Understanding Farmer Motivation and Attitudes Regarding the Adoption of Specific Soil Best Management Practices

Background Literature Review

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ACKNOWLEDGEMENTS

I would like to thank Bruce Kelly and Morgan Ellis of Food and Farm Care Ontario for their helpful comments and input, as well as the Project Advisory Committee for reviewing documents and providing useful references and feedback on the report. I would also like to thank Chris Mallon, Shauna-Lee Chai, Diana Staley and Kaelyn Hunter for Research Assistance.
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1. Introduction

This report reviews factors influencing farmer adoption of Best Management Practices for climate change. The focus of the study is on socio-demographic factors that influence motivation and attitudes to target programs to increase adoption. The scope of the study includes factors influencing adoption of soil and nutrient management practices for climate change mitigation; approaches for segmenting farmers into groups for the purposes of targeting programs; and a review of features and lessons learned from existing programs. Specific objectives include:

- Understand the process of adoption and behavior change including:
  - Factors that influence farmers’ motivations and attitudes;
  - The role of information and local support;
  - Socio-demographic and economic factors which are barriers to adoption;
- Understand how market segmentation or clustering techniques have been used to understand the adoption process and influence farmer behavior (including adoption of specific soil management practices);
- Review lessons learned and success factors for agri-environmental programs including:
  - Elements that target different groupings of farmers;
  - Knowledge and technical transfer (KTT) approaches that are successful for different groups of farmers; and
  - New ideas for program elements.

The review focuses on soil BMPs recognizing that while adoption behavior tends to be BMP specific, some relevant studies are not BMP specific:

- Diverse Crop Rotations (perennials)
- Use of Cover Crops to extend the months of ground cover with live plants
- Reduced tillage, residue management
- Organic amendments
- Afforestation, Buffer strips, windbreaks, wind strips
- Minimizing compaction
- Soil Testing
- Nutrient Management (4Rs, nitrification inhibitors, etc.)
- Retirement of Fragile Lands
• Erosion control (uncertain impact on climate change).

The information was synthesized into three sets of recommendations for developing programs to support climate change adaptation and mitigation practices for Ontario farmers:

• How Ontario farmers can be effectively categorized in “like-minded” groups based on the relative importance of factors (such as attitude, risk tolerance, socio-economic factors, social and peer supports) that drive their adoption of soil management practices;
• How to target engagement and messaging to enhance adoption of soil BMPs among different groups either directly or through influencers;
• Technology transfer methods that are expected to be effective now and in the future.

The main results and findings are summarized in the report “Understanding Farmer Motivation and Attitudes Regarding the Adoption of Specific Soil Best Management Practices: Summary and Recommendations”. This report provides the background literature review to support the summary and recommendations. The report is structured as follows. First we review frameworks for organizing and synthesizing information about factors affecting adoption behavior. In Section 3 we review the literature on factors influencing adoption behavior, providing a narrative description of the evidence and a summary of key findings and recommendations. These factors are related to farm characteristics for Statistics Canada farm regions in Ontario based on the 2016 Agricultural Census. The studies are summarized in a Table. In Section 4 we review the literature related to farmer segmentation approaches, providing a narrative summary of the literature as well as a detailed description of the studies reviewed and a summary table. Finally in Section 5 we review the main findings from the program review, as well as provide a summary of case studies for 11 programs.

2. The Reasoned Action Approach Framework

The Reasoned Action Approach (RAA) (Figure 1) is a well-used model that postulates that action is a result of intention, and attempts to describe and quantify the factors that impact intention (Fishbein & Ajzen, 2010; Hansson, Ferguson, & Olofsson, 2012; Jorgensen & Martin, 2015). Other frameworks that have been used in this literature are included in Appendix 1. The RAA has been developed over many decades, and is based on the theory of planned behavior (Ajzen, 1985), and the theory of reasoned action (Fishbein & Ajzen, 2010). This approach takes background variables as inputs, such as demographics of the individual landowner, characteristics of the farm operation, and information
regarding the landowner’s farming community and significant others, and uses them to describe or quantify behavioral beliefs, normative beliefs, and control beliefs. In this theory, behavioral beliefs are beliefs about the specific BMP (including the characteristics of the BMP), and whether or not it will have a positive or negative impact on the individual. Normative beliefs refer to both the individuals’ expectations of the actions of others (i.e. what their neighbors will do), and their beliefs regarding others’ expectations of the individuals actions (i.e. what their neighbors expect they will do). Finally, control beliefs refer to the degree of self-efficacy the individual believes they have in the present situation, specifically whether or not they are able to adopt the proposed BMP, due to skills, abilities, farm characteristics, and economic considerations. Each of the three types of beliefs creates intention, which then creates behavior. The advantage of this approach is that it considers psychological, sociological, and economic impacts on the perceptions of the landowner, which then impacts intention, and action. This theory can be criticized as making the assumption that all behavior is intentional, which may not always be the case.

