commercial fertilizer or an organic source such as manure, involves applying what the crop needs when the crop needs it:
 - In spring, apply before planting most valued crop;
 - In summer, sidedress to growing row crops on cereal stubble or between cuts of forages (don’t spread on foliage);
 - In fall, apply to winter cereals, summer-planted forages or cover crops; and
 - In winter, manure should be stored.

Appropriate timing reduces the cost and loss of nutrients, while promoting plant growth” (Lane, 1998, p. 29). The Crop Nutrients Council (2004) indicates that the timing of application for different fertilizer application methods will provide varying levels of fertilizer efficiency. The research suggests that fall banding applications can be as efficient as or more efficient than some spring fertilizer applications. Split nitrogen applications may help reduce nutrient losses by more closely matching the timing of nutrient availability to that of crop uptake to reduce nutrient losses (McRae et al., 2000).

8. Variable rate fertilization (VRF) - part of a site-specific or precision farming system. Fertilizer rates are automatically controlled by an on board computer with an electronic prescription map and Global Positioning System (GPS) technology helps to guide applications of fertilizers (AAFRDa; Goddard, 1997). However, VRF does not necessarily have to be computer and GPS controlled.
9. Enhanced efficiency fertilizers include fertilizers with inhibitors or controlled release fertilizers that reduce nutrient losses and improve nutrient efficiency (The Fertilizer Institute).
10. Vegetated buffer strips – “areas of land, adjacent to a water course or water body, kept in permanent vegetation. Vegetated buffers strips protect water quality by slowing the flow of water, thus facilitating the trapping of sediment, organic matter, nutrients and pesticides (AAFRDb).”
11. Cover crops – “grown to protect the soil when a crop is not normally growing. They help maintain soil structure, add organic matter, tie up excess nutrients and control pests (Lane, 1997, p. 55).”
12. Crop rotation – “as a BMP, crop rotation involves alternating forage or cereal crops with row crops such as corn or potatoes. The forage and cereal crops have root systems that improve the soil structure and add organic matter to the soil. Some also grow over winter and protect the soil from erosion (Lane, 1997, p. 56).”
13. Reduced tillage practices
 - a. Minimum/Conservation tillage – “reduces the number of tillage passes, works the land across the slope and leaves crop residues on the soil surface to control erosion (Gasser et al. 1993, p. 54).”
 - b. No-till/Zero-till – “the practice of planting/seeding crops with no primary or secondary tillage separate from planting/seeding operations (Lane, 1997, p. 63).”
14. Fertilizer storage – “as a BMP, it involves storing only the amount of fertilizer needed for immediate use. This reduces the risk of a major spill or other accident. Stored fertilizer should be secured in a strong, stable, dry structure with a good roof and a cement floor, where moisture, rain and surface water can not enter (AAFRDc).”

This list was developed by looking at practices that were common across all of the provinces. For example, under the Agricultural Policy Framework, each province is given the authority to develop a list of BMPs that producers can implement to receive technical assistance under an approved Environmental Farm Plan.

Additional practices advocated by the Crop Nutrients Council and the Canadian Fertilizer Institute include ensuring that application equipment is maintained and calibrated properly, crop scouting for visual symptoms of nutrient deficiencies, keeping records of nutrients applied to and available in fields, and mapping and managing soil variability within fields (CFI, 2005).

BMPs are also promoted under the concept of “right rate, right time and right place (Bruulsema, 2004).” “Right rate” deals with choosing appropriate nutrient application rates. The principle of “right time” suggests that producers need to consider when nutrients should be applied in order to make nutrients available according to crop needs and minimize losses to the environment. Lastly, the notion of ‘right place’ implies that nutrients be applied where they are needed and where crops are able to use them. [Table 2.1](#) groups the aforementioned crop nutrient BMPs according to the concept of “right rate, right time and right place” and identifies the resource protected when these BMPs are utilized.

Table 2.1 Resources Protected Through BMP Adoption

BMPs According to Performance Area	Resource Protected			
	Air	Water	Soil	Habitat
<i>Right Rate: Match Supply and Demand for Crop Nutrients</i>				
Application calibration & upkeep	X	X	X	X
Crop removal balance	X	X	X	X
Crop scouting/ assessment			X	
Nutrient management plans	X	X	X	X
Plant tissue analysis			X	
Record keeping			X	
Soil testing/manure testing	X	X	X	X
Variable rate fertilization	X	X	X	X
Yield goal analysis			X	
<i>Right Time: On Time Delivery of Crop Nutrients</i>				
Application timing	X	X	X	X
Enhanced efficiency fertilizers	X	X		X
Inhibitors	X	X		X
<i>Right Place: Appropriate Nutrient Placement</i>				
Application method	X	X	X	X
Buffer strips		X		X
Reduced tillage	X	X	X	X
Cover cropping		X	X	X
Incorporation of fertilizer	X	X		X
On-farm fertilizer storage	X	X		

Source: CFI, 2005

2.2 Factors Affecting Adoption of BMPs in Canada and the United States

2.2.1 Factors Affecting Adoption of BMPs in Canada

Serman and Filson (1999) conducted a study to determine the socio-economic factors that affected adoption of soil and water conservation practices recommended by the Soil and Water Environmental Enhancement Program (SWEEP⁶) for southwestern Ontario. Factors that were found to influence adoption included number of crops cultivated, farm size, level of gross sales generated by the farm, education of the producer, the age of producer, and the producer's years of experience in agricultural production. The research results indicated that number of crops cultivated, farm size, gross sales, and the education of the producer positively influenced the number of BMPs adopted by the producer. Conversely, the research found that the producer's age and experience were not directly correlated with the adoption of BMPs. In other words, age and experience did not have an effect (influence) on a producer's decision to adopt BMPs.

Agnew and Filson (2004) conducted research that included the use of focus groups to identify factors that influenced producer participation in the Healthy Futures⁷ program and the use of environmental farm plans and nutrient management programs in the Hobbs-McKenzie and Osborne watersheds in southern Ontario. Initially, an analysis similar to that of Serman and Filson (1999) was conducted and found that farms with higher income, larger farms and those producing livestock and forages were more likely to participate in the Healthy Futures program. On the other hand, education level, age of producer, previous participation in environmental programs and awareness of organizations that provide technical and financial assistance to adopt BMPs were found to have no influence on BMP adoption. With respect to environmental farm plans, a producer's cultivated land base was not found to affect whether or not the producer decided to go through the environmental farm planning process, whereas larger livestock farms were more likely to have an environmental farm plan. Implementation of an environmental farm plan and greater livestock numbers positively influenced participation in nutrient management programs, while increased farm revenues and the producer's perception of government regulation of the program negatively affected participation.

In the focus group sessions, Osborne watershed participants identified legislation, funding, the belief that adopting BMPs was the 'right thing to do', and economics as key factors that

⁶ SWEEP recommended the following practices: (1) increasing use of forages in crop rotation, (2) making tile drainage improvements, (3) plowing down crops, (4) reducing fertilizer use, (5) reducing pesticide use, (6) maintaining over 20% crop residue cover on, (7) the use of winter cover crops, (8) using appropriate pesticide storage/handling facilities, (9) creating tree windbreaks and block plantings, (10) employing reduced tillage, (11) making manure storage/handling improvements, (12) using grass waterways, (13) performing ditch and stream bank protection, (14) developing erosion control structures, (15) keeping livestock out of water courses, (16) disposal of milkhouse waste, (17) fencing woodlots, and (18) using contour farming/strip cropping.

⁷ The Healthy Futures initiative (2002) provided funding to producers for implementation of BMPs that helped to protect and improve surface and groundwater quality in Southern Ontario. It was a \$90 million, 4-year program administered by the OMAFRA Rural Secretariat, and delivered in partnership with organizations such as the Grand River Conservation Authority (GRCA). Eligible BMPs included: diverting clean water away from manure storages and exercise yards; restricting livestock access to watercourses; adopting nutrient management plans; protection wellheads, and plugging unused wells; establishing contour cropping systems designed for erosion control, and erecting erosion control structures; and retiring fragile land from production (GRCA, 2002). The program ended in March 2004.

influenced their adoption of BMPs. The participants in the Hobbs-McKenzie focus group identified the following key factors affecting BMP adoption: involvement of producer organizations in developing programs; clear, long-term programs with sufficient compensation; simple application processes; and assurance of confidentiality.

Lamba et al. (2005) provided a summary of barriers to adoption of voluntary environmental programs identified by southern Ontario producers from research conducted by McCallum (2003), Wells (2004) and Agnew (2005). Findings from these studies indicated that producers do not utilize programs that provide incentives to adopt BMPs because: programs are too complex and do not provide sufficient compensation; BMPs negatively affect yields; producers do not believe there is an environmental need and they already try to be environmental stewards. Furthermore, producers mentioned that they did not participate in environmental programs because they did not want external interferences in their operations.

2.2.2 Factors Affecting Adoption of BMPs in United States

Research conducted by Fulgie (1999) analyzed the use of conventional and conservation tillage practices in the corn belt of the United States. The results of the analysis suggested that producers following conventional tillage practices were more likely to: not have a college education; have below average experience in agricultural production; be operating a small farm; not have a formal conservation plan where technical assistance is offered; and have irrigation. For conservation tillage, statistically significant relationships were found between conservation tillage adoption and larger farms, more educated producers, and producers that had off-farm income. More educated producers were more likely to use conservation tillage practices such as mulch till or ridge till. Another important finding was that land ownership was not found to affect choice of tillage system.

In a study on factors influencing adoption of BMPs among Louisiana sugarcane producers, Henning and Cardona (2000) found a positive relationship between BMP adoption and the number of times a producer met with extension service personnel and the number of grower meetings attended in the previous year. Producers were also more likely to implement BMPs on their farm if they had previously participated in cost sharing programs. On the other hand, the researchers found no relationship between the adoption of BMPs and risk of yield loss.

Another study by Rahelizatovo and Gillespie (2002) assessed factors that influenced adoption of BMPs in the U.S. dairy industry. The results suggested that relationships found for many of the factors that influence BMP adoption are similar across commodities. As in studies that addressed crop production, this study found that larger farms were more likely to adopt BMPs, frequent meetings with extension personnel lead to increased rates of adoption, and producers with higher levels of education were more likely to adopt BMPs. Contrary to previous findings, Rahelizatovo and Gillespie (2002) found that older producers were less likely to adopt BMPs, whereas Serman and Filson (1999) and Agnew and Filson (2004) both found that a producer's age did not affect adoption. Other findings from the Rahelizatovo and Gillespie (2000) study indicated that greater milk productivity per cow increased adoption of BMPs and that risk averse producers were more likely to adopt capital-intensive BMPs.

A study conducted by Feather and Cooper, 1995 (as cited in Cestti et al., 2003) found that increased farm profitability was the most important factor influencing farmers' decisions to participate and adopt BMPs. The adoption of less polluting management practices was driven by the farmer's perception of the effect on profitability. On-farm water quality benefits, farmer

knowledge and familiarity with the practices also influenced farmers' decision to adopt improved management practices.

[Table 2.2](#) below is a summary of the various factors found in the literature that affect the adoption of BMPs in Canada and the United States.

Table 2.2 Summary of Factors Affecting the Adoption of BMPs in Canada and US

Study	Factors Positively Affecting Adoption	Factors Negatively Affecting Adoption	No Influence on Adoption
CANADA			
Serman and Filson (1999) Soil and Water Conservation	<ul style="list-style-type: none"> • # of crops cultivated • Farm size • Gross sales • Education of the producer 		<ul style="list-style-type: none"> • Producer's age • Experience of producer
Agnew & Filson (2004) Healthy Futures Program	<ul style="list-style-type: none"> • Higher income • Larger farms • Livestock and forage producers 		<ul style="list-style-type: none"> • Education • Age • Previous participation in environmental programs
Agnew & Filson (2004) Environmental Farm Plans	<ul style="list-style-type: none"> • Larger livestock farms exhibit greater adoption of EFP 	<ul style="list-style-type: none"> • Participation in NMPs negatively influenced by larger revenues and producers perception of government regulation 	
Agnew & Filson (2004) Watershed participants	<ul style="list-style-type: none"> • Legislation • Funding for BMPs • BMPs are the 'right' thing to do 		
Lamba et al. (2005) Voluntary environmental programs		<ul style="list-style-type: none"> • Do not use programs that provide incentives for BMPs because: too complex; do not provide sufficient compensation; negatively affect yields; external influences 	
UNITED STATES			
Fulgie (1999) Conventional & conservation tillage	<ul style="list-style-type: none"> • Larger farms more likely to adopt conservation tillage, more education, off-farm income 	<ul style="list-style-type: none"> • Education - Less education, more likely to use conventional tillage • Smaller farm size • No formal conservation plan • Have irrigation systems 	<ul style="list-style-type: none"> • Land ownership

Henning & Cardona (2000) Sugarcane	<ul style="list-style-type: none"> • How often producer meets with an extension service personnel • Attendance at grower meetings • Previous participation in cost-share programs 		<ul style="list-style-type: none"> • Risk of yield loss
Rahelizatovo & Gillespie (2002) Dairy Industry	<ul style="list-style-type: none"> • Larger farms • Frequent meetings with extension service personnel • Higher level of education 	<ul style="list-style-type: none"> • Age – older producers less likely to implement BMPs 	<ul style="list-style-type: none"> •
Feather and Cooper (1995) as cited in Cestti et al., (2003)	<ul style="list-style-type: none"> • Farmer’s perception of the effect (of the BMP) on profitability. • On-farm water quality benefits • Farmer knowledge and familiarity with the practices. 		

2.3 Adoption Levels of BMPs in Canada and the United States

2.3.1 Adoption of BMPs in Canada

Information on adoption of BMPs in Canada is available through a few sources. The primary source of information relating to BMPs is the 2001 Farm Environmental Management Survey (FEMS) conducted by Statistics Canada. Other sources include the Census of Agriculture, where data on tillage practices and manure application is collected and the Environmental Sustainability of Canadian Agriculture Report compiled by McRae et al., 2000.

The following discussion presents the findings from these surveys and studies for specific provinces that exhibited either high or low rates of adoption relative to the Canadian average. The dissimilarities among provinces will be influenced by regional differences in farm practices, crops grown and provincial legislation. Unfortunately the information collected, for the most part, simply indicates what BMPs producers are using and does not provide insight into why (or why not) adoption has occurred. For example, producers may use other BMPs to assess soil fertility levels if they do not soil test; therefore it can be difficult to assess what an appropriate adoption level for soil testing should be.

One question on the 2001 FEMS survey pertains specifically to BMPs. Responses relating specifically to nutrient BMPs indicated that 29%, 36% and 31% of the more than 180,000 producers surveyed had either fully or partially implemented BMPs for manure, fertilizer, and water management, respectively. However, approximately 39% of respondents were unfamiliar with the manure management BMPs for their region and 44% of producers were unfamiliar with the fertilizer and water management BMPs for their region. This suggests that communication and education could be affecting the use of BMPs in Canada.

Several other questions posed on the FEMS survey related to specific crop nutrient BMPs. Fertilizer and manure application questions indicated that 70% of respondents used soil testing to base their fertilizer decisions on and 50% of those respondents performed soil tests at least every 3 years. Conversely, 25% of respondents indicated they never use soil testing. Of the respondents that applied manure to land, 85% indicated that the nutrient content was not tested. Foliage testing for crop nutrients was also conducted by producers in Canada, but was not a common practice as it was used by merely 4% of those surveyed.

Respondents also indicated that they applied the majority of their nitrogen and phosphate fertilizers in the spring⁸. Applications in the fall and summer were considerably less common. Forty-eight percent of respondents used broadcasting to apply their fertilizer, whereas 25% and 12% banded and injected fertilizers, respectively. In addition, 69% of respondents that grew nitrogen fixing crops (i.e. red clover, alfalfa, pulse crops) adjusted fertilizer applications to account for nutrients left in the soil. Furthermore, despite the fact that the majority of respondents did not test the nutrient content of the manure they applied to their cropland, 78% of those that applied manure to fields adjusted fertilizer rates to account for its nutrient content and 4% used feed additives to reduce the nutrient content of manure. Manure applications were commonly performed during the spring, summer and after harvest⁹. No season seemed to be preferred to others; however, winter manure applications were not used often. Surface applications appear to be used almost exclusively by producers as few reported injecting manure¹⁰. Many producers that use surface manure application methods appear to incorporate manure applications within a week, but surface applications left on the soil are still performed by a good portion of producers as well.

Responses to FEMS questions pertaining to the environmental management of agricultural lands indicated that where agricultural production occurred adjacent to natural sources of water, 44%, 6%, and 1% of respondents used permanent vegetation, planted vegetation, and winter cover crops respectively, to reduce runoff into these areas. Furthermore, 15% of respondents indicated that they had a formal Nutrient Management Plan for their operation, 18% had a formal Manure Management Plan where field records of manure applications are kept, and 13% had a formal Whole Farm Environmental Plan. Findings suggest that environmental management of agricultural lands has been influenced both by regulations and environmental concerns and that Manure Management Plans and Nutrient Management Plans were often conducted as part of the process.

[Table 2.3](#) below summarizes the level of adoption of selected best management practices in Canada.

⁸ This question is broken down into several components which made it difficult to provide more meaningful interpretations of the results.

⁹ This question is broken down into several components which made it difficult to provide more meaningful interpretations of the results.

¹⁰ This question is broken down into several components which made it difficult to provide more meaningful interpretations of the results.

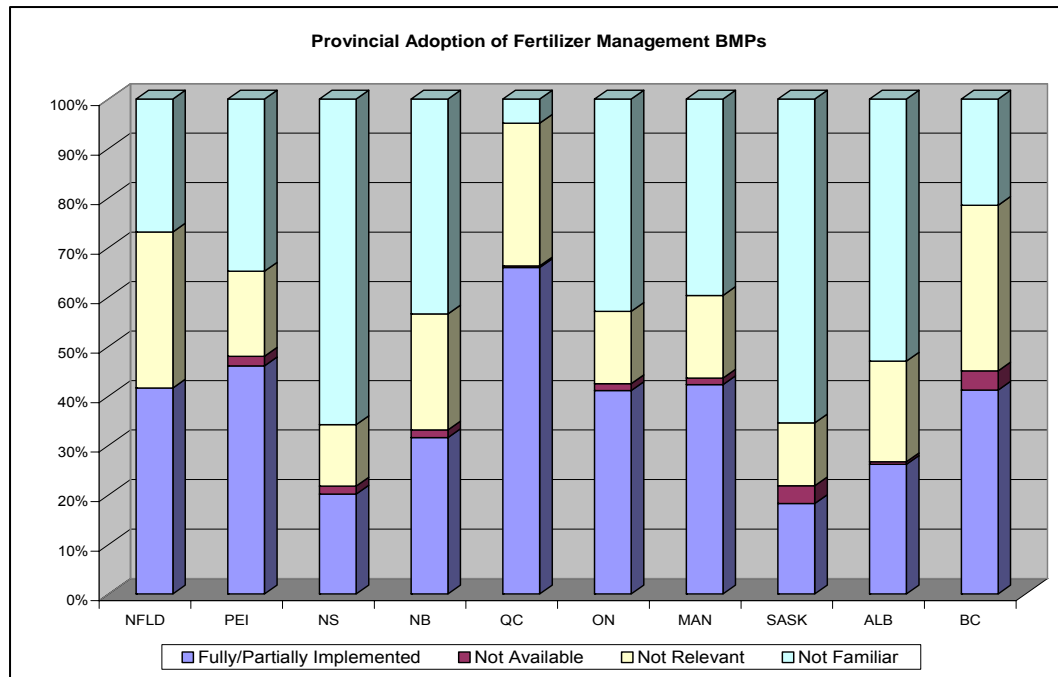
Table 2.3 Adoption Levels of Selected Beneficial Management Practices in Canada

Best Management Practice		Level of Adoption (%)
Manure Management	Fully or partially implemented	29
	<i>Unfamiliar with practice</i>	39
Fertilizer Management	Fully or partially implemented	36
	<i>Unfamiliar with practice</i>	44
Water Management	Fully or partially Implemented	31
	<i>Unfamiliar with practice</i>	44
Soil testing on which to base fertilizer decisions	Fully or partially Implemented	70
	<i>Never Use</i>	25
Fertilizing Methods	Broadcasting	48
	Banded	25
	Injected	12
Protection of natural water sources adjacent to agricultural land	Permanent Vegetation	44
	Planted Vegetation	6
	Winter Cover Crops	1
Environmental Plan	Nutrient Management Plan	15
	Manure Management Plan	18
	Environmental Farm Plan	13

Source: Statistics Canada, FEMS, 2001a.

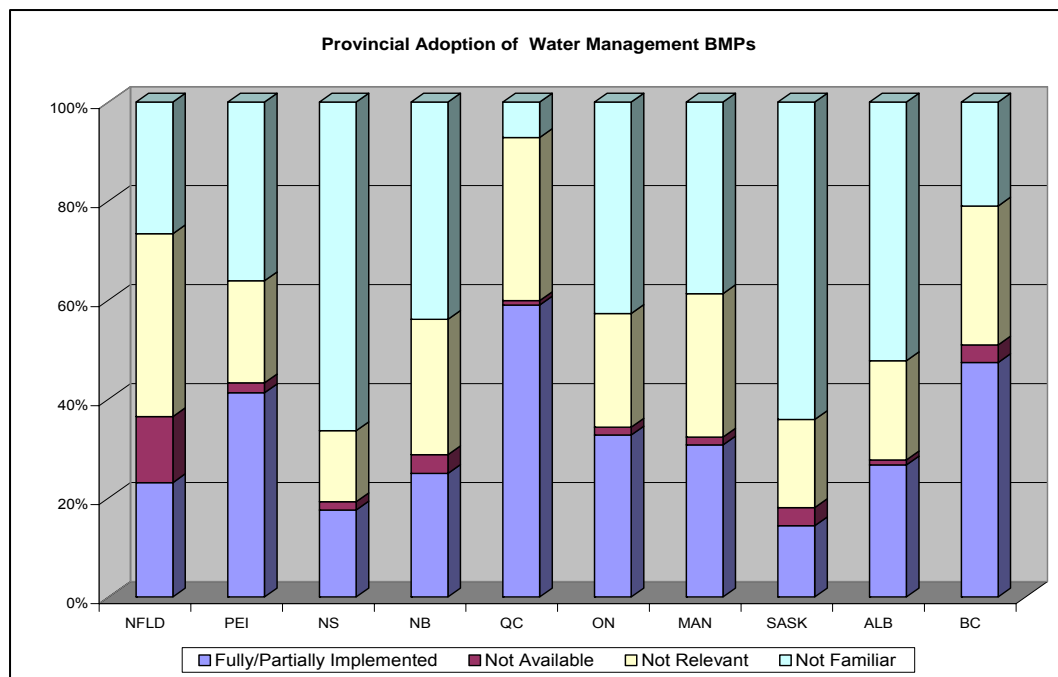
Provincial information suggested that awareness of BMPs is low in some provinces and high in others (refer to [Figures 2.1](#) and [Figure 2.2](#) below). Increased awareness also appears to lead to higher levels of BMP adoption within these provinces. In Quebec, British Columbia, and Newfoundland respectively, approximately 6%, 20%, and 27% of producers surveyed were unfamiliar with the fertilizer and water management BMPs in their region. With this in mind, it is not surprising that Quebec had the highest percentage of respondents that had either fully or partially implemented fertilizer, manure, and water management BMPs at 66%, 65%, and 58% respectively. Prince Edward Island, British Columbia, Manitoba, Newfoundland, and Ontario were other provinces where over 40% respondents indicated they had either fully or partially implemented the fertilizer management BMPs for their region. In addition to Quebec, Prince Edward Island and Newfoundland also exhibited high rates of BMP adoption for manure management as 58% and 42% of respondents (respectively) indicated they had either fully or partially implemented the manure management BMPs for their region. For water management, British Columbia and Prince Edward Island displayed high percentages (47% and 41% respectively) of respondents that either fully or partially implemented these BMPs for their region. On the other hand, approximately two-thirds of the respondents in Nova Scotia and Saskatchewan were unfamiliar with the manure, fertilizer and water management BMPs for their region. Furthermore, the two provinces were the only ones where 20% of respondents or less indicated they had either fully or partially implemented the manure, fertilizer, and water management BMPs for their region.

Figure 2.1 Provincial Differences in the Adoption of Fertilizer Management BMPs



Source: Statistics Canada, FEMS, 2001a.

Figure 2.2 Provincial Differences in Adoption of Water Management BMPs



Source: Statistics Canada, FEMS, 2001a.

For the questions on specific crop nutrient BMPs in each of the provinces, less than 60% of respondents in British Columbia, Saskatchewan, Prince Edward Island, Nova Scotia and Newfoundland used soil testing to make fertilizer decisions and only about 40% of those respondents in British Columbia, Saskatchewan, and Nova Scotia soil tested at least every 3 years. Moreover, approximately one-third of respondents in British Columbia and Saskatchewan never soil test. Conversely, 90% of those surveyed in Quebec base fertilizer decisions on soil tests. In Quebec, 59% of respondents that applied manure to land indicated that they did not test it for nutrient content, which was the lowest among provinces by a considerable margin. For example, greater than 95% of those that applied manure to land in Alberta, Saskatchewan, and PEI indicated they did not test it for nutrient content.

With respect to fertilizer application methods, approximately 70% or more of the respondents in British Columbia, Ontario, Quebec, New Brunswick, Nova Scotia and Newfoundland use broadcasting. Furthermore, only about 15% of British Columbia and Nova Scotia respondents used banding as a fertilizer application method and fewer than 2% of respondents in Nova Scotia and New Brunswick injected fertilizers. Conversely, in the Prairie Provinces, a much lower percentage of respondents broadcasted fertilizer. In Saskatchewan, only 12% of respondents indicated they used broadcasting as a method to apply fertilizers. Injecting fertilizers was most common in Manitoba where 17% of respondents indicated they used this application method. Quebec and Ontario had the highest percentage of respondents (~85%) who adjusted fertilizer rates to account for nutrients left in the soil by legume crops. Quebec had the highest percentage of respondents (94%) that adjusted fertilizer applications to account for the nutrient content of manure, whereas fewer than 60% of respondents in each of the Prairie provinces did so.

With respect to environmental management of lands, 64% of Prince Edward Island respondents indicated that they left areas adjacent to natural water sources permanently vegetated, which was considerably higher than in other provinces. Quebec had the highest percentage of farms (47%) with formal Nutrient Management Plans, Manure Management Plans (52%) and Whole Farm Environmental Plans (37%). Whole Farm Environmental Plans are also common in Ontario as 22% of respondents indicated that a formal one was written for their operation. On the other hand, about 5% of Nova Scotia and Saskatchewan respondents had formal Nutrient Management Plans, less than 9% of respondents in Alberta and Saskatchewan had Manure Management Plans and 3% or fewer respondents in each of the Prairie provinces had formal written Whole Farm Environmental Plans.

Many of the Prairie provinces have a particularly low adoption rate of Whole Environmental Farm Plans because these programs have just recently been introduced to the Prairie provinces. On the other hand, Environmental Farm Plans were implemented in Ontario, Quebec, and the Atlantic provinces more than ten years ago. Specifically, EFP's were implemented in Ontario in 1993, in Quebec in 1993/94, in Atlantic Canada (through the Atlantic Canada Environmental Farm Plan Initiative) in 1995/96 and in Alberta and British Columbia in 2003, and Saskatchewan and Manitoba introduced their EFP programs in 2005.

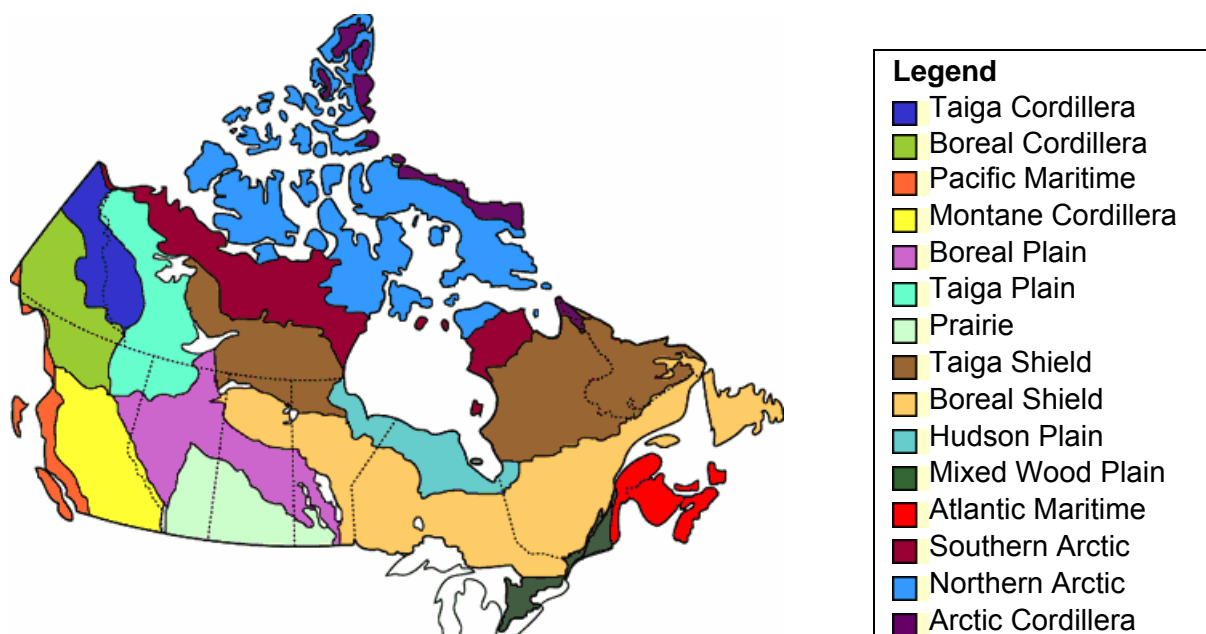
The Environmental Sustainability of Canadian Agriculture Report (McRae et al., 2000) included research on the application of fertilizer and manure in Canada for 1995. The report was compiled from a survey of 6,000 producers conducted by Statistics Canada. Findings from the

report were summarized according to ecozone¹¹. A map of the ecozones is provided in [Figure 2.3](#). Many of the questions posed to producers were similar to those now included in the FEMS survey. However, since the findings were summarized according to ecozone rather than by province and since the way many of the variables were reported differed between the two surveys (i.e. number of farms versus area applied), no direct comparisons could be made.

For Canada, results showed that 72% of Canadian farms used fertilizer in 1995. Injection was used to apply fertilizer on 22% of the cropland, 43% was applied by banding, 34% by broadcasting and 1% using other methods. Some farms reported using more than one method of fertilizer application. Results from the different ecozones suggested that BMPs for fertilizer application methods were most common among producers in the Boreal Plain and Prairie ecozones as these areas had the highest rates of fertilizer applied with seed. Broadcasting was the most popular fertilizer application method in all other ecozones.

Findings specific to the application of nitrogen indicated that 67% of the farms in Canada that used fertilizer also applied commercial nitrogen. Eleven percent (11%) of nitrogen was applied after planting, 31% was applied at the time of planting, and 60% was applied before planting. In the Boreal Plains and Prairie ecozones, a high percentage of nitrogen was applied before planting (71% and 62% respectively). However, these ecozones were noted to be less susceptible than others to nutrient leaching. In the other ecozones, about 40% of fertilizer was applied after planting. The ecozones most susceptible to nutrient leaching, the Pacific Maritime and Atlantic Maritime ecozones, had the highest percentages of nitrogen applied after planting (42% and 41% respectively).

Figure 2.3 Ecozones of Canada



Source: Space for Species, 2005.

¹¹ The ecozones included in the McRae et al. (2000) were: Pacific Maritime, Montane Cordillera, Boreal Plains, Prairies, Boreal Shield, Mixed Wood Plains, and Atlantic Maritime.

The results also indicated that, for Canada, fertilizer applications were reduced on 24% of the area that also received an application of manure. The percentage of area where fertilizer applications were reduced to account for the nutrient content of manure were lowest in the Boreal Plain and Prairie ecozones. In all other ecozones, except the Montane Cordillera, about 40% of the area where manure was applied received reduced rates of fertilizer. Results for the application of manure suggested that solid manure is most commonly applied using surface applications and injecting manure is used on less than 1% of cropped area.

McCrae et al. (2000) also reported that in 1995 about 60% of Canadian producers were using soil tests. However, soil tests were not necessarily performed on all of the producer's cultivated area and 40% of respondents indicated that they did not use soil tests at all. Of the respondents that performed soil tests, about 75% of producers performed soil tests at least every three years. Results for the percentage of farms that soil tested at least every three years were similar across all ecozones except for the Montane Cordillera ecozone. In this ecozone, about 57% of producers soil tested every three years.

The 2001 Census of Agriculture is another source of information pertaining to the application of manure to land. Specifically, it provides information on the area of land to which manure is applied and the method of application (Table 2.4). The information in Table 2.4 provides some context for previously presented results regarding manure management within the different provinces from FEMS 2001 and McCrae et al. (2000). The results suggest that producers in the Prairie provinces appeared less likely to have Nutrient Management Plans, Manure Management Plans, and Whole Farm Environmental Plans and less likely to test their manure for nutrient content and reduce fertilizer application rates where manure was applied. However, the western provinces had a greater percentage of the area using injection methods for manure applications than central and eastern Canada.

Table 2.4 Manure Applications in Canada and the Provinces, 2001

	Manure Applied (ac)	Total Area^a (ac)	Area Injected: % of Manure Applied	Area Applied: % of Total Area
Canada	6,724,454	113,372,075	5	6
Newfoundland	13,531	27,375	0	49
Prince Edward Island	80,841	463,353	0	17
Nova Scotia	114,518	352,621	1	32
New Brunswick	101,437	414,478	0	24
Quebec	1,877,604	5,035,115	4	37
Ontario	1,785,129	9,844,740	2	18
Manitoba	589,273	13,230,114	16	4
Saskatchewan	656,124	49,206,851	9	1
Alberta	1,272,244	32,604,729	3	4
British Columbia	233,219	2,192,699	1	11

^a This value is comprised of cropland, summer fallow and tame or seeded pasture.

Source: Statistics Canada, Census, 2001b.

Responses from the 2001 Census of Agriculture regarding tillage practices indicated that 70%, 28% and 22% of farms used conventional tillage, minimum tillage and no-till practices

respectively ([Table 2.5](#))¹². Conventional, minimum and no-till practices comprised 41%, 30% and 30% of tilled area, respectively. To provide an indication of the increased use of reduced tillage practices (minimum tillage and no-till) in Canada, conventional, minimum and no-till practices comprised 69%, 24%, and 7% of tilled area, respectively, in 1991 and 53%, 31%, and 16% of tilled area, respectively, in 1996. Across provinces, however, the statistics indicate that reduced tillage practices are commonly used in some provinces (e.g. the Prairie provinces and Ontario) but not in others. Variability in adoption of reduced tillage practices can be partly attributed to different cropping patterns across Canada. Wheat, barley, canola, peas and other crops grown in the Prairies grow well under reduced tillage systems, whereas crops such as potatoes and corn do not (Fulgie, 1999; University of Guelph, 1998; Conservation Technology Information Center, 2002).

2.3.2 Adoption of BMPs in the United States

Data on adoption rates of BMPs in the U.S. provided information similar to that discussed for Canada. However, there were data gaps in Canada with respect adoption of variable rate fertilization (VRF) technologies, which will be the focus of this section.

A survey of producers conducted by the Kansas Department of Agriculture revealed that less than one-third of respondents had adopted nutrient BMPs such as variable-rate applications, split fertilizer applications and annual soil testing (Kansas Department of Agriculture, 1997). With respect to variable rate fertilization (VRF) technology, USDA data for 1998 indicated that 6% of grain and oilseed producers in the US use VRF applications (Daberkow and McBride, 2000). Khanna et al. (1998) found that 12% of survey respondents used VRF in Illinois, Indiana, Iowa, and Wisconsin. Of these respondents, however, 80% either hired VRF services or leased used VRF equipment. In Ohio, a 1999 survey found that 7% of producers used VRF (Batte, 2001).

2.4 Assessing the Economics of BMPs

Economics plays an important role in whether a producer adopts a certain beneficial management or not. When the economics of implementing BMPs are not known or uncertain, producers may be hesitant to adopt them. Therefore, research is required that enables producers to make informed decisions on how BMPs would affect the profitability of their operations.

¹² Totals do not add to 100% since farms were allowed to report more than one type of tillage practice.

Table 2.5 Tillage Practices Used by Producers across Canada and by Province, 2001 Census of Agriculture

Region	Conventional Tillage ¹						Minimum Tillage ²						No-Till ³					
	1991		1996		2001		1991		1996		2001		1991		1996		2001	
	Farms	Area	Farms	Area	Farms	Area	Farms	Area	Farms	Area	Farms	Area	Farms	Area	Farms	Area	Farms	Area
(%)																		
Canada	83	69	75	53	70	41	22	24	29	31	28	30	8	7	15	16	22	30
Newfoundland	89	84	87	88	81	75	10	8	16	8	18	13	9	8	5	4	21	12
Prince Edward Island	94	91	88	82	90	76	10	8	20	16	22	22	5	1	3	2	3	2
Nova Scotia	91	88	89	77	88	71	11	8	16	20	15	20	7	4	5	3	9	8
New Brunswick	93	85	89	80	88	82	12	13	18	18	16	15	5	2	6	2	8	3
Quebec	94	85	89	80	89	77	13	12	16	16	22	19	5	3	9	4	9	5
Ontario	89	78	82	60	78	52	19	18	26	22	25	22	8	4	19	18	29	27
Manitoba	77	66	74	63	69	55	29	29	31	28	31	33	9	5	11	9	13	13
Saskatchewan	74	64	63	45	55	32	28	26	39	33	33	29	13	10	21	22	30	39
Alberta	83	73	74	57	63	37	21	24	30	33	31	36	4	3	9	10	19	27
British Columbia	87	84	85	66	81	65	11	12	16	24	13	21	9	5	8	10	13	14

¹Tillage incorporating most of the crop residue into the soil.

²Tillage retaining most of the crop residue on the surface.

³Tillage that uses no-till seeding or zero-till seeding.

Source: Statistics Canada, Census, 2001b.

The literature review indicated the information required to assess the economics of each BMP and also provided insight into methods that would be applicable for use in this research. Many of the analyses conducted in these studies used representative farms or partial budgeting in order to assess the economics of various BMPs¹³. Unless field trials had been performed as part of the analysis, estimates of actual benefits were not available. In cases where field trials were not performed, the benefits received from implementing BMPs were often based on assumptions made by researchers. Roberts et al. (2000, p. 141) stated that this is because “actual benefits can only be determined on a field-by-field basis as they depend on the particular characteristics of each field.” Costs of implementing BMPs, on the other hand, were usually included in the studies. Sources of cost data in the studies reviewed were often governments and agricultural retailers within the region analyzed.

Variable rate fertilization, mid-season fertilizer applications, vegetated buffer strips, reduced tillage systems, cover crops, manure management and nutrient management planning were the nutrient BMPs discussed in the literature reviewed. The following sections (2.4.1-2.4.7) review the methods used to evaluate the BMPs, identify the types of benefits and costs typically borne by producers when implementing BMPs, and discuss the results of the research reviewed.

2.4.1 Variable Rate Fertilization

The economics of variable rate fertilization (VRF) were addressed in the following studies:

Literature	Region Analyzed
Swinton and Lowenberg-DeBoer (1998)	North America
Babcock and Pautsch (1998)	Iowa
Thrikawala et al. (1999)	Ontario
Roberts et al. (2000)	Tennessee
Yang et al. (2001)	Texas
Bullock et al. (2002)	North America
Tawainga et al. (2003)	North Eastern US

These research studies suggest that the benefits from using VRF are the result of efficient input use, which would result in increased yields and savings in fertilizer costs. Additional costs associated with adopting VRF technologies were mainly associated with investment in equipment including yield monitors and controllers for fertilizer implements. Producers, however, are often able to hire VRF application services through retailers. This allows producers to become familiar with the technology prior to investing in equipment. VRF applications were generally not based on soil tests within these studies because of the prohibitive costs associated with the number of soil tests required. Thrikawala et al. (1999) used yield monitor data to develop a fertility map to make fertilizer recommendations. In Babcock and Pautsch (1998) variable fertilizer rates were based on soil maps since these maps incorporate field characteristics such as slope, clay and sand content that would provide a measure of yield potential as well as yield variability.