![Figure 1 Schematic of the Reasoned Action Model, adapted from Fishbein & Ajzen (2010) and Jorgensen & Martin (2015).](image)

### 2.1 The Application of the Reasoned Action Approach

For the current project, the RAA is recommended as the framework for analyzing the literature. It is inherently interdisciplinary, and is designed to account for economic (internal and external), social, and psychological factors that impact the BMP adoption decision. As such, using this approach, the researcher can account for attributes like trust. It is also able to account for the characteristics of the landowner, the landowner’s community, and the BMP itself, which together form the causal nexus of the BMP adoption decision. The framework is also generic, and will therefore be easily applied to
different jurisdictions, and describe and evaluate different program elements. Additionally, it can serve as a basis for not just segmenting landowners, but for describing both their attributes and their perceptions, which are both important when panning extension programs. In essence, the framework takes elements from almost all of the frameworks described, and allows for a theoretically consistent analysis.

There is uncertainty around the link between intention and action (Sutton, 1998). In this study, the principles of expected utility theory assume that farmers derive utility from economic, social, and environmental sources. Therefore, the link between intention and action implies an evaluation of utility, and if the utility is above a specific threshold, the farmer adopts the BMP (Borges et al., 2015). The quantification of the utility threshold is beyond the scope of this work.

The determinants of adoption that have been studied in other works are categorized here based on the RAA into four categories: behavioral beliefs, normative beliefs, control beliefs, and background variables. In this context, behavioral beliefs refer to the landowner’s perception of the future impact of the BMP. Factors attributed to this category are factors of the BMP itself, such as its relative advantage, complexity, trialability, and observability. Normative beliefs refer to the landowner’s expectations of their neighbors, and their perception of the expectations of their neighbors. As such, this category describes factors that include interaction with others, such as extension officers, conservation agencies, family members, farm organizations, or customers. Control beliefs refer to a landowners perception of their self-efficacy. In this context, this category holds factors that pertain to the farmer’s capacity, such as their skill level, availability of credit, availability of expertise, or access to information, etc. Finally, background factors are things that can be quantitatively measured and refer to a trait of the farm or the landowner. These include age, gender, farm size, climate, income, etc. Through applying the RAA to describe these variables, the framework can conceptualize both quantitative measures, and more qualitative or perceived conditions that can impact the adoption of BMPs.

3. Factors affecting adoption behavior

3.1 Summary of the Studies by Study Characteristic

We reviewed 46 studies which are summarized in Table 3 below, at the end of this section. The following criteria were used to screen and select the studies that were reviewed: 1) Objective focus on socio-economic factors affecting adoption; BMP focus on soil management practices for crop systems (which could be implemented for either nutrient management or climate mitigation and adaptation); b)
Agricultural system focus on cropping systems, particularly corn and soy which are the predominant crops in Ontario; c) Geographic focus on Midwest and Great Lakes Regions in USA and Canada particularly those with a focus on Ontario farmers; d) Temporal focus within the last 10 years. The characteristics of the studies are as follows. In terms of methods, 35 involve primary data collection and 10 are literature reviews; 10 literature reviews. In terms of geographies, 26 studies focus on the USA, 13 are from Canada, 2 are from Australia, and 1 is from New Zealand. The remainder are not geography specific.

3.2 Narrative Summary

The main finding is that there are no universally correlated variables and no predictive models that are valid in every context (Carlisle 2016; Prokopy 2008; Kowler and Bradshaw 2007; American Farmland Trust 2013). Therefore, localized approaches to understanding adoption behavior are recommended. An important recent study for soil management practices is Carlisle (2016) who provides a narrative summary of recent literature for adoption of soil health practices in the US, focusing on the practices of cover cropping, crop rotation, and conservation tillage. The goal of that study was to understand the persistent adoption gap for these practices given that they are largely profitable and to make recommendations for policy and extension. McCallum’s (2003) review of the Environmental Farm Plan illustrates the multiple factors that motivate farm practice behavior in Ontario, with the most frequent motivations environmental concern (34.0%), followed by economics (23.7%), stewardship (21.1%), education (13.4%), and finally persuasion by others (4.0%). In the remainder of this section we report on the results of studies summarizing the factors using the Reasoned Action Model set out in the previous section.

3.2.1 Behavioral Beliefs

Pannell et al. (2006) found innovations are more likely to be adopted when they have a high ‘relative advantage’ (perceived superiority to the idea or practice that it supersedes), and when they are readily trialable (easy to test and learn about before adoption). Most farmers would participate in programs if the advantage to them was clear. Several studies emphasize the importance of response efficacy (e.g. Pannell et al. 2006; Niles et al. 2016; Wilson et al. 2014; Tosakana et al. 2010). Wilson et al. (2014) find response efficacy – belief that practice will make a difference, significantly influences attitudes especially for older farmers who are more motivated by profit. Reimer et al. (2012) found positive effects of increased response efficacy including reduced inputs, time-savings, and on-farm and environmental benefits. Similarly Dring et al. (2016) found farmers in Quebec were motivated to adopt
controlled tile drainage by soil water retention benefits, increased crop yields, and gratification at improving the environment. Finally, farmers need to know that there is a problem and that they are part of the solution. Understanding that there is an environmental response is particularly important as farmers feel they are already good and innovative environmental actors and need to be convinced they are not doing enough (McCallum 2003).