The reviewed studies identified the variability of in-field fertility and differences in yield responses within fields to nutrients as important factors that affect the economic feasibility of using VRF strategies. Results of the literature reviewed suggested that wide variations in fertility

¹³ A representative farm is a typical farm within the study area. Partial budgets are calculated by subtracting losses (increases in costs and reductions in revenue) from gains (reductions in costs and increases in revenues) (Swinton and Lowenberg-DeBoer, 1998).

within fields and large differences in yield responses to nutrients greatly improve the returns to VRF technologies. An article by Tawainga et al., 2003 adds to this result by suggesting that temporal variation from year to year also affects yield response and nitrogen uptake (rather than just in field variation). Investing in VRF technologies was found to be more economically feasible for larger farms as associated fixed costs are spread over a larger area. In Ontario, Thrikawala et al. (1999) found that VRF systems would be profitable for most commercial corn farms in the region. On the other hand, Swinton and Lowenberg-DeBoer (1998) indicated that VRF strategies are generally not profitable for low value crops (i.e. wheat, barley, corn) because over-fertilizing does not significantly reduce returns as costs of macronutrient fertilizers are relatively low (although recent changes in price ratios may impact economic calculations). It is important to note that research studies likely overestimate the benefits of VRF since they assume that low-yielding areas are associated with low fertility (Swinton and Lowenberg-DeBoer, 1998). These areas could have poor yields because of soil moisture holding capacity constraints rather than fertility problems (Swinton and Lowenberg-DeBoer, 1998).

2.4.2 Split Applications and Mid-Season Applications (Timing) of Fertilizer

The timing of fertilizer applications is an important factor which affects the efficiency of fertilization. The interval between application and crop uptake determines the length of exposure of fertilizer to loss processes such as leaching and denitrification (Michigan State University Extension, 2002). Many factors affect the efficacy of time application including: soil texture; drainage characteristics of the soil; rainfall frequency and amount; and soil temperature (Michigan State University Extension, 2002; Papendick et al., 1987; Alabama Cooperative Extension System, 1995). Nitrogen timing options usually include fall applications, spring preplant applications, sidedress or delayed applications made after planting, and split or multiple treatments added in two or more increments during the growing season.

The costs and benefits of each application method, as well as the agronomic factors mentioned above, must be considered on an individual farm basis to determine the most beneficial practice. It is important that fertilizer application meets the requirements of each producer, but does not exceed them. Over-fertilization can have adverse environmental effects (such as leaching, ground water contamination, and soil erosion), which need to be considered in a farmer's cost-benefit analysis.

Split application fertilizer has been studied to determine if there are benefits in yield and nutrient uptake. Bandel et al., (1989) at the University of Maryland looked at the different methods for nitrogen management for high yield small grain production. They found that split nitrogen applications frequently result in higher grain yields, but not in every case, as benefits depend on the soil type. Split nitrogen applications on soils that are more subject to leaching often result in better nitrogen utilization and higher yields compared to heavier textured soils that are less subject to leaching. A study by Kratochvil et al. (2005) looked at nitrogen management for hard red winter wheat in the Mid-Atlantic States. The research found that the most profitable nitrogen management strategy for hard red winter wheat was to use split applications. However, they also found that when there was a particularly wet growing season, split nitrogen application had no yield response at all.

Split application can provide some benefits to farmers, such as an increased yield response, reduced leaching, increased nitrogen uptake and improved profitability when yield responses are greater than input costs (Randall and Schmitt, 1994). However, there are also costs associated with the split application method. The most prevalent costs are the increased time

and labour that is required for the extra applications. Other costs include the equipment costs, the carryover of unused nitrogen and soil tests to determine the exact amount of nitrogen to be applied. Furthermore, while it has been shown that split applications are beneficial for specific soils and climates (such as irrigated sandy soils), the same benefits may not apply for all soil types (Randall and Schmitt, 1994).

2.4.3 Vegetated Buffer Strips

The use of vegetated buffer strips near natural sources of water such as wetlands, riparian areas, lakes, and streams has received some attention in the literature by Yang and Weersink (2004), Nakao et al. (1999), and the University of Maryland Cooperative Extension (2000). The Yang and Weersink (2004) study was conducted in Ontario, Nakao et al. (1999) performed their research in Ohio, and Maryland was the region analyzed by the Maryland Cooperative Extension. These studies indicated that buffer strips generally remove land from agricultural production and reduce a producer's net returns. Although, depending on what they are seeded to, buffer strips may provide some income generating opportunities (Nakao et al., 1999; Maryland Cooperative Extension). Managing these areas for hay or timber production are revenue generating possibilities within the buffer strip area (Nakao et al., 1999).

Environmental benefits that can be achieved from implementing a buffer strip include improvements in water quality, topsoil retention, fish and wildlife habitat, and recreation (Maryland Cooperative Extension, 2000). These environmental benefits can be turned into economic benefits. Improved water quality enhances goods and services that are bought or sold in the marketplace and can lead to a higher product price. As well, increased topsoil retention can lead to higher crop yields and thus added production and income for a producer (Maryland Cooperative Extension, 2000).

Costs associated with vegetated buffer strips include costs of establishment, maintenance and forgone income from crops previously grown in these areas. If financial incentives are provided for the establishment and/or maintenance of buffer strips, those organizations providing the assistance may impose restrictions on activities that may be performed within these areas. Costs are influenced by the width of the buffer strip. Wider buffer strips are generally necessary to reduce runoff in instances where, for example, the field slopes towards a natural water source. The type of vegetation grown in the buffer strip may impact the amount of runoff that reaches natural water sources and therefore may influence the width of the buffer strip required to achieve environmental objectives (Nakao et al., 1999; Maryland Cooperative Extension, 2000).

2.4.4 Reduced Tillage Practices

Reduced tillage practices are continually being adopted by producers in the Prairie provinces in Canada. Gray et al. (1996) and Zentner et al. (2002) are two studies that analyzed the economics of switching to reduced tillage practices. In Ontario, reduced tillage is becoming more popular despite the fact that research on corn suggests no-till corn does not yield as well as conventionally tilled corn (Fulgie, 1999; University of Guelph, 1998; Conservation Technology Information Center, 2002). Reduced tillage practices in Ontario were studied by Aspinall and Kachanoski (1993) and Deloitte and Touche (1992).

Both Prairie studies suggested that reduced tillage practices can improve returns in certain soil zones relative to conventional tillage. Gray et al. (1996) used a representative farm simulation to evaluate the economic viability of no-till, whereas the Zentner et al. study primarily reported on

data and findings from AAFC field experiments. Zentner et al. (2002) concluded that reduced tillage practices were more profitable than conventional tillage systems in the black and gray soil zones, whereas conventional tillage systems were more profitable in the brown and dark brown soil zones. Both studies suggested that the profitability of reduced tillage technologies, however, was dependent on yield advantages over conventional tillage systems. Lower yield variability associated with reduced tillage practices was also found to reduce business risk and therefore the practice would be attractive for risk averse producers (Zentner et al., 2002).

The Prairie studies also identified herbicide costs, labour availability, and reductions in yield variability as other economic factors that could influence producers' decisions to adopt reduced tillage technologies. Gray et al. (1996) mentioned that a reduction in the cost of glyphosate has been essential to the profitability of reduced tillage technologies. Furthermore, Zentner et al. (2002) mentioned that improved post-emergent technologies have also encouraged adoption of these practices.

Crop diversification was associated with switching tillage practices in the Prairies as well. Diversification has helped producers improve the profitability of their operations through increased revenues and reduced risk (Zentner et al., 2002). On the other hand, investment in reduced tillage equipment had a significant impact on the economic feasibility of switching to reduced tillage practices. Switching tillage practices may not be profitable for producers that would require a substantial investment in equipment despite apparent agronomic benefits (Gray et al., 1996).

The Ontario studies also suggested that reduced tillage practices could improve returns relative to conventional tillage. Aspinall and Kachanoski (1993) used a study of 40 farms across the province to compare the economics of different tillage practices. Deloitte and Touche (1992) used data from a number of sources including the data used by Aspinall and Kachanoski (1993) to assess the economics of reduced tillage. Both studies suggested that returns to labour hours, however, were always greater for minimum tillage and no tillage systems since these practices require fewer field operations.

Economic returns for specific crops were used in the Aspinall and Kachanoski (1993) report. The findings revealed that average net returns for corn were highest using no-till and lowest for conventional tillage. Higher returns were primarily the result of a significant decrease in the cost of field operations. For soybeans, conventional tillage had the highest returns. Substantially higher herbicide costs and slightly lower yields were cited as reasons why conventional tillage outperformed the other tillage systems. Finally, for winter wheat, net returns were, on average, the highest for minimum tillage and the lowest for conventional tillage.

Conclusions from Deloitte and Touche (1992) were based on crop rotations. The results suggested that returns for continuous corn rotations were similar across tillage systems. Conventional tillage provided marginally better returns for soybeans following corn. Reduced tillage practices provided improved returns relative to conventional tillage for wheat following soybeans, and no-till and minimum tillage provided higher returns relative to conventional tillage for corn followed by other crops (i.e. crops other than soybeans and wheat).

Aspinall and Kachanoski (1993) also drew conclusions for a number of factors that affected the economic returns of various tillage practices including yield comparisons, plant populations, and soil type. Five years of yield comparisons between tillage practices revealed that corn and soybean yields were greatest under conventional tillage systems and lowest under no-till. For

other crops, results indicated that yields were similar across tillage systems. However, lower yield variability was found for reduced tillage systems relative to conventional tillage. Plant populations were found to be lower under reduced tillage systems relative to conventional tillage. This was attributed to poorer emergence from increased residue on soil surfaces and wetter, cooler soil conditions at planting. The results also indicated that certain soil types were more suitable for particular tillage systems. No-till was found best suited for sandy soils, minimum tillage was best on silt soils, and conventional tillage was most appropriate for clay soils.

Longer term environmental benefits of reduced tillage practices that impact soil productivity were also identified. These benefits included reductions in soil erosion, soil organic matter loss, and soil salinity (Gray et al., 1996). However, the economic implications of these benefits were difficult to estimate due to the associated time frame. Accounting for these benefits in an economic analysis would improve the attractiveness of reduced tillage systems. On the other hand, if the time frame associated with these benefits is longer than a producer's planning horizon then they likely would not be included in a producer's decision to adopt reduced tillage practices.

2.4.5 Cover Crops

Cover crops are designed to absorb excess nitrogen after crop harvest and prevent erosion during winter months (Cestti et al., 2003). Crops such as rye, oats, sweet clover, winter barley and winter wheat are planted to temporarily protect the ground from wind and water erosion during times when cropland is not adequately protected against soil erosion. Cover crops may also be used to absorb surplus nutrients. Cover cropping is a short-term practice not exceeding one crop year.

The crop cover keeps the ground covered, adds organic matter to the soil, traps nutrients, improves the soil tilth, and reduces weed competition. When properly grown, cover crops or green manure may contain 1–2% nitrogen, 0.5–0.75% phosphorus, and 3–5% potassium, which is equivalent to low-analysis fertilizing materials (Cestti, 2003). In addition, cover crops are used to decrease erosion, runoff, and leaching between cropping seasons as well as pest problems. Crop covers can reduce soil erosion by 70% and runoff by 11-96% (Dillaha, 1990, p. 6 as cited in Cestti, 2003).

Research at the Biological Station in Michigan that compared continuous corn to corn following frost seeded red clover in wheat showed a US\$40 per acre per year incremental net return when cover crops were incorporated into a crop rotation (Michigan State University Extension, 1998, p. 52 as cited in Cestti, 2003).

A study by Hanson et al. (1993) analyzed the profitability of a hairy vetch cover crop for corn in Maryland. The study compared experimental plot results for three different rotational practices and concluded that the economics of a hairy vetch cover crop would be comparable to more conventional rotational practices under a number of different scenarios.

A study by Andraski and Bundy (2005) looked at the effect that cover crops have on corn yield responses to nitrogen. This study was conducted in the Central Sands region of Wisconsin, and looked particularly at irrigated sandy soil. Previous work had been done in warmer climates that indicated that significant amounts of nitrogen can be accumulated by nonlegume cover crops (Vaughn and Evanylo, 1998 as cited in Andraski and Bundy, 2005). The Andraski and Bundy

study did not directly examine the costs of implementing cover crops, but their study found that cover crops generally provided wind erosion control on sandy soils and that fall-planted cover crops such as oats, winter triticale, and winter rye can provide significant yield benefits to the corn crop at slightly lower nitrogen fertilizer rates.

2.4.6 Manure Management Planning

A manure management plan illustrates how manure generated at a livestock facility will be used during the upcoming cropping year(s) in a way that maximizes the benefits of applying manure to cropland, meets all rules and regulations, and protects surface and ground water quality (Minnesota Pollution Control Agency, 2005).

Manure management is adopted as a BMP to control odour and to minimize runoff and nutrient loss. The economics of manure management are dependent on many factors (not just storage). These factors include (but are not limited to) changes in prices of commercial fertilizers, crop prices, energy prices, labour costs, interest rates, and the cost of application equipment (Freeze et al., 1993; Huijsmans et al., 2004; and Rausch and Sohngen, 1999).

There are also many benefits that can be achieved by using a manure management system. Klausner (1989) points out that, depending on the animal, 70-80% of nitrogen, 60-85% of phosphorous, and 80-90% of potassium is excreted as manure (as cited in Rausch and Sohngen, 1999). But aside from these nutrient benefits, manure also provides soil tilth, increases water holding capacities, and promotes beneficial organisms (Freeze et al., 1993; Ohio State Extension Bulletin 604, 1992).

Freeze et al. (1993) looked at the economics of hauling manure to assess how manure can be used as a restorative amendment for eroded soil. They included the costs for hauling and spreading and also looked at potential pollution costs (nitrogen, salts, pathogens) to the soil and groundwater. They found that barnyard manure is a valuable amendment for restoring the productivity of eroded soil (eroded wheat cropland) and that it improves soil structure and tilth.

A study by Hanna et al. (2000) looked at the effects of manure incorporation in Iowa on both corn and soybean cover crop residues. The study found that mixing manure through injection or incorporation often resulted in greater yields and reduced nutrient loss in runoff and volatilization to the environment. Similarly, they found that the choice of manure application method with soybeans was more important than with corn, because corn residue was less affected by application technique.

Huijsmans et al. (2004) looked at the economics of manure application, using data from eight different European countries. The authors developed a model to calculate the costs of application techniques that were designed to reduce ammonia losses and compared the techniques to the costs of conventional broadcast spreading. The study found that the costs of application techniques that reduce ammonia volatilization are higher than costs for conventional broadcast spreading.

A study by Pierce et al. (1992) evaluated the economic impacts on returns of using swine manure to meet crop nutrient needs on a typical Midwest crop/livestock farm (specifically a soy-corn rotation and continuous corn). The study found that, in addition to adverse environmental impacts, the sole use of commercial fertilizer reduces returns, in all cases, by as much as 5%, and that farm returns can be increased through the efficient use of manure from swine

operations. The study also found that, although the use of manure to help meet corn production nitrogen requirements is profitable, it often requires hiring part-time labour for incorporation of manure when the nutrient availability is highest. Hiring labour leads to increased costs.

2.4.7 Nutrient Management Planning

Nutrient management planning is a key component of the economic and environmental management of agricultural operations. A Nutrient Management Plan (NMP) is a strategy to manage the amount, placement, timing, and application of nutrients (commercial fertilizer, manure, biosolids, etc.) for maximum economic benefit and minimum environmental risk. Nutrient management requires planning and recognizes that every farm has its own set of circumstances that affect efficiency of nutrient use. A NMP is tailored to the farming operation and the needs of the person implementing the plan. Nutrient management planning in many ways incorporates the BMPs discussed above.

The Division of Soil and Water Conservation of Virginia Polytechnic and State University (Pease et al., 1998) conducted research to investigate the before-and-after effects of nutrient management practices on farm profit and farm-level nitrogen losses for four Virginia livestock farms which had implemented a NMP: a southwest dairy, a Shenandoah Valley dairy, a southeast crop/swine farm, and a Piedmont poultry farm. The results of the study indicated that as a result of the NMP, N applications were reduced by 21-47% across the four farms. Adoption of nutrient management practices resulted in significant reductions of potential nitrogen and phosphorus losses for each farm. Average annual N losses decreased by 23-45% (37 to 106 kilograms per hectare), while phosphorus losses decreased by 0-66%. The net impact of farm practice changes increased net farm income by US\$395 (US\$12/ha) to \$7,249 per year (US\$160/ha) (VanDyke, 1997). Increases in farm income resulted primarily from reductions in commercial fertilizer purchases, which in turn were caused by more accurately crediting animal wastes for nutrient content. On the Piedmont poultry farm, however, income was increased by additional sales of poultry litter resulting from decreased litter application rates. All farms spread manure on larger acreages after implementing the plan, thus lowering applications and losses on the smaller area formerly preferred for application.

Pease et al., 1998 noted that nutrient management planning is a cost-effective process to reduce nitrogen losses on livestock farms. On each of the studied farms, nutrient management planning was a win-win investment that produced significant nitrogen loss reductions and moderate farm income increases. For livestock farms, manure storage¹⁴, manure nutrient crediting, and proper timing of applications were keys to the nutrient management success. Manure testing was also a critical element in achieving cost savings. Eliminating manure applications on fields with steep slopes will have a significant impact on reducing soil erosion and related nitrogen/phosphorus losses.

In 1990, the State of Maryland estimated that if nutrient management plan recommendations were followed by farmers, farmers would experience average savings of \$55 per hectare (USEPA, 1993, p. 2-60 as cited in Cestti, 2003).

¹⁴ Note that the economics of BMP associated with manure storage and handling were beyond the scope of this study.

2.5 Incentives for Canadian Producers to Adopt BMPs

In this section of the literature review, incentives were reviewed that are currently available for Canadian producers to adopt BMPs. The specific programs reviewed include the National Farm Stewardship Program (NFSP) ([section 2.5.1](#)), the Federal-Provincial Environmental Farm Plan (EFP) program ([section 2.5.2](#)), the National Water Supply Expansion Program (NWSEP) ([section 2.5.3](#)), the Greencover Canada (GC) program ([section 2.5.4](#)), as well as programs that assist producers in adopting BMPs related to manure application ([section 2.5.5](#)). Government programs for crop BMPs may be influenced by the federal government's Kyoto implementation plan in the future as BMPs that reduce the use of tillage on farming operations or increase the use of permanent cover may be treated as carbon sinks¹⁵ (Government of Canada, 2005).

2.5.1 The National Farm Stewardship Program (NFSP)

According to Agriculture and Agri-Food Canada, the National Farm Stewardship Program (NFSP) 2005-2008 is a joint federal and provincial cost-share initiative to support environmental stewardship in agriculture by providing funding for the producer adoption of BMPs (AAFC, 2005a; AAFC 2005c; AAFC 2005d; AAFC 2004). The NFSP also provides the Critical Areas component of the Greencover Canada program and the BMP portion of the Greencover's Shelterbelt component. The objectives of the NFSP are to help agricultural producers, individually and collectively, take action to reduce identified environmental risks and to improve management of Canada's agricultural land to reduce risks to water and air quality, improve soil productivity and enhance wildlife habitat. These objectives coincide with the goals of the environmental programs under the Agricultural Policy Framework (APF), which are to improve producer-based stewardship of land, water, air and biodiversity resources that agriculture depends on and influences. Another objective is to increase domestic and international confidence that Canadian-grown food products are being produced in a safe, environmentally sound manner. The funds for the programs are provided by AAFC through the environment pillar of the APF. Provinces generally provide technical support for the program in the form of Environmental Farm Plan delivery.

For the NFSP program, BMPs were defined as any agricultural management practice that: mitigates or minimizes negative impacts and risk to the environment; ensures the long term health of land related resources used for agriculture; and does not negatively impact the long term economic viability of producers (McGarry, 2004). The focus of the BMPs was to improve management in areas such as nutrients, riparian areas, erosion control, pests and wildlife habitat. Lists of eligible BMP categories (refer to [Appendix A](#)) as well as BMP cost-share percentages and funding caps were developed on a provincial/territorial basis by Federal/Provincial/Territorial working groups.

¹⁵ The Government of Canada (2005) is currently in the process of developing programs for an offset system for greenhouse gases. In agriculture this will relate to carbon soil sequestration. The agriculture sink projects will involve the adoption of agricultural management practices that increase carbon levels in the soil. Many of the BMPs being proposed under the federal government Kyoto implementation plan will overlap with nutrient BMPs. Examples of potential agricultural sink projects will include:

- reducing the intensity of tillage operations
- adopting crop rotations and grazing management practices that sequester more carbon in the soil
- increasing the use of permanent cover.

The funding period for this program ends March 31, 2008 and the funding cap per legal farm entity is \$50,000 over the life of the program. The maximum funding available for a legal farm entity under the Greencover Canada and the NFSP programs together is \$50,000 over the life of the programs. Generally the program will cover 30-50% of eligible costs of approved BMPs. [Table 2.6](#) depicts the federal-provincial farm stewardship programs by province.

Table 2.6 Federal-Provincial Farm Stewardship Programs by Province

Program by Province	Funding (2005-2008)	Provincial Agency Responsible For Program Delivery
Canada-Ontario (COFSP)	\$43 million	Ontario Soil and Crop Improvement Association
Canada-Manitoba (CMFSP)	\$~30 million	Manitoba Agriculture, Food and Rural Initiatives
Canada-Saskatchewan (CSFSP)	\$28-29 of \$40 million under APF	Saskatchewan Agriculture and Food
Canada-Alberta (CAFSP)	\$48.8 million (federal) \$32 million (provincial)	Alberta Environmental Farm Plan Company
Canada-Quebec (CQFSP)	\$74.25 million	Conseil pour le développement de l'agriculture du Québec
Canada-Prince Edward Island (SRCP)	\$828,600	PEI Dept of Agriculture, Fisheries, Aquaculture and Forestry; PEI Federation of Agriculture

The following is a list of eligible BMPs and national funding cost-share amounts. Note that individual provinces¹⁶ may provide top-ups in addition to the national funding. For detailed information on national cost-share amounts and provincial top-ups, refer to [Appendix A](#). Crop nutrient BMPs eligible for funding include water well management, farmyard runoff control, riparian area management, improved cropping systems, winter cover crops, nutrient recovery from waste water, shelterbelt establishment, nutrient management planning, and irrigation management planning. Specific eligibility criteria and funding caps have been included for the BMPs evaluated in this analysis (soil testing, manure management planning, buffer strips, nutrient management planning, minimum tillage, no tillage and variable rate fertilization):

- Improved Manure Storage and Handling
- Manure Treatment
- *Manure Land Application*
 - Specialized/modification to equipment for improved manure application
 - Includes 30% cost share to a maximum of \$10,000.
- In-Barn Improvements
- Farmyard Runoff Control
- Relocation of Livestock Confinement and Horticultural Facilities
- Wintering Site Management
- *Product and Waste Management*
 - Improved on-farm storage and handling of agricultural products (eg. fertilizers, petroleum products, silage and pesticides)

¹⁶ Note that in Ontario there are two top-up programs that apply only to specific regions of the province, i.e., the Oak Ridges Moraine and the Greenbelt. These top-up programs have not been included in the following list or the model analysis due to the regionally specific nature of the top-up programs.

- Improved on-farm storage, handling, and disposal of agricultural waste (eg. livestock mortalities, fruit and vegetable cull piles, and wood waste).
- Composting of agricultural waste (eg. fruit, vegetable, wood, straw residues)
- Engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA))
 - Includes 30% cost share for product and waste management to a maximum of \$15,000.
- Water Well Management
- *Riparian Area Management*
 - Establishment / planting of forages (planting and establishment costs for trees and shrubs for the year of planting and one year after the planting year, or the termination of the NFSP funding, whichever comes first)
 - Includes 50% cost share for establishing buffer strips to a maximum of \$20,000.
- Erosion Control Structures (Riparian Areas – Greencover)
- Erosion Control Structures (Non Riparian Areas - NFSP Funding)
- *Land Management for Soils at Risk*
 - Forage or annual barrier establishment for soils at risk (e.g. stripcropping, grassed waterways, perennial forages on severely erodible or saline soils)
 - Includes 50% cost share for establishing forage or annual barrier to a maximum of \$5,000.
 - Top-ups are available in BC (funding provided by Ducks Unlimited Canada).
 - Provincial top-ups are available in PEI.
- *Improved Cropping Systems*
 - Equipment modification on pre-seeding implements for restricted zone tillage for row crops, seeding and post seeding implements for low disturbance placement of seed and fertilizer.¹⁷
 - Includes 30% cost share for improved cropping systems to a maximum of \$15,000.¹⁸
 - Chaff collectors and spreaders installed on combines
 - Precision farming applications: GPS to collect information, GPS guidance systems (i.e.: autosteer, lightbars, software), or manual and variable rate controllers for variable rate fertilizer application.

¹⁷ Funding will be provided for various equipment components that facilitate improved placement of seed and fertilizer through lower soil disturbance. Eligible components include openers, coulters, and trash clearance devices. The cost of installing these components is also an eligible expense. All other components of seed and fertilizer application are not eligible, including seeding implement frame, tanks, delivery system (ie. hoses), and packer wheels (except as noted below). This BMP is intended to provide support primarily through equipment modification, although a producer may alternatively claim the value of the eligible components when purchasing an entire equipment unit. Eligible equipment include pre seeding implement modifications for restricted zone tillage for row crops, seeding and post seeding implements that apply fertilizer through low soil disturbance (eg. liquid coulters or row crop bander). In addition, gang mounted on-row packers as well as shank mounted on-row packers are an eligible item when applied for as part of a complete conversion to low disturbance. Note that eligibility criteria may differ by province..

¹⁸ Category 14 provides cost share on, among other things, the specialized components of equipment components that facilitate improved placement of seed and fertilizer through lower soil disturbance. The 30% cost share is not applied on the entire implement, only the specialized components which differentiate the conservation unit from a conventional unit.

- Includes 30% cost share for improved cropping systems to a maximum of \$15,000.¹⁹
- Cover Crops
- Improved Pest Management
- Nutrient Recovery from Waste Water
- Irrigation Management
- *Shelterbelt Establishment (Greencover)*
 - Establishment of shelterbelts (planting and establishment costs for trees and shrubs for the year of planting and one year after the planting year, or the termination of the NFSP funding, whichever comes first) for farmyard, livestock facilities, dugout snowtrap, wildlife habitat enhancement, field.
 - Tree materials required for shelterbelt establishment
 - Includes 50% cost share to a maximum of \$10,000.
 - Provincial top-ups are available in Quebec and PEI.
- Invasive Alien Plant Species Control
- *Enhancing Wildlife Habitat and Biodiversity*
 - Buffer Strips - Native Vegetation: plant or enhance native vegetation (e.g. non woody species such as grass, forbes, legumes) to increase buffer width around existing habitats including field margins, riparian areas, dugouts, wetlands, or to connect native grass or woodland parcels (similar to Buffer Establishment described above)
 - Plant appropriate shrub and tree species for the landscape/habitat objective (similar to Shelterbelt Establishment BMP above, first and second year planting and establishment costs of shrubs, trees; weed control, and mulch)
 - Includes 50% cost share to a maximum of \$10,000.
 - Top-ups are available in BC (funding provided by Ducks Unlimited Canada).
- *Species at Risk*
 - Plant Species Establishment: planting appropriate grass, shrub or tree species for improved cover for selected species at risk, (e.g. thorny shrubs for Loggerhead Shrike; re-establishment of a specific plant species at risk (e.g. American Chestnut tree). Similar to Buffer Establishment and Shelterbelt Establishment described above.
 - Includes 50% cost share to a maximum of \$10,000.
 - Top-ups are available in BC (funding provided by Ducks Unlimited Canada).
- *Preventing Wildlife Damage*
 - Forage Buffer Strips: Convert cropland to forage around wetlands/dugouts where waterfowl cause recurring damage. Similar to Buffer Establishment described above).
 - Includes 30% cost share to a maximum of \$10,000.
 - Top-ups are available in BC (funding provided by Ducks Unlimited Canada).
- *Nutrient Management Planning*
 - Consultant fees to conduct nutrient management plan & produce report for farmer
 - Planning and decision support tools (eg. computer software and aerial photos)
 - Includes 50% cost share to a maximum of \$4,000.

¹⁹ For precision farming applications, category 14 will cover 30% on the specialized components of fertilizer spreaders necessary to handle heavy residue. It is important to note that the 30% cost share is available only for the specialized components not for the entire cost of the fertilizer spreaders. For GPS, the cost share is 30% on the entire unit, up to the category cap of \$15,000.

- Provincial top-ups are available in Manitoba.
 - During the development of a nutrient management plan, producers are eligible for financial assistance related to soil testing including soil sampling and analysis).
 - Integrated Pest Management Planning
 - Grazing Management Planning
 - Soil Erosion and Salinity Control Planning
 - Biodiversity Enhancement Planning
 - Irrigation Management Planning
 - Riparian Health Assessment
- Sources: AAFC, 2005e; AAFC, 2006b.

It is worth noting that funding for certain BMPs (e.g. buffer strips) is available through several categories of the National Farm Stewardship Program and Greencover program. Therefore, program administrators and producers can select various categories from which funding can be accessed.

2.5.2 Federal-Provincial Environmental Farm Plan (EFP) Program

Environmental Farm Plans help producers identify environmental risks and develop an action plan to mitigate these risks on their farm operations (AAFC, 2005a; AAFC, 2005c; AAFC, 2005d; AAFC, 2004). The objectives of the EFP program are: to establish principles of environmental action; to achieve measurable progress in meeting environmental goals for the landscape; to reinforce public confidence that Canadian agricultural resources are being managed in a sustainable fashion; to brand Canada as a source of safe, high quality food produced using environmentally sustainable systems; and to support producers and landowners in taking actions which reduce the risk to the environment from agricultural operations (OSCIA, 2005b).

The federal government provides financial support for the completion of EFPs, whereas the province usually provides technical support in the endeavour. EFP funding is also provided under the APF, as the Federal-Provincial EFP program is a major component of the APF and NFSP agreement between the federal government and provinces/territories.

EFPs can be completed independently of participation in the National Farm Stewardship Program. Without an EFP, however, producers are not eligible for BMP funding under the NSFP as described in the previous section. This is due to the fact that one of the goals of the NFSP is to provide financial incentives to producers for the adoption of BMPs to address environmental risks identified in the EFP process. In lieu of an EFP, a producer could complete an Equivalent Agri-Environmental Plan (EAEP) to qualify for BMP funding under the NFSP. An EAEP is similar to an EFP, but is implemented by an organized group of agricultural producers. Groups can be formed on a geophysical (e.g. watershed), geopolitical (e.g. municipality), or sector basis (e.g. pork producers).

2.5.3 National Water Supply Expansion Program (NWSEP)

The National Water Supply Expansion Program (NWSEP) is providing \$60 million worth of Canada-wide funding to improve the capacity of Canada's agricultural community to address water supply concerns (AAFC, 2005b). The program began in 2002 and funding of \$10 million in that first year was used to help develop high-priority water supply projects in drought-affected areas. NWSEP funding was also used to conduct a one-year National Scoping Study whose goal was to identify agricultural areas of Canada experiencing or at risk of experiencing water

shortages. The results of this study determined the focus of federal-provincial agreements under the NWSEP, which was to provide financial and technical assistance for farmers to plan and adopt projects that promote sustainable water supplies.

To qualify for NWSEP funding, projects must reduce the risk of future water shortages, meet a provincial water development priority, be scientifically, technically and financially feasible, be environmentally acceptable, enhance the potential for rural economic growth, and result in a long-term water supply solution (AAFC, 2005b). Those projects eligible for funding under the program are categorized into three tiers. Tier one projects are on-farm water infrastructure projects. These are described as smaller scale water development projects, such as dugouts/ponds, off-stream storage, wells and pasture pipelines, which provide secure, safe and reliable water supplies for agricultural use. Tier one projects can qualify for a federal contribution of one third of eligible project costs to a maximum of \$5,000 per project. The maximum a producer can receive in funding under the program is \$15,000. Some provinces, however, provide additional funding. Tier two projects are those that affect water supplies for a number of users. These are larger scale infrastructure projects, such as tank loaders and regional water pipelines, which provide a long-term agricultural water source for a number of water users and promote economic growth in an area or region. These projects can also qualify for a federal contribution of one third of eligible costs. Projects that fall into tier three are those that are deemed strategic initiatives. These are studies, planning activities and/or undertakings that increase the knowledge base pertaining to water resources. Strategic work includes the development of information and technologies or the dissemination of information. Projects that are considered under tier three include regional groundwater studies, regional groundwater exploration and testing, regional water management and water supply planning, feasibility studies, and information extension studies. Cost sharing arrangements for tier three projects are determined and approved on a project-by-project basis.

2.5.4 Greencover Canada

The Greencover Canada program objectives are to improve grassland-management practices, protect water quality, reduce greenhouse gas emissions, and enhance biodiversity and wildlife habitat (AAFC, 2005a). Greencover Canada is a five-year \$110 million program which has four components:

- Land conversion – converting environmentally sensitive land to perennial cover
- Technical assistance – helping producers adopt BMPs; Watershed Evaluation of BMPs (WEBs)
- Critical area – managing agricultural land near water
- Shelterbelts – planting trees on agricultural land

[Table 2.7](#) summarizes the type and quantity of support and the eligibility under the Land Conversion component of the Greencover Canada program. The final deadline date for the land conversion component is January 31, 2007.

Table 2.7 Support and Eligibility under the Land Conversion Component of Greencover

Type of Support	Quantity of Support	Eligibility
Advice	- \$20/acre per seeding or planting	- Landowner registration required
Financial	- tame forage or trees ¹ - or \$75/acre for seeding native species ¹ - \$25/acre after establishment of perennial cover ²	- Land meets program criteria (quality, use, assessment of environmental sensitivity) - Commitment to maintain cover for 10 yrs after establishment

¹With signing of Contribution and Land-Use Agreement

²Establishment must be verified by Greencover Canada and be issued a Certificate of Stand Establishment

Source: AAFC, 2005a

The Technical Assistance component offers producers information on BMPs to encourage their implementation.

Producers who have a completed and reviewed environmental farm plan are eligible to apply for financial and technical assistance through the National Farm Stewardship Program for the critical area and shelterbelt components of the Greencover program.

The objective of the Critical Areas component is to enhance the health and function of riparian ecosystems by encouraging the adoption of beneficial management practices (BMPs). Financial assistance is available for remote watering systems, buffer establishment, fencing, native rangeland, grazing management, improved stream crossings, erosion control structures, grazing management plans and assessing riparian health (AAFC 2005a).

The Shelterbelt component encourages the adoption of beneficial management practices to plant trees and shrubs on agricultural land. Financial assistance is available for site preparation, planting, weed control, temporary fencing and tree materials (AAFC, 2005a).

2.5.5 Assistance for Adopting BMPs Related to Manure Application

Alberta, Saskatchewan and Manitoba²⁰ provide the Tri-Provincial Manure Application and Use Guidelines. The objective of the guidelines is “to assist producers to implement manure related beneficial management practices” (AAFRDe). The guidelines include sections on Calculating Manure Application Rates, and Manure Application Equipment²¹.

The section entitled *Calculating Manure Application Rates* discusses recommended manure application rates according to the manure’s nutrient content, the soil nutrient availability and the expected crop nutrient requirements (as in nutrient management).

²⁰ Alberta Agriculture, Food and Rural Development, Saskatchewan Agriculture and Food, Manitoba Agriculture, Food and Rural Initiatives, University of Saskatchewan, University of Manitoba, Prairie Agricultural Machinery Institute

²¹ Other sections include: Introduction, Understanding Manure, Soil Sampling and Analysis, Manure Sampling and Analysis, Understanding the Soil Test & Manure Test Reports, Manure and the Protection of Water, Air & Soil, and Record Keeping

The *Manure Application Equipment* section of the guidelines focuses on liquid manure application technology that “maximizes nutrient recovery, minimizes odour, and reduces the risk of runoff, compaction and soil disturbance.” The document also describes calibration of manure application equipment, and outlines uniformity of application.

The Beneficial Management Practices: Environmental Manual for Dairy Producers in Alberta²² is intended to provide “greater awareness and understanding of beneficial environmental practices.” The manual includes a section entitled *Land Application of Manure* which discusses manure application methods and timing of application. Application methods discussed include injection, low disturbance injection, broadcast with incorporation, and broadcast. The manual provides a summary table of alternative application times and the BMPs associated with each alternative. The table is reproduced in Appendix B.

Under the Canada-Ontario Farm Stewardship Program (COFSP), delivered by Ontario Soil and Crop Improvement Association (OSCIA) between April 2005 and March 31, 2008, Manure Land Application practices are eligible for funding assistance. Specifically, under COFSP “specialized modifications to equipment for improved manure application” are eligible for 30% cost sharing, up to \$10,000. Improved Cropping Systems is another category eligible for 30% cost sharing under COFSP, with a funding cap of \$15,000. The specific practices under this program include:

- “Equipment modification on seeding and post-seeding implements for low disturbance placement of seed and fertilizer;
- Chaff collectors and chaff spreaders installed onto existing combines; and
- Precision farming applications: GPS information collection, GPS guidance, manual controllers for variable rate fertilizer application.”

2.6 Summary and Discussion of the Literature

The purpose of the literature review was to develop a solid understanding of existing research regarding the economics and adoption of BMPs.

Phase 1 of this report consisted of the following:

Provide a clear definition of beneficial management practices for the purposes of this research.

The definition most appropriate for the types of BMPs that will be analyzed in this research was provided by the Crop Nutrients Council (2005). According to the Crop Nutrients Council (2005), a beneficial management practice considers the balance of nutrients for agricultural production with the goal of protecting environmental resources and ensuring profitable crop production²³.

Review of the economic literature that assesses adoption levels of beneficial management practices.

In the literature, there were a number of factors analyzed that could influence a producer’s decision to adopt BMPs. Characteristics of farms and farm operators that appear to influence

²² Developed by: Alberta Milk and Alberta Agriculture, Food and Rural Development
Funded by: Alberta Environmentally Sustainable Agriculture Program, Alberta Agriculture, Food and Rural Development and Canadian Adaptation and Rural Development Fund, Agriculture and Food Council, Agriculture and Agri-Food Canada

²³ In other words the management of crop nutrients for maximum economic, social and environmental benefit.

adoption were education level, farm size, level of gross sales and whether or not the producer earns off-farm income. Higher levels of education, larger farms, farms with higher levels of gross sales and producers who earned off-farm income were generally more likely to adopt BMPs. However, these findings were not necessarily consistent across all literature reviewed as some studies did not find significant relationships among these variables.

In assessing why some of these factors were found to influence BMP adoption, Fulgie (1999) suggested that education increases a producer's ability to learn and adapt new technologies to farm operations. Fulgie (1999) and Deloitte and Touche (1992) also suggested that producers with off-farm income were more likely to use reduced tillage systems because of a higher opportunity cost of labour. Larger farms and farms with higher gross sales are more likely to use BMPs because they generally have more financial resources.

With regards to programs currently in place that encourage the use of BMPs, producer participants in focus groups mentioned that participation could be improved if there was greater involvement of farm organizations and producers in the design of BMP programs, programs were clear and straightforward, and there was sufficient financial compensation offered. Producers also stated that, in the absence of financial incentives, they would use BMPs if they were cost effective for their farming operation.

Information on adoption levels of BMPs is available for Canada and the United States. Canadian sources suggest that familiarity with BMPs is lacking in certain provinces. This finding suggests that simply increasing awareness of BMPs may improve adoption levels in these provinces; whereas in other provinces addressing the lack of research conducted pertaining to the economics of BMPs may help increase adoption. Canadian data sources suggested that certain BMPs are more commonly used in the different agricultural regions of Canada. Environmentally sustainable fertilizer application methods such as banding and injecting appear more common in the Prairie provinces. Reduced tillage practices, especially no-till are gaining widespread acceptance not only in the Prairie provinces, but also in Ontario and Newfoundland. Quebec and Ontario were the provinces most likely to adjust fertilizer applications to account for nitrogen from previous crops and the nitrogen content of manure. These two provinces also had the highest percentages of farms that indicated they had formal Nutrient Management Plans and Environmental Farm Plans.

Review of the economic literature that assesses benefits and costs of beneficial management practices and methods used to evaluate the benefits and costs.