Economic Efficacy

Economic factors include cost of transitioning to new practices including labor and capital, financial capacity, risk, and deferred economic benefits (Presley 2014). Several studies note the importance of economic benefits for positively influencing adoption and attitudes towards adoption (Vanclay 1992; Pannell et al. 2006; Prokopy et al. 2008; Sassenrath 2010; Reimer and Prokopy 2014). Wilson et al. (2014) found perceived cost of practices was significant for profit oriented farmers. Costs, particularly labor and operating costs (e.g. Brick 2013; Tosakana et al. 2010; AAFC 2012) and opportunity costs (Carlisle 2016; Luymes 2017) are important barriers to adoption – particularly for adoption of cover crops (Carlisle 2016, Miller et al. 2012). Yields are also an important motivator - interviews with Lake Erie farmers indicated that they were motivated by farm yields and practices which reduce yields would not be adopted (Luymes 2017). Niles et al. (2014) found farmers who have already adopted climate mitigation practices are less likely to further mitigate even though there are many additional practices that could be adopted suggesting that practices were adopted for profitability and not climate change mitigation. Similarly, Andrews et al. (2013) found that the reasons for choosing conservation tillage included concerns about soil erosion; soil productivity, water quality, and carbon, however most farmers who adopted the practice did so to improve yields. Nonetheless, in her comprehensive review Carlisle (2016) finds evidence that direct profit motives may not be as strong as other motives, and that farmers are more concerned with productivity and maintaining yields and long term soil health rather than immediate financial benefits.

Compatibility with Existing Practices

Compatibility with existing system including increased labor and time and specialized equipment requirements, incompatibility with cash crop rotations and market constraints and site-specific factors related to climate, soils, etc. (Presley 2014). One of the most important agronomic barriers to adopting soil health practices is fitting these practices into the growing seasons with commodity crops – particularly for the practice of cover crops which interacts with the timing of spring planting and fall harvest (Carlisle 2016; Miller 2016; Dunn et al. 2016). Agronomic barriers are more pronounced for large
farmers, those unfamiliar with cover crops and soy producers. Cover crops may also compete with soil moisture for cash crops (Carlisle 2016). Miller et al. (2012) cited long-term soil improvement as the most important reason for planting cover crops. Their greatest challenge is finding time to work a cover crop into their cash crop rotation (Miller et al. 2015). Agronomic barriers to cover crops may be lower for meat and vegetable producers as cover crops can be used for grazing and also provide more direct benefits for vegetable production (Connor et al. 2016).

The cost of cover crops is viewed as limiting adoption (Miller et al. 2012; Carlisle 2016) however Dunn et al. (2016) found that cost sharing was not a significant factor for expansion of farmers who already undertake cover cropping. Issues of timing and capital costs and lack of equipment were cited as barriers to cover crop adoption in Lake Erie (Luymes 2017). This suggests emphasizing agronomic benefits for long term soil health and solving existing agronomic problems in extension programs (Carlisle 2016).

**Risk and Uncertainty**

Related to environmental and financial efficacy is the certainty of outcomes which is related to a positive attitude towards risk as well as the ability to test the practice to reduce risk positively influence attitude towards adoption (Presley 2014). Early adoption of cover crop practices has been associated with willingness to self-learn and experiment through trial and error (Dunn et al. 2016). Trialability, observability, past experience of environmental events and perceived adaptive capacity are positively associated with a positive risk attitude (Vanclay 1992). Contact with extension agencies and learning also reduce risk. Negative factors about the BMPs that increase risk include complexity of the BMP as well as observability of the outcome including length of time to implement the practice and realise economic benefits. Divisibility of the practice, or allowing for partial may increase adoption rates and probability of full adoption and is associated with higher trialability and lower risk (Vanclay 1992). Trialability of cover crops may be particularly challenging. Perceptions that cover crops make planting more difficult and that they are tough to terminate are major limiting factors to adoption (Dunn et al. 2016).

Complexity was mentioned in several studies as a factor impeding BMP adoption. More complex innovations are difficult to understand, require greater management skills, and increase risk (Vanclay 1992; Pannell et al. 2008; Connor et al. 2016; McCann 2017). However, Reimer et al. (2012) found perceived risk and complexity associated with specific practices were only found to limit adoption for a few practices. Information reduces risk and is positively associated with adoption (Baumgart-Getz et al 2012; Prokopy et al. 2008). Adoption is also associated with observability of the practice and its effects.
For example, farmers were more likely to adopt manure management practices such as manure setbacks which have a more observable effect on water quality (McCann et al. 2017). The hidden benefits of sustainable practices in contrast to immediate costs is a barrier to adoption (Carolan 2006). Carolan (2006) highlights the time lags between actions and benefits and the hidden nature of the costs of conventional agriculture versus the immediate costs and long run returns of sustainable agriculture as an impediment to sustainable practice adoption.