Variable rate nutrient applications, mid-season fertilizer applications, vegetated buffer strips, reduced tillage systems, cover crops, manure management and nutrient management planning were the BMPs reviewed in the literature. The review of existing literature identified partial budgeting and representative farm models as appropriate methods to assess the economics of BMPs. However, in most studies, estimates of actual benefits of BMPs were not provided, unless field trials had been performed. When actual benefits were not available, benefits from implementing BMPs were based on assumptions made by researchers. Costs of implementing BMPs, on the other hand, were usually included in the studies. Costs used in the studies were generally region specific and would need to be collected for each particular region analyzed. For example, costs associated with establishment of vegetated buffer zones in Ohio identified by Nakao (1999) would likely not be applicable in Alberta due to differences in cropping practices between the two regions.

Review the current incentive programs that are available to producers

In the final section of the literature review, Canadian incentive programs for the adoption of BMPs were reviewed. The specific programs included the National Farm Stewardship Program (NFSP), the Federal-Provincial Environmental Farm Plan Program, the National Water Supply Expansion Program (NWSEP), the Greencover Canada (GC) program and assistance programs available for the adoption of manure application BMPs. Payments vary across provinces and programs, but most incentives for BMPs are offered on a cost-share basis. Funding caps per legal farm entity are also common across programs.

3.0 METHODS

Representative farm models for western, central and eastern Canadian farm operations were developed to determine the economic costs and benefits of specific BMPs. Section 3.1 outlines the general approach to developing the representative farm models and the input data requirements. Section 3.2 outlines the selection criteria and lists the specific BMPs evaluated in the study. Section 3.3 describes the survey data assumptions and outlines how profitability was evaluated based on BMP adoption. Section 3.4 discusses interpretation of the survey data used in the economic analysis and additional caveats that the reader must be aware of when reviewing the results of the representative farm models.

3.1 Representative Farm Models – General Approach and Required Input Data

The purpose of this phase of the work was to estimate farm profitability before and after participation in BMPs by using representative farm models of typical crop rotations for selected provinces ([Table 3.1](#)).

Table 3.1 Crop Rotations Evaluated by Province

Province	Crop Rotation #1	Crop Rotation #2
Alberta	<i>Black Soil Zone:</i> spring wheat, canola, barley, peas	<i>Brown Soil Zone:</i> spring wheat, lentils, barley
Saskatchewan	<i>Black Soil Zone:</i> spring wheat, canola, barley, peas	<i>Brown Soil Zone:</i> spring wheat, lentils, barley
Manitoba	spring wheat, canola, barley, peas	
Ontario	corn, soybeans, winter wheat	
Quebec	corn, soybeans, spring wheat	
PEI	potatoes	

The farm models were developed using 2006 crop enterprise budgets obtained from the respective provincial²⁴ governments. The enterprise budgets provided an estimate for revenue, variable costs, fixed costs²⁵ and expected net revenue for individual crops on a per acre basis. The enterprise budgets were based on average cost and return estimates (e.g. average provincial crop yields and average farm prices for a specific crop). Specific assumptions regarding the enterprise budgets are outlined below:

- In Manitoba and Quebec the enterprise budgets were based on conventional tillage practices.

²⁴ Provinces where enterprise data was unavailable or out dated were left out of the analysis (the lack of enterprise data represents a serious research gap in the Atlantic provinces and British Columbia). Crop enterprise budgets for Ontario were obtained from the Ontario Ministry of Agriculture, Food and Rural Affairs. Crop enterprise budgets for Quebec were obtained from the Ministry of Agriculture, Fisheries and Food. Crop enterprise budgets for the Prairie provinces were obtained from Alberta Agriculture, Food and Rural Development, Saskatchewan Agriculture and Food, and Manitoba Agriculture, Food and Rural Initiatives. Crop enterprise budgets were obtained from Prince Edward Island Agriculture, Fisheries and Aquaculture and updated by Meyers Norris Penny.

²⁵ Although fixed costs do not change with changes in acreage, overall fixed costs, including depreciation, must be covered to maintain long-term profitability.

- Quebec had no-till budgets for corn and soybeans, but conventional tillage budgets were used for this analysis.
- Ontario and Saskatchewan had conventional and no-till budgets available for use. Conventional tillage budgets were used in this analysis.
- All enterprise budgets in Alberta were based on low till/no-till producer surveys except those generated for brown soil zones.
- The enterprise budgets used for Alberta and Saskatchewan were based on black and brown soil zones.
- The model for the Alberta brown soil zone did not include canola in the rotation as enterprise budgets were not available for this crop.

Electronic spreadsheet files with specific enterprise data were provided to the study sponsor with the final report.

Using the per acre profitability estimates for the individual crops, representative farm models were developed based on the crop rotations identified in [Table 3.1](#). The Ontario and Quebec models assumed an even distribution of crops across the farm. Therefore, it was assumed that 1/3 of the enterprise was planted to corn, 1/3 to soybeans and 1/3 to wheat. For the farm models in the Alberta and Saskatchewan black soil zones the distribution of crops was assumed to be 40% spring wheat, 30% canola, 20% barley and 10% peas. The farm models in the brown soil zones for the same two provinces assumed a distribution of 70% wheat, 15% lentils and 15% barley. In Manitoba, it was assumed that the farm acreage was planted to 40% spring wheat, 30% canola, 20% barley and 10% peas. The caveat to this analysis was that the farm represented only one year in time.

A national survey of producers was used to obtain the data required to estimate the economic costs and benefits of participation in BMPs. The George Morris Centre worked closely with Ipsos Reid, a market research company, to identify statistically representative sample sizes and to design questions that would provide the necessary data for this component of the research. The results of the survey represented the knowledge-based perceptions of farm respondents and were considered to be a valid source of information since actual financial data from farm records was not available. Cost and benefit data from specific survey questions was incorporated into the representative farm models (or base models) to estimate the economic impact of BMPs on the expected net revenue (ENR) on a per acre basis and on a whole farm basis. The resulting estimates from the models were compared to estimates of the economic impacts of the BMPs provided by farm respondents to the survey.

The representative farms were assigned an assumed size because the crop enterprise budgets were based on per acre data. The size of each representative farm was based on the mean farm size observed in the survey data for each of the provinces ([Table 3.2](#)).

Table 3.2 Average Farm Size Based on Ipsos Reid Survey

Province	Average Size of Farm (ac)
Alberta	1,358
Saskatchewan	1,308
Manitoba	1,525
Ontario	430
Quebec	316
Prince Edward Island	563

Notes: PEI acreage was based on the average farm size of the respondents who grew potatoes. AB acreage was based on the AB/BC Peace River average.

Source: Ipsos Reid Survey, 2006

In western Canada, soil type is a significant factor affecting the profitability of crops, cropping patterns and use of BMP practices. To separate the survey data into soil zones, the data was filtered by census agricultural region and linked to the closest soil zone within that region. Since the census agricultural regions were not directly correlated to soil zones, this was not a perfect fit and in some cases data sets included responses representative of other soil zones.

Once the data was filtered by soil zone, some BMP data samples became very small. To alleviate the statistical problem of small sample size, data for regions with the same soil zones were merged. For example, the data set from the black soil zone in Saskatchewan was very small, so it was combined with the data set from the black soil zone in Alberta to increase the sample size for the BMP evaluation. In the case of pulses (i.e. peas and lentils), when filtered by soil zone, the sample sizes were often less than three respondents and, as a result, the entire provincial data set was used to evaluate the profitability of a BMP for pulses. In Manitoba, the provincial data set for peas was too small and so the provincial data set for Saskatchewan was used to evaluate the profitability of a BMP for peas in Manitoba. In the case of minimum tillage for pulses in Alberta in the brown soil zone, the brown soil zone and the provincial data sets (i.e. all Alberta data) were too small. As a result, data from the brown soil zone for Saskatchewan was used.

The BMPs selected for evaluation in the survey were based on the findings in the literature review and included: soil testing, variable rate fertilization, manure management planning, buffer strips, no-till, minimum till and nutrient management planning. Insufficient data was collected for manure management planning to conduct a complete economic analysis; however, the results obtained from the survey were included as a qualitative assessment for western and central Canada, with specific reference to provinces where appropriate.

A total of 39 models were developed (eight base models of representative farms prior to the implementation of BMPs and 31 iterations of the models after the implementation of BMPs).

The 39 models identified above were also run with the estimated financial assistance available from federal and provincial programs in Canada. As identified in [section 2.5.1](#) there is financial assistance available for five of the six BMPs evaluated (all but soil testing - note that funding for soil testing is only available during the development of a nutrient management plan). [Appendix A](#) provides complete details on the level of financial assistance available from the National Farm Stewardship and GreenCover programs, as well as all provincial top up programs. The

following table ([Table 3.3](#)) outlines the specific financial assistance that was incorporated into the models for each of the BMPs evaluated. The results from the models with financial assistance included have been presented separately for the purposes of comparison.

It is worth noting that funding for certain BMPs (e.g. buffer strips) is available through several categories of the National Farm Stewardship Program and Greencover program. For the purposes of this research, funding categories were selected based on the most likely choice by producers and program administrators. For example, financial assistance for buffer strips is available through category 10 (riparian area management) and through category 21 (enhancing wildlife habitat and biodiversity). This research used category 10 as it was the most likely category to be selected by program administrators and producers.

Table 3.3 National and Provincial Financial Assistance Programs Available for the BMPs Evaluated

BMP	Financial Assistance Specifications	
	National	Provincial Top-up
VRF	<ul style="list-style-type: none"> • Precision farming applications under category 14 <ul style="list-style-type: none"> ○ 30% cost share for improved cropping systems to a maximum of \$15,000²⁶ 	
Minimum Tillage	<ul style="list-style-type: none"> • Equipment modification for low disturbance placement of seed and fertilizer under category 14 (improved cropping systems) <ul style="list-style-type: none"> ○ cost share of 30% on specialized components up to maximum of \$15,000²⁷ 	
No Tillage	<ul style="list-style-type: none"> • Equipment modification for low disturbance placement of seed and fertilizer under category 14 (improved cropping systems) <ul style="list-style-type: none"> ○ cost share of 30% on specialized components up to maximum of \$15,000²⁸ 	
NMP	<ul style="list-style-type: none"> • Nutrient management planning under category 24 <ul style="list-style-type: none"> ○ cost share of 50% up to a maximum of \$4,000 	<ul style="list-style-type: none"> • Manitoba - 25% provincial top-up, to a maximum of \$5,000 (totalling 75% to a maximum of

²⁶ For precision farming applications, category 14 will cover 30% of the specialized components of fertilizer spreaders necessary to handle heavy residue. It is important to note that the 30% cost share is available only for the specialized components not for the entire cost of the fertilizer spreaders. For GPS, the cost share is 30% on the entire unit, up to the category cap of \$15,000. For the purposes of this analysis, it was assumed that the cost of switching to VRF as identified by producers in the survey was largely for GPS units and therefore a 30% cost share was applied to the entire cost of the unit as identified in the survey. It is important to recognize that this assumption may overestimate the available financial assistance.

²⁷ Category 14 provides cost share on, among other things, the specialized components of equipment components that facilitate improved placement of seed and fertilizer through lower soil disturbance. The 30% cost share is not applied on the entire implement, only the specialized components which differentiate the conservation unit from a conventional unit.

²⁸ Category 14 provides cost share on, among other things, the specialized components of equipment components that facilitate improved placement of seed and fertilizer through lower soil disturbance. The 30% cost share is not applied on the entire implement, only the specialized components which differentiate the conservation unit from a conventional unit.

BMP	Financial Assistance Specifications	
	National	Provincial Top-up
		\$9,000).
Buffers	<ul style="list-style-type: none"> • Buffer establishment under category 10 (riparian area management) <ul style="list-style-type: none"> ◦ cost share of 50% up to a maximum of \$20,000 under Greencover. 	<ul style="list-style-type: none"> • Quebec - 20% provincial top-up up to federal maximum (totalling 70% to a maximum of \$20,000) • PEI - 16% provincial top-up to a federal/provincial maximum of \$13,200 (totalling 66% to a maximum of \$13,200)

Source: AAFC, 2006a & 2006b

3.2 Selection of BMPs for Evaluation

Selection criteria to determine which BMPs to evaluate per province were developed based on the results of the Ipsos Reid survey. A BMP was selected for evaluation if:

- it was not currently in use in an area and it was felt that having information about the economic costs and benefits of the BMP could improve adoption.
- producer interest in the BMP was evident when cost was not an issue.
 - For example, VRF was identified in a number of provinces as cost prohibitive.
- data from the Ipsos Reid survey could be used in its evaluation.

A BMP was not selected for evaluation if:

- it was currently in use in the area and provincial data suitable for determining the cost of implementing the BMP was readily available.
 - For example, in areas where no-till was a common practice and data was available in enterprise budgets, this BMP was not selected for evaluation so that complementary information on other BMPs could be generated from the study.

The list of BMPs evaluated for each province is provided in [Table 3.4](#).

Table 3.4 Beneficial Management Practices Selected for Evaluation

Province	Soil Testing	VRF	MMP	Buffer Strips	No-till	Min Till	NMP
Alberta; Black Soil Zone		x		x			x
Alberta; Brown Soil Zone	x					x	x
Saskatchewan; Black Soil Zone	x	x					x
Saskatchewan; Brown Soil Zone	x					x	x
Manitoba	x	x	x	x	x	x	x
Ontario	x	x	x	x	x	x	x
Quebec	x	x	x	x	x	x	x
Prince Edward Island				x			

VRF: variable rate fertilization
MMP: manure management plans
Min Till: minimum tillage
NMP: nutrient management plans

3.3 Estimating the Profitability of BMPs – Survey Data Assumptions

As indicated previously, a national survey of producers, conducted by Ipsos Reid, was used to obtain the data required to estimate the economic costs and benefits of participation in BMPs.

An important caveat regarding the survey data was that the costs and/or benefits of implementing the BMP on the farm represented the knowledge-based perceptions of farm respondents and were considered to be a valid source of information since actual financial data from farm records was not available.

There were some important assumptions made regarding the survey data:

- The mean value of the data was used as the representative value (whether a cost or benefit) from the survey. The sample size (n) and standard deviation (σ) of the estimated value were listed in the relevant table of survey results (Appendix C) to indicate the variability in the data.
- The survey results for cereal crops were used for both wheat and barley.
- Provincial data from the survey was used where possible; however, when the data set was too small a regional or soil zone value was used. This was particularly relevant for pulse data since sample sizes were small. The regions were defined as:
 - western Canada (Alberta/BC Peace, Saskatchewan, Manitoba);
 - central Canada (Ontario, Quebec); and
 - atlantic Canada (New Brunswick, Nova Scotia, Prince Edward Island).

The soil zones, located in western Canada, and were defined as black and brown.

- The survey included questions in series where the response to the next question was related to the response to the previous question. For example, producer respondents were asked whether they experienced increases or decreases in crop yields or operating costs as a result of using a specific BMP. A relevant tier of questions was as follows:
 - Did the producer experience a change in yield or operating costs by crop?
 - Respondent answered yes or no
 - If the respondent answered yes, they were asked if the change was an increase or decrease
 - The respondent was then asked to indicate the numeric value of the change

Rather than use the individual data for each tier within a question, the data was compiled at the point where the respondents were asked the yes or no question regarding yield or operating change. This approach increased the sample size of the data set. Those that responded 'no' to the change question were recorded as a zero and those that responded 'yes' were recorded as a positive value for an increase or a negative value for a decrease in either yield or operating costs. The mean of the entire question provided the best indication of the response to the question within the sample of producers.

- Where possible, the enterprise budgets were adjusted to reflect other changes in revenues and expenses that may have occurred with changes in yield or operating costs. For example, if the yield change caused a change in drying, storage, trucking or marketing costs, these changes were incorporated in the model. Similarly, if operating costs changed, changes to operating interest were made.

Farm profitability (as indicated by expected net revenue (ENR)) was simulated with and without implementation of the BMP on a per acre and whole farm basis using the representative farm models. To determine the overall economic incentive to adopt a BMP, the profitability incurred when the BMP was in place had to be greater than the profitability incurred for the base model crop rotation when the BMP was not in place. The results of the simulation were used to assess whether participation in the BMP was economically justifiable.

3.4 Survey Data Interpretation and Caveats of the Analysis

The survey data collected by Ipsos Reid was based on the opinions of producers with first-hand knowledge of what had occurred on their operations. Therefore, the results of the economic analysis, such as changes in yield due to a particular BMP, should be interpreted as knowledge-based perceptions of values rather than actual values obtained from farm records. Further, the perceived values used in the representative models were the estimated means of the answers provided by the producer respondents to the survey questions.²⁹

Sample size, denoted as 'n', was the number of individuals that responded to a particular question. [Table 3.5](#) indicates the total number of respondents to the survey for each of the provinces. As the respondents progressed through the tier of questions for each BMP relevant to their operations, the response sample sizes decreased for the more specific questions. Sample sizes of less than 30 were considered very small. The results of this analysis, however, were not tested for statistical significance regardless of sample size.

Table 3.5 National and Provincial Sample Sizes and Associated Margins of Error, Ipsos Reid Survey, 2006

Province	Sample Size (n)	Margin of Error (%)
Ontario	200	± 6.9
Quebec	200	± 6.9
Central Canada	400	± 4.9
New Brunswick	35	na
Nova Scotia	35	na
Prince Edward Island	30	na
Eastern Canada	100	± 9.8
Manitoba	125	± 8.7
Saskatchewan	200	± 6.9
Alberta/BC Peace	175	± 7.4
Western Canada	500	± 4.3
Total	1000	± 3.0

na = not available; data combined for eastern Canada

Standard deviation, denoted as ' σ ', was used to measure the variability in the data set. The standard deviation represents the typical difference between any one point in the data set and the mean or average of all the data points in the data set. In other words, the standard deviation is a statistical indicator that explains how tightly all the various data points are clustered around the mean in a set of data. When the data points are tightly bunched together, the standard deviation is small. When the data points are spread apart, the standard deviation is large. In the Ipsos Reid survey, the standard deviation was largest when respondents gave very different answers to the same question. The samples size (n) and standard deviation (σ) were included in the results tables ([Appendix C](#)) to indicate number of respondents and variability within the data set.

²⁹ Answers to survey questions related to specific BMPs were provided by respondents who used the BMPs. For example, answers related to the economic gain or loss from soil testing were provided by respondents who used soil testing. These producers could therefore make a judgment as to whether soil testing resulted in an economic gain or loss or no change.

Caveats of the Analysis

The economic evaluations were based on an estimate of expected net revenue (ENR) otherwise known as net farm income. Several models showed a negative ENR in the base model. The inclusion of land value in the estimates may have caused this result as not all provinces reported land expense in the same manner. Ontario was the only province where the model had a positive ENR and, in this case, land was not included in the enterprise budgets of the Ontario base model. Another contributing factor may be the fact that farm income has been exceptional low in Canada for the last few years (Mussell et al., 2006).

Four BMPs (minimum tillage, no tillage, buffer strips, VRF) required producers to commit to large capital outlays when initially adopting the technology. For example, producers usually purchased planters suitable for minimum tillage or no tillage conditions or they purchased precision farming equipment to practice VRF. To establish buffer strips, producers may have incurred the cost of planting trees. Overall, the costs associated with switching from conventional practices to BMPs were significant. The equipment and buffer establishment cost estimates provided by respondents were therefore adjusted to an annualized basis before they were used in the enterprise budgets.

Equipment costs were annualized using estimates of the purchase price, salvage value and useful life of the equipment, as well as market interest rates to reflect the opportunity cost of capital. The market interest rate was estimated at 7%.³⁰ The useful life of the equipment for no tillage and minimum tillage was 10 years and the salvage value (after 10 years) was assumed to be 40% of the purchase price³¹. For VFR, the useful life of the precision farming equipment was five years and the salvage value (after five years) was zero due to the rapid pace of technological change³². For buffer strips, the useful life was assumed to be 10 years³³ with a salvage value of zero. The purchase price for the minimum tillage, no tillage and VRF equipment was based on the cost estimates provided by the respondents to the Ipsos Reid survey. The annualized costs of the equipment were divided by the number of acres associated with the BMP to calculate an equipment cost per BMP acre. Similarly, the establishment cost for buffer strips was based on survey responses and quoted on a per BMP acre.

The cost of establishing or developing a nutrient management plan (NMP) was not collected as part of the survey. However, estimated values were collected from agricultural extension personnel from each province. The estimated value was divided by the number of acres on the farm ([Table 3.2](#)) to estimate the per acre cost of establishing a NMP. These values were incorporated into the provincial models during the analysis.

It is important to note that the models do not capture environmental benefits related to the BMPs. For example, buffer strips may reduce erosion, reduce drain and ditch maintenance, and reduce the risk of impairment to watercourses over time. However, due to the difficulties

³⁰ Calculated using the average of the chartered banks' prime interest rate from 2001-2006 + 2%.
Source: Bank of Canada.

³¹ Source: Ontario Ministry of Agriculture, Food and Rural Affairs. Budgeting Farm Machinery Costs. Retrieved Aug. 3/06 from <http://www.omafra.gov.on.ca/english/busdev/facts/01-075.htm#Table1>.

³² Source: GeoResources Institute. Estimating Total Costs and Possible Returns from Precision Farming Practices. Retrieved Aug. 3/06 from <http://www.gri.msstate.edu/information/pubs/docs/2005/precisionfarmingMARTIN.pdf>.

³³ Selection of a useful life of 10 years was based on the previous Greencover Program requirements that buffers be maintained for a minimum of 10 years.

associated with placing a value on these types of benefits, it was not possible to include these benefits in the models. As a result, the benefits of buffer strips may be underestimated in this analysis. Other BMPs, such as variable rate fertilization, may have similar benefits which are not captured in the models.

An additional caveat related to the buffer strip analysis is that we have assumed that the survey respondents' answers with respect to operating costs take into account that production costs are eliminated when land is taken out of production with the establishment of the buffer strip, i.e., there are no longer crop production costs for the area allocated to the buffer.

All the funding programs across Canada have a percentage cost share and maximum funding limit. Cost share portions were applied to the eligible costs required to establish the BMP in order to determine the amount of financial assistance and the remaining producer cost. The expected costs of establishing the BMPs were based on responses in the survey, with the exception of NMP costs as described above.

Since financial assistance is a revenue line item in a typical enterprise budget, it was expected that financial assistance would be incorporated in the revenue section of the budget. However, there were some cases in which incorporating the financial assistance in the revenue section resulted in higher operating interest than would be typically born. For example, in the case of farm equipment (minimum or no tillage or VRF), if the financial assistance was taken into account in the revenue portion of the budget, operating interest on the cost of the equipment would be higher than was actually incurred. As a result, the financial assistance was taken into account directly with the BMP costs (i.e., the financial assistance was subtracted from the estimated BMP cost from the survey).

To estimate the impact of financial assistance on the representative farms, the calculated financial assistance was amortized using the same period and interest rate as the estimated BMP implementation costs (as per the paragraphs above). As a result, in some cases when the financial assistance was annualized, the resulting funding available for the BMP implementation was low. For example, \$1,000 in financial assistance annualized over ten years at 7%, resulted in \$142 per year of funding.

The total financial assistance estimated for the whole farm was confirmed with the funding limits to make sure it did not go over the maximum funding available from the programs.

There are some important points to note regarding the financial assistance available for soil testing, variable rate fertilization, minimum tillage and no-till.

Financial assistance for soil testing is only available while a producer is in the process of developing a nutrient management plan. Since this analysis considers soil testing as an ongoing beneficial management practice, financial assistance was not included as part of the soil testing models.

For variable rate fertilization (i.e. precision farming applications), category 14 will cover 30% on the specialized components of fertilizer spreaders necessary to handle heavy residue. It is important to note that the 30% cost share is available only for the specialized components not for the entire cost of the fertilizer spreaders. For GPS, the cost share is 30% on the entire unit, up to the category cap of \$15,000. For the purposes of this analysis, it was assumed that the cost of switching to VRF as identified by producers in the survey was largely for GPS units and

therefore the 30% cost share was applied to the entire cost of switching to VRF. It is also important to recognize that this assumption may slightly overestimate the available financial assistance.

For reduced tillage equipment, financial assistance is available under category 14 of the National Farm Stewardship Program. Category 14 provides cost share on, among other things, the specialized components of pre-seeding implements for restricted zone tillage for row crops, and seeding and post seeding implements for low disturbance placement of seed and fertilizer. The 30% cost share is not applied on the entire implement, only to the specialized components which differentiate the conservation unit from a conventional unit. In order to calculate the cost-share available to a producer, program administrators for the National Farm Stewardship Program may use two different approaches.³⁴ One approach is for the applicant to provide an itemized list of the specialized components to which the 30% cost-share may be applied. The second approach is to deduct the price of an equivalent conventional unit from the purchase price of a conservation unit, and apply the 30% cost-share to the difference.

In order to incorporate financial assistance into the minimum tillage and no-tillage models used in this analysis, it was important to consider the cost of the conservation equipment that producers would require in order to switch from conventional agricultural practices to BMPs such as minimum tillage and no-tillage. In the Ipsos-Reid survey, respondents were asked, when thinking about the changes in equipment required, whether it cost them money or saved them money to switch to minimum tillage or no-tillage, factoring in any costs for trading in equipment as well as purchasing new equipment. Thus, the survey solicited costs reflecting the cost of new conservation equipment minus the value of conventional equipment that was traded in.

In order to apply the financial assistance to the data that was collected from the survey, it was necessary to make an assumption that the survey data trade-in value was equivalent to the conventional equipment value used by program administrators in the second approach for applying cost share described above. It should be noted that the costs collected in the survey (i.e. cost of new conservation equipment minus traded conventional equipment) are not equivalent to the cost of new conservation equipment minus the price of equivalent conventional units since the traded conventional equipment is likely older and therefore worth less than equivalent conventional units. However, for the purposes of this analysis, it was assumed that the survey costs were a reasonable approximation of the values that would be used by program administrators to determine cost share. As such, in the minimum tillage and no-till models for this analysis, the 30% cost share was applied to the costs collected in the survey (i.e. cost of new conservation equipment minus traded conventional equipment). Given this assumption, the minimum tillage and no-till models with financial assistance will likely overestimate the amount of eligible cost share that representative farms would receive for the adoption of reduced tillage BMPs. However, the intent of this analysis was to demonstrate approximate cost share values using the data that was available.

³⁴ Source: Communication with Andrew Graham, Program Manager, Ontario Soil and Crop Improvement Association, 519-826-4216.

4.0 RESULTS AND DISCUSSION

Section 4.0 presents the results of the economic evaluation of BMPs in Canada. Section 4.1 discusses the results (with and without financial assistance) for western Canada (i.e. Alberta/Peace River region/British Columbia (referred to hereafter as Alberta), Saskatchewan and Manitoba). Section 4.2 presents the results for central Canada (Ontario and Quebec) with and without financial assistance, while Section 4.3 addresses eastern Canada with results for Prince Edward Island (with and without financial assistance). A summary of the provincial results including changes to the models when financial assistance was incorporated is provided in Section 4.4. Section 4.5 discusses the economic rationale for the adoption of BMPs by producers and makes recommendations regarding economic incentives.

4.1 Western Canada

4.1.1 Assessment Of Manure Management Planning

Western Canadian producers have been using manure on their farms since the land was first settled. Of the western farmers surveyed by Ipsos Reid, 53% apply manure on their farms (Alberta 64%; Saskatchewan 43%; Manitoba 65%). Surprisingly, however, only 27% of producers who apply manure use a formal manure management plan (Alberta 34%; Saskatchewan 22%; Manitoba 30%). Among those producers using a MMP, the main reasons for using it were:

- more efficient use of fertilizer (Alberta 32%; Saskatchewan 22%; Manitoba 25%),
- to increase and maximize crop yields (Saskatchewan 22%), and
- due to government mandate (Manitoba 40%).

For producers who use manure (from the survey), approximately 18% of their acres were treated with manure (Alberta 22%; Saskatchewan 15%; Manitoba 22%). Approximately half of producers who use manure in the Prairies use a custom operator to apply manure on their behalf (Alberta 55%; Saskatchewan 42%; Manitoba 41%). In western Canada, the majority of manure (from the survey) was applied as solids (Alberta 89%; Saskatchewan 86%; Manitoba 70%), which producers typically incorporated (Alberta 77%; Saskatchewan 76%; Manitoba 80%). In Alberta and Manitoba, 46% and 65% of producers, respectively, incorporated solid manure within 1-5 days of application, while in Saskatchewan, 59% of producers incorporated their solid manure more than 5 days after it was applied to the land. When asked what criteria they used to estimate the rate of application of manure:

- 52% of Alberta respondents said they used soil testing results,
- 45% of Alberta respondents said it depended on how much manure needed to be applied
- 44% of Saskatchewan respondents said it depended on the acreage available for spreading, and
- 44% of Saskatchewan respondents said it depended on the amount of manure to be spread.

In Manitoba, where manure management was mandated by government,

- 65% of producers said they applied manure according to the nutrient requirements of the crops they were planning to grow and
- 60% said they applied manure according to the results of soil testing.

Very few producers in western Canada analyzed their solid manure for nutrient content (Alberta 10%, Saskatchewan 3%, Manitoba 13%). In contrast, producers were much more likely to

analyze their liquid manure for nutrient content (Alberta 38%; Saskatchewan 40%; Manitoba 57%).

When asked to indicate the cost of manure application on their operation, 38% of producers in western Canada believed the cost of applying manure was greater than \$20/acre ([Table 4.1](#)).

Table 4.1 Producer Estimates of Cost of Manure Application in Western Canada, Ipsos Reid Survey, 2006

	Alberta	Saskatchewan (%)	Manitoba
Less than \$10/ac	24	23	23
Between \$10-\$20/ac	28	23	21
Greater than \$20/ac	39	35	44
Don't Know	9	19	12

Despite the costs of application, the majority of respondents from western Canada felt that having a MMP resulted in a net economic gain for their operation (Alberta 77%; Saskatchewan 94% and Manitoba 65%). In Manitoba, 30% of respondents also indicated that having a MMP resulted in no change to their net economics.

In western Canada, 31% of producers said it was very important for the government to provide financial incentives or grants for manure management planning (Alberta 32%; Saskatchewan 28%; Manitoba 35%). Another 31% of producers felt this was somewhat important (Alberta 26%; Saskatchewan 33%; Manitoba 35%). In terms of financial contribution, the results were mixed:

- in Alberta, 50% of producers felt the government should pay 26-50% of the cost of MMP while 28% felt government should pay 1-25%
- in Saskatchewan, 64% of producers felt the government should pay 26-50% of the cost of MMP while 18% felt government should pay 1-25%, and
- in Manitoba, where manure management was mandated, 36% of producers felt the government should pay 26-50% of the cost of MMP while 29% felt government should pay 100% or all of the cost of MMP.

4.1.2 Alberta

4.1.2.1 Brown Soil Zone

The representative farm model for the brown soil zone in Alberta included a single crop rotation of feed barley, spring wheat and lentils, which were evaluated for three BMPs: soil testing, minimum tillage and nutrient management planning (NMP). [Table C.1 \(Appendix C\)](#) illustrates the total revenue, variable and fixed costs and expected net revenue (ENR) before the implementation of a BMP. Note that the ENR was negative for all three crops in the rotation because total expenses were greater than total revenue and the enterprise budgets did not include payments received from government programs. [Table C.2](#) presents the results from the Ipsos Reid survey for each of the BMPs evaluated in the Alberta brown soil zone.

Soil Testing

The survey results indicated that 78% of producers in Alberta practiced soil testing on their operations (across both soil zones), with 44% testing every year and 42% testing every two to

three years. This finding for Alberta resulted in the assumption that soil tests occurred approximately every two years, which was incorporated into the economic analysis for this BMP. As a BMP, soil testing had a positive impact on the production of the three crops evaluated in the Alberta brown soil zone. Producers estimated a 2.8 to 4.4 bu/ac increase in yield depending on the crop. This positive impact carried through in the economic analysis despite the increase to the operating costs of \$5.2/ac and the addition of a soil testing fee (amortized over two years). Spring wheat and lentils had the greatest increase in ENR (20% over the base model), however, the resulting ENR was still negative ([Tables C.3 – C.6](#)).

All three crops continued to show a negative ENR at the whole farm level of analysis, however, the total ENR for the three crops was 19% better when compared to the ENR for the base model farm. Overall, the ENR for the whole farm was **-\$64,019** when soil testing was included in the analysis compared to the ENR for the whole farm base model, which was **-\$78,914**. These results were consistent with the survey results, which indicated that 70% of Alberta producers (across both soil zones) believed that using soil testing caused a net economic gain for their operation.

Financial assistance for soil testing is only available while a producer is in the process of developing a nutrient management plan. Since this analysis considers soil testing as an ongoing beneficial management practice, financial assistance was not included as part of the soil testing models.

Minimum Tillage

According to the survey, 70% of the respondents in Alberta (across both soil zones) were practicing minimum tillage and covering 84% of the total acres on their farms. The minimum tillage had a positive impact on the production of the three crops evaluated for operations in the Alberta brown soil zone. A yield increase between 1.3-4.2 bu/ac was estimated by producers, depending on the crop. The introduction of minimum tillage to the operation added an equipment cost of \$3.3/ac (annualized over ten years) compared to the base model. Interestingly, producers believed their operating costs decreased by \$12.2/ac with the introduction of minimum tillage. Overall, minimum tillage practices had a positive economic impact on ENR for feed barley (46%), spring wheat (42%) and lentils (27%) in the Alberta brown soil zone ([Tables C.3 – C.6](#)).

The estimated ENR for the whole farm after adoption of minimum tillage practices was **-\$52,323**, an improvement of 34% over the base model ([Table C.6](#)). Minimum tillage had the greatest improvement in ENR of the three BMPs evaluated for the Alberta brown soil zone. These results were consistent with the survey which indicated that 67% of producers in Alberta (across both soil zones) believed that using minimum tillage resulted in a net economic gain for their farms, while 28% of producers believed it would have no change.

When financial assistance was taken into account with the use of minimum tillage for the Alberta brown soil whole farm model (individual crop results have been included in [Tables D.1-D.5](#) ([Appendix D](#)), ENR improved by approximately 2%. Therefore, the minimum tillage BMP (without financial assistance) increased the ENR by 34% over the base model, whereas the ENR increased by 36% over the base model when financial assistance was taken into account.

Nutrient Management Plans (NMP)

In Alberta, 52% of producers used a NMP on their farm (across both soil zones). In this study, the implementation of a NMP had a positive impact on the production and profitability of barley,

spring wheat and lentils. Of the three BMPs evaluated in the Alberta brown soil zone, producers estimated that NMP had the greatest positive impact on yields, with estimates between 3.9-5.9 bu/ac depending on the crop. The expected increase in operating costs from using a NMP was estimated at \$2.6/ac in addition to the estimated \$0.4/ac to establish the plan (amortized over five years). Overall, the ENR associated with using a NMP improved by 28% for barley, 33% for spring wheat and 34% for lentils, when compared to the base model ([Tables C.3 – C. 6](#)).

The total ENR for the whole farm after adoption of a NMP was at **-\$53,179**, a 33% improvement over the base model for the whole farm ([Table C.6](#)). These results were consistent with the Ipsos Reid survey as 71% of producers in Alberta (across both soil zones) believed that having a formal nutrient management plan resulted in a net economic gain.

When financial assistance was incorporated into the Alberta brown soil model for NMP there was approximately 1% improvement in ENR when compared to the results without financial assistance (refer to [Table 4.2](#)).

Summary

[Tables C.3 – C. 6](#) present the results from the analysis for the Alberta brown soil zone for a crop rotation of feed barley, spring wheat and lentils. [Table C.6](#) includes the whole farm results for an average operation of 1,358 acres growing feed barley (15%), spring wheat (70%) and lentils (15%). [Tables D.2 – D.5](#) present the results with the inclusion of financial assistance. [Table 4.2](#) summarizes the changes in the estimates of ENR that resulted from the economic evaluation of each BMP with and without financial assistance.

Table 4.2 Summary Of Changes In Estimates Of ENR After Participation In BMPs, Alberta Brown Soil Zone

Basis of Analysis		Change in ENR from Base Model			
		Base Model	Soil Test	Min-Till	NMP
		(%)			
Per acre (without financial assistance)	Barley	0	14	46	28
	Spring Wheat	0	19	42	33
	Lentils	0	20	27	34
Whole Farm (without financial assistance)		0	18.9	33.7	32.6
Whole Farm (with financial assistance)		0	18.9	35.5	33.2
Difference		0	0.0	1.8	0.6

ENR – expected net revenue
Min-Till – minimum tillage
NMP – nutrient management planning

In the Alberta brown soil zone, all three BMPs included in the analysis (soil testing, minimum tillage and NMP) resulted in greater ENR on a per acre and whole farm basis when compared to the base model. Minimum tillage generated the greatest change in ENR on a whole farm basis of the three BMPs evaluated in the Alberta brown soil zone and represented a 34% improvement over the base model (without financial assistance). The Ipsos Reid survey showed that 70% of producers in Alberta practiced minimum tillage and, when asked, these producers indicated that minimum tillage had the greatest improvement in ENR of the three BMPs

evaluated for barley and spring wheat. Nutrient management planning was considered to be the second most profitable BMP on a whole farm basis. The estimate of ENR for NMP showed a 33% improvement over the base model (without financial assistance). On a per acre basis, use of a NMP was estimated to improve profit for lentils by 34%. The impact of soil testing, as a BMP, was estimated to improve ENR by 19% over the base model at the whole farm level.

When financial assistance was included in the farm model, the change in ENR over the base model improved by approximately 1% for NMP and 2% for minimum tillage compared to the ENR results without financial assistance.

4.1.2.2 Black Soil Zone

The representative farm model for the black soil zone in Alberta included a single crop rotation of malt barley, canola, spring wheat and peas, which were evaluated for three BMPs: variable rate fertilization, nutrient management plans and buffer strips. [Table C.7](#) illustrates the total revenue, variable and fixed costs and expected net revenue (ENR) before the implementation of a BMP. [Table C.8](#) presents the results from the survey for each of the BMPs evaluated in the Alberta black soil zone. The average farm size was 1,358 acres ([Table 3.2](#)).

Variable Rate Fertilization (VRF)

In Alberta, 11% of the survey respondents (across both soil zones) indicated they used VRF on their operations. These respondents used VRF on 86% of their cropland (black soils). Producers estimated that yields increased 4-8 bu/ac, depending on the crop. Operating costs and equipment costs (amortized over five years) were estimated to increase by \$1.8/BMP ac and \$4.5/BMP ac respectively, with the introduction of VRF. The overall impact of VRF was positive as the estimates of ENR increased for all crops, ranging from 16-65% over the base model. However, the ENR for all the crops remained negative, with the exception of canola. The ENR for canola increased to \$16/ac from \$0/ac in the base model ([Tables C.9-C.12](#)).

The ENR for VRF in the whole farm analysis increased by 53% over the base model. The total whole farm ENR remained negative (-\$17,422), but the whole farm ENR for canola was positive at \$5,488 ([Table C.13](#)).

When financial assistance was incorporated for VRF in the Alberta black soil model, ENR improved by 4%. Thus, ENR before financial assistance went from 53% over the base model to 57% over the base model with the inclusion of financial assistance ([Table 4.3](#)).

Nutrient Management Planning (NMP)

In Alberta, 52% of producers used a nutrient management plan (NMP) on their farm (across both soil zones). Producers estimated that implementation of a NMP had a positive impact on the production of barley, canola, spring wheat and peas, with yields increasing 3.8-7.7 bu/ac (depending on the crop). The expected increase in operating costs from using a NMP was estimated at \$6.5/ac in addition to the estimated \$0.7/ac to establish the plan (annualized over five years). Overall, the ENR improved by 34% for malt barley, 62% for spring wheat and 9% for peas, when compared to the base model ([Tables C.9-C.12](#)). Since the base model results for canola were near zero, the estimated percent change in ENR for all of the BMPs were unrealistic and therefore not reported.

The whole farm total ENR calculated for NMP was -\$8,153, which was a 78% improvement over the base model ([Table C.13](#)). These results were consistent with the survey as 71% of

producers in Alberta (across both soil zones) believed that having a formal NMP resulted in a net economic gain for their operation.

When NMP funding was incorporated into the Alberta black soil model, the change in ENR over the base model increased by 1% ([Table 4.3](#)).

Buffer Strips

According to the survey, 28% of producers in Alberta (across both soil zones) had buffer strips on their farms. Producers in the black soil zone indicated that 8% of their total acres were devoted to buffer strips. As expected, buffer strips had a negative impact on ENR due to establishment costs (annualized over 10 years) and a loss in production from the land devoted to the buffer. Producers indicated that the loss in crop production from implementing buffer strips was approximately 11% (across both soil zones). As such, the assumption used in the economic model was that producers lost 11% of their total yield by establishing buffer strips. However, in reality, yield losses were probably lower as buffers are typically established on marginally productive land. In addition, it is important to note that the yield loss from the establishment of buffer strips was based on producer knowledge rather than field trials. Overall, ENR fell substantially for malt barley, canola, spring wheat and peas with the implementation of a buffer strip ([Tables C.9-C.12](#)).

When the whole farm results were calculated, the ENR after the cost of a buffer strip was included in the analysis was **-\$40,541**, a 10% decrease compared to the base model of **-\$36,829** ([Table C.13](#)). These results were not consistent with the survey, as 44% of producers in Alberta (across both soil zones) believed that establishing a buffer strip had no economic impact for their farm, while 31% believed it resulted in a net loss and 21% believed it resulted in a net gain for their farm.

With the introduction of financial assistance for buffer strips, the change in ENR over the base model improved by 2%. However it still resulted in an ENR of negative 8% over the base model (from -10% over the base model without financial assistance) (refer to [Table 4.3](#)). This may suggest the financial assistance for buffers in the Alberta black soil model is not sufficient given the assumptions (amortized over 10 years) and parameters of the malt barley, canola, spring wheat and feed peas whole farm model (8% of the 1358 acres was devoted to a buffer (approximately 110 acres)).

Summary

[Tables C.9-C.12](#) presents the results from the model for the Alberta black soil zone. [Table C.13](#) includes the results from the whole farm analysis of a 1,358 acre operation with a crop rotation of malt barley (20%), canola (30%), spring wheat (40%) and feed peas (10%). [Tables D.7-D.11](#) include the results when financial assistance for BMP adoption was incorporated into the models. [Table 4.3](#) summarizes the changes in the estimates of ENR that resulted from the economic evaluation of each BMP with and without financial assistance.

Table 4.3 Summary of Changes In Estimates Of ENR After Participation In BMPs, Alberta Black Soil Zone

Basis of Analysis		Change in ENR from Base Model			
		Base Model	VRF	NMP	Buffer Strips
		(%)			
Per acre (without financial assistance)	Barley	0	36	34	-78
	Canola	0	n/a*	n/a*	n/a*
	Spring Wheat	0	65	62	-105
	Peas	0	16	9	-42
Whole Farm (without financial assistance)		0	52.7	77.9	-10.1
Whole Farm (with financial assistance)		0	57.0	79.2	-8.2
Difference		0	4.3	1.3	1.8

ENR – expected net revenue

VRF – variable rate fertilization

NMP – nutrient management planning

* % change was not calculated because the base expected net revenue was zero.

In the base model the ENR on a per acre basis was negative for barley, spring wheat and peas, and zero for canola. Despite the positive impact of VRF and NMP on the outcome of the models, the ENR remained negative for these BMPs (with the exception of canola where ENR was positive). Implementing buffer strips had a negative impact on the ENR for all crops on a per acre basis.

In the model for the Alberta black soil zone, it was estimated that the use of VRF and NMP resulted in greater ENR for the whole farm compared to the base model (i.e. before the implementation of the BMPs). NMP generated the highest estimate of ENR of the three BMPs evaluated in the Alberta black soil zone and represented a 78% improvement over the base model. On a per acre basis, the ENR for the NMP analysis for all crops showed a gain over the base model ENR. VRF was the second most profitable BMP on a whole farm basis. The ENR for VRF showed a 53% improvement over the base model. On a per acre basis, VRF was estimated to be the most profitable for spring wheat (65%) and canola (% not determined). At the whole farm level, establishing buffer strips decreased whole farm ENR by 10% compared to the base farm model.

When financial assistance was incorporated, the change in ENR over the base model was further improved by 4% for VRF, 1% for NMP and 2% for buffers (although the change in ENR over the base model still remained negative for buffers) at the whole farm level.

When the Alberta black soil model was compared to the brown soil model, the following observations were made. At the per acre crop level, the common BMP evaluated was NMP, which had the greatest impact on the ENR for canola for the black soil zone and lentils for the brown soil zone. At the whole farm level (note differences in crop rotations), NMP had the greatest impact in the black soil zone, with a 78% improvement in the ENR, compared to a 33% improvement for the brown soil zone.

4.1.3 Saskatchewan

4.1.3.1 Brown Soil Zone

The representative farm model for the Saskatchewan brown soil zone included a single crop rotation of barley, lentils and spring wheat, which were evaluated for three BMPs: soil testing, minimum tillage and nutrient management planning. Note that canola was not included in the rotation as enterprise budgets were not available for canola in the brown soil zone in Saskatchewan. [Table C.14](#) illustrates the total revenue, variable and fixed costs and expected net revenue (ENR) before the implementation of a BMP. Note that the estimate of the ENR was negative for all three crops as total expenses were higher than total revenue. [Table C.15](#) presents the results from the survey for the Saskatchewan brown soil zone for each of the BMPs evaluated. The average farm size was 1,308 acres ([Table 3.2](#)).

Soil Testing

The survey results indicated that 57% of producers in Saskatchewan practiced soil testing on their operations (across both soil zones), with 50% testing every two to three years. When asked, producers indicated that soil testing had a positive impact on the production of the three crops evaluated in Saskatchewan (on brown soils) and a 2.8 to 4.5 bu/ac increase in yield was expected, depending on the crop. This positive impact occurred despite a large increase to the operating costs (\$6.5/ac) and the addition of a soil testing fee (annualized over two years). Lentils had the greatest percentage increase in ENR as a result of soil testing when compared to the base model, however, the resulting ENR was still negative ([Tables C.16 – C.18](#)).

The whole farm analysis assumed a split of 15% feed barley, 15% lentils and 70% spring wheat. All three crops showed negative ENR; however, the total ENR for the three crops was 15% better with soil testing when compared to the ENR estimated by the base model farm. Overall, the ENR for the whole farm was **-\$48,903** compared to the ENR for the base model at **-\$57,735** ([Table C.19](#)). These results were consistent with the survey results, which indicated that 74% of Saskatchewan producers (across both soil zones) believed that using soil testing resulted in a net economic gain for their farm.

Minimum Tillage

According to the survey, 74% of the respondents in Saskatchewan were practicing minimum tillage on their farms (across both soil zones). Of the total acres on their farms, 72% were minimum tillage acres (brown soil zone). Producer opinion was that minimum tillage had a positive impact on crop production and they expected yields to increase between 1.3-2.2 bu/ac, depending on the crop. The introduction of minimum tillage added an equipment cost of \$3.9/BMP ac (annualized over 10 years) compared to the base model farm. The cost was more than offset by the overall changes to operating cost, which decreased by \$6.8/BMP ac. Minimum tillage practices had a positive economic impact on the production of barley, spring wheat and lentils in Saskatchewan ([Tables C.16 – C.18](#)). The ENR for the individual crops increased 12-29% over the base model on a per acre basis.

The ENR on a whole farm basis, after minimum tillage was included in the analysis, was still negative (**-\$47,677**), although it improved by 17% over the base farm ([Table C.19](#)). These results were consistent with the survey results where 50% of producers in Saskatchewan believed that using minimum tillage resulted in a net economic gain for their operations (across both soil zones). A significant proportion of producers (41%) believed it would have no effect on the economic of their farm (across both soil zones).

When financial assistance was taken into account with the use of minimum tillage for the Saskatchewan brown soil model (results have been included in [Tables D.12-D.16](#), the change in ENR over the base model improved by approximately 3% (refer to [Table 4.4](#)). Therefore, the minimum tillage BMP (without financial assistance) increased the ENR by 17% over the base model, where as the ENR increased by 20% over the base model when financial assistance was taken into account.

Nutrient Management Planning (NMP)

According to the survey, 38% of the respondents in Saskatchewan had a nutrient management plan (NMP) for their farm (across both soil zones). Producers felt that the implementation of nutrient management planning generally had a positive impact on the production of the three crops in the Saskatchewan brown soil zone. Of the three BMPs evaluated, NMP had the greatest positive impact on yields, with yields increasing 4.3-7.4 bu/ac depending on the crop. However, NMP also increased the overall operating costs by \$11.5/ac in addition to the estimated \$0.7/ac to establish the NMP plan (amortized over 5 years). Despite the large increase in operating costs, the ENR improved for both spring wheat (36%) and lentils (43%), when compared to the base model. The ENR for barley was similar to the ENR for the base farm (3%). Overall, NMP had a positive impact on spring wheat and lentils and a limited impact on barley ([Tables C.16 – C.18](#)).

The whole farm analysis for NMP showed the most improvement in total ENR for the three BMPs evaluated at **-\$40,243**, a 30% improvement over the base model farm ([Table C.19](#)). These results were consistent with the survey, as 69% of producers in Saskatchewan believed that having a formal NMP resulted in a net economic gain.

When financial assistance was incorporated into the model for NMP there was approximately 1% improvement in the change in ENR over the base model when compared to the ENR without financial assistance (refer to [Table 4.4](#)).

Summary

[Tables C.16 – C.18](#) present the results for the representative farm models in the Saskatchewan brown soil zone. [Table C.19](#) includes the results from the whole farm analysis for an average farm of 1,308 ac of feed barley (15%), spring wheat (70%) and lentils operation (15%). [Tables D.13-D.16](#) include the results when financial assistance for BMP adoption was incorporated into the models. [Table 4.4](#) summarizes the changes in the estimates of ENR that resulted from the economic evaluation of each BMP with and without financial assistance.

Table 4.4 Summary Of Changes In Estimates Of ENR After Participation In BMPs, Saskatchewan Brown Soil Zone

Basis of Analysis		Change in ENR from Base Model			
		Base Model	Soil Test	Min-Till	NMP
		(%)			
Per acre (without financial assistance)	Barley	0	-1	12	3
	Spring Wheat	0	18	27	36
	Lentils	0	26	29	43
Whole Farm (without financial assistance)		0	15.3	17.4	30.3
Whole Farm (with financial assistance)		0	15.3	19.9	31.2
Difference		0	0.0	2.5	0.9

ENR – expected net revenue
Min-Till – minimum tillage
NMP – nutrient management planning

The ENR on a per acre basis was negative for all three crops in the base model. The introduction of each BMP still resulted in a negative ENR. However, the magnitude of loss either did not change appreciably or it declined across the three BMPs.

In Saskatchewan, inclusion of soil testing, nutrient management planning or minimum tillage resulted in greater ENR for the whole farm model compared with the base farm model. NMP generated the highest estimate of ENR of the three BMPs evaluated for Saskatchewan, which was a 30% improvement over the base model in the whole farm analysis. Since 38% of the producers polled in Saskatchewan indicated they were using a NMP, there may be an opportunity for revenue improvement with the implementation of NMP in Saskatchewan.

Minimum tillage was the second most profitable of the three BMPs in the Saskatchewan brown soil zone on a whole farm basis, with a positive impact on ENR when compared to the base model. The ENR for minimum tillage for the whole farm model was 17% higher than the base farm model. When compared to the base model farm, minimum tillage appeared to have the most positive impact on the ENR for lentil production (29%), when compared to barley (12%) and spring wheat (27%).

In this study, soil testing was the least profitable BMP on a whole farm basis. The ENR for soil testing represented a 15% improvement over the base model. On a per acre basis, soil testing was the most profitable for lentils (26% greater than base model), and least profitable for barley (1% lower than base model).

When financial assistance was incorporated into the Saskatchewan brown soil model, the change in ENR was improved a further 2.5% for minimum tillage and 1% for NMP when compared to the estimated change in ENR over the base model without financial assistance.

4.1.3.2 Black Soil Zone

Data from the Saskatchewan and Alberta black soil zone were combined to improve the sample size. The representative farm model for the Saskatchewan black soil zone included a single crop rotation of feed barley (20%), canola (30%), spring wheat (40%) and feed peas (10%),

which were evaluated for three BMPs: soil testing, variable rate fertilization and nutrient management planning. [Table C.20](#) illustrates the total revenue, variable and fixed costs and expected net revenue (ENR) before the implementation of a BMP. As in previous analyses, the ENR was negative for all four crops in the black soil zone prior to the implementation of the BMPs. [Table C.21](#) presents the results from the survey in the Saskatchewan black soil zone for each of the BMPs evaluated. The average farm size was 1,308 ac ([Table 3.2](#)).

Soil Testing

The survey results indicated that 57% of producers in Saskatchewan practiced soil testing on their farms (across both soil zones), with 50% testing every two to three years. When asked, producers indicated that soil testing had a positive impact on the yield of the four crops evaluated in the Saskatchewan black soil zone. They estimated that yields increased 4-6 bu/ac depending on the crop and that cereal crops showed the greatest yield increase. The impact on operating costs was estimated at \$9/ac and soil testing fees were approximately \$0.4/ac (amortized over 2 years). Soil testing had a positive impact on ENR for the four crops, although ENR remained negative ([Tables C.22 – C.25](#)). Estimates for canola and spring wheat improved the most (39% and 36%, respectively) when compared to the base model.

In the whole farm analysis all crops showed negative ENR, but with soil testing, the ENR improved by 24% over the base model. The ENR for the whole farm was **-\$43,996** compared to the ENR for the base farm at **-\$57,568** ([Table C.26](#)). These results were consistent with the survey results, which indicated that 74% of Saskatchewan producers (across both soil zones) believed that using soil testing caused a net economic gain for their operation.

Variable Rate Fertilization (VRF)

Variable rate fertilization was an uncommon BMP with only 6% of producers practicing it on their farms in Saskatchewan (across both soil zones). The few producers who did use VRF indicated they used it on 81% of their total acres. They felt that VRF increased yield from 3.4-6.4 bu/ac, depending on the crop. However, the yield increases were coupled with an increase in equipment costs (\$4.4/BMP ac, amortized over five years) and a slight increase in operating costs (\$0.7/BMP ac). ENR on a per acre basis increased compared to the base model for all crops and particularly for spring wheat, which was 56% higher than the ENR for the base model ([Tables C.22 – C.25](#)).

The whole farm results were consistent with the results on a per acre basis. The calculated ENR for VRF on a whole farm basis was **-\$43,046**, a 25% increase from the base model ([Table C.26](#)). These results were consistent with the survey results, which indicated that 50% of producers in Saskatchewan (across both soil zones) believed that using VRF resulted in a net economic gain for their farm, while 42% expected no change.

When financial assistance was incorporated for VRF in the Saskatchewan black soil model, the change in ENR over the base model improved by 2.5% (refer to [Table 4.5](#)). Thus, ENR before financial assistance went from 25% over the base model to 28% over the base model with the inclusion of financial assistance.

Nutrient Management Planning (NMP)

According to the survey, 38% of the respondents in Saskatchewan had a NMP for their farm (across both soil zones). Producers felt that the implementation of NMP generally had a positive impact on the yield of the four crops analyzed in the Saskatchewan black soil zone. Of the three BMPs, NMP was expected to have the greatest positive impact on yields i.e. 4-7 bu/ac increase.

The implementation of NMP, however, also increased operating costs by \$4.8/ac and added an establishment cost of \$0.7/ac (amortized over 5 years). Overall, the estimated ENR improved for all four crops. The ENR for spring wheat and canola improved by more than 50% when compared to the base model ([Tables C.22 – C.25](#)).

On a whole farm basis, the ENR calculated for NMP had the greatest positive impact on profitability of the three BMPs evaluated. ENR increased by 38% over the base farm model ([Table C.26](#)). These results were consistent with the survey as 69% of producers in Saskatchewan (all soil zones) believed that having a formal NMP resulted in a net economic gain.

When NMP funding was incorporated into the Saskatchewan black soil model, the change in ENR over the base model increased by 1% when compared to the results without financial assistance (refer to [Table 4.5](#)).

Summary

[Tables C.22 – C.25](#) present the results for the representative farm model in the Saskatchewan black soil zone. [Table C.26](#) includes the results of the analysis for an average farm of 1,308 acres and a rotation of feed barley (20%), spring wheat (40%), canola (30%) and feed peas (10%). [Tables D.18-D22](#) include the results when financial assistance for BMP adoption was incorporated into the models. [Table 4.5](#) summarizes the changes in the estimates of ENR that resulted from the economic evaluation of each BMP with and without financial assistance.

Table 4.5 Summary Of Changes In Estimates Of ENR After Participation In BMPs, Saskatchewan Black Soil Zone

Basis of Analysis		Change in ENR from Base Model			
		Base Model	Soil Test	VRF	NMP
		(%)			
Per acre (without financial assistance)	Barley	0	3	14	14
	Canola	0	39	30	55
	Spring Wheat	0	36	56	58
	Peas	0	2	12	7
Whole Farm (without financial assistance)		0	23.6	25.2	38.4
Whole Farm (with financial assistance)		0	23.6	27.7	39.3
Difference		0	0.0	2.5	0.9

ENR – expected net revenue
VRF – variable rate fertilization
NMP – nutrient management planning

Despite the positive impact of all three BMPs on ENR, the actual estimate of ENR remained negative for all crops on a per acre and whole farm basis. NMP generated the highest ENR of the three BMPs evaluated for Saskatchewan, and represented a 38% improvement over the base model. On a per acre basis, both spring wheat and canola showed a 58% and 55% improvement respectively over the base model ENR. VRF was the second most profitable BMP on a whole farm basis. The ENR for VRF was a 25% improvement over the base model. On a per acre basis, VRF was the most profitable for spring wheat (56%) and canola (30%). Soil

testing was the least profitable of the BMPs according to the analysis, however, it was estimated to be 24% more profitable than the base model. On a per acre basis, soil testing was the most profitable for canola (39%) and spring wheat (36%).

When financial assistance was included in the farm model, the change in ENR over the base model improved by 2.5% for VRF and 1% for NMP compared to the ENR results without financial assistance.

When the Saskatchewan black soil model was compared to the brown soil model, the following observations were made. On a per acre per crop basis, NMP had the greatest impact on the ENR for spring wheat in the black soil zone with an estimated 58% improvement over the base model compared to a 36% improvement over the base model in the brown soil zone. At the whole farm level (note differences in crop rotations) NMP had the greatest impact on the crop rotation in the black soil zone with a 38% improvement in the ENR compared to 30% for the brown soil zone.

4.1.4 Manitoba

The Manitoba model consisted of a single crop rotation of malt barley, canola, spring wheat and peas, and was evaluated for six BMPs: soil testing, VRF, minimum tillage, no-till, NMP and buffer strips). [Table C.27](#) shows the total revenue, variable and fixed costs and expected net revenue (ENR) before the implementation of a BMP. Similar to Alberta and Saskatchewan, the ENR was negative for the Manitoba base model for all crops in the analysis. [Table C.28](#) presents the results from the survey for each of the BMPs evaluated in Manitoba. The average farm size was 1,525 acres ([Table 3.2](#)).

Soil Testing

The survey results indicated that 84% of producers in Manitoba practiced soil testing on their farms, with 59% of these testing every year. When asked, producers believed that soil testing had a positive impact on yield in Manitoba (3.3-4.5 bu/ac increase) depending on the crop. Participants of the survey also indicated that there were increased costs associated with soil testing. These included an increase to operating costs of \$2.8/ac and a soil testing fee of \$5.8/ac (annual soil testing was assumed in the Manitoba analysis). Despite the soil testing fees and changes to operating costs, it was estimated that soil testing had an overall positive economic impact on the four crops in Manitoba. Although the ENRs remained negative, they improved 15-29% when compared to the base model, with spring wheat having the greatest improvement to ENR ([Tables C.29 – C.32](#)).

The ENR remained negative when soil testing was included in the analysis, but when compared to the base model, soil testing represented a 12% improvement (i.e. **-\$104,971** compared to **-\$118,627**) ([Table C.33](#)). These results were consistent with the survey which indicated that 65% of Manitoba producers believed that soil testing resulted in a net economic gain for their farm, while 31% believed there is no change.

Variable Rate Fertilization (VRF)

Like the other western provinces, VRF was a fairly uncommon BMP with 10% of producers practicing it on their farms in Manitoba. As a result, the evaluation was based on relatively small sample sizes. Producers using VRF indicated they used it on 63% of their acreage. According to the survey, the introduction of VRF increased yields 3.6-7.1 bu/ac. Of the six BMPs evaluated, producers using VRF indicated the greatest yield increases. However, the positive impact to

production was accompanied by a relatively high increase in equipment costs (\$22.6/BMP ac, amortized over five years)³⁵ and operating costs (\$9.5/BMP ac). Due to the increases in costs, the ENR on a per acre basis decreased compared to the base model. Reductions in ENR ranged between 4-20%, with the ENR for spring wheat showing the least reduction compared to the base model ([Tables C.29 – C.32](#)).

When the whole farm results were estimated, the ENR was **-\$126,502**, a 7% decrease compared to the base model (**-\$118,627**) ([Table C.33](#)). These results were not consistent with the survey results, which indicated that 75% of producers in Manitoba believed that using VRF had a net economic gain for their farm.

When financial assistance was incorporated for VRF in the Manitoba model, the change in ENR over the base model improved by approximately 3% (refer to [Table 4.6](#)). However, the change in ENR was negative both before financial assistance (-7% over the base model) and after financial assistance was taken into account (-4% over the base model). This may imply that the financial assistance for VRF may not be sufficient, particularly because in this case the cost share reached the maximum allowed from the program (\$15,000 which was amortized over five years). However, it is important to note that the sample size was particularly small and the standard deviation in the estimated cost was quite large for this BMP.

Minimum Tillage

According to the survey, 73% of the respondents in Manitoba were practicing minimum tillage on their farms. Of the total acres on their farms, 82% were minimum tillage acres. When asked, producers indicated that minimum tillage had a modest impact on yield (0.5-1.4 bu/ac increase) for the four crops evaluated in Manitoba. However, producers also indicated that minimum tillage resulted in a decrease in operating costs of \$7.2/BMP ac, despite the increase in equipment costs of \$1.6/BMP ac (annualized over ten years). Overall, minimum tillage had a positive impact on ENR for all four crop (7-18% over the base model), with the greatest improvements realized for barley and spring wheat (18% and 17% respectively) ([Tables C.29 – C.32](#)).

In this study, the ENR for the whole farm analysis including minimum tillage was **-\$104,589** which represented a 12% increase over the base model (**-\$118,627**) ([Table C.33](#)). These results were consistent with the survey, which indicated that 72% of producers in Manitoba believed that using minimum tillage resulted in a net economic gain for their farms.

When financial assistance was included in the model, the minimum tillage BMP resulted in a 1% increase in ENR (over the base model) when compared to the results without financial assistance (refer to [Table 4.6](#)).

No Tillage

According to the survey, 40% of the respondents in Manitoba practiced no tillage on their farms. These producers used this BMP on approximately 69% of their acres. They believed that no tillage had a positive impact on production with yield increases of 1.5-3.7 bu/ac, depending on the crop. No-till also had a positive impact on operating costs, with producers indicating a decrease in operating costs of \$5.6/BMP ac. However, this decrease in costs was partially offset by the increase in equipment costs at \$2.9/BMP ac (annualized over 10 years). Overall, no-till

³⁵ Data includes one outlier with high equipment costs relative to the other respondents. This is compounded by a small sample size.

had a positive impact when compared to the base model for all crops evaluated. Estimated ENR increased 11-22% when compared to the base model ([Tables C.29 – C.32](#)). The greatest improvement in ENR was observed for spring wheat.

Results from the whole farm analysis indicated that no-till improved ENR by 12%, although actual ENR remained negative at **-\$104,836**.

When financial assistance was included in the model, the no-tillage BMP resulted in a 1% increase in ENR (over the base model) when compared to the results without financial assistance (refer to [Table 4.6](#)).

Nutrient Management Planning (NMP)

According to the survey, 55% of the respondents in Manitoba had a NMP for their farm. Producers believed that NMP had a positive impact on production across all four crops and that yields increased 3.8-5.1 bu/ac, depending on the crop. However, NMP had a negative impact on costs as these increased by \$4.3/ac, in addition to the estimated establishment cost for a NMP of \$0.6/ac (amortized over five years). Despite the increased costs, the ENR for all four crops increased compared to the base model, with an improvement in ENR of 9-26% over the base model. Spring wheat showed the greatest improvement (26%) and peas showed the least improvement (9%) when all four crops were compared ([Tables C.29 – C.32](#)).

Whole farm results indicated that NMP improved ENR by an estimate of 20% compared to the base model. The ENR for NMP was negative (**-\$95,358**) but showed an improvement over the base model (**-\$118,627**) ([Table C.33](#)). These results were consistent with the survey, as 60% of producers in Manitoba believed that having a formal NMP resulted in a net economic gain, while 31% believed there was no change.

When financial assistance was included in the model, the NMP BMP resulted in a 1% increase in ENR (over the base model) when compared to the results without financial assistance (refer to [Table 4.6](#)).

Buffer Strips

According to the survey, only 33% of the respondents in Manitoba had buffer strips on their farms. These producers indicated that 5% of their total acres were devoted to buffer strips. Buffer strips had a negative impact on ENR because there were high establishment costs and a loss in production from the land devoted to the buffer. Producers indicated that the loss in crop production from implementing buffer strips was approximately 8%. The 8% loss in yield was incorporated into the model, however, yield losses could be expected to be lower as buffers are typically established on marginally productive land. In addition, it is important to note that the yield loss from the establishment of buffer strips was based on producer knowledge rather than field trials. The loss in yield and an establishment cost of \$7.8/BMP ac (annualized over 10 years) resulted in decreased ENRs (14-35%) for all crops when compared to the base model ([Tables C.29 – C.32](#)).

On a whole farm basis, with buffer strips in place, the estimated ENR was **-\$120,067**, a 1% decrease compared to the base model ([Table C.33](#)). These results were consistent with the survey results as 59% of producers in Manitoba believed that establishing buffer strips had no economic impact for their farm.

The financial assistance for buffer strips resulted in no change in the ENR (over the base model when compared to the results without financial assistance). Once again, this may suggest that the funding available for buffers may not be sufficient given the assumptions (amortized over 10 years) and parameters of the malt barley, canola, spring wheat and peas whole farm model (5% of the 1525 acres was devoted to a buffer (approximately 76 acres)).

Summary

Tables C.29 – C.32 present the results for the Manitoba models. Table C.33 includes the results on a whole farm basis for an average farm of 1,525 ac and a crop rotation of barley (20%), canola (30%), spring wheat (40%) and peas (10%). Tables D.23-D.28 include the results when financial assistance for BMP adoption was incorporated into the models. Table 4.6 summarizes the changes in the estimates of ENR that resulted from the economic evaluation of each BMP with and without financial assistance.

Table 4.6 Summary Of Changes In Estimates Of ENR After Participation In BMPs, Manitoba

Basis of Analysis		Change in ENR from Base Model						Buffer Strips
		Base Model	Soil Test	VRF	Min-Till	No-Till	NMP	
		(%)						
Per acre (without financial assistance)	Barley	0	26	-20	18	21	20	-35
	Canola	0	19	-12	14	11	18	-20
	Spring Wheat	0	29	-4	17	22	26	-29
	Peas	0	15	-13	7	16	9	-14
	Whole Farm (without financial assistance)	0	11.5	-6.6	11.8	11.6	19.6	-1.2
Whole Farm (with financial assistance)	0	11.5	-3.5	12.5	12.6	20.2	-1.0	
Difference		0	0.0	3.2	0.6	1.0	0.6	0.3

ENR – expected net revenue
VRF – variable rate fertilization
Min-Till – minimum tillage
No-Till – no tillage
NMP – nutrient management planning

The ENR on a per acre basis was negative for all four crops, including the base model. In Manitoba, all of the BMPs, with the exception of VRF and buffer strips, resulted in an improvement in ENR over the base model. On a whole farm basis, NMP had the greatest improvement in ENR of the six BMPs evaluated for Manitoba, with a 20% improvement over the base model.

Minimum tillage, no tillage and soil testing were the next most profitable BMPs in the analysis. The estimates for these BMPs represented a 12% improvement over the base model. As expected, VRF was the least profitable BMP and resulted in decreased ENR over the base model. On a whole farm basis, the ENR for VRF decreased by 7%.

On a per acre per crop basis, soil testing and spring wheat resulted in the greatest estimated improvements in ENR (29%) over the base model. Interestingly, producers indicated that spring wheat was particularly responsive to the introduction of BMPs as it showed the greatest improvements in ENR for all of the BMPs evaluated (with the exception of buffer strips and VRF). Increases in ENR for spring wheat were 17-29% over the base model on a per acre basis, for four of the six BMPs evaluated, excluding buffers and VRF. The ENR for spring wheat for buffers and VRF when included in the analysis declined 29% and 4%, respectively.

When financial assistance was included in the farm model, the change in ENR over the base model improved by approximately 3% for VRF, 1% for minimum tillage, no tillage and NMP, and resulted in no change for buffers.

4.2 Central Canada

4.2.1 Assessment Of Manure Management Planning

Of the farmers in central Canada surveyed by Ipsos Reid, 76% apply manure on their farms (Ontario 75%; Quebec 78%). In Quebec, 90% of producers who used manure followed a formal manure management plan (MMP). In Ontario, only 35% of respondents who used manure indicated they used a formal MMP. The main reasons for using a formal plan were:

- government mandate (Ontario 11%; Quebec 36%),
- more efficient use of fertilizer (Ontario 26%; Quebec 17%), and
- to increase and maximize crop yields (Ontario 18%; Quebec 11%).

For producers who use manure (from the survey), approximately 45% of their total acres were treated with manure (Ontario 42%, Quebec 49%), more than double that in western Canada (18%). Of those who apply manure, 83% self apply (Ontario 92%; Quebec 65%) rather than hire a custom operator. In central Canada, the majority of manure was applied as solids (Ontario 80%; Quebec 63%) although liquid manure application was common in Quebec (53%) (Note that some producers may have applied both types). The majority of producers in Ontario and Quebec indicated that they incorporated their solid and liquid manure within five days of application. When asked what criteria they used to estimate the rate of application of manure, both Ontario and Quebec producers indicated:

- they used the nutrient requirements of the crops they were planning to grow (Ontario 61%; Quebec 52%), and
- soil testing (Ontario 50%; Quebec 73%).

Despite this, 85% of Ontario producers indicated they were not analyzing the nutrient content of their solid manure, while 54% were not analyzing liquid manure. In Quebec, 77% of producers who applied liquid manure and 73% of producers who applied solid manure indicated they were analyzing the nutrient content of their manure.

When asked to indicate the cost of manure application on their farm, similar to producers in western Canada (38%), 40% of producers in central Canada believed cost of applying manure was greater than \$20/ac ([Table 4.7](#)).

Table 4.7 Producer Estimates of Cost of Manure Application in Central Canada, Ipsos Reid Survey, 2006

	Ontario	Quebec
	(%)	
Less than \$10/ac	15	15
Between \$10-\$20/ac	28	18
Greater than \$20/ac	36	49
Don't Know	21	17

In central Canada, and similar to western Canada, the majority of producers indicated that having a MMP resulted in a net economic gain for their farm (Ontario 55%; Quebec 67%); although a significant proportion of other producers indicated there was no change for their operations (Ontario 45%; Quebec 30%).

When Ontario and Quebec producers were asked about financial assistance for manure management planning, 71% of Ontario producers said it was very important and 43% went on to say that the government should be providing 26-50% of the cost. In Quebec, 44% of producers also indicated it was very important to have government financial assistance with 54% indicating the contribution from the government should be 26-50% of the cost.

4.2.2 Ontario

The representative farm model for Ontario included a single crop rotation of corn, soybeans and winter wheat, which were evaluated for six BMPs: soil testing, variable rate fertilization (VRF), minimum tillage, no-till, nutrient management planning (NMP) and buffer strips. [Table C.34](#) illustrates the total revenue, variable and fixed costs and expected net revenue (ENR) before the implementation of a BMP. Note that the ENR was negative for the base model for corn. This was a function of the low expected prices for the crop year. [Table C.35](#) presents the results from the survey for Ontario for each of the BMPs evaluated. An average farm size of 430 acres was used in the analysis ([Table 3.2](#)).

Soil Testing

The survey results indicated that 86% of producers in Ontario practiced soil testing on their farms, with 65% of these testing every two to three years. Producers thought that soil testing had a positive impact on the production of all three crops in Ontario and believed a 2-8 bu/ac increase in yield occurred depending on the crop. Despite the soil testing fees (amortized over three years) and minimal changes to operating costs, soil testing had a positive economic impact on corn, soybeans and wheat in Ontario. Although corn showed the greatest increase in estimated ENR (80%) when soil testing was included in the analysis and when compared to the base model, the resulting ENR was still slightly negative (-\$3/ac) ([Tables C.36-C.38](#)).

On a whole farm basis, the ENR was negative for corn and positive for soybeans and winter wheat. These increases more than offset the loss for corn. Overall, the estimated ENR for the whole farm was \$17,130 compared to the ENR for the base farm at \$10,754, representing a 59% increase in ENR ([Table C.39](#)). These results were consistent with the survey results, which indicated that 84% of Ontario producers believed that using soil testing resulted in a net economic gain for their farm.

Variable Rate Fertilization (VRF)

Variable rate fertilization was less common as a BMP with only 17% of producers practicing it on their farms in Ontario. These producers said they used VRF on 59% of their cropland. Despite a perceived increase in yield from 1-9 bu/ac depending on the crop, the changes to operating costs and the custom application costs outweighed the benefits from the yield increase. The results of the economic evaluation on a per acre basis indicated that with the use of VRF the ENR declined for corn (-66%) and soybeans (-53%), but increased modestly for winter wheat (15%), when compared to the base model ([Tables C.36-C.38](#)).

When the whole farm results were estimated after including VRF in the analysis, the ENR was \$9,776, a 9% decrease compared to the base model ([Table C.39](#)). Interestingly, these results were not consistent with the survey results, which indicated that 61% of producers in Ontario believed that using VRF resulted in a net economic gain for their farm, while 33% expected no change.

There was no financial assistance incorporated into the model for VRF in Ontario (although financial assistance is available) as the majority of producers use a custom application service.

Minimum Tillage

According to the survey, 76% of the respondents in Ontario were practicing minimum tillage on their farms. These producers used minimum tillage on 52% of their total acres. The estimated impact of minimum tillage was modest as producers expected a 0.6-3.1 bu/ac increase in yield depending on the crop. Despite equipment costs (\$3.7/BMP ac annualized over a 10 year period), minimum tillage had a positive economic impact for corn, soybeans and wheat in Ontario ([Tables C.36-C.38](#)).

On a whole farm basis when minimum tillage was included in the analysis, the estimated ENR was \$13,195, a 23% increase over the base model ([Table C.39](#)). These results were consistent with the survey results where 55% of producers in Ontario believed that using minimum tillage resulted in a net economic gain for their farms and 38% of producers believed it did not have a net economic impact.

When financial assistance was taken into account with the use of minimum tillage for the Ontario whole farm (individual crop results have been included in [Tables D.29-D.33](#), the change in ENR over the base model improved a total of 3% (refer to [Table 4.8](#)). Therefore, the minimum tillage BMP (without financial assistance) increased the ENR by 23% over the base model and when financial assistance was taken into account the ENR increased by 26% over the base model.

No Tillage

In Ontario, 64% of the producers surveyed used no-till. These producers used this BMP on 44% of their acreage. Producers did not expect a significant change in yields when using no till for corn (no change), soybeans (decrease of 0.1 bu/ac), and winter wheat (increase of 1.1 bu/ac). Producers said they experienced a significant decline in operating costs of \$17.6/BMP ac due to the adoption of no-till. However, they also indicated an increase in equipment costs of \$6/BMP ac (annualized over a 10 year period). Given the anticipated large decline in operating costs, no-till resulted in an increase in ENR on a per acre basis for corn, soybeans and winter wheat in Ontario (ranging from 24-84% over the base model) ([Tables C.36-C.39](#)).

The positive impacts of no-till resulted in an increase in the estimated ENR for the whole farm model from \$10,754 to \$13,221 or a 23% increase in net revenue [Table C.39](#). Overall, the results of the model were in line with the survey as 64% of producers in Ontario felt that no tillage resulted in an economic net gain and 29% felt that there was no change.

Financial assistance for no-tillage equipment resulted in similar results as minimum tillage with a 4% improvement in ENR over the base model (i.e. the change in ENR went from 23% over the base model without financial assistance to 27% over the base model with financial assistance; refer to [Table 4.8](#)).

Nutrient Management Planning (NMP)

According to the survey, 39% of the respondents in Ontario had a nutrient management plan for their farm. NMP had a positive impact on ENR for all three crops, with the greatest impact on corn (56% over the base model). Producers indicated a 1-3 bu/ac increase in yield depending on the crop, with a corresponding reduction in operating costs. In Ontario, establishment of a NMP was estimated at \$1.1/ac (amortized over 5 years) and incorporated into the model. The cost of the NMP was offset by the increase in revenue and reduction in operating costs, and NMP had a positive economic impact on the three crops in Ontario on a per acre basis (ranging from 19-56% over the base model) ([Tables C.36-C.39](#)).

On a whole farm basis with NMP included in the analysis, the ENR was \$15,197, a 41% increase over the base model [Table C.39](#). These results were not consistent with the survey as only 36% of producers in Ontario believed that having a formal NMP resulted in a net economic gain, while 53% believed there was no change.

When financial assistance was incorporated into the model for NMP there was approximately a 2% improvement in ENR (i.e. the change in ENR went from 41% over the base model without financial assistance to 44% over the base model with financial assistance; refer to [Table 4.8](#)).

Buffer Strips

According to the survey, 56% of the respondents in Ontario had buffer strips on their farms. These producers estimated that 3% of their acreage was devoted to buffer strips. As expected, buffer strips had a negative impact on ENR because there were high establishment costs and a loss in production from the land devoted to the buffer. Producers indicated that the loss in crop production approximately 4%. In the model it was assumed that producers lost 4% of their total yield per BMP acre due to establishing buffer strips. However, in reality yield losses could be expected to be lower as buffers are typically established on marginally productive land. In addition, it is important to note that the yield loss from the establishment of buffer strips was based on producer knowledge rather than field trials. Overall, ENR fell substantially for corn, soybeans and wheat in Ontario with the implementation of a buffer strip ([Tables C.36-C.39](#)).

On a whole farm basis the addition of a buffer strip resulted in an estimated ENR of \$10,426, a 3% decrease compared to the base model ([Table C.39](#)). These results were relatively consistent with the survey results as 45% of producers in Ontario believed that establishing a buffer strip had no economic impact for their farm, 31% believed it resulted in a net gain, and 25% believed it resulted in a net loss for their farm.

When financial assistance was included in the model for buffer strips (at the whole farm level), the change in ENR over the base model improved by only 1% which still resulted in a change in ENR of negative 2% over the base model (refer to [Table 4.8](#)) (from -3% over the base model

without financial assistance). This may suggest the financial assistance for buffers in Ontario is not sufficient given the assumptions (amortized over 10 years) and parameters of the corn, soybean and winter wheat whole farm model (3% of the 430 acres was devoted to a buffer (approximately 13 acres)).

Summary

[Tables C.36-C.38](#) present the results for the Ontario models. [Table C.39](#) includes the whole farm results for an average farm with 430 acres and a rotation of corn, soybean and wheat. [Tables D.30-D.33](#) include the results when financial assistance for BMP adoption was incorporated into the models. [Table 4.8](#) summarizes the changes in the estimates of ENR that resulted from the economic evaluation of each BMP with and without financial assistance.

Table 4.8 Summary Of Changes In Estimates Of ENR After Participation In BMPs, Ontario

Basis of Analysis		Change in ENR from Base Model						
		Base Model	Soil Test	VRF	Min-Till	No-Till	NMP	Buffer Strips
		(%)						
Per acre (without financial assistance)	Corn	0	80	-66	94	84	56	-190
	Soybeans	0	39	-53	45	49	45	-106
	Winter	0	37	15	14	24	19	-38
	Wheat							
Whole Farm (without financial assistance)		0	59.3	-9.1	22.7	22.9	41.3	-3.0
Whole Farm (with financial assistance)		0	59.3	-9.1	25.7	27.0	43.7	-2.1
Difference		0	0.0	0.0	3.0	4.1	2.3	0.9

ENR – expected net revenue
VRF – variable rate fertilization
Min-Till – minimum tillage
No-Till – no tillage
NMP – nutrient management planning

The ENR on a per acre basis was negative for corn in the base model and remained negative for all the BMPs evaluated. The change in estimated ENR for corn ranged from -190% for buffer strips to 94% for minimum tillage compared to the base model (i.e. set at 0%).