**Environmental Efficacy**

Reimer and Prokopy found that farmers were motivated by the environmental benefits of practices, in particular public (or off-farm) environmental benefits were the most significant motive. Similarly, Nebel et al. (2017) found the most highly rated motivation to participate in a wetland enhancement program was 'more information on how the decline in wetland area affects them personally'. Jahusz (2014) found farmers motivated by health impacts on farm and animals. Thus lack of control over environmental outcomes had a negative effect on adoption. For example, Niles et al. (2014) found perceived adaptive capacity was associated with actual practice change, which could be related to a sense of powerlessness influencing non-adopters (Niles et al. 2014). Similarly, Luymes 2017 found lack of perceived control over phosphorous levels a barrier to adoption in Lake Erie farmers.

**Lack of Appropriate Monitoring and Reporting Metrics**

Genskow and Wood (2011) review data and information required to support voluntary programs, noting that a barrier to learning about the efficacy of new practices is lack of suitable data and metrics to move beyond anecdotal information. For example, effectiveness of water quality programs has been tracked using physical and chemical measures related to ecological and public health but those measures are slow to respond to BMPs making practice efficacy and assessment of voluntary programs difficult.

### 3.2.2 Normative Beliefs

**Environmental Concerns**

Positive Factors identified in this category include: ethical attitude towards community; environmental concern variables, stewardship motivation (positively correlated with participation with conservation agencies and conservation program awareness), profit motivation, local network participation, proximity of other adopters (could also be a behavioral belief), strength of neighborhood networks (3/4 studies), pro-government attitude; trust attitude; support for government regulation. Negative normative factors included – attitude towards climate change, farming heritage, social beliefs
about what is good farming, the perceived ‘oddness’ of practice; gendered social networks. Ties to conservation agencies have been found to be relatively strong predictors of BMP adoption (Lockeretz 1990; Prokopy 2008). Congruence with farm and personal objectives including management approach, age of life and family decisions (Vanclay 1992).

Agri-environmental extension activities and advisory clubs play an important role in disseminating information, raising awareness of BMP adoption and ultimately affect the supply of ecological goods and services (Tamini 2011). Sassenrath et al. (2010) found Social drivers, especially internal social drivers, are one of the two most prominent drivers impacting production decisions. Wilson et al. (2014) found the belief that negative impacts to profit and water quality from nutrient loss were likely, was the most consistent predictor of farmer willingness to adopt nutrient management BMPs.

**Ethical Attitude**

Ethical attitude – or care for impacts on others - is associated with intrinsic motivations and positively associated with adoption and protecting the environment. These motivations are associated with conserving land for future generations; attachment to the land; and reducing harmful pollution for downstream neighbors and provision of off-stream environmental benefits (Andrews et al. 2013; Carlisle 2016; Reimer and Prokopy 2014). In Canada, ethical attitudes have been shown to have both positive (Nadella et al. 2014) and insignificant (Brick 2013) effects on conservation behavior. However, Nebel et al. (2017) found ethics was a significant factor for land conservation and that environmental attitude was the strongest predictor of pro-environmental behavior.

**Beliefs and Attitudes about Climate Change and the Environment**

The level of belief about climate change and its causes very considerably among farmers and therefore causes attitudes towards adaptive and mitigative actions to differ amongst farmers in systematic ways (Arbuckle et al. 2013). However, general concern about the environment was a significant factor for adoption in several studies (Niles et al. 2014, Arbuckle et al. 2013, Barnes et al. 2011, & Andrews et al. 2013). Environmental Awareness and Knowledge are also positively associated with adoption (Prokopy et al., 2008; Baumgart-Getz et al. 2012; American Farmland Trust 2014) and tend to be captured by past experience with a climate event, or concern for the environment. Farmers who believed that climate change is occurring and attributable to human activity were significantly more
likely to express concern about impacts and support adaptive and mitigative action (Arbuckle et al. 2013).

Baumgart-Getz et al. (2012) examined the different factors motivating intended versus actual adoption of mitigation practices. They found actual adaptation and mitigation were uncorrelated with beliefs and attitudes about climate change, and positively correlated with favorable perceptions of government intervention. However, climate change attitudes and belief were associated with intended adoption. For example, Roesch-McNally et al. (2017) found that farmers who believed they should adjust their practices to protect their farm from the negative impacts of increased weather variability were more likely to indicate that they would increase their use of BMPs in response to climate change. Visiting other farmers to observe their practices was also positively associated with farmers' intentions to increase their use of BMPs. Also, farmers who were using BMPs reported that they intended to increase their use of BMPs in response to weather variability associated with climate change, however, for those who reported a high level of confidence in their current practices were less likely do make any changes. There is no evidence that subjective norms, related to climate change policy, significantly influenced either intended or actual adoption. Only perceived capacity and self-efficacy were important predictors of both intended and actual adoption.