In Ontario, the use of soil testing, nutrient management planning, minimum tillage and no-till BMPs all resulted in greater ENR for when included in the whole farm model than for the base farm model. Recall from the survey that 86% of respondents in Ontario were using the soil testing BMP. Thirty-three per cent (33%) of the producers who did not use soil testing said it was not needed on their farm. Despite this perception by some producers, the economic evaluation of the impact of soil testing generated the highest ENR of the six BMPs evaluated for Ontario. On a whole farm basis the estimated ENR was 59% more than the base model. Soil testing was particularly profitable for corn on a per acre basis (80% improvement in estimated ENR).

On a whole farm basis, NMP was the next most profitable BMP where the estimate of ENR was 41% greater than the base model. On a per acre basis, corn production benefited the most from NMP.

As expected, VRF, a BMP that is relatively uncommon in Ontario (17%) showed a 9% reduction in the estimate of ENR at the whole farm level. It was the least profitable BMP in the Ontario analysis. High establishment costs and reductions in yields due to land retirement resulted in a reduction in ENR of 3% at the whole farm level when buffer strips were included in the analysis.

An interesting observation from the survey indicated that most producers (>84%) did not receive financial assistance for any of the BMPs implemented on their farms, despite the fact that federal funding was available to Ontario producers for all the BMPs except soil testing ([Appendix A](#)). When financial assistance was included in the farm model, the change in ENR over the base model improved by approximately 3% for minimum tillage, 4% for no tillage, 2% for NMP and 1% for buffers compared to the ENR results without financial assistance. No financial assistance was incorporated in the model for VRF because the majority of Ontario producers (from the survey) indicated they use custom application which is not eligible for financial assistance.

4.2.3 Quebec

For the Quebec model, a single crop rotation of corn, soybeans and spring wheat was evaluated for six BMPs: soil testing, VRF, minimum tillage, no-till, NMP and buffer strips. [Table C.40](#) illustrates the total revenue, the combined variable and fixed costs classified as total expenses, and the expected net revenue (ENR) before the implementation of a BMP. The estimate of ENR was negative for the base model for all three crops, with wheat having the smallest loss on a per acre basis. The negative ENR was largely due to the fact that the Quebec enterprise budgets included land rental costs of \$97/ac. [Table C.41](#) presents the survey results for Quebec for each of the BMPs evaluated. The average farm size was 316 acres ([Table 3.2](#)).

Soil Testing

The survey results indicated that 90% of Quebec producers practiced soil testing on their farms, with 50% of these producers testing every two to three years. Producers felt that soil testing had a positive impact on yield of 1-4 bu/ac depending on the crop. However, the soil testing fees (amortized over three years) and operating cost changes offset the expected increase in yield for both corn and soybeans. Wheat was the only crop where the estimate of ENR increased (9%) when soil testing was included in the analysis compared to the base model ([Tables C.42 – C.44](#)).

On a whole farm basis, the ENR after soil testing was included in the analysis was greater (-\$23,811), although still negative, than the base model (-\$23,938), a 0.5% increase ([Table C.45](#)). These results were consistent with the survey results that indicated 77% of Quebec producers believed that using soil testing resulted in a net economic gain for their farm, while 20% believed there was no change.

Variable Rate Fertilization (VRF)

Variable rate fertilization was also an uncommon BMP in Quebec with just 7% of producers practicing it on their farms. The sample sizes were small for this evaluation, with less than ten producers answering most of the VRF questions. Respondents used VRF on 58% of their cropland. The producers perceived no change in yield for soybeans, a 1.7 bu/ac increase for

corn and a 7.5 bu/ac increase in yield for spring wheat with use of VRF. However, the changes to operating costs and the custom application costs outweighed the yield benefits in corn. On a per acre basis when VRF was included in the analysis, ENR declined for corn (-17%) and soybeans (-18%), and increased for spring wheat (16%), when compared to the base model ([Tables C.42 – C.44](#)).

On a whole farm basis when VRF was included in the analysis, the estimate of ENR was -**\$25,461**, a 6% decrease compared to the base model (-**\$23,938**) ([Table C.45](#)). Similar to Ontario, these results were not consistent with the survey results, which indicated that 69% of producers in Quebec believed that using VRF had a net economic gain for their farm, while 23% expected no change.

There was no financial assistance incorporated into the model for VRF in Quebec (although funding is available) as the majority of producers use a custom application service.

Minimum Tillage

In Quebec, 72% of producers used minimum tillage on 52% or just over half of their acres. When asked, the producers said they experienced small increases in yield (approximately 1%) for corn and spring wheat but there was no significant change in soybean yield (0.1 bu/ac). The producers also experienced a decline in operating costs of \$13/BMP ac and thought they saved approximately \$1.4/BMP ac in equipment costs (annualized over 10 years). In this study, using minimum tillage resulted in an increase in ENR on a per acre basis for corn, soybeans and spring wheat in Quebec (ranging from 16-40% over the base model) ([Tables C.42 – C.44](#)).

On a whole farm basis, the positive impacts of minimum tillage led to an increase in the estimate for ENR from -**\$23,938** to -**\$21,030**, or a 12% increase in net revenue ([Table C.45](#)). Overall, 46% of producers in Quebec felt that minimum tillage resulted in an economic net gain for their operation and 46% felt there was no change.

When financial assistance was taken into account with the use of minimum tillage for the whole farm (results have been included in [Tables D.34-D.38](#)), ENR improved by less than half a percent (i.e. the change in ENR went from 12% over the base model without financial assistance to 13% over the base model with financial assistance; refer to [Table 4.9](#)).

No Tillage

In Quebec, 33% of the producers surveyed used no tillage. When asked, these producers said they used no-tillage on 33% of their total acreage. They also expected yields to remain the same or decline for no-tillage corn (increase of 0.1 bu/ac), soybeans (decrease of 0.2 bu/ac), and spring wheat (decrease of 0.4 bu/ac). The producers estimated that operating costs declined by \$23/ac and equipment costs increased by \$5.4/BMP ac (annualized over a 10 year period). On a per acre basis, the inclusion of no-tillage in the economic analysis resulted in an increase in ENR for corn, soybeans and spring wheat in Quebec (ranging from 18%-36% over the base model), which was influenced mainly by the decline in operating costs ([Tables C.42 – C.44](#)).

On a whole farm basis, the positive impacts of no-tillage led to an increase in the estimate for ENR from -**\$23,938** to -**\$22,117**, or an 8% increase in net revenue ([Table C.45](#)). Overall, 60% of producers in Quebec felt that no-tillage resulted in an economic net gain and 26% felt there was no change.

Financial assistance for no-tillage equipment resulted in a 1% increase in ENR over the base model without financial assistance (refer to [Table 4.9](#)).

Nutrient Management Planning (NMP)

In Quebec, 73% of the producers surveyed practiced nutrient management planning. Crop production for corn, soybeans and spring wheat was positively affected by NMP and producers estimated increase in yield of 1-2 bu/ac depending on the crop. Producers indicated that NMP decreased operating costs by approximately \$5/ac. In Quebec, establishment of a NMP was estimated at \$1.3/ac (amortized over 5 years) and incorporated into the model. NMP had a positive economic impact on net revenues per acre for corn, soybeans and spring wheat in Quebec ([Tables C.42 – C.44](#)).

The whole farm model showed negative ENR despite the positive impact of NMP. NMP increased the whole farm ENR by 13% from the base model of (i.e. from **-\$23,938** to **-\$20,887**) ([Table C.45](#)). Overall, these findings were consistent with the opinions of producers who used NMP. Sixty-four per cent (64%) of them stated that NMP resulted in an economic net gain for their operation.

Financial assistance for NMP resulted in a 1% increase in ENR over the base model without financial assistance (refer to [Table 4.9](#)).

Buffer Strips

The survey results indicated that 55% of producers in Quebec had buffer strips on their farms and of these producers, approximately 5% of their acreage was devoted to buffer strips. The primary reason for using buffer strips in Quebec was concern surrounding soil quality and erosion. Buffer strips had a negative impact on the estimate of cost of production of corn, soybeans, and spring wheat in Quebec, due mainly to establishment costs of \$11.1/BMP ac (amortized over 10 years). In addition, producers perceived a loss in crop production of 8%. On a per acre basis, the estimates of ENR for corn, soybeans and spring wheat decreased by 38-55% relative to the base model ([Tables C.42 – C.44](#)).

When buffer strips were included in the whole farm economic analysis, the estimate of ENR declined by 2% (**-\$23,938** to **-\$24,388**) compared to the base model ([Table C.45](#)). The survey results showed that Quebec producers had diverse perceptions regarding the economic impact of buffer strips. Overall, 26% of producers indicated that buffers resulted in an economic net gain, 30% indicated a net loss and 44% indicated no change for their operation.

Financial assistance for buffers resulted in similar improvements with a 1% increase in ENR over the base model without financial assistance (refer to [Table 4.9](#)). Once again, the change in ENR over the base model with the use of buffer strips remained negative, suggesting financial assistance (when amortized) from the program may not be sufficient, even with the additional 20% provincial top (totalling 70%).

Summary

[Tables C.42 – C.44](#) present the results for the Quebec models. [Table C.45](#) includes the whole farm results for an average farm with 316 acres and a rotation of corn, soybean and spring wheat. [Tables D.35-D.38](#) include the results when financial assistance for BMP adoption was incorporated into the models. [Table 4.9](#) summarizes the changes in the estimates of ENR that resulted from the economic evaluation of each BMP with and without financial assistance.

Table 4.9 Summary Of Changes In Estimates Of ENR After Participation In BMPs, Quebec

Basis of Analysis		Change in ENR from Base Model						
		Base Model	Soil Test	VRF	Min-Till	No-Till	NMP	Buffer Strips
		(%)						
Per acre (without financial assistance)	Corn	0	-1	-17	20	22	9	-38
	Soybeans	0	-2	-18	16	18	13	-38
	Spring Wheat	0	9	16	40	36	20	-55
Whole Farm (without financial assistance)		0	0.5	-6.4	12.1	7.6	12.7	-1.9
Whole Farm (with financial assistance)		0	0.5	-6.4	12.5	8.5	13.6	-1.3
Difference		0	0.0	0.0	0.4	0.9	0.9	0.5

ENR – expected net revenue
VRF – variable rate fertilization
Min-Till – minimum tillage
No-Till – no tillage
NMP – nutrient management planning

The ENR on a per acre basis was negative for corn, soybeans and spring wheat production in the base model and remained negative for all of the BMPs evaluated. The change in estimated ENR ranged from -55% for buffer strips to 40% for minimum tillage compared to the base model (i.e. set at 0%) on a per acre basis.

In Quebec, the use of soil testing, minimum tillage, no tillage and NMP resulted in greater ENR when included in the whole farm model than for the base model. Minimum tillage and NMP were the most profitable BMPs in Quebec and resulted in economic gains of 12% and 13%, respectively. The use of no-till and soil testing led to an increase in the estimate of whole farm net revenue of 8% and 0.5%, respectively. Many producers in Quebec understood the value of minimum tillage and NMP as demonstrated by the high adoption rates and consensus regarding economic net gains. On a per acre basis, minimum tillage and no tillage had the most profitable impact for spring wheat production.

Buffer strips and VRF resulted in declines in ENR estimates when included in the whole farm economic analysis due to high establishment and custom application costs.

Similar to Ontario, the majority of producers (>83%) in Quebec did not receive financial assistance for any of the BMPs implemented on their farms. However, when available financial assistance was included in the farm model, the change in ENR over the base model improved by less than a half percent for minimum tillage and buffers and by 1% for no-tillage and NMP compared to the ENR results without financial assistance. No financial assistance was incorporated in the model for VRF because the majority of Quebec producers (from the survey) indicated they use custom application which is not eligible for financial assistance.

4.3 Eastern Canada

4.3.1 Prince Edward Island

In eastern Canada, the original objective of the study was to evaluate the economic impacts of three BMPs: buffer strips, VRF and soil testing, on potato production in Prince Edward Island. When the survey data were filtered by BMP for potatoes, the sample size was too small to complete the analysis for soil testing and VRF for potatoes.³⁶ This section provides an economic analysis for buffer strips on an average potato farm (single crop) of 563 acres in Prince Edward Island ([Table 3.2](#)).

[Table C.46](#) illustrates the total revenue, the combined variable and fixed costs classified as total expenses, and the expected net revenue (ENR) before the implementation of the BMP. The financial items in the PEI government enterprise budgets for potatoes, prepared in 1995, were adjusted to 2003 levels by Meyers Norris Penny LLP to reflect changes in inflation. In the base model, before buffer strips were included in the analysis, the estimate of ENR for potatoes was negative. [Table C.47](#) presents the survey results for Prince Edward Island for buffer strips.

Buffer Strips

The survey results suggested that 67% of producers in eastern Canada have buffer strips on their farms. These producers indicated that 5% of their land was devoted to buffers. On a per acre basis, buffer strips had a negative impact on the cost of production of potatoes in Prince Edward Island, due mainly to establishment costs of \$21.7/BMP ac (amortized over ten years). In addition, producers perceived a loss in production of 5.1%. In the economic analysis the estimate of ENR per acre for potatoes fell by 12% compared to the base model ([Table C.48](#)).

On a whole farm basis, when buffer strips were included in the analysis, the estimate of ENR declined by 1% from **-\$491,656** to **-\$494,499** ([Table C.49](#)). The survey results suggested that producers in eastern Canada had diverse perceptions regarding the economic impact of buffer strips. Overall, 34% of producers indicated that the establishment of a buffer strips resulted in an economic net gain on their farm, 34% said a net loss and 32% said no change.

In the case of buffer strips for the PEI potato model, ENR improved by only 0.1% with the introduction of financial assistance (refer to [Table 4.10](#)). This may suggest the financial assistance for buffers in PEI is also not sufficient given the assumptions (amortized over 10 years) and parameters of the potato model (5% of the 563 acres was devoted to a buffer (approximately 28 acres)).

³⁶ The data was filtered for Prince Edward Island first and then later filtered by Atlantic region (included data from New Brunswick, Nova Scotia and Prince Edward Island) and the sample sizes were still too small to conclude anything from the introduction of beneficial management practices.

Table 4.10 Summary Of Changes In Estimates Of ENR After Participation In BMPs, PEI

Basis of Analysis		Change in ENR from Base Model	
		Base Model	Buffer Strips (%)
Per acre (without financial assistance)	Potatoes	0	-12%
Whole Farm (without financial assistance)		0	-0.6%
Whole Farm (with financial assistance)		0	-0.5%
Difference		0	0.1%

ENR – expected net revenue

4.4 Summary of Provincial Results

Soil testing, nutrient management planning, minimum tillage and no tillage were the top-performing BMPs within the economic evaluation phase of this study. They were generally perceived as increasing yields that offset increases in operating costs. Producers using minimum tillage and no tillage identified lower increases in yields, although these BMPs typically showed improvements in estimates of the ENR due to reductions in operating costs despite equipment costs (annualized over a 10 year period).

In general, VRF and buffer strips were not as profitable as other BMPs in this study. Typically these two practices reduced the estimate of profitability because of increased costs.

The following tables present the whole farm results for all provinces evaluated. What is shown in the tables is the percent change of expected net revenue over the base model when the various BMPs are implemented. [Table 4.11](#) illustrates the results without financial assistance. Note that the crop rotations are different across the provinces. When all the results are compared, the NMP BMP in the Alberta black model had the greatest impact on ENR, with 78% more ENR than base model without financial assistance and 79% with financial assistance.

Table 4.11 Provincial Whole Farm Results: % Change from Base Model with BMP, WITHOUT Financial Assistance

	Soil Testing	VRF	Min-Till	No-Till	NMP	Buffers
Alberta - Black		53%			78%	-10%
Alberta - Brown	19%		34%		33%	
Sask - Black	24%	25%			38%	
Sask - Brown	15%		17%		30%	
Manitoba	12%	-7%	12%	12%	20%	-1%
Ontario	59%	-9%	23%	23%	42%	-3%
Quebec	1%	-6%	12%	8%	13%	-2%
PEI						-0.6%

On a whole farm basis, the impacts associated with soil testing, minimum tillage, no tillage and nutrient management planning consistently improved the estimates of ENR for all provinces. On a per acre basis, the analysis for most crops showed an increase in the estimate of ENR for soil

testing with the exception of corn and soybeans in Quebec (ENR declined by 1-2% for both crops) and in the Saskatchewan brown soil zone where the ENR declined by 1% for barley. Similarly, on a per acre basis, the analysis for all crops showed an increase in the estimate of ENR for minimum tillage, no tillage and NMP. Overall, the four BMPs were particularly profitable across Canada.

The results for VRF were mixed across the provinces. The results for central Canada (Ontario and Quebec) and Manitoba showed a negative impact on ENR at the whole farm level due to higher custom application costs or equipment costs, and minimal increases in expected yields. However, in the Alberta and Saskatchewan black soil zones, VRF was expected to have a positive impact on ENR.

In all cases, there were declines in the estimates of ENR associated with the use of buffer strips due to higher establishment costs and the loss of crop production in the area of the buffer.

At the individual crop level, spring wheat in western Canada and Quebec, and winter wheat in Ontario were the crops that appeared to be most responsive to the introduction of BMPs the estimates of ENR increased for all BMPs, with the exception of buffer strips in all provinces and VRF in Manitoba.

In all cases, the inclusion of financial assistance resulted in greater expected net revenue than the models without financial assistance. However, the magnitude of improvement depended highly on the cost share percentages of available funding and the number of years over which the funding was amortized. In the case of buffer strips, with an assumed life of 10 years, the funding in all provinces evaluated was not sufficient to generate a positive change in ENR over the base model when financial assistance was included. This may suggest that funding for buffer strips under Canadian programs is not sufficient, given the assumptions in the representative models.

Variable rate fertilization was another BMP that demonstrated negative changes in ENR when compared to the base model for many of the provinces. However, producers in Ontario and Quebec indicated that they used custom application services which are ineligible for financial assistance. For the Saskatchewan and Alberta black soil models the change in ENR for VRF improved, although it was positive to begin with. Finally, in Manitoba, the financial assistance for VRF was not sufficient enough to improve the change in ENR to the point where it was no longer negative. In Manitoba, variable rate fertilization was also the only BMP in which the program payment reached the maximum funding limit based on the estimated costs from the producer survey.

[Table 4.12](#) presents the results with financial assistance. Note that the crop rotations are different across the provinces

Table 4.12 Provincial Whole Farm Results: % Change from Base Model with BMP, WITH Financial Assistance

	Soil Testing	VRF	Min-Till	No-Till	NMP	Buffers
Alberta - Black		57%			79%	-8%
Alberta - Brown	19%		35%		33%	
Sask - Black	24%	28%			39%	
Sask - Brown	15%		20%		31%	
Manitoba	12%	-3%	12%	13%	20%	-1%
Ontario	59%	-9%	26%	27%	44%	-2%
Quebec	1%	-6%	13%	9%	14%	-1%
PEI						-0.5%

4.5 Assessment of BMP Incentives

Producers have lacked information on the economic viability of BMPs. It is important to recognize that on-farm BMP implementation will always be site specific and there is no guarantee that implementation will be a profitable venture. However, this research, which used provincial enterprise budgets, demonstrated that BMPs can have a positive impact on ENR due to an improvement in yield, reduction in operating costs or both.

The results clearly demonstrated that for the representative farms, the implementation of soil testing, minimum tillage, no-tillage and NMP were profitable. For the remaining BMPs, profitability was highly dependent on the crop grown and the province in which the BMP was practiced.

It was clear there are a number of BMP incentive programs available, as demonstrated in [section 2.5](#). However, the survey results indicated that farmers were not taking advantage of the program dollars available:

- VRF – 95% of the total survey (all respondents using VRF BMP across all provinces) indicated they had not received financial assistance.
- Manure management - 94% of the total survey (all respondents using MMP across all provinces) indicated they had not received financial assistance.
- Buffer strips - 92% of the total survey (all respondents that use buffer strips across all provinces) indicated they had not received financial assistance.
- Minimum tillage – 97% of the total survey (all respondents that use minimum tillage across all provinces) indicated they had not received financial assistance.
- No tillage - 96% of the total survey (all respondents that use no tillage across all provinces) indicated they had not received financial assistance.
- Nutrient management planning – 93% of the total survey (all respondents that use nutrient management planning across all provinces) indicated they had not received financial assistance.
- Soil Testing – questions regarding financial assistance were not asked for soil testing.

Although the producers in the survey did not generally access financial assistance (1-7% of respondents received financial incentives depending on the BMPs adopted), this study determined that funding was available for all BMPs (with the exception of soil testing). The following list from the National Farm Stewardship program ([section 2.5.1](#)) recaps the relevant

categories of funding, cost share amounts and maximum available for the BMP (refer to [Appendix A](#) for more detail).

- Manure Land Application - Includes 30% cost share to a maximum of \$10,000.
- Product and Waste Management - Includes 30% cost share for product and waste management to a maximum of \$15,000.
- Riparian Area Management - Includes 50% cost share for establishing buffer strips to a maximum of \$20,000.
- Land Management for Soils at Risk - Includes 50% cost share for establishing forage or annual barrier to a maximum of \$5,000. Top-ups are available in BC (funding provided by Ducks Unlimited Canada). Provincial top-ups are available in PEI.
- Improved Cropping Systems - Includes 30% cost share for improved cropping systems (including equipment modifications and VRF) to a maximum of \$15,000.
- Shelterbelt Establishment - Includes 50% cost share for shelter belt establishment (similar to buffer strips) to a maximum of \$10,000. Provincial top-ups are available in Quebec and PEI.
- Enhancing Wildlife Habitat and Biodiversity - Includes 50% cost share for buffer strip establishment to a maximum of \$10,000. Top-ups are available in BC (funding provided by Ducks Unlimited Canada).
- Species at Risk - Includes 50% cost share for plant species establishment to a maximum of \$10,000. Top-ups are available in BC (funding provided by Ducks Unlimited Canada).
- Preventing Wildlife Damage - Includes 30% cost share for forage buffer strips to a maximum of \$10,000. Top-ups are available in BC (funding provided by Ducks Unlimited Canada).
- Nutrient Management Planning - Includes 50% cost share for consultant fees to establish a nutrient management plan and for planning and decision tools to a maximum of \$4,000. Provincial top-ups are available in Manitoba.
 - During the development of a nutrient management plan, producers are eligible for financial assistance related to soil testing (including soil sampling and analysis).

Sources: AAFC 2005e; AAFC 2006b.

It is worth noting that funding for certain BMPs (e.g. buffer strips) is available through several categories of the National Farm Stewardship Program and Greencover program. Therefore, program administrators and producers can select various categories from which funding can be accessed.

The National Farm Stewardship Program Administrators were contacted to understand current uptake levels in the national program. As of September 30, 2006, approximately 6,000 producers had applied and received funding for 9,623 BMPs. This represents 3% of all Canadian producers (6,000 of approximately 200,000 producers). Total spending equalled 37.6 million dollars (approximately 30-40% of the available funding) (Snell, 2006).

Given that a number of BMP incentive programs were available and that the survey indicated farmers were not taking advantage of them, perhaps the focus of future efforts should be on education about the economic and environmental of BMPs. One conclusion that can be drawn from this research is that at least some types of BMPs (e.g. VRF and buffer strips) are not affordable to many farms without incentives, regardless of the environmental benefits gained from the practice. Even though some incentive programs already exist to address these low profit BMPs, it is key that governments ensure that:

- producers are aware of the programs;
- there is sufficient compensation from the programs;

- the application processes are simple (as found in the literature); and
- confidentiality is maintained when producers who apply (as found in the literature).

5.0 SUMMARY AND CONCLUSIONS

The purpose of this project was to determine what the economic benefit would need to be to encourage agricultural producers to participate in beneficial management practices (BMPs), specifically those related to crop nutrients.

The first phase of the research was a literature review. The purpose of the literature review was to develop a solid understanding of existing research regarding the economics and adoption of BMPs. The literature review focused largely on research from Canada and the United States.

According to the Crop Nutrients Council (2005), a BMP considers the balance of nutrients for agricultural production with the goal of protecting environmental resources and ensuring profitable crop production.

Review of the economic literature that assessed adoption levels of beneficial management practices.

In the literature, there were a number of factors analyzed that could influence a producer's decision to adopt BMPs. Characteristics of farms and farm operators that appeared to influence adoption were education level, farm size, level of gross sales and whether or not the producer earned off-farm income. Higher levels of education, larger farms, farms with higher levels of gross sales, and producers who earned off-farm income were generally more likely to adopt BMPs. However, these findings were not necessarily consistent across all literature reviewed as some studies did not find significant relationships among these variables.

In assessing why some of these factors were found to influence BMP adoption, Fulgie (1999) suggested that education increased a producer's ability to learn and adapt new technologies to farm operations. Fulgie (1999) and Deloitte and Touche (1992) also suggested that producers with off-farm income were more likely to use reduced tillage systems because of a higher opportunity cost of labour. Larger farms and farms with higher gross sales were more likely to use BMPs because these farms generally had more financial resources.

With regards to programs in place that encourage the use of BMPs, producer participants in focus groups conducted by Agnew and Filson (2004) mentioned that participation could be improved if there was greater involvement of farm organizations and producers in the design of BMP programs, programs were clear and straightforward, and there was sufficient financial compensation offered. Producers also stated that, in the absence of financial incentives, they would use BMPs if they were cost effective for their farming operation.

In addition, the literature review presented information on adoption levels of BMPs for Canada and data suggested that familiarity with BMPs was lacking in certain provinces. This finding suggests that simply increasing awareness of BMPs may improve adoption levels in these provinces. In other provinces addressing the lack of research conducted pertaining to the economics of BMPs may help increase adoption. Canadian data sources suggested that certain BMPs are more commonly used in the different agricultural regions of Canada. Environmentally sustainable fertilizer application methods such as banding and injecting appear more common in the Prairie provinces. Reduced tillage practices, especially no-till are gaining widespread acceptance not only in the Prairie provinces, but also in Ontario and Newfoundland. Quebec and Ontario were the provinces most likely to adjust fertilizer applications to account for nitrogen from previous crops and the nitrogen content of manure. These two provinces also had the

highest percentages of farms that indicated they had formal Nutrient Management Plans and Environmental Farm Plans.

The second phase of the research was to understand the profitability of BMPs in the context of Canadian agricultural crop production. The specific objectives of the project and the corresponding results are outlined in the paragraphs below.

To estimate farm profitability before and after participation in beneficial management practices.

The purpose of this phase of the work was to estimate farm profitability before and after participation in BMPs using representative farm models for Alberta, Saskatchewan, Manitoba, Ontario, Quebec and Prince Edward Island. The models were developed to represent typical crop rotations in each of the provinces, in order to evaluate BMPs by crop rotation, by province.

The George Morris Centre worked closely with Kent Goldie, Senior Research Manager for Ipsos Reid, to design survey questions that would provide the necessary data for this component of the research. The BMPs selected for evaluation in the survey were based on the literature review and included: soil testing, variable rate fertilization, manure management, buffer strips, no-till, minimum till and nutrient management plans.

Insufficient survey data was collected for manure management planning to conduct a complete economic analysis; however, the results obtained from the survey were included as a qualitative assessment for western and central Canada in [sections 4.1](#) and [4.2](#).

A total of 39 models were developed (8 base models representing the farm prior to implementing a BMP and 31 BMP iterations). The farm models were developed using 2006 crop enterprise budgets obtained from the respective provincial governments. The enterprise budgets provided an estimate for revenue, variable costs, fixed costs and expected net revenue (ENR) for individual crops on a per acre basis. The enterprise budgets were based on average cost and return estimates, for example, average provincial crop yields, and average farm prices for a specific crop.

The models were also run with the estimated financial assistance available from federal and provincial programs in Canada. As identified in [section 2.5.1](#) there is financial assistance available for all of the BMPs evaluated except soil testing (recall that soil testing financial assistance is only available with the development of a nutrient management plan and was not included in the soil testing models).

Using the per acre profitability estimates for the individual crops, representative farm models were developed based on specific crop rotations. The Ontario and Quebec models assumed an even distribution of crops across the farm while the models for the Prairie provinces were based on typical crop rotations. Because the crop enterprise budgets were based on per acre data, the representative farms were given an assumed size. The size of each representative farm was based on the mean farm size from the survey for each of the provinces.

The results of the model analysis suggested that soil testing, nutrient management planning, minimum tillage and no tillage were the top-performing BMPs. These practices generally produced increased yields that offset any increases in operating costs. Producers using minimum tillage and no tillage identified fewer increases in yields, although these BMPs typically

still showed improvements in ENR due to reductions in operating costs despite equipment costs (annualized over a ten year period).

In general, variable rate fertilization and buffer strips were not as profitable. Typically these practices reduced profitability because of increased costs. In all cases buffer strips reported declines in expected net revenue (ENR) due to the higher costs in establishment of the buffers and the lost crop production in the area of the buffer.

The following tables present the whole farm results for all provinces evaluated. What is shown in the tables is the percent change of expected net revenue over the base model when the various BMPs are implemented. [Table 5.1](#) illustrates the results without financial assistance, while [Table 5.2](#) presents the results with financial assistance. Note that the crop rotations are different across the provinces. When all the results are compared, the NMP BMP in the Alberta black model had the greatest impact on ENR, with 78% more ENR than base model without financial assistance and 79% with financial assistance.

Table 5.1 Provincial Whole Farm Results: % Change in ENR from Base Model with BMP, WITHOUT Financial Assistance

	Soil Testing	VRF	Min-Till	No-Till	NMP	Buffers
Alberta - Black		53%			78%	-10%
Alberta - Brown	19%		34%		33%	
Sask - Black	24%	25%			38%	
Sask - Brown	15%		17%		30%	
Manitoba	12%	-7%	12%	12%	20%	-1%
Ontario	59%	-9%	23%	23%	42%	-3%
Quebec	1%	-6%	12%	8%	13%	-2%
PEI						-0.6%

ENR – expected net revenue
VRF – variable rate fertilization
Min-Till – minimum tillage
No-Till – no tillage
NMP – nutrient management planning

In all cases, the inclusion of financial assistance resulted in greater expected net revenue than the models without financial assistance. However, the magnitude of improvement depended highly on the cost share percentages of available funding and the number of years over which the funding was amortized. In the case of buffer strips, with an assumed life of 10 years, the funding in all provinces evaluated was not sufficient to generate a positive change in ENR over the base model when financial assistance was included. This may suggest that funding for buffer strips under Canadian programs is not sufficient, given the assumptions in the representative models.

Variable rate fertilization was another BMP that demonstrated negative changes in ENR when compared to the base model for many of the provinces. However, producers in Ontario and Quebec indicated that they used custom application services which are ineligible for financial assistance. For the Saskatchewan and Alberta black soil models the change in ENR for VRF improved, although it was positive to begin with. Finally, in Manitoba, the financial assistance for VRF was not sufficient enough to improve the change in ENR to the point where it was no

longer negative. In Manitoba, variable rate fertilization was also the only BMP in which the program payment reached the maximum funding limit based on the estimated costs from the producer survey.

Table 5.2 Provincial Whole Farm Results: % Change in ENR from Base Model with BMP, WITH Financial Assistance

	Soil Testing	VRF	Min-Till	No-Till	NMP	Buffers
Alberta - Black		57%			79%	-8%
Alberta - Brown	19%		35%		33%	
Sask - Black	24%	28%			39%	
Sask - Brown	15%		20%		31%	
Manitoba	12%	-3%	12%	13%	20%	-1%
Ontario	59%	-9%	26%	27%	44%	-2%
Quebec	1%	-6%	13%	9%	14%	-1%
PEI						-0.5%

ENR – expected net revenue
 VRF – variable rate fertilization
 Min-Till – minimum tillage
 No-Till – no tillage
 NMP – nutrient management planning

At the individual crop level, spring wheat in western Canada and Quebec and winter wheat in Ontario were the crops that were most responsive to the introduction of BMPs, showing an increase in ENR for all BMPs (with the exception of buffers in all provinces and VRF in Manitoba). The results at the individual crop level were the same with the inclusion of financial assistance.

To assess the incentives currently available for producers to adopt beneficial management practices.

As part of the literature review, Canadian incentive programs for the adoption of BMPs were reviewed. The specific programs included the National Farm Stewardship Program (NFSP), the Federal-Provincial Environmental Farm Plan Program, the National Water Supply Expansion Program (NWSEP), the Greencover Canada (GC) program and assistance programs available for the adoption of manure application BMPs. Payments varied across provinces and programs, but most incentives for BMPs are offered on a cost-share basis.

Most programs had funding caps. The most expansive program offering funding for BMPs was the National Farm Stewardship Program. The funding period for this program ends March 31, 2008 and the funding cap per legal farm entity is \$50,000 over the life of the program. The maximum funding available for a legal farm entity under the Greencover Canada and the NFSP programs together is \$50,000 over the life of the programs. Generally the programs will cover 30-50% of eligible costs of approved BMPs.

To assess the need for additional incentives for producers to adopt/participate in beneficial management practices (i.e. what incentive is required to overcome the short-term costs for a BMP that will provide long-term benefits).

Although the producers in the survey did not generally access financial assistance (1-7% of respondents received financial incentives depending on the BMPs adopted), this study determined that funding was available for all BMPs (with the exception of soil testing³⁷). The following list from the National Farm Stewardship program and Greencover program ([section 2.5.1](#)) recaps the relevant categories of funding, the cost share amount and maximum available for the BMP. Note that individual provinces may provide 'top-ups' in addition to the national funding, as detailed below.

- Manure Land Application - Includes 30% cost share to a maximum of \$10,000.
- Product and Waste Management - Includes 30% cost share for product and waste management to a maximum of \$15,000.
- Riparian Area Management - Includes 50% cost share for establishing buffer strips to a maximum of \$20,000.
- Land Management for Soils at Risk - Includes 50% cost share for establishing forage or annual barrier to a maximum of \$5,000. Top-ups are available in BC (funding provided by Ducks Unlimited Canada). Provincial top-ups are available in PEI.
- Improved Cropping Systems - Includes 30% cost share for improved cropping systems (including equipment modifications and VRF) to a maximum of \$15,000.³⁸
- Shelterbelt Establishment - Includes 50% cost share for shelter belt establishment (similar to buffer strips) to a maximum of \$10,000. Provincial top-ups are available in Quebec and PEI.
- Enhancing Wildlife Habitat and Biodiversity - Includes 50% cost share for buffer strip establishment to a maximum of \$10,000. Top-ups are available in BC (funding provided by Ducks Unlimited Canada).
- Species at Risk - Includes 50% cost share for plant species establishment to a maximum of \$10,000. Top-ups are available in BC (funding provided by Ducks Unlimited Canada).
- Preventing Wildlife Damage - Includes 30% cost share for forage buffer strips to a maximum of \$10,000. Top-ups are available in BC (funding provided by Ducks Unlimited Canada).
- Nutrient Management Planning - Includes 50% cost share for consultant fees to establish a nutrient management plan and for planning and decision tools to a maximum of \$4,000. Provincial top-ups are available in Manitoba.
 - During the development of a nutrient management plan, producers are eligible for financial assistance related to soil testing including soil sampling and analysis).

Sources: AAFC 2005e; AAFC 2006b.

It is worth noting that funding for certain BMPs (e.g. buffer strips) is available through several categories of the National Farm Stewardship Program and Greencover program. Therefore, program administrators and producers can select various categories from which funding can be accessed.

³⁷ Note that financial assistance can be obtained for soil testing through the development of a nutrient management plan.

³⁸ Note that category 14 provides cost share on the specialized components of conservation equipment. Therefore, in some cases, the cost share may not apply to the entire implement, but only the specialized components. However, for GPS, the 30% cost share can be applied on the entire unit, up to the category cap of \$15,000.

The National Farm Stewardship Program administrators were contacted to understand current uptake levels in the national program. As of September 30, 2006, approximately 6,000 producers had applied and received funding for 9,623 BMPs. This represents 3% of all Canadian producers (6,000 of approximately 200,000 producers). Total spending equalled 37.6 million dollars (approximately 30-40% of the available funding) (Snell, 2006).

Conclusions

Producers have lacked information on the economic viability of BMPs. The goal of this study was to provide a framework for producers to assess the benefits and costs of BMPs for their farm operations. It is important to note that changes in farm profitability due to the adoption of BMPs for individuals farms may vary from the results of this study. This is because the research is based on producer perceptions, representative farm models that are based on industry averages, and additional assumptions for modelling purposes. Therefore, individual producers may experience different effects on farm profitability from the adoption of BMPs due to factors such as the site specific nature of their property (resulting in varying yield changes from BMPs), as well as revenues and expenses which are different from those used in provincial enterprise budgets (due to different management styles).

Based on producer perceptions and the assumptions used in this analysis, the results of this study indicated that the majority of the selected BMPs, including soil testing, minimum tillage, no tillage and nutrient management planning, improved profitability for the representative farms. The profitability of farms using variable rate fertilization depended on the crop grown and the province in which the BMP was practiced. In all cases, the models suggested that buffer strips reduced expected net revenue. Although many of the BMPs evaluated in this study were found to be profitable, these results are not meant to suggest that financial assistance programs are not required. As stated above, results will vary, thereby impacting profitability and the need for financial assistance.

Another goal of this research was to assess the incentives currently available for producers to adopt BMPs. The study found that funding was available for all the BMPs evaluated except soil testing (unless obtained through the development of a nutrient management planning). Despite this, respondents in the Ipsos Reid survey indicated they were not taking advantage of the funding programs. Only 1-7% of respondents received financial incentives depending on the BMPs adopted on their farms. The National Farm Stewardship Program administrators were contacted to understand current uptake levels in the national program. As of September 30, 2006, approximately 6,000 producers had applied and received funding for 9,623 BMPs (Snell, 2006). This represents 3% of all Canadian producers (6,000 of approximately 200,000 producers). For this reason, it would seem there are additional barriers to adoption that need to be addressed.

From the survey, the following results emerged regarding barriers to adoption for the specific BMPs evaluated in this study. The main reasons cited for not using a BMP were as follows:

- Soil testing
 - 33% of the total respondents not practicing soil testing indicated it was because it was too costly/expensive.
 - 28% said there was no need for it.
- Variable rate fertilization

- 54% of the respondents familiar with VRF but not using the BMP indicated it was because it was too costly/expensive.
- 35% said they don't have the equipment.
- Buffer strips
 - 59% of the respondents without buffer strips said there was no need for it.
- Minimum tillage
 - 15% of the respondents not using minimum tillage said it was because they were already practicing no tillage usage.
 - 20% said it was because it was too costly/expensive.
 - 15% said there was no need for it.
- No tillage
 - 31% of respondents who do not use no-till said it was because it was too costly/expensive.
 - 28% said it was because they didn't have the equipment.
- Nutrient management planning
 - 30% of the respondents not using nutrient management plans said it was because there was no need for it.
 - 20% said it was because it was too costly/expensive.

From the bullets above, the greatest barriers to adoption appear to be cost and not seeing the need for the BMP. While not indicated above, one observation made while doing this analysis was that many producers did not recognize that BMPs could have an economic net gain for their farms. While financial assistance deals with the cost barrier, not seeing the need for the BMP or recognizing the economic viability implies that the focus for future direction needs to be communication and education of the benefits (both environmental and economic) of the BMPs.

Transition costs, real or perceived, may also be major barriers preventing further adoption by producers. As described above, the capital costs (e.g. equipment) required for no-tillage and VRF may prevent producers from establishing these practices. Transition costs may also include costs dedicated to learning about BMPs (e.g. time, education) and perceived risks of adopting new practices versus continuing reliable methods. There may also be transition costs involved in accessing financial assistance for BMPs such as costs of paperwork and meeting program requirements (e.g. completion of Environmental Farm Plan). Overall, transition costs may hinder producers from adopting BMPs despite the economics of the practices after adoption is established.

According to the survey, the following types of resources would assist producers in adopting and using beneficial management practices:

- Written material on how to adopt/implement the practice
- Workshops or seminars
- More financial assistance
- Agricultural extension assistance
- More information

One final conclusion that can be drawn from this research is that at least some types of BMPs (e.g. variable rate fertilization and buffer strips) were not affordable to many farms even with incentives, regardless of the environmental benefits gained from the practice. Even though some incentive programs already exist to address these low profit BMPs, it is key that governments ensure that:

- producers are aware of the programs;
- there is sufficient compensation from the programs; and
- the application processes are simple (as per the literature).

6.0 REFERENCES

- Alberta Agriculture, Food and Rural Development (AAFRDa). About Precision Farming. [http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/sag1950#conference](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sag1950#conference). INTERNET. Cited September 28, 2005.
- Alberta Agriculture, Food and Rural Development (AAFRDb). Buffer Zones for a Healthy Watershed. [http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/irr6419](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/irr6419). INTERNET. Cited September 28, 2005.
- Alberta Agriculture, Food and Rural Development (AAFRDc). Beneficial Management Practices: Environmental Manual for Crop Producers in Alberta - 4.2 Commercial Fertilizers and Manure. [http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/agdex9398](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex9398). INTERNET. Cited September 28, 2005.
- Alberta Government, Agriculture, Food and Rural Development (AAFRDd). 2003. Beneficial Management Practices: Environmental Manual for Dairy Producers in Alberta. [http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/epw7716?opendocument](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/epw7716?opendocument). INTERNET. Cited: November 2, 2005.
- Alberta Government, Agriculture, Food and Rural Development (AAFRDe). Tri-Provincial Manure Application and Use Guidelines: Alberta Version. [http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/epw8709?opendocument](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/epw8709?opendocument). INTERNET. Cited: November 2, 2005.
- Agnew, P. and G. Filson. 2004. Landowner Motivations for the Adoption/Non-Adoption of Best Management Practices in the Hobbs-McKenzie Drainage Area and Usborne Township. Ausable-Bayfield Conservation Authority, Exeter, ON.
- Agriculture and Agri-Food Canada (AAFC). 2004. News release: Enhanced Environmental Farm Planning coming to Prince Edward Island. http://www.agr.gc.ca/cb/index_e.php?s1=n&s2=2004&page=n40819a. INTERNET. Cited: August 8, 2005.
- Agriculture and Agri-Food Canada (AAFC). 2005a. Greencover Canada. http://www.agr.gc.ca/env/greencover-verdir/index_e.phtml. INTERNET. Cited: August 10, 2005.
- Agriculture and Agri-Food Canada (AAFC). 2005b. National Water Supply Expansion Program. http://www.agr.gc.ca/env/index_e.php?section=h2o&page=h2o. INTERNET. Cited: August 10, 2005.
- Agriculture and Agri-Food Canada (AAFC). 2005c. Canada-Saskatchewan Farm Stewardship Program (CSFSP) Application Guide for 2005/06; National Farm Stewardship Program (NFSP) Terms and Conditions. http://www.agr.gov.sk.ca/docs/about_us/apf/CSFSP_Application_Guide.pdf. INTERNET. Cited: August 10, 2005.
- Agriculture and Agri-Food Canada (AAFC). 2005d. Environmental Farm Plan News Releases.

- News release: Canada-Nova Scotia program triggers improvement in environmental performance of farm producers.
http://www.agr.gc.ca/cb/index_e.php?s1=n&s2=2005&page=n50609a.
- News release: New incentives for Environmental Farm Plans in Alberta.
http://www.agr.gc.ca/cb/index_e.php?s1=n&s2=2005&page=n50609b.
- News release: Environmental farm planning under way in Manitoba.
http://www.agr.gc.ca/cb/index_e.php?s1=n&s2=2005&page=n50609c.
- News release: New incentives for on-farm environmental practices in Saskatchewan.
http://www.agr.gc.ca/cb/index_e.php?s1=n&s2=2005&page=n50609d.
- News release: Quebec agricultural producers receive \$3.686 million to improve water quality. http://www.agr.gc.ca/cb/index_e.php?s1=n&s2=2005&page=n50719a.
INTERNET. Cited: August 4, 2005.
- Agriculture and Agri-Food Canada (AAFC). 2005e. National Farm Stewardship Program System Development: BMP Category Code/Practice Code Assignment. December 19, 2005.
- Agriculture and Agri-Food Canada (AAFC). 2006a. National Farm Stewardship Program Beneficial Management Practice Descriptions. November 1, 2006.
- Agriculture and Agri-Food Canada (AAFC). 2006b. 2006/2007 National Farm Stewardship Program and Greencover Incentive Funding Top-Ups for BMPs Across Canada.
- Alabama Cooperative Extension System. 1995 *Fertilizer Management to Protect Water Quality: Fertilizer Application Techniques*. Prepared by James E. Hairston. ANR-790-4.4.3
- Andraski, Todd W. and Larry G. Bundy. 2005. Cover Crop Effects on Corn Yield Response to Nitrogen on an Irrigated Sandy Soil. *Agronomy Journal*. Volume 97, July. Pp. 1239-1244.
- Arnold, J. and E. Van Donkersgoed. undated. Livestock and Poultry Waste Management. Best Management Practices. Guelph, ON: Agriculture and Agri-Food Canada.
- Aspinall, J. D. and R. G. Kachanoski. 1993. Tillage 2000. Ontario Ministry of Agriculture and Food, University of Guelph, Guelph, Ontario.
- Babcock, B. A., and G. R. Paustch. 1998. Moving from Uniform to Variable Fertilizer Rates on Iowa Corn: Effects on Rates and Returns. *Journal of Agricultural and Resource Economics* 23(2): 385-400.
- Bandel, V. Allen, David J. Sammons and Ronald Mulford. 1989. *Nitrogen Management for High Yield Small Grain Production*. Fact Sheet 511. University of Maryland, College of Agriculture and Natural Resources.
- Batte, M.T. 2001. Precision Farming and Profits – What Should I Expect? Ohio State University Extension Regional Agronomy Day, 16 January.
- Bruulsema, T.W. 2004. Agri-Environmental Indicators. CAAR Crop Management Forum, 2004 Potash & Phosphate Institute of Canada.

- Bulletin 604. 1992. *Ohio Livestock Manure and Wastewater Management Guide*. Ohio State University Extension. Available on the internet at:
<http://ohioline.osu.edu/b604/index.html>.
- Bullock, D. S., J. Lowenberg-DeBoer, and S. M. Swinton. 2002. Adding Value to Spatially Managed Inputs by Understanding Site-specific Yield Response. *Agricultural Economics* 27: 233-245.
- Canadian Fertilizer Institute (CFI). <http://www.cfi.ca/default.asp>. INTERNET. Cited: July 19, 2005.
- Cestti, R., Jitendra, S., & Jung, S. 2003. Agriculture Non-Point Source Pollution Control. (p19-20). Washington, DC: The World Bank.
- Conservation Technology Information Center. 2002. Economic Benefits with Environmental Protection. Conservation Technology Information Center, West Lafayette, Indiana.
- Crop Nutrients Council (CNC). Crop nutrient BMP definition.
http://www.cropnutrients.ca/Beneficial_Management_Practices/. INTERNET. Cited August 9, 2005.
- Crop Nutrients Council (CNC). 2004. Beneficial Management Practices.
http://www.cropnutrients.ca/files/BMP/BMP_Practices_Web.pdf. INTERNET. Cited October 13, 2005.
- Daberkow, S. G. and W. D. McBride. 2000. Adoption of precision agriculture technologies by U.S. Farmers. In: P. C. Roberts, R. H. Rust, and W. E. Larson (Eds.), *Proceedings of the Fifth International Conference on Precision Agriculture, ASA-CSSA-SSSA*, Madison, Wisconsin.
- Deloitte and Touche Management Consultants. 1992. *An Economic Evaluation of Soil Tillage Technologies*. Guelph, Ontario.
- The Fertilizer Institute. *Enhanced Efficiency Fertilizer*. Washington, D. C.
- Flynn, R., S. T. Ball and R.D. Baker. 1999. Sampling for Plant Tissue Analysis. College of Agriculture and Home Economics New Mexico State University, Las Cruces, NM.
- Freeze, Brian S., C. Webber, C.W. Lindwall and J.F. Dormaar. 1993. Risk Simulation of the economics of manure application to restore eroded wheat cropland. *Canadian Journal of Soil Science*. Volume 73(2), pp. 367-274.
- Fulgie, K. O. and C. A. Kascak. 2001. Adoption and Diffusion of Natural-Resource-Conserving Agricultural Technology. *Review of Agricultural Economics* 23(2): 386-403.
- Fulgie, K. O. 1999. Conservation Tillage and Pesticide Use in the Cornbelt. *Journal of Agricultural and Applied Economics* 31(1): 133-147.

- Gasser, P. Y., G.Glasman, G.Iler, D.Lobb, M.Vanden Heuvel, L.Cruickshank, A.Hayes, B.Kennedy, K.Reid & A.Graham 1993. Field Crop Production. Best Management Practices. Guelph, ON: Agriculture and Agri-Food Canada.
- Goldie, K. 2006. "Adoption of Environmentally and Economically Sustainable Beneficial Management Practices." Raw survey data collected as part of the research for Crop Nutrients Council and Agriculture and Agri-food Canada's Advancing Canadian Agriculture (ACAAF) Program. May 2006.
- Goddard, T. 1997. What is Precision Farming? Proceedings: Precision Farming Conference, January 20 - 21, 1997, Taber, Alberta, Canada.
[http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/sag1951?opendocument](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sag1951?opendocument). INTERNET. Cited September 28, 2005.
- Government of Canada. 2005. Offset System for Greenhouse Gases - Technical Background Document. http://climatechange.gc.ca/english/publications/offset_gg_tech/3.asp#a. INTERNET. Cited October 7, 2005.
- Government of Prince Edward Island. Agriculture, Fisheries and Aquaculture: SRCP Program Description – 2005. <http://www.gov.pe.ca/af/agweb/index.php3?number=72385&lang=E>. INTERNET. Cited: August 10, 2005.
- Government of Saskatchewan. The Canada-Saskatchewan Environmental Farm Plan (EFP) Program. http://www.agr.gov.sk.ca/docs/about_us/apf/EFP_Final.pdf. INTERNET. Cited: August 10, 2005.
- Grand River Conservation Authority (GRCA). 2002. Newsletter: March 2002. <http://www.grandriver.ca/index/document.cfm?Sec=14&Sub1=66&Sub2=65>. INTERNET. Cited: September 29, 2005.
- Gray, R. S., J. S. Taylor, and W. J. Brown. 1996. Economic Factors Contributing to the Adoption of Reduced Tillage Technologies in Central Saskatchewan. *Canadian Journal of Plant Science* 76(4): 661-668.
- Hanna, H.M., D.S. Bundy, J.C. Lorimor, S.K. Mickelson, S.W. Melvin and D.C. Erbach. 2000. Manure Incorporation equipment effects on odor, residue cover, and crop yield. *Applied Engineering in Agriculture Journal*. Volume 16(6), pp. 621-627.
- Hanson, J. C., E. Lichtenberg, A. M. Decker, and A. J. Clark. 1993. Profitability of No-Tillage Corn following a Hairy Vetch Cover Crop. *Journal of Production Agriculture* 6(3): 432-437.
- Henning, S. and H. Cardona. 2000. An Analysis of Factors Influencing Adoption of BMPs Among Louisiana Sugarcane Producers. Selected paper presented at the 2000 American Agricultural Economics Association Meeting, Tampa, Florida, July 30-August 2, 2000.
- Hilliard, C., N. Scott, L. Armando, and S. Reedyk. 2002. "Agricultural Best Management Practices for the Canadian Prairies: a review of literature."
http://www.agr.gc.ca/pfra/water/wqbmp_e.pdf. INTERNET. Cited: September 29, 2005.

- Huijsmans, J, B. Verwijs, L. Rodhe and K. Smith. 2004. Costs of emission-reducing manure application. *Bioresource Technology*. Volume 93 (1), pp. 11-19.
- Kansas Department of Agriculture. 1997. Governor's Water Quality Initiative: Kansas Cropping Practice Survey, 1996. Kansas Department of Agriculture, Topeka, Kansas.
- Khanna, M., O. F. Epouhe, and R. Hornbaker. 1998. Adoption of site-specific crop management: Current status and likely trends. University of Illinois Program for Environment and Resource Economics Working Paper no. 15.
- Kratochvil, Robert J., Michael R. Harrison, Jr., Justin T. Pearce, Kevin J. Conover, and Mark Sultenfuss. 2005. "Nitrogen Management for Mid-Atlantic Hard Red Winter Wheat Production", *Agronomy Journal*, Vol. 97, pp. 257-264.
- Lamba, P., P. Agnew, K. Wells and G. Filson. 2005. Review of Ontario, U.S. and Europe's Water Quality Assurance Programs and Legislation. University of Guelph. Guelph, Ontario (internal publication).
- Lane, A. Ed. 1998. Nutrient Management Planning. Best Management Practices. Guelph, ON: Agriculture and Agri-Food Canada.
- Lane, A. Ed. 1997. Soil Management. Best Management Practices. Guelph, ON: Agriculture and Agri-Food Canada.
- Lynch, Lori and Robert Tjaden. 2000. When a Landowner Adopts a Riparian Buffer – Costs and Benefits. Fact Sheet 774. Maryland Cooperative Extension. University of Maryland.
- McCallum, C. 2003. Identifying Barriers to Participation in Agri-Environmental Programs in Ontario. Christian Farmers Federation of Ontario (CFFO). Guelph, Ontario.
- McGarry, P. Prairie Farm Rehabilitation Administration (PFRA). 2004. Agricultural Policy Framework – Canada-Manitoba Farm Stewardship Program. Presentation at Living with Livestock Conference.
<http://www.gov.mb.ca/agriculture/livestock/livestockliv/powerpoint/mcgarry.ppt>.
INTERNET. Cited July 25, 2005.
- McNeill, S.G. Precision agriculture definition.
<http://www.bae.uky.edu/~precag/PrecisionAg/PATerms.htm> University of Kentucky Princeton Research and Education Center, Princeton, Kentucky. INTERNET. Cited September 11, 2005.
- McRae, T. C.A.S. Smith, and L.J. Gregorich (editors). 2000. Environmental Sustainability of Canadian Agriculture. Research Branch, Policy Branch, Prairie Farm Rehabilitation Project, Agriculture and Agri-Food Canada.
- Michigan State University Extension. 2002. "Tri-State Fertilizer Recommendations for Corn, Soybeans, Wheat and Alfalfa. Available on the internet:
www.agry.purdue.edu/ext/forages/publications/ay9-32.html. Accessed November 9, 2005.

- Minnesota Pollution Control Agency. 2005. Manure Management Plan Requirements and Checklist. <http://www.pca.state.mn.us/publications/wq-f8-07.pdf>. St. Paul, Minnesota. INTERNET. Cited January 5, 2006.
- Morris, D. 1994. Nutrient Management. Best Management Practices. Guelph, ON: Agriculture and Agri-Food Canada.
- Mussell, A., T. Moore, K. McEwan, R. Duffy. 2006. "Understanding the Structure of Canadian Farm Incomes in the Design of Safety Net Programs." Special Report *by the George Morris Centre and Ridgetown College University of Guelph*. November 2006.
- Nakao, M., B. Sohngen, L. Brown, and R. Leeds. 1999. The Economics of Vegetative Filter Strips. <http://ohioline.osu.edu/ae-fact/0006.html>. Ohio State University Extension, Columbus, Ohio. INTERNET. Cited September 11, 2005.
- Nova Scotia Government of Agriculture and Fisheries. 2005. Farm Investment Fund: Schedule G. http://www.gov.ns.ca/nsaf/prm/programs/schedule_g.shtml. INTERNET. Cited: August 8, 2005.
- Ohio State University Extension. 1992. *Ohio Livestock Manure and Wastewater Management Guide*. Bulletin 604.
- Ontario Ministry of Agriculture and Food (OMAF). Best Management Practices Series. Dec. 23, 2003. <http://www.omafra.gov.on.ca/english/environment/bmp/series.htm>. INTERNET. Cited: May 30, 2004
- Ontario Soil and Crop Improvement Association (OSCIA). 2005a. Beneficial Management Practices: Environmental Cost-Share Opportunities for Ontario Farmers. <http://www.ontariosoilcrop.org/EFP/BMPfinal.pdf>. INTERNET. Cited: July 28, 2005.
- Ontario Soil and Crop Improvement Association (OSCIA). 2005b. Canada-Ontario Environmental Farm Plan: Backgrounder-Third Generation of Environmental Farm Plans Launched in Ontario. <http://www.ontariosoilcrop.org/EFP/backgrounder.htm>. INTERNET. Cited: July 26, 2005.
- Papendick, Robert I., Elliot F. Lloyd, and James F. Power. 1987, "Alternative production systems to reduce nitrates in ground water", *American Journal of Alternative Agriculture*, Vol. 2 (1), pp. 19-24.
- Pease, J., L. VanDyke, D. Bosch, and J. Baker. 1998. "Nutrient Management Planning: Win-Win and We Can Do Better." *Proceedings from the Manure Management Conference February 10-12, 1998*. <http://www.ctic.purdue.edu/Core4/Nutrient/ManureMgmt/Paper61.html>. INTERNET. Cited: November 10, 2005.
- Pierce, Vern, James B. Kliebenstein and Michael D. Duffy. 1992. Economic and sustainable evaluation of fertilizer application scenarios for Iowa crop/livestock operations. *Iowa State University*.

- Rahelizatovo, N. and J. Gillespie. 2002. Factors Influencing the Implementation of Best Management Practices in the Dairy Industry. Selected paper presented at the southern Agricultural Economics Association Annual Meeting, Mobile, Alabama, February 1-5, 2003.
- Randall, G.W., and M.A. Schmitt. 1994. Split vs. preplant application of nitrogen for corn. In *Agronomy abstracts*. ASA Madison, WI. P.396.
- Randall, G.W., M.A. Schmitt and J.P. Schmidt. 1999. Corn production as affected by time and rate of manure application and nitrapyrin. *Journal of Production Agriculture*. Volume 12(2), pp. 317-323.
- Rausch, Jon and Brent Sohngen. 1999. *An Economic Comparison of Three Manure Handling Systems*. Ohio State University Extension Fact Sheet AE-5-99. Available online at <http://ohioline.osu.edu/ae-fact/0005html>
- Rehm, W. G. 2001. Soil Sampling for Variable Rate Fertilizer and Lime Application. <http://www.extension.umn.edu/distribution/cropsystems/DC7647.html>. NCR-13 Committee, Minnesota Agriculture Experiment Station, University of Minnesota. INTERNET. Cited September 11, 2005.
- Roberts, R. K., B. C. English, and S. B. Mahajanashetti. 2000. Evaluating the Returns to Variable-Rate Nitrogen Application. *Journal of Agricultural and Applied Economics* 32(1): 133-143.
- Roberts, R. K., D. C. Gerloff, and D. D. Howard. 1997. Economics of Foliar-Applied Potassium for Conventional and No-Till Cotton. *Journal of Production Agriculture* 10(4): 585-589.
- Schafer, J. Reduced tillage definition. http://www.pals.iastate.edu/agron154/Agron_154/Unit_13/terms.htm. INTERNET. Cited August 8, 2005. Department Of Agronomy, Iowa State University, Ames, Iowa.
- Schafer, J. Soil testing definition. http://www.pals.iastate.edu/agron154/Agron_154/Unit_23/terms.htm. INTERNET. Cited August 8, 2005. Department Of Agronomy, Iowa State University, Ames, Iowa.
- Serman, N. and G. C. Filson, Oct. 20-23, 1999. Factors affecting Farmers' Adoption of Soil and Water Conservation. Sustaining Agriculture in the 21st Century: Proceedings of the 4th Biennial Meeting, North American Chapter, International Farming Systems Association, Guelph: University of Guelph: 69-78.
- Snell, Curtis. 2006. Personal Communication. Agriculture and Agri-food Canada, National Farm Stewardship Program.
- Soil and Water Conservation Society (SWCS). 1982. Resource conservation glossary, 3rd edition. Soil Conservation Society of America. Ankeny, IA.
- Space for Species. Canada's Ecozones Map. <http://www.spaceforspecies.ca/resources/ecozone/canada/>. INTERNET. Cited September 19, 2005.

- Statistics Canada. 2001a. Farm Environmental Management Survey. Agriculture Division, Statistics Canada. Ottawa, Ontario.
- Statistics Canada. 2001b. Census of Agriculture. Agriculture Division, Statistics Canada. Ottawa, Ontario.
- Statistics Canada. 1996. Census of Agriculture. Agriculture Division, Statistics Canada. Ottawa, Ontario.
- Statistics Canada. 1991. Census of Agriculture. Agriculture Division, Statistics Canada. Ottawa, Ontario.
- Swinton, S. M. and J. Lowenberg-DeBoer. 1998. Evaluating the Profitability of Site-Specific Farming. *Journal of Production Agriculture* 11(4): 439-446.
- Tawainga, Katsvairo W., William J. Cox, Harold M. Van Es and Michael Glos. 2003. Spatial Yield Response of Two Corn Hybrids at Two Nitrogen Levels. *Agronomy Journal*. Vol. 95, pp. 1012-1022.
- Thrikawala, S., A. Weersink, G. Kachanoski, and G. Fox. 1999. Economic Feasibility of Variable-Rate Technology for Nitrogen on Corn. *American Journal of Agricultural Economics* 81(4): 914-927.
- University of Guelph Field Crop Research Plant Program Report. 1998.
<http://www.uoguelph.ca/research/omafra/reviews/PDF/field.pdf>. INTERNET. Cited September 11, 2005. University of Guelph, Guelph, Ontario.
- University of Maryland Cooperative Extension. 2000. When a Landowner Adopts a Riparian Buffer – Benefits and Costs. University of Maryland, College Park, Maryland.
- VanDyke, Laura. 1997. “Nutrient Management Planning on Virginia Livestock Farms: Impacts and Opportunities for Improvement.” Master of Science in Agricultural and Applied Economics. *Faculty of the Virginia Polytechnic Institute and State University*
<http://scholar.lib.vt.edu/theses/available/etd-39581323973910/unrestricted/etd.pdf>. INTERNET. Cited November 10, 2005.
- Vermont Farm Bureau. Cover crop definition. http://www.vtfb.org/education.cfm?edit_id=76. INTERNET. Cited August 8, 2005. Vermont Farm Bureau, Richmond, Vermont.
- Wells, K. 2004. Factors Affecting the Adoption of Best Management Practices in the Canagagigue Creek Sub-Watershed. Unpublished Masters Thesis. Rural Extensions Studies, University of Guelph, Guelph, Ontario.
- Yang, C., J. H. Everitt, and J. M. Bradford. 2001. Comparisons of Uniform and Variable-Rate Nitrogen and Phosphorus Fertilizer Applications for Grain Sorghum. *Transactions of the ASAE* 44(2): 201-209.
- Yang, W. and A. Weersink. 2004. Cost-effective Targeting of Riparian Buffers. *Canadian Journal of Agricultural Economics* 52: 17-34.

Zentner, R. P. D. D. Wall, C. N. Nagy, E. G. Smith, D. L. Young, P. R. Miller, C. A. Campbell, B. G. McConkey, S. A. Brandt, G. P. Lafond, A. M. Johnston, and D. A. Derksen. 2002. Economics of Crop Diversification and Soil Tillage Opportunities in the Canadian Prairies. *Agronomy Journal* 94(2): 216-230.

APPENDIX A: LIST OF BMPS ELIGIBLE FOR FUNDING UNDER THE NATIONAL FARM STEWARDSHIP PROGRAM (NFSP) AND GREENCOVER PROGRAM (GC)

Eligible: 2006-2007

NOTE 1: The units of measurement are: distance = kilometers (km), area = acres, volume = cubic meters (m³)

NOTE 2: Funding is expressed as thousands of \$ = K (eg. \$4K = \$4,000)

BMP Category Code	BMP Category Description	BMP PracticeCode	BMP Practice Description	BMP PracticeUnit Type	CostShare	Caps
01	Improved Manure Storage and Handling	0101	increased storage to meet winter spreading restrictions (including satellite storage)	volume (m ³)	30%	\$30K
		0102	improved features to prevent risks of water contamination (leaks, spills)	N/A		
		0103	slurry storage covers to reduce odours and GHG emissions	N/A		
		0104	containment systems for solid manure (includes covers)	N/A		
		0105	assessment and monitoring of existing manure storage infrastructure	N/A		
		0106	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA))	N/A		
		02	Manure Treatment	0201		
0202	composting of manure					
0203	anaerobic biodigestors					
0204	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA))					
03	Manure Land Application			0301	specialized/modification to equipment for improved manure application	N/A
04	In Barn Improvements	0401	more efficient livestock watering devices and cleanout systems to reduce water use and decrease manure volumes	N/A	30%	\$20K
		0402	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA))			

05	Farmyard Runoff Control	0501	upstream diversion around farmyards ;downstream protection (eg. catch basins, retention ponds, constructed wetlands)	N/A	50%	\$20K
		0502	construction of impermeable base and roof for minimizing runoff from livestock pen areas and confinement areas (feed bunks, water infrastructure, walls and electrical costs are not eligible)			
		0503	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA))			
06	Relocation of Livestock Confinement and Horticultural Facilities	0601	relocation of livestock facilities such as corrals, paddocks and wintering sites away from riparian areas	N/A	50%	\$30K
		0602	relocation of horticultural facilities such as greenhouses and container nurseries from riparian areas			
		0603	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA))			
07	Wintering Site Management	0701	shelterbelt establishment	# kms	50%	\$15K
		0702	portable shelters and windbreaks	# kms		
		0703	alternative watering systems (ie: solar, wind or grid power)	N/A		
		0704	field access improvements: alleyway/access lane upgrades	# kms		
		0705	fence modifications	# kms		
08	Product and Waste Management	0801	improved on-farm storage and handling of agricultural products (eg. fertilizer, silage, petroleum products, and pesticides)	N/A	30%	\$15K
		0802	improved on-farm storage, handling, and disposal of agricultural waste (eg. livestock mortalities, fruit and vegetable cull piles, wood waste)			
		0803	composting of agricultural waste (eg. fruit, vegetable, wood, straw residue)			
		0804	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA))			

09	Water Well Management	0901	sealing & capping old water wells	N/A	50%	\$6K
		0902	protecting existing water wells from surface contamination			
10	Riparian Area Management (GREENCOVER)	1001	alternative watering systems (i.e.: solar, wind or grid power)to manage livestock:	N/A	50%	\$20K
		1002	buffer establishment and planting of forages (planting and establishment costs for trees and shrubs for the year of planting and one year after the planting year, or the termination of the NFSP funding, whichever comes first)	# acres		
		1003	fencing to manage grazing and improve riparian condition/function	# kms		
		1004	native rangeland restoration or establishment: native species of forages, shrubs, and trees	# acres		
		1005	grazing management in surrounding uplands: alternative watering systems (ie: solar, wind or grid power) and cross fencing	# kms offence		
		1006	improved stream crossings	N/A		
		1101	constructed works in riparian areas: contour terraces, gully stabilization, bank stabilization, erosion control matting, silt fencing, drop inlet and enhanced infiltration systems, in-channel control, retention ponds and erosion control dams	N/A		
1102	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA))					
12	Erosion Control Structures(Non Riparian)	1201	constructed works in non riparian areas: contour terraces, gully stabilization, bank stabilization, erosion control matting, silt fencing, drop inlet systems and enhanced infiltration systems, in-channel control, retention ponds and erosion control dams, mechanical wind screens	N/A	50%	\$20K
		1202	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA))			

13	Land Management for Soils at Risk	1301	forage or annual barrier establishment for soils at risk (eg. stripcropping, grassed waterways, perennial forages on severely erodible or saline soils)	# acres	50%	\$5K
		1302	straw mulching	# acres		
		1303	grazing management in critical erosion areas not associated with riparian zones: alternative watering systems (ie: solar, wind or grid power), crossfencing	# kms offence		
14	Improved Cropping Systems	1401	equipment modification on pre-seeding implements for restricted zone tillage for row crops, seeding and post seeding implements for low disturbance placement of seed and fertilizer	N/A	30%	\$15K
		1402	chaff collectors and chaff spreaders installed on combines			
		1403	precision farming applications: GPS information collection, GPS guidance (ie: autosteer, lightbars, software) , manual and variable rate controllers for variable fertilizer application			
15	Cover Crops	1501	establishment of non-economic cover crop	# acres	30%	\$5K
		1502	equipment modification for inter row seeding of cover crops (eg. relay crops)	N/A		
16	Improved Pest Management	1601	equipment modification for improved application	N/A	30%	\$5K
		1602	information collection and monitoring			
		1603	biological control agents			
		1604	cultural control practices			
		1605	mobile water tanks			
17	Nutrient Recovery from Waste Water	1701	recycling of waste water streams from milkhouses, fruit and vegetable washing facilities, and greenhouses in order to recover nutrients	N/A	30%	\$20K
		1702	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA)			

18	Irrigation Management	1801	irrigation equipment modification/improvement to increase water or nutrient use efficiency	N/A	30%	\$10K
		1802	equipment to prevent backflow of altered irrigation water into water sources			
		1803	improved infiltration galleries and irrigation intake systems			
19	Shelterbelt Establishment (GREENCOVER)	1901	establishment of shelterbelts for farmyard, live stock facilities, dugout snowtrap, wildlife habitat enhancement, field (planting and establishment costs for trees and shrubs for the year of planting and one year after the planting year, or the termination of the NFSP funding, whichever comes first)	# kms	50%	\$10K
		1902	tree materials required for shelterbelt establishment	N/A		
20	Invasive Alien Plant Species Control	2001	integrated approaches (cultural, mechanical, and biological) for control of invasive plant species (eg. leafy spurge, purple loosestrife, scentless chamomile)	N/A	50%	\$5K
21	Enhancing Wildlife Habitat and Biodiversity	2101	buffer strips: native vegetation	# acres	50%	\$10K
		2102	alternative watering systems (ie: solar, wind or grid power)	N/A		
		2103	improved grazing systems: crossfencing	# kms		
		2104	wildlife shelterbelt establishment	# kms		
		2105	improved stream crossings	N/A		
		2106	hayland management to enhance wildlife survival	N/A		
		2107	wetland restoration	acres		
22	Species at Risk	2201	alternative watering systems (ie: solar, wind or grid power)	N/A	50%	\$10K
		2202	improved grazing systems: crossfencing	# kms		
		2203	plant species establishment	# acres		
		2204	infrastructure development and relocation	N/A		

23	Preventing Wildlife Damage	2301	forage buffer strips	# acres	30%	\$10K
		2302	fencing or netting to protect stored feed, concentrated livestock, high value crops, drip irrigation systems, and other ag. activities	# km offence		
		2303	scaring and repellent systems and devices	N/A		
24	Nutrient Management Planning	2401	consultative services to develop nutrient management plans, planning and decision support tools	# acres	50%	\$4K
25	Integrated Pest Management Planning	2501	consultative services to develop integrated pest management plans, planning and decision support tools	# acres	50%	\$2K
26	Grazing Management Planning (GREENCOVER)	2601	consultative services to develop range and grazing management plans, planning and decision support tools	# acres	50%	\$2K
27	Soil Erosion and Salinity Control Planning	2701	consultative services to develop soil erosion and salinity control plans, planning and decision support tools	# acres	50%	\$2K
28	Biodiversity Enhancement Planning	2801	consultative services to plan habitat enhancement, wetland restoration, stewardship for species at risk and/or wildlife damage prevention within agricultural land base; planning and decision support tools	# acres	50%	\$2K
29	Irrigation Management Planning	2901	consultative services for planning improved water use efficiency and reduced environmental risk of existing irrigation systems, planning and decision support tools	# acres	50%	\$2K
30	Riparian Health Assessment (GREENCOVER)	3001	consultative services for assessing riparian health, planning and decision support tools	# acres	50%	\$2K

Provincial top-ups

BMP Category	Practice Code	Type of Practice	BC		MB	Prairies	ON			QC ⁶		NB	NS	Prince Edward Island				
			DUC	Agriculture Environment Initiative ^{7,8}	Manitoba Water Stewardship ⁴	DUC ⁵	OMAF (2005-2006 Only) ¹	Oak Ridges Moraine Foundation ²	Friends of the Greenbelt Foundation ³	Integrated MAPAQ & AFFC through Prime Verte	CDAO (Group GC BMPs)	NB Manure Stewardship Program	Integrated NSDAF and AAFC Funding	Integrated PEIDAF and AAFC Funding	DUC			
01	Improved Manure Storage and Handling	0101			25% (Prov. Max \$5,000/farm unit)		60% (Prov Max \$60K)	45% (GB Max \$10,000)				40% (Prov Max \$40K)	Prov 50% (to a Max \$20 K) Fed 25% (to a Max \$30 K)	Prov 20% on first \$40,000 Fed 30%-first 40K, 25%-next 60K				
		0102			25% (Prov. Max \$5,000/farm unit)													
		0103															Prov 20% on first \$40,000 Fed 30%-first 40K, 25%-next 60K	
		0104			25% (Prov. Max \$5,000/farm unit)												Fed 30%-first 40K, 25%-next 60K	
		0105			25% (Prov. Max \$5,000/farm unit)													
		0106													70 % (Prov Max \$40K) ⁹			Prov 20% on first \$40,000 Fed 30%-first 40K, 25%-next 60K
02	Manure Treatment	0201			25% (Prov. Max \$5,000/farm unit)		60% (Prov Max \$30K)	45% (GB Max \$10,000)					Prov 50% (to a Max \$10 K) Fed 25% (to a Max \$30 K)					
		0202																
		0204																
03	Manure Land Application	0301					60% (Prov Max \$30K)			20% (Fed Cap Applies)			Prov 50% (to a Max \$10 K) Fed 25% (to a Max \$10 K)					
04	In Barn Improvements	0401					60% (Prov Max \$30K)						Prov 50% (to a Max \$10 K) Fed 25% (to a Max \$20 K)					

**An Economic Evaluation of Beneficial Management Practices in Canadian Agriculture
FINAL REPORT**



BMP Category	Practice Code	Type of Practice	BC		MB	Prairies	ON			QC ⁶		NB	NS	Prince Edward Island	
			DUC	Agriculture Environment Initiative ^{7,8}	Manitoba Water Stewardship ⁴	DUC ⁵	OMAF (2005-2006 Only) ¹	Oak Ridges Moraine Foundation ²	Friends of the Greenbelt Foundation ³	Integrated MAPAQ & AFFC through Prime Verte	CDAO (Group GC BMPs)	NB Manure Stewardship Program	Integrated NSDAF and AAFC Funding	Integrated PEIDAF and AAFC Funding	DUC
05	Farmyard Runoff Control	0501	upstream diversion around farmyards downstream protection (eg. catch basins, retention ponds, constructed wetlands)	10% (DUC Max \$4,000)				40% (Prov Max \$30K)		25% (GB Max \$10,000)				Prov 50% (to a Max \$10 K) Fed 25% (to a Max \$20 K)	DUC 25% / Fed 50% (Max \$6,000) Only applies to constructed wetlands
		0503	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA))												
06	Relocation of Livestock Confinement and Horticultural Facilities	0601	relocation of livestock facilities such as corrals, paddocks and wintering sites away from riparian areas	10% (DUC Max \$6,000)				40% (Prov Max \$30K)		25% (GB Max \$10,000)					
		0602	relocation of horticultural facilities such as greenhouses and container nurseries from riparian areas												
07	Wintering Site Management	0703	mobile water systems: summer/winter water systems (solar, wind, pipeline, other)	10% (DUC Max \$3,000)											
		0705	fence modifications												
08	Product & Waste Management	0801	improved on-farm storage and handling of agricultural products (eg. fertilizer, petroleum products, and pesticides)											Prov 50% (to a Max \$10 K) Fed 25% (to a Max \$15 K) Not applied to silage and fertilizer storage	Fuel Storage - 20% on first \$8,000 Pesticide Storage - 20% on first \$10,000
		0802	improved on-farm storage, handling, and disposal of agricultural waste (eg. livestock mortalities, fruit and vegetable cull piles, wood waste)						45% (GB Max \$10,000)					20% Milkhouse waste only	
		0803	composting of agricultural waste (eg. fruit, vegetable, wood, straw residue)											20% Deadstock and Fruit/vegetable cull composting only	
		0804	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA))												
09	Water Well Management	0901	sealing & capping old water wells							20% (Fed Cap Applies)					
		0902	protecting existing water wells from surface contamination					40% (Prov Max \$30K)					Prov 50% (to a Max \$10 K) Fed 25% (to a Max \$6 K)		

BMP Category	Practice Code	Type of Practice	BC		MB	Prairies	ON			QC ⁶		NB	NS	Prince Edward Island		
			DUC	Agriculture Environment Initiative ^{7,8}	Manitoba Water Stewardship ⁴	DUC ⁵	OMAF (2005-2006 Only) ¹	Oak Ridges Moraine Foundation ²	Friends of the Greenbelt Foundation ³	Integrated MAPAQ & AFFC through Prime Verte	CDAO (Group GC BMPs)	NB Manure Stewardship Program	Integrated NSDAF and AAFC Funding	Integrated PEIDAF and AAFC Funding	DUC	
10 Riparian Area Management	1001	remote watering systems to manage livestock: gravity fed, pump & pipeline systems	10% (DUC Max \$4,000)				40% (Prov Max \$30K)	40% (ORMF Max \$10K)	25% (GB Max \$10K)	20% (Fed Cap Applies)	Up to 20%			16% (Total Fed/Prov Cap \$26,400)		
	1002	buffer establishment: forages, shrubs, trees - planting, weed control								20% (Fed Cap Applies)			16% (Total Fed/Prov Cap)			
	1003	fencing to manage grazing and improve riparian condition/function											20% (Fed Cap Applies)		16% (Total Fed/Prov Cap \$26,400)	
	1004	native rangeland restoration or establishment: native species of forages, shrubs, and trees														
	1005	grazing management in surrounding uplands: watering systems and cross														
	1006	improved stream crossings											20%		Prov 50% (to a Max \$10 K) Fed 25% (to a Max \$20 K)	
11 Erosion Control Structures (Riparian)	1101	constructed works in riparian areas: contour terraces, gully stabilization, bank stabilization, drop inlet and enhanced infiltration systems, in-channel control	10% (DUC Max \$4,000)				40% (Prov Max \$30K)	40% (ORMF Max \$10K)	25% (GB Max \$10K)	20% (Fed Cap Applies)	Up to 20%		Prov 50% (to a Max \$10 K) Fed 25% (to a Max \$6 K)	16% (Total Fed/Prov Cap \$26,400)		
	1102	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA))														
12 Erosion Control Structures (Non Riparian)	1201	constructed works in non riparian areas: contour terraces, gully stabilization, bank stabilization, drop inlet systems and enhanced infiltration systems, in-channel control, mechanical wind screens					40% (Prov Max \$30K)	40% (ORMF Max \$10K)	25% (GB Max \$10K)	20% (Fed Cap Applies)			Prov 50% (to a Max \$10 K) Fed 25% (to a Max \$6 K)			
	1202	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA))														
13 Land Management for Soils at Risk	1301	forage or annual barrier establishment for soils at risk (eg. stripcropping, grassed waterways, perennial forages on severely erodible or saline soils)	10% (DUC Max \$1,000 for Category)					40% (ORMF Max \$4K)	25% (GB Max \$10K)					Prov. 100% of \$20/acre (Max \$2,000/farm)		
	1302	Straw Mulching														
	1303	grazing management in critical erosion areas not associated with riparian zones: watering systems, crossfencing	10% (DUC Max \$1,000 for Category)													

BMP Category	Practice Code	Type of Practice	BC		MB	Prairies	ON			QC ⁶		NB	NS	Prince Edward Island		
			DUC	Agriculture Environment Initiative ^{7,8}	Manitoba Water Stewardship ⁴	DUC ⁵	OMAF (2005-2006 Only) ¹	Oak Ridges Moraine Foundation ²	Friends of the Greenbelt Foundation ³	Integrated MAPAQ & AFFC through Prime Verte	CDAO (Group GC BMPs)	NB Manure Stewardship Program	Integrated NSDAF and AAFC Funding	Integrated PEIDAF and AAFC Funding	DUC	
15	Winter Cover Crops	1501	fall seeded winter cover crops for erosion control on row or speciality cropped land. Incentive offered as one time payment - crop can not be harvested or grazed								20% (Fed Cap Applies)					
		1502	equipment modification for seeding relay crops for winter cover	20% (DUC Max \$3,333)												
16	Improved Pest Management	1602	information collection and monitoring							45% (GB Max \$10K)	20% (Fed Cap Applies)					
17	Nutrient Recovery from Waste Water	1701	recycling of waste water streams from milkhouses, fruit and vegetable washing facilities, and greenhouses in order to recover nutrients					60% (Prov Max \$30K)		45% (GB Max \$10K)						
18	Irrigation Management	1801	irrigation equipment modification/improvement to increase water use efficiency	20% (DUC Max \$6,667)									Prov 50% (to a Max \$10 K)			
		1803	improved infiltration galleries and irrigation intake systems											Fed 25% (to a Max \$10 K)		
19	Shelterbelt Establishment	1901	establishment of shelterbelts for farmyard, live stock facilities, dugout snowtrap, wildlife habitat enhancement, field.						40% (ORMF Max \$8K)	25% (GB Max \$10K)	20% (Fed Cap Applies)	Up to 20%			16% (Total Fed/Prov Cap \$13,200)	
		1902	tree materials required for shelterbelt establishment													
20	Invasive Alien Plant Species Control	2001	integrated approaches (cultural, mechanical, and biological) for control of invasive plant species (eg. leafy spurge, purple loosestrife, scentless chamomile).	10% (DUC Max \$1,000)						25% (GB Max \$10K)						
21	Enhancing Wildlife Habitat and Biodiversity	2101	buffer strips: native vegetation													
		2102	off site watering systems													
		2103	improved grazing systems: crossfencing	10% (DUC Max \$2,000)												
		2104	wildlife shelterbelt establishment													
		2105	improved stream crossings													
		2106	hayland mgmnt to enhance wildlife survival													
		2107	wetland restoration					50% (DU Max \$)								

BMP Category	Practice Code	Type of Practice	BC		MB	Prairies	ON			QC ⁶		NB	NS	Prince Edward Island			
			DUC	Agriculture Environment Initiative ^{7,8}	Manitoba Water Stewardship ⁴	DUC ⁵	OMAF (2005-2006 Only) ¹	Oak Ridges Moraine Foundation ²	Friends of the Greenbelt Foundation ³	Integrated MAPAQ & AFFC through Prime Verte	CDAO (Group GC BMPs)	NB Manure Stewardship Program	Integrated NSDAF and AAFC Funding	Integrated PEIDAF and AAFC Funding	DUC		
22	Species at Risk	2201	off site watering systems														
		2202	improved grazing systems: crossfencing	10% (DUC Max \$2,000)													
		2203	plant species establishment														
		2204	infrastructure development and relocation														
23	Preventing Wildlife Damage	2301	forage buffer strips	20% (DUC Max \$6,667 for Category)													
		2302	fencing to protect stored feed, concentrated livestock, high value crops, drip irrigation systems, and other ag. activities		Above the NFSP Cap, an additional \$ 15K available at 30%												
		2303	scaring and repellent systems and devices	20% (DUC Max \$6,667 for Category)													
24	Nutrient Management Planning	2401	consultative services to develop nutrient management plans, planning and decision support tools			25% (Prov. Max \$5,000/farm unit)		60% (Prov Max \$30K)								Prov 100% (to a Max \$1,500)	
25	Integrated Pest Management Planning	2501	consultative services to develop integrated pest management plan, planning and decision support tools	10% (DUC Max \$400)													
26	Grazing Management Planning	2601	consultative services for range and grazing management planning, planning and decision support tools	10% (DUC Max \$400)													
27	Soil Erosion and Salinity Control Planning	2701	consultive services to develop soil erosion and salinity control plans, planning and decision support tools														
28	Biodiversity Enhancement Planning	2801	consultative services to plan habitat enhancement, stewardship for species at risk and/or wildlife damage prevention within agricultural land base; planning and decision support tools	10% (DUC Max \$400)													

BMP Category	Practice Code	Type of Practice	BC		MB	Prairies	ON			QC ⁶		NB	NS	Prince Edward Island	
			DUC	Agriculture Environment Initiative ^{7,8}	Manitoba Water Stewardship ⁴	DUC ⁵	OMAF (2005-2006 Only) ¹	Oak Ridges Moraine Foundation ²	Friends of the Greenbelt Foundation ³	Integrated MAPAQ & AFFC through Prime Verte	CDAQ (Group GC BMPs)	NB Manure Stewardship Program	Integrated NSDAF and AAFC Funding	Integrated PEIDAF and AAFC Funding	DUC
29	Irrigation Management Planning	2901	consultative services for improving water use efficiency of existing irrigation systems, planning and decision support tools	10% (DUC Max \$400)											
30	Riparian Health Assessment	3001	consultative services for riparian health, planning and decision support tools				40% (Prov Max \$30K)		25% (GB Max \$10K)	20% (Fed Cap Applies)	Up to 20 %				

Notes:

Ontario:

¹Top up funding for farms > 300 animal units through the Nutrient Management Financial Assistance Program (NMFAP) for applications received by September 30, 2005. All claims needed to be finalized by September 2006.