Norms and Trust

Studies suggest that norms in a commodity/cash crop culture may be barriers to beneficial practices. Marketing context and social norms are seen as promoting conventional agriculture with focus on short term yields and profits over sustainable practices (Carolan 2006). Farmers may be reluctant to be out of step with their peers and seen as showing off if they are early adopters. For example, McCallum (2003) found the perception by some farmers that program participants might be viewed as status seekers, and others did not want to advertise that they were participating in programs. In the farming subculture there are norms about the agricultural management practices that are acceptable in the community which affects attitude and motivation (Vanclay 1992). Farmers may care about the look of their properties and fields and certain tillage and management practices may not be viewed as productive or good.

Studies emphasized the importance of working with social infrastructure, particularly networks between producers, to convey information about farming and create environmental awareness. Higher levels of social networking, and environmental awareness are positively correlated with adoption, particularly interactions between farmers and with extension agencies (Prokopy et al. 2008, Baumgart-
Getz et al. 2012). In an Iowa study, McGuire et al. (2013) examined the impact of social context on pollution reducing activities for corn and soy production and found when individuals received input from the social environment that defined them as polluters they took action to clean up their watershed. In terms of “isolation” Juhasz (2014) also found no significant relationship between the strength of their social relationships and degree of program participation. Dairy farmers saw themselves as independent/individualistic and worried about the “group think” of networks, as well as potential corporate agendas of some farmers and advisors pushing “pharma’ or fertilizer.

3.2.3  Control Beliefs

Control Beliefs concern the farmer’s perceptions about her/his capacity to adopt the practice. These factors depend on knowledge and skill levels, financial capacity, and technological and policy barriers and enablers.

Knowledge/Skill

Knowledge and access to information have positive impacts on adoption, specifically the environmental and agronomic benefits of these practices and understanding the potential costs and ability of farmers to successfully implement practices. Knowledge mitigated perceived barriers such as local climate conditions or interference with a cash crop and first-hand experience was the most effective source of information (Carlisle 2016).

Several studies noted the importance of extension and the need to help farmers to understand how to implement practices (McCallum 2003, PRA 2011, Jahusz 2014). The importance of peer learning was emphasized and mistrust by farmers of government agencies and their personnel is a potential barrier (McCallum 2003, PRA 2011, Juhasz 2014). Blackstock et al. (2010) found that while peer to peer networks are important that farm heterogeneity is also important so it is necessary to tailor advice to different farm segments. Juhasz (2014) found no statistically significant relationship between social sources of information about agri-environmental programs and degree of program participation. Juhasz (2014) also found farmers learned about programs through a wide variety and multiple sources. Importantly, farmers are less likely to learn or adopt new practices based on observing their neighbors.

Where or who farmers obtain information from determines who the important influencers are, and which BMPs will be adopted. In Ontario, Juhasz (2014) found no statistically significant relationship between participation of a farmer’s immediate neighbor and their own participation. Friends, industry and farm organization contacts were more important. Weber and McCann (2015) found Information
The source for N recommendations was significant in adoption; farmers who did not obtain external recommendations from crop consultants and fertilizer dealers were less likely to adopt practices than farmers who received recommendations from these sources though the practice adopted depended on the source. Collaborative extension may be most important for BMPs that have watershed level benefits but not individual farm benefits. For example, Campbell et al. (2011) found that collaboration per se did not result in higher rates of BMP adoption than traditional, agency-based approaches, but that partnerships resulted in the selection of more collaboratively beneficial BMPs rather than individually efficacious BMPs.

Financial Capacity

The financial capacity to cover investments in new practices, including physical infrastructure costs such as fences and seed costs, costs of new equipment, as well as increased operating costs are impediments to adoption including adoption of profitable BMPs that have long term payoffs. Capital costs, particularly equipment barriers were important for both cover crop and crop rotation BMPs, and prevented opportunities for low cost experiments for these BMPs (e.g. Carlisle 2016). Cost share may be more important for non-adopters than early adopters, and may remove financial barriers for farmers whose primary motivations are noneconomic (Arbuckle 2013).

In Canada, Dring et al. (2016) found that capital and labor costs were also impediments to adoption of tile drainage in Quebec. Financial capacity is linked to farm income, sources of farm income, and indebtedness. Participation was positively and significantly associated with farm income (Dupont 2010, Nebel et al. 2017) Juhasz (2014) reported that one of the most prominent issues for farmers was indebtedness and the need to finance operating costs to adopt BMPs or complete projects. However, Brick (2013) and Nebel et al. (2017) found insignificant correlations for debt load. Financial barriers may be BMP specific. For example, Tosakana et al. (2010) did not find that financial capacity or capital costs were deterrents to practice adoption for gully plugs and buffer strips.