²Oak Ridges Moraine Foundation (ORMF) through the Oak Ridges Moraine Environmental Enhancement Program, will provide the above indicated top up incentive funds to producers within the Oak Ridges Moraine, to a total maximum contribution of \$45K per legal farm entity.

³Friends of the Greenbelt through the Greenbelt Farm Stewardship Program to offer costshare assistance for a number of BMPs. Details pending.

Manitoba:

⁴Final details for this top up program are pending.

Ducks Unlimited Canada:

⁵Prairie Provinces Top-Up – Final Details pending.

DUC has agreed to provide funding and technical assistance related to 2107 – Wetland Restoration across Canada.

Quebec:

⁶MAPAQ: Funding supports individual BMPs. Total program cap is \$30K (federal and provincial).

CDAQ: Funding support group GC BMPs. For producers applying to CDAQ, total program cap is \$50,000 (federal), including what was accessed through Prime Verte.

BC:

⁷Two additional BMPs not on the current BMP list are funded by Agriculture Environment Initiatives (AEI) – Air Emissions (30%, \$15K max) and Water Management Planning (50%, \$2K max).

⁸Prior to the raising of the National BMP Cap to \$50K, AEI funding was used to increase the total program producer cap \$30K to \$50K. All individual category caps were maintained.

New Brunswick:

⁹For portions of projects not funded through NFSP, provincial funding is 50% with \$50K max for 0101 or 100% for 0106.

APPENDIX B: TIMING OF MANURE APPLICATION

Season	Watch For	BMP
Winter	<ul style="list-style-type: none"> • Runoff that can pollute surface water. • Sensitive areas. • Sloping topography. • Manure that soaks in too slowly on wet soils. • Wet soils that are prone to compaction. 	<ul style="list-style-type: none"> • Manure should be going into storage. • Avoid application on frozen or snowcovered ground. • Avoid spreading on land with a history of floods or heavy runoff. • In case of emergency, apply on grass or winter cover crops or on areas of high crop residue where there is less danger of runoff or floods. • Apply only on level, non-sensitive areas and only in emergencies
Spring	<ul style="list-style-type: none"> • Wet soils that are prone to compaction. • Denitrification that happens in cold, wet soils. • Excessive application that can create a contamination hazard. • Very dry soil with large cracks where liquid manure can flow into drainage systems. • Heavy surface residue that slows the drying process of seedbeds. • Planting too soon after heavy manure application can create ammonia toxicity and reduce germination and seedling growth. 	<ul style="list-style-type: none"> • Apply to land before seeding annual crops. • Apply to row crops as a side dressing after plants emerge. • Work manure into soil within 48 hours after application. • Inject liquid manure. • Apply to well-drained soils. • Till very dry soil with large cracks before applying manure. • Allow for more time to dry following application of liquid manure.
Summer	<ul style="list-style-type: none"> • Loss of nitrogen if there is no rainfall within 72 hours. Rain helps manure soak in. • Mature crops that are not growing; they do not need nutrients. • Application on forages and direct seeded crops. 	<ul style="list-style-type: none"> • Apply to grasslands, inject liquid manure. • Apply lightly on hay fields after cuttings. • Apply early enough to pasture to avoid trampling re-growth. • Compost manure to reduce odour and break up clumps. • Consider injection of liquid manure.
Fall	<ul style="list-style-type: none"> • Denitrification in cold, wet soils. • Manure that soaks in slowly on wet fields; excess water will run off. • Wet soils that are prone to compaction. • Large dry cracks where liquid manure can flow into the drainage system. 	<ul style="list-style-type: none"> • Apply liquid manure to grassland that has no history of runoff or floods. • Apply to annual crop lands before ground freezes, and incorporate within 48 hours. Base application rates on soil tests and crop rotation for next year. • Apply to well-drained soils. • Till very dry soil with large cracks before manure application.

Extracted from: *Beneficial Management Practices – Environmental Manual for Dairy Producers in Alberta*.
Original Source: *Best Management Practices, Livestock and Poultry Waste Management: Agriculture and Agri-Food Canada and Ontario Ministry of Agriculture and Food, 1994*.

APPENDIX C: TABLES WITHOUT FINANCIAL ASSISTANCE

Alberta Brown Soil Zone

Table C.1 Expected Net Revenue¹ For Barley, Spring Wheat And Lentils In Alberta Brown Soil Zone Before Implementation Of BMP, 2006

	Barley	Spring Wheat	Lentils
	(bu/ac)		
Pre-BMP Yield	44	28	14
*Change in Yield due to BMP	0	0	0
Crop Expected Yield	44	28	14
	(\$/ac)		
Crop Expected Price	2.6	3.9	6.6
Expected Crop Revenue	114	109	94
Program Payment	0	0	0
Straw Expected Yield (bales/ac)	0	0	0
Straw Expected Price	0	0	0
Straw Expected Revenue	0	0	0
Total Revenue	114	109	94
Seed & Treatment & Cleaning	11	13	15.2
Fertilizer - Nitrogen	12	12	0
Fertilizer - Phosphorus	8	8	8
Fertilizer - Potassium	0	0	0
Fertilizer - Sulfur	0	0	0
Chemicals - Pre-Seed	5	5	4.5
Chemicals - In Crop	8	19	15
Chemicals - Pre-Harvest	0	0	0
Crop Insurance Premium (70%)	14	13	16
Trucking & Marketing	3	3	2.5
Fuel, Oil & Lube	9	9	9
Machinery Repairs	9	9	8.5
Building Repairs	3	3	2.5
Custom Work	2	2	1.5
Labour	14	14	14
Utilities & Miscellaneous	9	9	8.5
Other	0	0	0
*Change in Operating Costs due to BMP	0	0	0
*Soil Testing Fee	0	0	0
*Custom Application Cost	0	0	0
*Equipment Cost	0	0	0
*Establishment Cost	0	0	0
*NMP Establishment Cost	0	0	0
Operating Interest	1	1	1

	Barley	Spring Wheat	Lentils
Total Variable Costs	104	116	106
Land Rent	20	20	20.0
Insurance & Licences	7	7	7.0
Depreciation	17	17	17.0
Paid Capital Interest	9	9	9.0
Total Fixed Costs	53	53	53
Total Expenses	157	169	159
Expected Net Revenue	-43	-60	-66

¹ calculations based on provincial or crop specific enterprise budgets and on producer estimates of actual crop yields and production costs from the Ipsos Reid survey, 2006

* values will change after implementing a BMP

BMP - Beneficial Management Practice(s)

NMP - Nutrient Management Plan

Table C.2 Results Of Ipsos Reid Survey¹ Of BMPs In Alberta Brown Soil Zone, 2006

	Base Model	Soil Testing	NMP	Min Till
Proportion of Cropland Using BMP (%):	0.0	100	100	84
Standard Deviation (σ)				
Number of Respondents (n)				19
Estimated Changes to Yield (bu/ac):				
Feed Barley	0.0	4.4	5.9	4.2
σ		3.3	5.4	4.8
n		25	33	15
Spring Wheat	0.0	4.4	5.9	4.2
σ		3.3	5.4	4.8
n		25	33	15
Lentils		2.8	3.9	1.3
σ		3.8	5.2	1.9
n		12	13	8*
Estimated Changes to Operating Costs (\$/ac):	0.0	5.2	2.6	-12.2
σ		8.9	20.2*	11.0
n		26	40	16
Estimates of Other Costs (\$/ac)**:				
Soil Testing Fee	0.0	0.3	0.0	0.0
σ		0.6		
n		13		
Equipment Cost (\$/BMP ac)	0.0	0.0	0.0	3.3
σ				
n				17
NMP Establishment Cost	0.0	0.0	0.7	0.0

	Base Model	Soil Testing	NMP	Min Till
Financial Assistance (\$/ac)				
Financial Assistance from Government	0.0	0.0	0.0	0.0
n			89	
Financial Assistance from Conservation Groups	0.0	0.0	0.0	0.0
n				

¹ values based on producer estimates (Ipsos Reid, 2006)

* results may be impacted by small sample size (<10) or large standard deviation

** all estimated BMP costs were amortized

BMP - Beneficial Management Practice(s)

NMP - Nutrient Management Plan

Source: Ipsos Reid Survey, 2006

Table C.3 Economic Comparison Of BMP For Barley In Alberta Brown Soil Zone

	Base Model	Soil Test	Min Till	NMP
			(\$/ac)	
Total Revenue	114	126	125	130
Total Variable Costs	104	110	95	107
Total Fixed Costs	53	53	53	53
Total Expenses	157	163	148	160
Expected Net Revenue	-43	-37	-23	-31
Change in Expected Net Revenue from Base (%)	n/a	14	46	28

Table C.4 Economic Comparison Of BMP For Spring Wheat In Alberta Brown Soil Zone

	Base Model	Soil Test	Min Till	NMP
			(\$/ac)	
Total Revenue	109	126	126	132
Total Variable Costs	116	121	107	119
Total Fixed Costs	53	53	53	53
Total Expenses	169	174	160	172
Expected Net Revenue	-60	-48	-34	-40
Change in Expected Net Revenue from Base (%)	n/a	19	42	33

Table C.5 Economic Comparison Of BMP For Lentils In Alberta Brown Soil Zone

	Base Model	Soil Test	Min Till	NMP
			(\$/ac)	
Total Revenue	94	112	102	119
Total Variable Costs	106	112	97	110
Total Fixed Costs	53	53	53	53
Total Expenses	159	165	150	163
Expected Net Revenue	-66	-53	-48	-43
Change in Expected Net Revenue from Base (%)	n/a	20	27	34

Table C.6 Comparison Of Expected Net Revenue For Average Whole Farm (1,358 ac) Using BMP In Alberta Brown Soil Zone

	Base Model	Soil Test	Min Till	NMP
	(\$/ac)			
Barley	-8,701	-7,498	-5,306	-6,252
Spring Wheat	-56,805	-45,751	-36,603	-38,086
Lentils	-13,408	-10,770	-10,413	-8,840
Total Expected Net Revenue	-78,914	-64,019	-52,323	-53,179
Change in Expected Net Revenue from Base (%)	n/a	18.9	33.7	32.6

Alberta Black Soil Zone

Table C.7 Expected Net Revenue¹ For Malt Barley, Canola, Spring Wheat And Peas In Alberta Black Soil Zone Before Implementation Of BMP, 2006

	Malt Barley	Canola	Spring Wheat	Peas
	(bu/ac)			
Pre-BMP Yield	65	45	55	45
*Change in Yield due to BMP	0	0	0	0
Crop Expected Yield	65	45	55	45
	(\$/ac)			
Crop Expected Price	2.7	5.5	3.4	3.5
Expected Crop Revenue	176	248	187	158
Program Payment	0	0	0	0
Straw Expected Yield (bales/ac)	0	0	0	0
Straw Expected Price	0	0	0	0
Expected Straw Revenue	0	0	0	0
Total Revenue	176	248	187	158
Seed & Treatment & Cleaning	10	25	13	27
Fertilizer - Nitrogen	33	42	33	0.0
Fertilizer - Phosphorus	10	10	10	21.0
Fertilizer - Potassium	1	1	1	12.0
Fertilizer - Sulfur	2	6	2	3.0
Chemicals - Pre-Seed	5	5	5	4.5
Chemicals - In Crop	23	25	23	25.0
Chemicals - Pre-Harvest	0	0	0	0.0
Crop Insurance Premium (70%)	7.0	8	7	8.5
Trucking & Marketing	2	2	2	2.0
Fuel, Oil & Lube	11	11	11	10.5
Machinery Repairs	10	10	10	9.5
Building Repairs	2	2	2	1.5
Custom Work	2	2	2	2.0
Labour	15	15	15	14.5
Utilities & Miscellaneous	7	7	7	7.0

	Malt Barley	Canola	Spring Wheat	Peas
Other	0	0	0	0.00
*Change in Operating Costs due to BMP	0	0	0	0
*Soil Testing Fee	0	0	0	0
*Custom Application Cost	0	0	0	0
*Equipment Cost	0	0	0	0
*Establishment Cost	0	0	0	0
*NMP Establishment Cost	0	0	0	0
Operating Interest	2	3	2	2
Total Variable Costs	139	171	142	150
Land Rent	36	36	36	36
Insurance & Licences	4	4	4	4
Depreciation	30	30	30	30
Paid Capital Interest	6	6	6	6
Total Fixed Costs	76	76	76	76
Total Expenses	215	247	218	226
Expected Net Revenue	-40	0	-31	-69

¹ calculations based on provincial or crop specific enterprise budgets and on producer estimates of actual crop yields and production costs from the Ipsos Reid survey, 2006

* values will change after implementing a BMP

BMP - Beneficial Management Practice(s)

NMP - Nutrient Management Plan

Table C.8 Results Of Ipsos Reid Survey¹ Of BMPs In Alberta Black Soil Zone, 2006

	Base Model	VRF	NMP	Buffer Strips
Proportion of Cropland Using BMP (%):	0.0	86	100	8
Standard Deviation (σ)				
Number of Respondents (n)		7		20
Estimated Changes to Yield (bu/ac):				
Malt Barley	0.0	7.7	7.7	-11%
σ		5.2	4.8	
n		6.0*	26.0	18.0
Canola	0.0	4.0	7.5	-11%
σ		5.3	5.0	
n		3.0*	15.0	18.0
Spring Wheat	0.0	7.7	7.7	-11%
σ		5.2	4.8	
n		6.0*	26.0	18.0
Feed Peas	0.0	5.0	3.8	-11%
σ		1.6	4.8	
n		4.0*	16.0	18.0

	Base Model	VRF	NMP	Buffer Strips
Estimated Changes to Operating Costs (\$/ac):	0.0	1.8	6.5	0.0
σ		3.8	15.0*	
n		6.0*	25.0	
Estimates of Other Costs (\$/ac)**:				
Equipment Cost (\$/BMP ac)	0.0	4.5	0.0	0.0
σ				
n		3.0*		
Establishment Cost (\$/BMP ac)	0.0	0.0	0.0	12.4
σ				
n				17.0
NMP Establishment Cost	0.0	0.0	0.7	0.0
Financial Assistance (\$/ac)				
Financial Assistance from Government	0.0	0.0	0.0	0.0
n				
Financial Assistance from Conservation Groups	0.0	0.0	0.0	0.0
n				

¹ values based on producer estimates (Ipsos Reid, 2006)

* results may be impacted by small sample size (<10) or large standard deviation

** all estimated BMP costs were amortized

BMP - Beneficial Management Practice(s)

NMP - Nutrient Management Plan

Source: Ipsos Reid Survey, 2006

Table C.9 Economic Comparison Of BMP For Malt Barley In Alberta Black Soil Zone

	Base Model	VRF	NMP	Buffer Strips
	(\$/ac)			
Total Revenue	176	196	196	157
Total Variable Costs	139	146	146	152
Total Fixed Costs	76	76	76	76
Total Expenses	215	222	222	228
Expected Net Revenue	-40	-25	-26	-71
Change in Expected Net Revenue from Base (%)	n/a	36	34	-78

Table C.10 Economic Comparison Of BMP For Canola In Alberta Black Soil Zone

	Base Model	VRF (\$/ac)	NMP	Buffer Strips
Total Revenue	248	270	289	221
Total Variable Costs	171	178	179	184
Total Fixed Costs	76	76	76	76
Total Expenses	247	254	255	260
Expected Net Revenue	0	16	34	-39
Change in Expected Net Revenue from Base (%)	n/a	n/a	n/a	n/a

n/a - change in ENR was not calculated because the ENR for the base model was zero

Table C.11 Economic Comparison Of BMP For Spring Wheat In Alberta Black Soil Zone

	Base Model	VRF (\$/ac)	NMP	Buffer Strips
Total Revenue	187	213	213	167
Total Variable Costs	142	148	149	154
Total Fixed Costs	76	76	76	76
Total Expenses	218	224	225	230
Expected Net Revenue	-31	-11	-12	-63
Change in Expected Net Revenue from Base (%)	n/a	65	62	-105

Table C.12 Economic Comparison Of BMP For Peas In Alberta Black Soil Zone

	Base Model	VRF (\$/ac)	NMP	Buffer Strips
Total Revenue	158	175	171	141
Total Variable Costs	150	157	158	163
Total Fixed Costs	76	76	76	76
Total Expenses	226	233	234	239
Expected Net Revenue	-69	-58	-63	-98
Change in Expected Net Revenue from Base (%)	n/a	16	9	-42

Table C.13 Comparison Of Expected Net Revenue For Average Whole Farm (1,358 ac) Using BMP In Alberta Black Soil Zone

	Base Model	VRF (\$/ac)	NMP	Buffer Strips
Malt Barley	-10,777	-7,406	-7,091	-11,462
Canola	8	5,488	13,873	-1,273
Spring Wheat	-16,700	-7,446	-6,400	-18,124
Peas	-9,360	-8,058	-8,535	-9,682
Total Expected Net Revenue	-36,829	-17,422	-8,153	-40,541
Change in Expected Net Revenue from Base (%)	n/a	52.7	77.9	-10.1

Saskatchewan Brown Soil Zone

Table C.14 Expected Net Revenue¹ For Barley, Spring Wheat And Lentils In Saskatchewan Brown Soil Zone Before Implementation Of BMP, 2006

	Barley	Spring Wheat	Lentils
	(bu/ac)		
Pre-BMP Yield	37	25	16
*Change in Yield due to BMP	0	0	0
Crop Expected Yield	37	25	16
	(\$/ac)		
Crop Expected Price	1.90	3.70	7.20
Expected Crop Revenue	70	91	118
Program Payment	0	0	0
Straw Expected Yield (bales/ac)	0	0	0
Straw Expected Price	0	0	0
Expected Straw Revenue	0	0	0
Total Revenue	70	91	118
Seed & Treatment	6	9	16
Fertilizer - Nitrogen: 46-0-0	21	21	3
Fertilizer - Phosphorus: 12-51-0	8	8	6
Fertilizer - Sulfur & Other: 20-0-0-24	0	0	0
Chemical - Herbicides	12	12	34
Chemical - Insecticides/Fungicides	0	1	1
Chemical - Others	3	3	2
Crop Insurance Premium	4	3	14
Custom Work & Hired Labour	4.8	6	5
Drying	0	0	0
Trucking	0	0	0
Marketing	0	0	0
Twine	0	0	0
Fuel	15	15	16
Machinery Repair	6	5.8	9
Utilities & Miscellaneous	3	3.4	3
*Change in Operating Costs due to BMP	0	0	0
*Soil Testing Fee	0	0	0
*Custom Application Cost	0	0	0
*Equipment Cost	0	0	0
*Establishment Cost	0	0	0
*NMP Cost	0	0	0
*Operating Interest	2.02	2.12	2.68
Total Variable Costs	85	89	112
Building Repair	1	1	1
Property Taxes	5	5	5

	Barley	Spring Wheat	Lentils
Insurance & Licences	1	1	1
Machinery Depreciation	14	14	18
Building Depreciation	1	1	1
Machinery Investment	7	7	9
Building Investment	1	1	1
Land Investment	14	14	14
Total Fixed Costs	44	44	49
Total Expenses	129	133	161
Expected Net Revenue	-58	-41	-43

¹ calculations based on provincial or crop specific enterprise budgets and on producer estimates of actual crop yields and production costs from the Ipsos Reid survey, 2006

* values will change after implementing a BMP

BMP - Beneficial Management Practice(s)

NMP - Nutrient Management Plan

Table C.15 Results Of Ipsos Reid Survey¹ Of BMPs In Saskatchewan Brown Soil Zone, 2006

	Base Model	Soil Testing	Min Till	NMP
Proportion of Cropland Using BMP (%):	0.0	100	72	100
Standard Deviation (σ)				
Number of Respondents (n)			27	
Estimated Changes to Yield (bu/ac):				
Feed Barley	0.0	4.5	2.2	7.4
σ		5.8	4.3	3.5
n		30.0	28.0	25.0
Spring Wheat	0.0	4.5	2.2	7.4
σ		5.8	4.3	3.5
n		30.0	28.0	25.0
Lentils	0.0	2.8	1.3	4.3
σ		4.2	1.9	5.5
n		10.0	8.0*	10.0
Estimated Changes to Operating Costs (\$/ac):	0.0	6.5	-6.8	11.5
σ		9.2	9.8	17.3*
n		28.0	22.0	29.0
Estimates of Other Costs (\$/ac)**:				
Soil Testing Fee	0.0	2.5	0.0	0.0
σ				
n		24.0		
Custom Application Cost (\$/BMP ac)	0.0	0.0	0.0	0.0

	Base Model	Soil Testing	Min Till	NMP
σ				
n				
Equipment Cost (\$/BMP ac)	0.0	0.0	3.9	0.0
σ				
n			25	
Establishment Cost (\$/BMP ac)	0.0	0.0	0.0	0.0
σ				
n				
NMP Cost	0.0	0.0	0.0	0.7
Financial Assistance (\$/ac):				
Financial Assistance from Government	0.0	0.0	0.0	0.0
n			91	124
Financial Assistance from Conservation Groups	0.0	0.0	0.0	0.0
n				

¹ values based on producer estimates (Ipsos Reid, 2006)

* results may be impacted by small sample size (<10) or large standard deviation

** all estimated BMP costs were amortized

BMP - Beneficial Management Practice(s)

NMP - Nutrient Management Plan

Source: Ipsos Reid Survey, 2006

Table C.16 Economic Comparison Of BMP For Barley In Saskatchewan Brown Soil Zone

	Base Model	Soil Test (\$/ac)	Min Till	NMP
Total Revenue	70	79	75	85
Total Variable Costs	85	94	82	97
Total Fixed Costs	44	44	44	44
Total Expenses	129	138	126	141
Expected Net Revenue	-58	-59	-51	-57
Change in Expected Net Revenue from Base (%)	n/a	-1	12	3

Table C.17 Economic Comparison Of BMP For Spring Wheat In Saskatchewan Brown Soil Zone

	Base Model	Soil Test (\$/ac)	Min Till	NMP
Total Revenue	91	108	100	119
Total Variable Costs	89	98	86	101
Total Fixed Costs	44	44	44	44
Total Expenses	133	142	130	145
Expected Net Revenue	-41	-34	-30	-27
Change in Expected Net Revenue from Base (%)	n/a	18	27	36

Table C.18 Economic Comparison Of BMP For Lentils In Saskatchewan Brown Soil Zone

	Base Model	Soil Test (\$/ac)	Min Till	NMP
Total Revenue	118	139	128	149
Total Variable Costs	112	121	109	125
Total Fixed Costs	49	49	49	49
Total Expenses	161	170	158	174
Expected Net Revenue	-43	-32	-31	-24
Change in Expected Net Revenue from Base (%)	n/a	26	29	43

Table C.19 Comparison of Expected Net Revenue For Average Whole Farm (1,308 ac) Using BMP In Saskatchewan Brown Soil Zone

	Base Model	Soil Test (\$/ac)	Min Till	NMP
Feed Barley	-11,409	-11,539	-10,402	-11,112
Spring Wheat	-37,926	-31,113	-30,614	-24,344
Lentils	-8,400	-6,251	-6,661	-4,787
Total	-57,735	-48,903	-47,677	-40,243
% Change of Expected Net Revenue from Base	n/a	15.3	17.4	30.3

Saskatchewan Black Soil Zone

Table C.20 Expected Net Revenue¹ For Barley, Canola, Spring Wheat and Peas In Saskatchewan Black Soil Zone Before Implementation Of BMP, 2006

	Barley	Canola	Spring Wheat	Peas
	(bu/ac)			
Pre-BMP Yield	58	26	36	31
*Change in Yield due to BMP	0	0	0	0
Crop Expected Yield	58	26	36	31
	(\$/ac)			
Crop Expected Price	1.90	5.50	3.70	2.80
Expected Crop Revenue	109	140	133	86
Program Payment	0	0	0	0
Straw Expected Yield (bales/ac)	0	0	0	0
Straw Expected Price	0	0	0	0
Expected Straw Revenue	0	0	0	0
Total Revenue	109	140	133	86
Seed & Treatment	6	22	9	14
Fertilizer - Nitrogen: 46-0-0	28	28	28	3
Fertilizer - Phosphorus: 12-51-0	8	6	8	4

	Barley	Canola	Spring Wheat	Peas
Fertilizer - Sulfur & Other: 20-0-0-24	0	4	0	0
Chemical - Herbicides	16	23	16	24
Chemical - Insecticides/Fungicides	0	1	2	0
Chemical - Others	3	0	3	4
Crop Insurance Premium	5	7	5	6
Custom Work & Hired Labour	5.0	5	7	4
Drying	0	0	0	0
Trucking	0	0	0	0
Marketing	0	0	0	0
Twine	0	0	0	0
Fuel	15	16	15	16
Machinery Repair	8	8	7.6	11
Utilities & Miscellaneous	5	5.2	5.2	5
*Change in Operating Costs due to BMP	0	0	0	0
*Soil Testing Fee	0	0	0	0
*Custom Application Cost	0	0	0	0
*Equipment Cost	0	0	0	0
*Establishment Cost	0	0	0	0
*NMP Cost	0	0	0	0
*Operating Interest	2.42	3.02	2.58	2.27
Total Variable Costs	101	126	108	95
Building Repair	2	2	2	2
Property Taxes	6	6	6	6
Insurance & Licences	2	2	2	2
Machinery Depreciation	19	19	19	23
Building Depreciation	2	2	2	2
Machinery Investment	9	9	9	11
Building Investment	2	2	2	2
Land Investment	17	17	17	17
Total Fixed Costs	59	59	59	64
Total Expenses	160	185	166	159
Expected Net Revenue	-50	-45	-33	-73

¹ calculations based on provincial or crop specific enterprise budgets and on producer estimates of actual crop yields and production costs from the Ipsos Reid survey, 2006

* values will change after implementing a BMP

BMP - Beneficial Management Practice(s)

NMP - Nutrient Management Plan

Table C.21 Results Of Ipsos Reid Survey¹ Of BMPs In Saskatchewan Black Soil Zone, 2006

	Base Model	Soil Testing	VRF	NMP
Proportion of Cropland Using BMP (%):	0.0	100	81	100
Standard Deviation (σ)				
Number of Respondents (n)			10	
Estimated Changes to Yield (bu/ac):				
Barley	0.0	5.8	6.4	6.7
σ		4.8	4.8	4.8
n		21.0	9.0*	35.0
Canola	0.0	4.9	3.4	5.5
σ		4.4	4.2	4.4
n		20.0	5.0*	23.0
Spring Wheat	0.0	5.8	6.4	6.7
σ		4.8	4.8	4.8
n		21	9*	35
Peas	0.0	4.0	5.0	3.8
σ		4.8	1.6	4.8
n		21.0	4*	16.0
Estimated Changes to Operating Costs (\$/ac):	0.0	9.0	0.7	4.8
σ		16.9	3.8	13.0
n		21	9*	35
Estimates of Other Costs (\$/ac)**:				
Soil Testing Fee	0.0	0.4	0.0	0.0
σ		0.6		
n		19		
Equipment Cost (\$/BMP ac)	0.0	0.0	4.4	0.0
σ				
n			5*	
NMP Cost	0.0	0.0	0.0	0.7
Financial Assistance (\$/ac):				
Financial Assistance from Government	0.0	0.0	0.0	0.0
n			12	72
Financial Assistance from Conservation Groups	0.0	0.0	0.0	0.0
n				

¹ values based on producer estimates (Ipsos Reid, 2006)

* results may be impacted by small sample size (<10) or large standard deviation

** all estimated BMP costs were amortized

BMP - Beneficial Management Practice(s)

NMP - Nutrient Management Plan

Source: Ipsos Reid Survey, 2006

Table C.22 Economic Comparison Of BMP For Barley In Saskatchewan Black Soil Zone

	Base Model	Soil Test (\$/ac)	VRF	NMP
Total Revenue	109	120	122	122
Total Variable Costs	101	111	106	107
Total Fixed Costs	59	59	59	59
Total Expenses	160	169	165	165
Expected Net Revenue	-50	-49	-43	-43
Change in Expected Net Revenue from Base (%)	n/a	3	14	14

Table C.23 Economic Comparison Of BMP For Canola In Saskatchewan Black Soil Zone

	Base Model	Soil Test (\$/ac)	VRF	NMP
Total Revenue	140	167	159	171
Total Variable Costs	126	136	132	132
Total Fixed Costs	59	59	59	59
Total Expenses	185	195	190	191
Expected Net Revenue	-45	-27	-31	-20
Change in Expected Net Revenue from Base (%)	n/a	39	30	55

Table C.24 Economic Comparison Of BMP For Spring Wheat In Saskatchewan Black Soil Zone

	Base Model	Soil Test (\$/ac)	VRF	NMP
Total Revenue	133	155	157	158
Total Variable Costs	108	117	113	113
Total Fixed Costs	59	59	59	59
Total Expenses	166	176	172	172
Expected Net Revenue	-33	-21	-15	-14
Change in Expected Net Revenue from Base (%)	n/a	36	56	58

Table C.25 Economic Comparison Of BMP For Peas In Saskatchewan Black Soil Zone

	Base Model	Soil Test (\$/ac)	VRF	NMP
Total Revenue	86	97	100	96
Total Variable Costs	95	104	100	100
Total Fixed Costs	64	64	64	64
Total Expenses	159	168	164	164
Expected Net Revenue	-73	-71	-64	-68
Change in Expected Net Revenue from Base (%)	n/a	2	12	7

Table C.26 Comparison of Expected Net Revenue For Average Whole Farm (1,308 ac) Using BMP In Saskatchewan Black Soil Zone

	Base Model	Soil Test (\$/ac)	VRF	NMP
Feed Barley	-13,136	-12,769	-11,663	-11,292
Canola	-17,534	-10,733	-13,246	-7,894
Spring Wheat	-17,360	-11,164	-9,532	-7,363
Field Peas	-9,537	-9,330	-8,606	-8,889
Total	-57,568	-43,996	-43,046	-35,437
% Change of Expected Net Revenue from Base	n/a	23.6	25.2	38.4

Manitoba

Table C.27 Expected Net Revenue¹ For Malt Barley, Canola, Spring Wheat and Peas In Manitoba Before Implementation Of BMP, 2006

	Malt Barley	Canola	Spring Wheat	Peas
	(bu/ac)			
Pre-BMP Yield	44.7	25.7	32.1	21.9
*Change in Yield due to BMP	0	0	0	0
Crop Expected Yield	44.7	25.7	32.1	21.9
	(\$/ac)			
Crop Expected Price	3.1	5.85	4.25	3.90
Expected Crop Revenue	139	150	136	85
Program Payment	0	0	0	0
Straw Expected Yield (bales/ac)	0	0	0	0
Straw Expected Price	0	0	0	0
Expected Straw Revenue	0	0	0	0
Total Revenue	139	150	136	85
Seed & Treatment	10	28	10	19.38
Fertilizer #1 - Nitrogen	26	35	31	0
Fertilizer #2 - Phosphorus	10	9	10	8.7
Fertilizer #3 - Potash	2	0	0	6.75
Fertilizer #4 - Sulphur	0	4	0	3.75
Chemicals - Weed Control	21	26	21	20
Chemicals - Disease Control	4	25	9	7.75
Chemicals - Insect Control	0	0	0	0
Crop Insurance Premium	5	9	5	6.08
Custom Work #1 Pesticide Application	0	0	0	0
Custom Work #2 Fertilizer Application	0	0	0	0
Custom Work #3 Other	0	0	0	0
Drying	0	0	0	0
Trucking	0	0	0	0
Marketing	0	0	0	0

	Malt Barley	Canola	Spring Wheat	Peas
Twine	0	0	0	0
Fuel	13	13	13	13.8
Machinery Operating	10	10	10	10.5
Building Repair	0	0	0	0
Labour	17.25	17.25	17.25	19.25
Miscellaneous	8	7.5	7.5	8
Land Taxes	5	5.25	5.25	5.25
*Change in Operating Costs due to BMP	0	0	0	0
*Soil Testing Fee	0	0	0	0
*Custom Application Cost	0	0	0	0
*Equipment Cost	0	0	0	0
*Establishment Cost	0	0	0	0
*NMP Establishment Cost	0	0	0	0
*Operating Interest	4	5	4	4
Total Variable Costs	135	194	143	133
Land Investment Costs	24	24	24	24
Machinery Depreciation	23	22.5	22.5	22.5
Machinery Investment	9	9	9	9
Storage Costs	3	3	3	3
Total Fixed Costs	58	58	58	58
Total Expenses	193	252	201	191
Expected Net Revenue	-54	-101	-65	-105

¹ calculations based on provincial or crop specific enterprise budgets and on producer estimates of actual crop yields and production costs from the Ipsos Reid survey, 2006

* values will change after implementing a BMP

BMP - Beneficial Management Practice(s)

NMP - Nutrient Management Plan

Table C.28 Results Of Ipsos Reid Survey¹ Of BMPs In Manitoba, 2006

	Base Model	Soil Testing	VRF	Min Till	No-Till	NMP	Buffer Strips
Proportion of Cropland Using BMP (%):							
	0.0	100	63	82	69	100	5
Standard Deviation (σ)			35	29	48		6
Number of Respondents (n)			12	36	35		41
Estimated Changes to Yield (bu/ac):							
Malt Barley	0.0	4.5	7.1	1.2	2.7	5.1	-8%
σ		4.4	4.0	4.3	4.8	4.6	10
n		42	7*	34	42	17	41
Canola	0.0	3.3	3.6	1.4	1.5	4.0	-8%
σ		3.9	3.3	2.6	3.1	3.6	10

	Base Model	Soil Testing	VRF	Min Till	No-Till	NMP	Buffer Strips
n		35	8*	29	35	44	41
Spring Wheat	0.0	4.5	7.1	1.2	2.7	5.1	-8%
σ		4.4	4.0	4.3	4.8	4.6	10
n		42	7*	34	42	17	41
Peas	0.0	4.0	5.0	0.5	3.7	3.8	-8%
σ		4.8	1.6	2.5	3.8	4.8	10
n		21	4*	11	26	16	41
Estimated Changes to Operating Costs (\$/ac):							
	0.0	2.8	9.5	-7.2	-5.6	4.3	0.0
σ		12.9*	22.5*	8.0	11.1*	14.4*	
n		44	11	30	42	57	
Estimates of Other Costs (\$/ac)**:							
Soil Testing Fee	0.0	5.8	0.0	0.0	0.0	0.0	0.0
σ		14.0					
n		40					
Equipment Cost (\$/BMP ac)	0.0	0.0	22.6	1.6	2.9	0.0	0.0
σ							
n			4*	31	41		
Establishment Cost (\$/BMP ac)	0.0	0.0	0.0	0.0	0.0	0.0	7.8
σ							
n							41
NMP Establishment Cost	0.0	0.0	0.0	0.0	0.0	0.6	0.0
Financial Assistance (\$/ac):							
Financial Assistance from Government	0	0	0	0	0	0	0
n			12	36	41	65	41
Financial Assistance from Conservation Groups	0	0	0	0	0	0	0
n			12	36	41	65	41

¹ values based on producer estimates (Ipsos Reid, 2006)

* results may be impacted by small sample size (<10) or large standard deviation

** all estimated BMP costs were amortized

BMP - Beneficial Management Practice(s)

NMP - Nutrient Management Plan

Source: Ipsos Reid Survey, 2006

Table C.29 Economic Comparison Of BMP For Malt Barley In Manitoba

	Base Model	Soil Testing	VRF	Min Till	No-Till	NMP	Buffer Strips
Total Revenue	139	153	161	142	147	154	127
Total Variable Costs	135	143	168	129	132	140	143
Total Fixed Costs	58	58	58	58	58	58	58
Total Expenses	193	193	226	187	190	198	201
Expected Net Revenue	-54	-40	-65	-45	-43	-43	-73
Change in Expected Net Revenue from Base (%)	n/a	26	-20	18	21	20	-35

Table C.30 Economic Comparison Of BMP For Canola In Manitoba

	Base Model	Soil Testing	VRF	Min-Till	No-Till	NMP	Buffer Strips
Total Revenue	150	170	171	159	159	174	138
Total Variable Costs	194	202	226	188	191	199	202
Total Fixed Costs	58	58	58	58	58	58	58
Total Expenses	252	252	285	246	249	257	260
Expected Net Revenue	-101	-82	-113	-87	-90	-83	-121
Change in Expected Net Revenue from Base (%)	n/a	19	-12	14	11	18	-20