Technology and Policy Barriers and Enablers

Technological barriers to beneficial practices include lack of access to specialized equipment as well as lack of science on how to implement best practices. Technological barriers to cover cropping and using crop rotation include locating varieties bred to thrive in the particular local region, accessing appropriate technical assistance and equipment. Higher value and shorter season crops are associated with cover crops, however, yield-oriented corn varietals are moving towards earlier planting dates leaving less time for cover crops (Carlisle 2016). The farm and food system context is identified with the
interpretive frames that farmers have about soil health practices and what is productive. Reimer et al. (2012) find technology adoption is positively correlated with compatibility with farm system and needs of producer.

Commodities are tied to particular marketing infrastructures that may not exist in certain areas (Vanclay 1992). The farm and food system context can be a barrier to adoption. This includes markets, research, technical assistance, agricultural financing, policy, and rural culture which all serve dominant cash crop systems and constrain cover cropping and crop rotation (Carlisle 2016). Cash crop and marketing constraints were also noted by Presley (2014). Market system barriers to cover cropping include finding willing agricultural lenders, and markets to sell their crop (Carlisle 2016; Miller et al. 2012).

Policy barriers include business risk management (Carlisle 2016) and perceived loss of flexibility (Vanclay 1992). Interactions with some cover cropping practices resulting in loss of crop insurance coverage, or uncertainty in coverage due to lack of policy clarity (how cover crops are classified, vegetables, fruits, fallow or not). There are also cross compliance policy barriers with cover crops receiving a poor ranking in the Environmental Quality Incentives Program (EQIP) (Carlisle 2016).

Several studies note the importance of incentives for reducing financial barriers (e.g. Reimer and Prokopy 2014, Presley 2014, Dring et al. 2016, Dupont 2010, Connor et al. 2016). A survey of farmers by Ipsos-Reid (2006) found cost of adoption to be one the main reasons cited for not using a specific BMP (33%) and (84%) felt it was important for the government to provide some sort of financial assistance for BMP adoption, a finding also reported by Filson (2009). Support/financial incentives for those asked to participate in programs, 29% felt that there needs to be more funding with the EFP, and 26% felt that there needs to be more EFP education and training. PRA (2011) found that 23% of the EFP survey respondents lacked finances to implement identified actions. On the flip side, lack of awareness of cost share and technical assistance can be a barrier (Reimer and Prokopy 2014). Awareness is greater for farmers who have ties to social networks, particularly those who are better connected to other farmers using soil health practices, as well as technical providers, agricultural retailers and researchers (Carlisle 2016).

3.2.4 Background Factors:

Background factors include socio-economic and demographic variables that relate to the farming enterprise including biophysical factors, farm size and gross receipts, farm type, level of off-farm
income, tenure, education, debt levels, and family and intergenerational factors. A study by Agriculture and Agri-Food Canada (AAFC 2012) found several socio-demographic factors influencing adoption were significant including education, age, gender, farm residence, farm size, and organic certification. However most syntheses of the literature find far less congruence of evidence. For example, the American Farmland Trust (2014) review found that of 170 variables, education was the only socio-demographic variable that was significant.

Socio-demographic factors

**Age**

- The impact of age is inconclusive with both younger and older farmers being positively and negatively associated with adoption in different studies, for different reasons. For example, Niles et al. (2014) find older farmers were positively associated with adoption, while positive attitudes were also associated with younger more educated farmers (Wilson et al. 2014). Carlisle (2016) found younger farmers might adopt soil health practices at higher rates because they have longer time horizons to realize benefits, are more likely to be environmentally oriented, and more open to learning and less influenced by community and social factors. However older farmers were more likely to recognize erosion and other soil health problems (Carlisle 2016). Several Canadian studies found practices were not correlated with age (Nebel et al. 2017, PRA 2011, Brick 2013, Filson 2009, Juhasz 2014). However, Jahusz (2014) did find differences between older and younger farmer attitudes towards debt which could reflect life cycle effects and could interact with practice adoption.

- Length of farm ownership was inconclusive with some studies showing positive correlation between number of years farming (PRA 2011, Brick 2013) and others finding that newer farm owners were more inclined to participate than long time farmers, perhaps because newer farmers have fewer ties to informal networks and norms that are resistant to change (Juhasz 2014).

**Education**

- Many studies find education is positively correlated with adoption (Niles et al. 2014, Carlisle 2016, American Farmland Trust 2013). The American Farmland Trust study found that education was one of the only consistently significant positive factors in their literature review. Interestingly, in Canadian studies, Education was insignificant (Filson 2009, Juhasz 2014) or negatively correlated with adoption (PRA 2011).
• Gender

Some studies find that women have more positive attitudes towards adoption (Niles et al. 2014) but are less knowledgeable about BMPs and less likely to adopt conservation practices, perhaps because they have less access to technical knowledge and knowledge networks (Carlisle 2016). Female landlords may be less likely to require adoption of soil health practices for fear of losing tenants and gendered norms around BMPs (Carlisle 2016, Carolan 2005). Juhasz (2014) found that gender was not a significant factor for dairy farmers in Ontario. Barbercheck et al. (2012) developed a baseline of female participation in sustainable, organic, commodity based and general agricultural groups. They found that female participants in organic agriculture organizations tended to be younger, have less farming experience, and more formal agricultural education than members of commodity-based, general farm and women’s agricultural groups. Practices supported were different for different groups with compost production/application, crop rotation, manure incorporation, and organic crop and livestock production more likely among members of sustainable/organic agriculture organizations, but less likely among members of general farm organizations. Integrated pest management was more likely with general farm organizations and for women motivated by profit and yield. Overall the results show that motivations for female producers are as varied as those for the farm sector in general (Barbercheck et al. 2012).

• In summary, the results for socio-demographic factors are unclear and inconclusive, particularly for Canadian studies reviewed. Of the farm factors reviewed, farm size was the most consistent factor.

Farm Factors

Farm size, farm income, capital, percent income from farm, and tenure (owning land) all have positive impact on adoption (Baumgart-Getz 2012, American Farmland Trust 2014).

Farm Size

• Farm size was the most consistent positive determinant of adoption (Prokopy et al. 2008; Carlisle 2016); Larger farm size and higher farm returns correlated with greater adoption of soil health practices like no-till and cover cropping and can spread initial investment over greater acreage and utilize higher revenues to cushion risks (Carlisle 2016). On the other hand, small farmers should not be ignored as they may be more motivated. Smaller farms planted a greater percentage of their acreage to cover crops and they may be more likely to recognize soil erosion and associate cover
crops with environmental benefits than larger-scale farmers (Carlisle 2016). In Ontario, a significant positive correlation was found between property size and net change in conservation land (Brick 2013). Size of the farm is a significant predictor of the proportion of operated land cover crop users planted to cover crops-larger farms are more likely to have a larger proportion of their farmland planted to cover crops (Dunn et al. 2016). Larger farms are also more likely to discontinue cover cropping (Dunn et al. 2016).

• In Ontario, the farms most likely to be implementing BMPs are the larger farms (Filson 2009, McCallum 2003, PRA 2011, Brick 2013, Juhasz 2014) with greater gross farm sales (Filson 2009). Environmental Farm Plan participants tend to have higher revenues and larger farms than the Ontario average, however newer participants tend to be smaller (PRA 2011). McCallum (2003) found low participation rates occurred in regions that had high net returns and the highest environmental risk in terms of habitat and biodiversity loss, and non-point source pollution (McCallum 2003). Nadell et al. (2014) found that conservation till was more likely on larger plots of land, and on land planted to soybeans and less likely on land planted to corn (possibly due to residues associated with corn crops). Cover crops were less likely in fields grown to soybeans, and more likely in fields growing winter wheat. Nebel et al. (2017) found the area of land set aside for conservation was positively related to land type.

Farm Tenure

• Research shows fewer conservation practices are generally used on leased land (American Farmland Trust 2014). Carlisle (2016) found no consistent relationship between soil health conservation and land tenure, but this may be because share renters and cash renters behave differently with the former behaving more like landowners and more willing to adopt conservation practices with medium to long run benefits (Carolan 2005; Varble et al. 2016). Interestingly, the amount of land in share cropping is increasing in Ontario. Varble et al. (2016) and Nadella et al. (2014) both found renters were more likely to practice short term BMPs such as conservation tillage than crop rotation. Varble et al. (2016) also found renters were more likely to access information from government sources than the farming community. A significant positive correlation was found between length of farm ownership and net change in conservation land (Brick 2013). Tosakana et al. (2010) found leasing had a significant negative impact on the adoption of gully plugs. Filson (2009) found that land ownership had a slightly negative effect on adoption, however the study was not structured to examine tenure specifically.
Off-farm Income

- Both low levels of off farm income and high levels of off-farm income contributed to lower participation rates – possibly illustrating the correlation of high off-farm income with part time farming, and low levels of off-farm income with more economically marginal farms or more traditional farms (PRA 2011). McCallum (2003) found significant differences between Primary (farming is the primary source of income) and Secondary (farming is the secondary source of income) with secondary farmers less motivated by environment and stewardship and more motivated by financial factors. Primary farmers were also more aware and more active in programs (McCallum 2003). Nebel et al (2017) found that willingness to set aside land was more likely for landowners who do not rely on farm income, while enrollment in a stewardship program was less likely.

Internet Use

- Internet use had mixed results with Dupont (2010) finding a positive correlation and Juhasz (2014) no correlation between internet use frequency and degree of program participation.