Table C.31 Economic Comparison Of BMP For Spring Wheat In Manitoba

	Base Model	Soil Testing	VRF	Min Till	No-Till	NMP	Buffer Strips
Total Revenue	136	156	167	142	148	158	126
Total Variable Costs	143	152	176	138	141	148	151
Total Fixed Costs	58	58	58	58	58	58	58
Total Expenses	201	201	234	196	199	207	209
Expected Net Revenue	-65	-46	-68	-54	-51	-48	-84
Change in Expected Net Revenue from Base (%)	n/a	29	-4	17	22	26	-29

Table C.32 Economic Comparison Of BMP For Peas In Manitoba

	Base Model	Soil Testing	VRF	Min-Till	No-Till	NMP	Buffer Strips
Total Revenue	85	101	105	87	100	100	79
Total Variable Costs	133	142	166	127	130	138	141
Total Fixed Costs	58	58	58	58	58	58	58
Total Expenses	191	191	224	185	188	196	199
Expected Net Revenue	-105	-90	-119	-98	-88	-96	-120
Change in Expected Net Revenue from Base (%)	n/a	15	-13	7	16	9	-14

Table C.33 Comparison of Expected Net Revenue For Average Whole Farm (1,525 ac) Using BMP In Manitoba

	Base Model	Soil Test	VRF	Min Till	No-Till	NMP	Buffer Strips
Barley	-16,535	-14,976	-18,635	-14,157	-14,191	-13,261	-16,827
Canola	-46,356	-41,567	-49,779	-41,112	-42,713	-37,973	-46,815
Spring Wheat	-39,650	-33,374	-40,711	-34,203	-33,656	-29,524	-40,227
Peas	-16,085	-15,054	-17,376	-15,118	-14,276	-14,599	-16,199
Total	-118,627	-104,971	-126,502	-104,589	-104,836	-95,358	-120,067
Change in Expected Net Revenue from Base (%)	n/a	11.5	-6.6	11.8	11.6	19.6	-1.2

Ontario

Table C.34 Expected Net Revenue¹ For Grain Corn, Soybeans and Soft Winter Wheat In Ontario Before Implementation Of BMP, 2006

	Grain Corn	Soybeans	Soft Winter Wheat
	(bu/ac)		
Pre-BMP Yield	146	41	70
*Change in Yield due to BMP	0.0	0.0	0.0
Crop Expected Yield	146	41	70
	(%/ac)		
Crop Expected Price	2.9	6.3	3.6
Expected Crop Revenue	415	258	250
Program Payment	0	0	0
Straw Expected Yield (bales/ac)	0	0	50
Straw Expected Price	0	0	1.5
Expected Straw Revenue	0	0	75
Total Revenue	415	258	325
Seed	50	31	35
Seed Treatment	8	5	0
Fertilizer #1	13	14	12
Fertilizer #2	11	0	42
Fertilizer #3	58	0	0
Herbicide - Annual grasses/broadleaf weeds	35	38	0
Herbicide - Broadleaf herbicides	0	0	6
Herbicide - other weed control	0	0	0
Insecticides	0	0	0
Fungicides	0	0	0
Crop Insurance Premium	15	10	8
Custom Work #1 Pesticide Application	9	9	9
Custom Work #2 Fertilizer Application	9	9	9
Custom Work #3 Other	0	0	0

	Grain Corn	Soybeans	Soft Winter Wheat
Drying	64	9	0
Storage	27	8	0
Trucking	26	7	12
Marketing	1	1	4
Twine	0	0	3
Fuel	16	11	13
Machinery Repair	17	17	19
Building Repair	0	0	0
Rent & Labour	11	8	16
Miscellaneous	0	0	0
*Soil Testing Fee	0	0	0
*Change in Operating Costs due to BMP	0	0	0
*Custom Application Cost	0	0	0
*Equipment Cost	0	0	0
*NMP Establishment Cost	0	0	0
*Establishment Cost	0	0	0
*Operating Interest	10	5	9
Total Variable Costs	381	183	196
Depreciation	26	28	33
Interest on Term Loans	17	20	23
Long-Term Leases	0	0	0
Other Fixed Costs	5	5	7
Total Fixed Costs	49	53	63
Total Expenses	429	235	259
Expected Net Revenue	-14	23	66

[†] calculations based on provincial or crop specific enterprise budgets and on producer estimates of actual crop yields and production costs from the Ipsos Reid survey, 2006

* values will change after implementing a BMP

BMP - Beneficial Management Practice(s)

NMP - Nutrient Management Plan

Table C.35 Results Of Ipsos Reid Survey¹ Of BMPs In Ontario, 2006

	Base Model	Soil Testing	VRF	Min Till	No-Till	NMP	Buffer Strips
Proportion of Cropland Using BMP (%):	0.0	100	59	52	44	100	3
Standard Deviation (σ)							
Number of respondents (n)			32	29	125		110
Estimated Changes to Yield (bu/ac):							
Corn	0.0	7.3	4.5	3.1	0.0	2.7	-4%
σ		6.1	5.8	5.4	5.0	5.4	6

	Base Model	Soil Testing	VRF	Min Till	No-Till	NMP	Buffer Strips
n		43	24	17	93	46	110
Soybeans	0.0	2.2	1.1	0.6	-0.1	1.4	-4%
σ		3.2	2.2	1.5	4.1	3.4	6
n		43	20	14	99	34	110
Wheat	0.0	8.3	8.6	0.6	1.1	3.0	-4%
σ		5.2	5.5	1.8	5.2	4.3	6
n		9*	5*	8*	98	13	110
Estimated Changes to Operating Costs (\$/ac):							
	0.0	0.2	3.6	-10.5	-17.6	-3.6	0.0
σ		16.3	22.4*	17.1	17.3	21.5*	
n		54	31	24	109	54	
Estimates of Other Costs (\$/ac)**:							
Soil Testing Fee	0.0	3.1	0.0	0.0	0.0	0.0	0.0
σ							
n		48					
Custom Application Cost (\$/BMP ac)	0.0	0.0	14.3	0.0	0.0	0.0	0.0
σ			11.1				
n			16				
Equipment Cost (\$/BMP ac)	0.0	0.0	0.0	3.7	6.0	0.0	0.0
σ							
n				24	101		
Establishment Cost (\$/BMP ac)	0.0	0.0	0.0	0.0	0.0	0.0	14.8
σ							
n							110
NMP Establishment Cost	0	0	0	0	0	1.1	0
Financial Assistance (\$/ac):							
Financial Assistance from Government	0	0	0	0	0	0	0
n			33	29	126	64	110
Financial Assistance from Conservation Groups	0	0	0	0	0	0	0
n							110

¹ values based on producer estimates (Ipsos Reid, 2006)

* results may be impacted by small sample size (<10) or large standard deviation

** all estimated BMP costs were amortized

BMP - Beneficial Management Practice(s)

NMP - Nutrient Management Plan

Source: Ipsos Reid Survey, 2006

Table C.36 Economic Comparison Of BMP For Corn In Ontario

	Base Model	Soil Testing	VRF	Min Till	No-Till	NMP	Buffer Strips
	(\$/ac)						
Total Revenue	415	436	428	424	415	423	399
Total Variable Costs	381	390	403	376	369	380	391
Total Fixed Costs	49	49	49	49	49	49	49
Total Expenses	429	439	451	425	417	429	440
Expected Net Revenue	-14	-3	-23	-1	-2	-6	-41
Change in Expected Net Revenue from Base (%)	n/a	80	-66	94	84	56	-190

Table C.37 Economic Comparison Of BMP For Soybean In Ontario

	Base Model	Soil Testing	VRF	Min-Till	No-Till	NMP	Buffer Strips
	(\$/ac)						
Total Revenue	258	272	265	262	258	267	248
Total Variable Costs	183	187	202	176	171	181	197
Total Fixed Costs	53	53	53	53	53	53	53
Total Expenses	235	240	254	229	223	234	249
Expected Net Revenue	23	32	11	33	34	33	-1
Change in Expected Net Revenue from Base (%)	n/a	39	-53	45	49	45	-106

Table C.38 Economic Comparison Of BMP For Wheat In Ontario

	Base Model	Soil Testing	VRF	Min Till	No-Till	NMP	Buffer Strips
	(\$/ac)						
Total Revenue	325	355	356	327	329	336	315
Total Variable Costs	196	201	217	189	184	194	211
Total Fixed Costs	63	63	63	63	63	63	63
Total Expenses	259	264	280	252	247	257	274
Expected Net Revenue	66	90	76	75	82	79	41
Change in Expected Net Revenue from Base (%)	n/a	37	15	14	24	19	-38

Table C.39 Comparison of Expected Net Revenue For Average Whole Farm (430 ac) Using BMP In Ontario

	Base Model	Soil Testing	VRF	Min Till	No-Till	NMP	Buffer Strips
	(\$/ac)						
Corn	-2,029	-413	-2,819	-1,042	-1,276	-887	-2,145
Soybeans	3,300	4,596	2,271	4,075	4,017	4,799	3,195
Wheat	9,483	12,948	10,323	10,163	10,480	11,285	9,376
Total Expected Net Revenue	10,754	17,130	9,776	13,195	13,221	15,197	10,426
Change in Expected Net Revenue from Base (%)		59.3	-9.1	22.7	22.9	41.3	-3.0

Quebec

Table C.40 Expected Net Revenue¹ For Grain Corn, Soybeans and Soft Winter Wheat In Quebec Before Implementation Of BMP, 2006

	Grain Corn	Soybeans	Wheat
	(bu/ac)		
Pre-BMP Yield (bu/acre)	135	45	53
*Change in Yield due to BMP (bu/acre)	0	0	0
Crop Expected Yield (bu/acre)	135	45	53
	(\$/ac)		
Crop Expected Price	3.23	7.62	4.49
Expected Crop Revenue	437	340	237
Program Payment	207	43	197
Straw Expected Yield/ (bales/ac)	0	0	0
Straw Expected Price	0	0	0
Expected Straw Revenue	0	0	0
Total Revenue	644	383	434
Seed	59	69	28
Innoculant	0	8	0
Fertilizer #1	18	39	59
Fertilizer #2	45	0	25
Fertilizer #3	46	0	0
Lime	6	2	4
Pesticides # 1	23	32	3
Pesticides # 2	22	17	0
Insecticides	0	0	0
Fungicides	0	0	14
Plowing (loam)	29	29	29
Harrowing (loam)	7	7	7
Cultivator (loam)	7	7	7
Spreading Fertilizer (single tractor)	3	2	3
Planter	16	11	11
Stone Picking	0	30	0
Spraying 1 time	5	5	10
Row Cultivation 8 rows 1 time	8	0	0
Combine	34	36	30
Grain Transportation	11	6	6
Drying	102	2	21
Storage and Ventilation	22	9	10
Transportation to Sale Outlet	33	12	14
Joint Plan	3	1	6*
Crop Insurance Premium	16	6	9
ASRA Premium	63	6	42
Hired Labour	0	0	0
Land Rent	97	97	97

	Grain Corn	Soybeans	Wheat
Maintenance and land taxes	30	30	30
*Soil Testing Fee	0	0	0
*Change in Operating Costs due to BMP	0	0	0
*Custom Application Cost	0	0	0
*Equipment Cost	0	0	0
*NMP Establishment Cost	0	0	0
*Establishment Cost	0	0	0
*Operating Interest	27	15	16
Total Expenses	729	478	481
Expected Net Revenue	-85	-96	-47

¹ calculations based on provincial or crop specific enterprise budgets and on producer estimates of actual crop yields and production costs from the Ipsos Reid survey, 2006

* values will change after implementing a BMP

BMP - Beneficial Management Practice(s)

NMP - Nutrient Management Plan

Table C.41 Results Of Ipsos Reid Survey¹ Of BMPs In Quebec, 2006

	Base Model	Soil Testing	VRF	Min Till	No-Till	NMP	Buffer Strips
Proportion of Cropland Using BMP (%):							
	0.0	100	58	52	33	100	5
Standard Deviation (σ)							
Number of respondents (n)							
			13	49	63		97
Estimated Changes to Yield (bu/ac):							
Corn	0.0	4.3	1.7	0.9	0.1	2.0	-8%
σ		4.3	3.5	3.2	5.1	5.2	16
n		19	9*	28	48	78	108
Soybeans	0.0	1.1	0.0	0.1	-0.2	1.2	-8%
σ		2.7		0.2	2.9	3.6	16
n		18	3*	18	38	63	108
Wheat	0.0	4.1	7.5	1.1	-0.4	1.6	-8%
σ		4.2		2.3	2.4	2.8	16
n		8*	2*	10	27	25	108
Estimated Changes to Operating Costs (\$/ac):							
	0.0	4.4	-1.5	-12.9	-22.8	-4.9	0.0
σ		19	21.3	23.6	25.6	28.4	
n		33	12	43	52	118	
Estimates of Other Costs (\$/ac)**:							
Soil Testing Fee	0.0	4.5	0.0	0.0	0.0	0.0	0.0
σ		17.2					
n		33					

	Base Model	Soil Testing	VRF	Min Till	No-Till	NMP	Buffer Strips
Custom Application Cost (\$/BMP ac)	0.0	0.0	18.1	0.0	0.0	0.0	0.0
σ			14.2				
n			7*				
Equipment Cost (\$/BMP ac)	0.0	0.0	0.0	-1.4	5.4	0.0	0.0
σ				44	57		
n							
NMP Establishment Cost (\$/ac)	0.0	0.0	0.0	0.0	0.0	1.3	0.0
σ							
n							
Establishment Cost (\$/BMP ac)	0.0	0.0	0.0	0.0	0.0	0.0	11.1
σ							
n							108
Financial Assistance (\$/ac):							
Financial Assistance from Government	0	0	0	0	0	0	0
n			13	50	65	138	108
Financial Assistance from Conservation Groups	0	0	0	0	0	0	0
n							108

¹ values based on producer estimates (Ipsos Reid, 2006)

* results may be impacted by small sample size (<10) or large standard deviation

** all estimated BMP costs were amortized

BMP - Beneficial Management Practice(s)

NMP - Nutrient Management Plan

Source: Ipsos Reid Survey, 2006

Table C.42 Economic Comparison Of BMP For Corn In Quebec

	Base Model	Soil Test	VRF	Min Till	No-Till	NMP	Buffer Strips
	(\$/ac)						
Total Revenue	644	658	650	647	644	651	609
Total Expenses	729	744	749	715	711	728	726
Expected Net Revenue	-85	-86	-99	-68	-67	-78	-117
Change in Expected Net Revenue from Base (%)	n/a	-1	-17	20	22	9	-38

Table C.43 Economic Comparison Of BMP For Soybean In Quebec

	Base Model	Soil Test	VRF	Min Till	No-Till	NMP	Buffer Strips
	(\$/ac)						
Total Revenue	383	391	383	384	381	392	356
Total Expenses	478	489	496	463	460	475	488
Expected Net Revenue	-96	-97	-113	-80	-79	-83	-132
Change in Expected Net Revenue from Base (%)	n/a	-2	-18	16	18	13	-38

Table C.44 Economic Comparison Of BMP For Wheat In Quebec

	Base Model	Soil Test	VRF	Min Till	No-Till	NMP	Buffer Strips
	(\$/ac)						
Total Revenue	434	453	468	439	433	442	415
Total Expenses	481	495	507	467	462	479	488
Expected Net Revenue	-47	-42	-39	-28	-30	-37	-72
Change in Expected Net Revenue from Base (%)	n/a	9	16	40	36	20	-55

Table C.45 Comparison of Expected Net Revenue For Average Whole Farm (316 ac) Using BMP In Quebec

	Base Model	Soil Test	VRF	Min Till	No-Till	NMP	Buffer Strips
	(\$/ac)						
Corn	-8,968	-9,101	-9,839	-8,014	-8,326	-8,164	-9,137
Soybeans	-10,065	-10,250	-11,132	-9,164	-9,478	-8,784	-10,256
Wheat	-4,906	-4,460	-4,490	-3,851	-4,314	-3,940	-4,995
Total	-23,938	-23,811	-25,461	-21,030	-22,117	-20,887	-24,388
Change in Expected Net Revenue from Base (%)	n/a	0.5	-6.4	12.1	7.6	12.7	-1.9

Prince Edward Island

Table C.46 Expected Net Revenue¹ For Potatoes In Prince Edward Island Before Implementation Of BMP, 2006

Potatoes	
(bu/ac)	
Pre-BMP Yield	443
*Change in Yield due to BMP	0
Crop Expected Yield	443
(\$/ac)	

Crop Expected Price	3.51
Expected Crop Revenue	1556
Program Payment	0
Total Revenue	1556
Seed	304
Fertilizer	319
Chemicals	273
Other	0
Fuel	94
Hired labour	508
Unpaid wages	48
Crop insurance	37
Licenses	29
Other	40
Rent	98
Custom work	11
Maintenance and repairs	198
Insurance	30
Utilities	33
Legal and professional fees	14
Taxes	9
Interest and bank charges	142
*Change in Operating Costs due to BMP	0
*Soil Testing Fee	0
*Custom Application Cost	0
*Equipment Cost	0
*Establishment Cost	0
*NMP Cost	0
Total Variable Costs	2187
Interest	55
Depreciation equipment	142
Depreciation buildings	36
Other	9
Total Capital Costs	242
Total Expenses	2429
Expected Net Revenue	-873

¹ calculations based on provincial or crop specific enterprise budgets and on producer estimates of actual crop yields and production costs from the Ipsos Reid survey, 2006

* values will change after implementing a BMP
BMP - Beneficial Management Practice(s)

Table C.47 Results Of Ipsos Reid Survey¹ Of BMPs In Prince Edward Island, 2006

	Base Model	Buffer Strips
Proportion of Cropland Using BMP (%) :	0.0	5
Standard Deviation (σ)		
Number of Respondents (n)		27
Estimated Changes to Yield (bu/ac):		
Potatoes	0.0	-5.1%
σ		
n		26.0
Estimated Changes to Operating Costs (\$/ac):	0.0	0.0
σ		
n		
Estimates of Other Costs (\$/ac):		
Soil Testing Fee	0.0	0.0
σ		
n		
Custom Application Cost (\$/BMP ac)	0.0	0.0
σ		
n		
Equipment Cost (\$/BMP ac)	0.0	0.0
σ		
n		
Establishment Cost (\$/BMP ac)	0.0	21.7
σ		
n		
NMP Cost	0.0	0.0
Financial Assistance (\$/ac):		
Financial Assistance from Government	0.0	0.0
n		28
Financial Assistance from Conservation Groups	0.0	0.0
n		61

Table C.48 Economic Comparison Of BMP For Potatoes In Prince Edward Island

	Base Model	Buffer Strips
	(\$/ac)	
Total Revenue	1556	1,477
Total Expenses	2,429	2,451
Expected Net Revenue	-873	-974
Change in Expected Net Revenue from Base (%)	n/a	-12

Table C.49 Comparison of Expected Net Revenue For Average Whole Farm (563 ac) Using BMP In Prince Edward Island

	Base Model	Buffer Strips
	(\$/ac)	
Total Expected Net Revenue	-491,656	-494,499
Change in Expected Net Revenue from Base (%)		-0.6

APPENDIX D: TABLES WITH FINANCIAL ASSISTANCE

Alberta Brown Soil Zone

Table D.1 Changes In BMP Costs* With Financial Assistance

	Soil Testing	NMP (\$/ac)	Min-Till
Soil Testing Fee			
Without funding	0.3	0	0
With funding	0.3	0	0
Equipment Cost			
Without funding	0	0	3.3
With funding	0	0	2.0
NMP Cost			
Without funding	0	0.7	0
With funding	0	0.4	0

*Note that operating interest may change as a result of changes in BMP costs.

Table D.2 Economic Comparison Of BMP For Barley In Alberta Brown Soil Zone With Financial Assistance

	Base Model	Soil Test (\$/ac)	Min Till	NMP
Total Revenue	114	126	125	130
Total Variable Costs	104	110	94	107
Total Fixed Costs	53	53	53	53
Total Expenses	157	163	147	160
Expected Net Revenue	-43	-37	-22	-30
Change in Expected Net Revenue from Base (%)	n/a	14	49	29

Table D.3 Economic Comparison Of BMP For Spring Wheat In Alberta Brown Soil Zone With Financial Assistance

	Base Model	Soil Test (\$/ac)	Min Till	NMP
Total Revenue	109	126	126	132
Total Variable Costs	116	121	106	119
Total Fixed Costs	53	53	53	53
Total Expenses	169	174	159	172
Expected Net Revenue	-60	-48	-33	-40
Change in Expected Net Revenue from Base (%)	n/a	19	44	34

Table D.4 Economic Comparison Of BMP For Lentils In Alberta Brown Soil Zone With Financial Assistance

	Base Model	Soil Test	Min Till (\$/ac)	NMP
Total Revenue	94	112	102	119
Total Variable Costs	106	112	96	109
Total Fixed Costs	53	53	53	53
Total Expenses	159	165	149	162
Expected Net Revenue	-66	-53	-47	-43
Change in Expected Net Revenue from Base (%)	n/a	20	28	35

Table D.5 Comparison Of Expected Net Revenue For Average Whole Farm (1,358 ac) Using BMP In Alberta Brown Soil Zone With Financial Assistance

	Base Model	Soil Test	Min Till (\$/ac)	NMP
Barley	-8,701	-7,498	-5,095	-6,179
Spring Wheat	-56,805	-45,751	-35,617	-37,745
Lentils	-13,408	-10,770	-10,202	-8,767
Total Expected Net Revenue	-78,914	-64,019	-50,914	-52,691
Change in Expected Net Revenue from Base (%)	n/a	19	35	33

Alberta Black Soil Zone

Table D.6 Changes In BMP Costs* With Financial Assistance

	VRF	NMP (\$/ac)	Buffer Strips
Equipment Cost			
Without funding	4.5	0	0
With funding	3.2	0	0
NMP Cost			
Without funding	0	0.7	0
With funding	0	0.4	0
Establishment Cost			
Without funding	0	0	12.4
With funding	0	0	6.2

*Note that operating interest may change as a result of changes in BMP costs.

Table D.7 Economic Comparison Of BMP For Malt Barley In Alberta Black Soil Zone With Financial Assistance

	Base Model	VRF (\$/ac)	NMP	Buffer Strips
Total Revenue	176	196	196	157
Total Variable Costs	139	144	146	145
Total Fixed Costs	76	76	76	76
Total Expenses	215	220	222	221
Expected Net Revenue	-40	-24	-26	-65
Change in Expected Net Revenue from Base (%)	n/a	40	35	-63

Table D.8 Economic Comparison Of BMP For Canola In Alberta Black Soil Zone With Financial Assistance

	Base Model	VRF (\$/ac)	NMP	Buffer Strips
Total Revenue	247.50	270	289	221
Total Variable Costs	171	176	178	178
Total Fixed Costs	76	76	76	76
Total Expenses	247.48	252	254	254
Expected Net Revenue	0.02	17	34	-33
Change in Expected Net Revenue from Base (%)	n/a	n/a	n/a	-n/a

n/a - change in ENR was not calculated because the ENR for the base model was zero

Table D.9 Economic Comparison Of BMP For Spring Wheat In Alberta Black Soil Zone With Financial Assistance

	Base Model	VRF (\$/ac)	NMP	Buffer Strips
Total Revenue	187	213	213	167
Total Variable Costs	142	147	149	148
Total Fixed Costs	76	76	76	76
Total Expenses	218	223	225	224
Expected Net Revenue	-31	-10	-11	-57
Change in Expected Net Revenue from Base (%)	n/a	69	63	-85

Table D.10 Economic Comparison Of BMP For Peas In Alberta Black Soil Zone With Financial Assistance

	Base Model	VRF (\$/ac)	NMP	Buffer Strips
Total Revenue	158	175	171	141
Total Variable Costs	150	155	157	157
Total Fixed Costs	76	76	76	76
Total Expenses	226	231	233	233
Expected Net Revenue	-69	-56	-62	-92
Change in Expected Net Revenue from Base (%)	n/a	18	9	-33

Table D.11 Comparison Of Expected Net Revenue For Average Whole Farm (1,358 ac) Using BMP In Alberta Black Soil Zone With Financial Assistance

	Base Model	VRF (\$/ac)	NMP	Buffer Strips
Malt Barley	-10,777	-7,089	-6,993	-11,326
Canola	8	5,962	14,019	-1,069
Spring Wheat	-16,700	-6,814	-6,205	-17,853
Peas	-9360	-7900	-8486	-9614
Total Expected Net Revenue	-36,829	-15,841	-7,665	-39,862
Change in Expected Net Revenue from Base (%)	n/a	57	79	-8

Saskatchewan Brown Soil Zone

Table D.12 Changes In BMP Costs* With Financial Assistance

	Soil Testing	Min-Till (\$/ac)	NMP
Soil Testing Fee			
Without funding	2.5	0	0
With funding	2.5	0	0
Equipment Cost			
Without funding	0	3.9	0
With funding	0	2.4	0
NMP Cost			
Without funding	0	0	0.7
With funding	0	0	0.4

*Note that operating interest may change as a result of changes in BMP costs.

Table D.13 Economic Comparison Of BMP For Barley In Saskatchewan Brown Soil Zone With Financial Assistance

	Base Model	Soil Test (\$/ac)	Min Till	NMP
Total Revenue	70	79	75	85
Total Variable Costs	85	94	80	97
Total Fixed Costs	44	44	44	44
Total Expenses	129	138	124	141
Expected Net Revenue	-58	-59	-50	-56
Change in Expected Net Revenue from Base (%)	n/a	-1	15	3

Table D.14 Economic Comparison Of BMP For Spring Wheat In Saskatchewan Brown Soil Zone With Financial Assistance

	Base Model	Soil Test (\$/ac)	Min Till	NMP
Total Revenue	91	108	100	119
Total Variable Costs	89	98	84	101
Total Fixed Costs	44	44	44	44
Total Expenses	133	142	128	145
Expected Net Revenue	-41	-34	-29	-26
Change in Expected Net Revenue from Base (%)	n/a	18	30	37

Table D.15 Economic Comparison Of BMP For Lentils In Saskatchewan Brown Soil Zone With Financial Assistance

	Base Model	Soil Test (\$/ac)	Min Till	NMP
Total Revenue	118	139	128	149
Total Variable Costs	112	121	108	124
Total Fixed Costs	49	49	49	49
Total Expenses	161	170	157	173
Expected Net Revenue	-43	-32	-29	-24
Change in Expected Net Revenue from Base (%)	n/a	26	32	44

Table D.16 Comparison of Expected Net Revenue For Average Whole Farm (1,308 ac) Using BMP In Saskatchewan Brown Soil Zone With Financial Assistance

	Base Model	Soil Test (\$/ac)	Min Till	NMP
Barley	-11,409	-11,539	-10,188	-11,037
Spring Wheat	-37,926	-31,113	-29,617	-23,994
Lentils	-8,400	-6,251	-6,447	-4,712
Total Expected Net Revenue	-57,735	-48,903	-46,253	-39,743
Change in Expected Net Revenue from Base (%)	n/a	15.3	19.9	31.2

Saskatchewan Black Soil Zone

Table D.17 Changes In BMP Costs* With Financial Assistance

	Soil Test	VRF (\$/ac)	NMP
Soil Testing Fee			
Without funding	0.4	0	0
With funding	0.4	0	0
Equipment Cost			
Without funding	0	4.4	0
With funding	0	3.1	0
NMP Cost			
Without funding	0	0	0.7
With funding	0	0	0.4

*Note that operating interest may change as a result of changes in BMP costs.

Table D.18 Economic Comparison Of BMP For Barley In Saskatchewan Black Soil Zone With Financial Assistance

	Base Model	Soil Test (\$/ac)	VRF	NMP
Total Revenue	109	120	122	122
Total Variable Costs	101	111	105	106
Total Fixed Costs	59	59	59	59
Total Expenses	160	169	164	165
Expected Net Revenue	-50	-49	-42	-43
Change in Expected Net Revenue from Base (%)	n/a	3	17	15

Table D.19 Economic Comparison Of BMP For Canola In Saskatchewan Black Soil Zone With Financial Assistance

	Base Model	Soil Test (\$/ac)	VRF	NMP
Total Revenue	140	167	159	171
Total Variable Costs	126	136	130	132
Total Fixed Costs	59	59	59	59
Total Expenses	185	195	189	190
Expected Net Revenue	-45	-27	-30	-20
Change in Expected Net Revenue from Base (%)	n/a	39	33	56

Table D.20 Economic Comparison Of BMP For Spring Wheat In Saskatchewan Black Soil Zone With Financial Assistance

	Base Model	Soil Test (\$/ac)	VRF	NMP
Total Revenue	133	155	157	158
Total Variable Costs	108	117	112	113
Total Fixed Costs	59	59	59	59
Total Expenses	166	176	170	172
Expected Net Revenue	-33	-21	-13	-14
Change in Expected Net Revenue from Base (%)	n/a	36	60	59

Table D.21 Economic Comparison Of BMP For Peas In Saskatchewan Black Soil Zone With Financial Assistance

	Base Model	Soil Test (\$/ac)	VRF	NMP
Total Revenue	86	97	100	96
Total Variable Costs	95	104	99	100
Total Fixed Costs	64	64	64	64
Total Expenses	159	168	162	164
Expected Net Revenue	-73	-71	-63	-68
Change in Expected Net Revenue from Base (%)	n/a	2	14	7

Table D.22 Comparison of Expected Net Revenue For Average Whole Farm (1,308 ac) Using BMP In Saskatchewan Black Soil Zone With Financial Assistance

	Base Model	Soil Test (\$/ac)	VRF	NMP
Barley	-13,136	-12,769	-11,378	-11,192
Canola	-17,534	-10,733	-12,817	-7,744
Spring Wheat	-17,360	-11,164	-8,961	-7,163
Peas	-9,537	-9,330	-8,463	-8,839
Total Expected Net Revenue	-57,568	-43,996	-41,619	-34,938
Change in Expected Net Revenue from Base (%)	n/a	24	28	39

Manitoba

Table D.23 Changes In BMP Costs* With Financial Assistance

	Soil Testing	VRF	Min Till	No-Till	NMP	Buffer Strips
Soil Testing Fee						
Without funding	5.8	0	0	0	0	0
With funding	5.8	0	0	0	0	0
Equipment Cost						
Without funding	0	22.6	1.6	2.9	0	0
With funding	0	18.7	1.0	1.8	0	0
NMP Cost						
Without funding	0	0	0	0	0.6	0
With funding	0	0	0	0	0.2	0
Establishment Cost						
Without funding	0	0	0	0	0	7.8
With funding	0	0	0	0	0	3.9

*Note that operating interest may change as a result of changes in BMP costs.

Table D.24 Economic Comparison Of BMP For Malt Barley In Manitoba With Financial Assistance

	Base Model	Soil Testing	VRF	Min Till	No-Till	NMP	Buffer Strips
Total Revenue	139	153	161	142	147	154	127
Total Variable Costs	135	143	164	128	131	139	139
Total Fixed Costs	58	58	58	58	58	58	58
Total Expenses	193	193	222	186	189	197	197
Expected Net Revenue	-54	-40	-61	-44	-42	-43	-69
Change in Expected Net Revenue from Base (%)	n/a	26	-13	19	23	21	-28

Table D.25 Economic Comparison Of BMP For Canola In Manitoba With Financial Assistance

	Base Model	Soil Testing	VRF	Min-Till	No-Till	NMP	Buffer Strips
Total Revenue	150	170	171	159	159	174	138
Total Variable Costs	194	202	223	187	190	198	198
Total Fixed Costs	58	58	58	58	58	58	58
Total Expenses	252	252	281	245	248	256	256
Expected Net Revenue	-101	-82	-109	-87	-89	-83	-117
Change in Expected Net Revenue from Base (%)	n/a	19	-8	14	13	19	-16

Table D.26 Economic Comparison Of BMP For Spring Wheat In Manitoba With Financial Assistance

	Base Model	Soil Testing	VRF	Min Till	No-Till	NMP	Buffer Strips
Total Revenue	136	156	167	142	148	158	126
Total Variable Costs	143	152	172	137	139	148	147
Total Fixed Costs	58	58	58	58	58	58	58
Total Expenses	201	201	230	195	198	206	205
Expected Net Revenue	-65	-46	-64	-54	-50	-48	-80
Change in Expected Net Revenue from Base (%)	n/a	29	2	18	24	26	-23

Table D.27 Economic Comparison Of BMP For Peas In Manitoba With Financial Assistance

	Base Model	Soil Testing	VRF	Min-Till	No-Till	NMP	Buffer Strips
Total Revenue	85	101	105	87	100	100	79
Total Variable Costs	133	142	162	126	129	137	137
Total Fixed Costs	58	58	58	58	58	58	58
Total Expenses	191	191	220	184	187	195	195
Expected Net Revenue	-105	-90	-115	-97	-87	-95	-116
Change in Expected Net Revenue from Base (%)	n/a	15	-9	8	17	10	-10

Table D.28 Comparison of Expected Net Revenue For Average Whole Farm (1,525 ac) Using BMP In Manitoba With Financial Assistance

	Base Model	Soil Test	VRF	Min Till	No-Till	NMP	Buffer Strips
Barley	-16,535	-14,976	-17,883	-14,005	-13,955	-13,111	-16,765
Canola	-46,356	-41,567	-48,652	-40,884	-42,358	-37,747	-46,723
Spring Wheat	-39,650	-33,374	-39,208	-33,900	-33,182	-29,224	-40,105
Peas	-16,085	-15,054	-17,000	-15,042	-14,158	-14,524	-16,168
Total Expected Net Revenue	-118,627	-104,971	-122,743	-103,832	-103,652	-94,606	-119,762
Change in Expected Net Revenue from Base (%)	n/a	12	-3	12	13	20	-1

Ontario

Table D.29 Changes In BMP Costs* With Financial Assistance

	Soil Testing	VRF	Min Till	No-Till	NMP	Buffer Strips
Soil Testing Fee						
Without funding	3.1	0	0	0	0	0
With funding	3.1	0	0	0	0	0
Custom Application Cost						
Without funding	0	14.3	0	0	0	0
With funding	0	14.3	0	0	0	0
Equipment Cost						
Without funding	0	0	3.7	6.0	0	0
With funding	0	0	2.3	3.7	0	0
NMP Cost						
Without funding	0	0	0	0	1.1	0
With funding	0	0	0	0	0.6	0
Establishment Cost						
Without funding	0	0	0	0	0	14.8
With funding	0	0	0	0	0	7.4

*Note that operating interest may change as a result of changes in BMP costs.

Table D.30 Economic Comparison Of BMP For Corn In Ontario With Financial Assistance

	Base Model	Soil Testing	VRF	Min Till	No-Till	NMP	Buffer Strips
	(\$/ac)						
Total Revenue	415	436	428	424	415	423	399
Total Variable Costs	381	390	403	375	366	380	383
Total Fixed Costs	49	49	49	49	49	49	49
Total Expenses	429	439	451	423	415	428	432
Expected Net Revenue	-14	-3	-23	1	0	-6	-33
Change in Expected Net Revenue from Base (%)	n/a	80	-66	104	101	60	-137

Table D.31 Economic Comparison Of BMP For Soybean In Ontario With Financial Assistance

	Base Model	Soil Testing	VRF	Min-Till	No-Till	NMP	Buffer Strips
	(\$/ac)						
Total Revenue	258	272	265	262	258	267	248
Total Variable Costs	183	187	202	174	168	180	189
Total Fixed Costs	53	53	53	53	53	53	53
Total Expenses	235	240	254	227	221	233	242
Expected Net Revenue	23	32	11	35	37	34	6
Change in Expected Net Revenue from Base (%)	n/a	39%	-53	51	59	48	-73

Table D.32 Economic Comparison Of BMP For Wheat In Ontario With Financial Assistance

	Base Model	Soil Testing	VRF	Min Till (\$/ac)	No-Till	NMP	Buffer Strips
Total Revenue	325	355	356	327	329	336	315
Total Variable Costs	196	201	217	187	182	193	203
Total Fixed Costs	63	63	63	63	63	63	63
Total Expenses	259	264	280	250	245	256	266
Expected Net Revenue	66	90	76	77	84	79	49
Change in Expected Net Revenue from Base (%)	n/a	37	15	16	27	20	-26

Table D.33 Comparison of Expected Net Revenue For Average Whole Farm (430 ac) Using BMP In Ontario With Financial Assistance

	Base Model	Soil Testing	VRF	Min Till (\$/ac)	No-Till	NMP	Buffer Strips
Corn	-2029	-413	-2819	-936	-1130	-804	-2112
Soybeans	3300	4596	2271	4181	4163	4883	3227
Wheat	9483	12948	10323	10271	10629	11370	9409
Total Expected Net Revenue	10754	17130	9776	13516	13662	15449	10525
Change in Expected Net Revenue from Base (%)	n/a	59	-9	26	27	44	-2

Quebec

Table D.34 Changes In BMP Costs* With Financial Assistance

	Soil Testing	VRF	Min Till	No-Till	NMP	Buffer Strips
Soil Testing Fee						
Without funding	4.5	0	0	0	0	0
With funding	4.5	0	0	0	0	0
Custom Application Cost						
Without funding	0	18.1	0	0	0	0
With funding	0	18.1	0	0	0	0
Equipment Cost						
Without funding	0	0	-1.4	5.4	0	0
With funding	0	0	-1.9	3.4	0	0
NMP Cost						
Without funding	0	0	0	0	1.3	0
With funding	0	0	0	0	0.6	0
Establishment Cost						
Without funding	0	0	0	0	0	11.1
With funding	0	0	0	0	0	3.3

*Note that operating interest may change as a result of changes in BMP costs.

Table D.35 Economic Comparison Of BMP For Corn In Quebec With Financial Assistance

	Base Model	Soil Test	VRF	Min Till	No-Till	NMP	Buffer Strips
	(\$/ac)						
Total Revenue	644	658	650	647	644	651	609
Total Expenses	729	744	749	715	709	727	718
Expected Net Revenue	-85	-86	-99	-68	-65	-77	-109
Change in Expected Net Revenue from Base (%)	n/a	-1	-17	20	24	10	-28

Table D.36 Economic Comparison Of BMP For Soybean In Quebec With Financial Assistance

	Base Model	Soil Test	VRF	Min Till	No-Till	NMP	Buffer Strips
	(\$/ac)						
Total Revenue	383	391	383	384	381	392	356
Total Expenses	478	489	496	463	458	475	479
Expected Net Revenue	-96	-97	-113	-79	-77	-83	-124
Change in Expected Net Revenue from Base (%)	n/a	-2	-18	17	20	13	-30

Table D.37 Economic Comparison Of BMP For Wheat In Quebec With Financial Assistance

	Base Model	Soil Test	VRF	Min Till	No-Till	NMP	Buffer Strips
	(\$/ac)						
Total Revenue	434	453	468	439	433	442	415
Total Expenses	481	495	507	467	460	478	480
Expected Net Revenue	-47	-42	-39	-27	-27	-37	-64
Change in Expected Net Revenue from Base (%)	n/a	9	16	41	41	21	-38

Table D.38 Comparison of Expected Net Revenue For Average Whole Farm (316 ac) Using BMP In Quebec With Financial Assistance

	Base Model	Soil Test	VRF	Min Till	No-Till	NMP	Buffer Strips
	(\$/ac)						
Corn	-8,968	-9,101	-9,839	-7,983	-8,251	-8,096	-9,094
Soybeans	-10,065	-10,250	-11,132	-9,132	-9,403	-8,715	-10,213
Wheat	-4,906	-4,460	-4,490	-3,819	-4,239	-3,872	-4,952
Total Expected Net Revenue	-23,938	-23,811	-25,461	-20,934	-21,892	-20,683	-24,259
Change in Expected Net Revenue from Base (%)	n/a	1	-6	13	9	14	-1

Prince Edward Island

Table D.39 Changes In BMP Costs* With Financial Assistance

	Buffer Strips (\$/ac)
Establishment Cost	
Without funding	21.7
With funding	7.4

*Note that operating interest may change as a result of changes in BMP costs.

Table D.40 Economic Comparison Of BMP For Potatoes In Prince Edward Island With Financial Assistance

	Base Model	Buffer Strips
	(\$/ac)	
Total Revenue	1556	1477
Total Expenses	2429	2437
Expected Net Revenue	-873	-960
Change in Expected Net Revenue from Base (%)	n/a	-10

Table D.41 Comparison of Expected Net Revenue For Average Whole Farm (563 ac) Using BMP In Prince Edward Island With Financial Assistance

	Base Model	Buffer Strips
	(\$/ac)	
Total Expected Net Revenue	-491,656	-494,097
Change in Expected Net Revenue from Base (%)		-0.5