3.3 Ontario Farm Characteristics

Table 1 below sets out farm management practices captured by the 2016 Census of Agriculture for the regions of Ontario. The table shows which regions lead in terms of practice adoption and which may need to target more non-adopters, recognizing that the potential for certain BMPs is also limited by farm type (e.g. cattle versus cropping operations) which is not represented here. Table 1 shows that the adoption of grazing management BMPs is highest in percentage terms in the Central, Eastern, and Northern regions. On the other hand, adoption of winter cover crops is relatively high in Western and Southern Ontario at 35% and 25 % respectively. The adoption of shelter belt practices and plowing down green crops was similar across regions. Finally, it is important to note that the number of farms adopting practices does not necessarily translate into an equivalent number of hectares in these practices.

<table>
<thead>
<tr>
<th>Region</th>
<th>Land Practice (# Farms and % of Farms)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In-field winter grazing or feeding</td>
</tr>
<tr>
<td></td>
<td>Rotational grazing</td>
</tr>
<tr>
<td></td>
<td>Plowing down green crops</td>
</tr>
<tr>
<td></td>
<td>Winter cover crops</td>
</tr>
<tr>
<td></td>
<td>Windbreaks or shelterbelts (natural or planted)</td>
</tr>
</tbody>
</table>

Table 1 Adoption of Farm Management Practices by Region (2016)
Table 2 below summarizes significant farm characteristics for Ontario indicating emerging trends that are relevant to engagement and the success of farm programs. First, the average age of farmers is high (mid 50s) and increasing. Thus farmers are getting older which may make some less innovative and open to new ideas, while other older farmers may be motivated to leave an environmental legacy.

Tenure was found to be a significant factor for adoption of soil management practices in a number of studies because renting tended to orient operators towards short term cash gains as opposed to long term soil productivity improvements. Share cropping is seen as a way for operators and land owners to better share risks of adopting new practices and for investing in practices with longer term gain. The 2016 census shows that renting and leasing is declining in Ontario, and crop-sharing is increasing, particularly in Western and Eastern Ontario. Adoption was found to be positively related to farm size and farm receipts (financial capacity). Average farm receipts are increasing throughout Ontario as is farm size. The largest farms are in Eastern and Northern Ontario – Northern Ontario farms are about 50% larger than Southern and Western region farms. Non-farm work is negatively associated with adoption. In 2016, the dependence of income off-farm was shown to be decreasing. Gender issues are also important and Table 2 shows that the ratio of male to female operators is declining, suggesting that addressing female issues in designing engagement strategies will be increasingly important though it is important to note that female farmers are heterogeneous with different motivations.
3.4 Summary of Lessons Learned on Factors Affecting Adoption

Recognize Adoption is a multi-stage Process

- Different motivations for planned versus actual adoption must be considered in program design (Nile 2014). Non-economic factors are primary for motivating adoption, while economic factors are important once farmers are motivated to adopt (Carlisle 2016).

- Work on increasing awareness of environmental impacts and practice efficacy for non-adopters (Carlisle 2016). Similarly, Baumgart-Getz et al. (2012) recommend a two-tiered approach, which targets farmers who are more likely to adopt first, along with efforts to strengthen community-based social networks to encourage BMP adoption in the longer term for farmers those less likely to adopt. Extension needs to be targeted to various economic and motivational issues for the non-adopters (Arbuckle et al. 2013).

Increase Compatibility with Agronomic System

- The farm and food system context is an agronomic as well as social-and institutional barrier (Carlisle 2016). There are interactions and synergies amongst adoption conservation practices and that practices may be adopted together (Carlisle 2016). Greater research on more compatible and cost-effective practices also recommended (Arbuckle et al. 2013; Carlisle 2016).

- Cover cropping is often incompatible with the farm-food system and the agronomic system. Suggestions for increasing cover crops include: program flexibility to accommodate differences particularly allowing flexible dates for cover crop planting and termination and expand incentives; offering discounted crop insurance premiums for cover crops; and address the cash crop context by additional research on short season rotation crops leaving more time for winter annual cover, and early harvest corn varieties, with high yields (Carlisle 2016).

- Capital barriers can be addressed through equipment cooperatives and low interest loans and encourage cropshare leasing to increase time horizons for returns and risk sharing between
landowners and tenants (Carlisle 2016; Miller et al. 2012). Dunn et al. (2016) suggest showcasing local examples where limitations have successfully been overcome and note that many current adopters are expanding their cover crop land without the use of cost-share funding. Extension efforts should focus on selection and management of cover crops; target particular groups such as renters or women (Carolan 2005).

Create new social ties and institutional arrangements

- Several studies suggest that policies that invest in social capital may help create a sufficiently enabling environment for the adoption of BMPs (Tamini 2011; Prokopy et al. 2008). The studies are vague on what this social capital would consist of and discussions with farmers and surveys should help address this question for different farming contexts (e.g. styles and regions).

- Carolan (2006) recommends forming new social ties and institutional arrangements that reveal novel ways of knowing and seeing the hidden costs of conventional agriculture, and which operate through existing social and marketing networks. These include labeling strategies such as organic certification, and food mile approaches which reveal whether pesticides and herbicides are used, or the embedded energy content of foods. New institutional arrangements are also needed, which involve the integration of farming systems with diverse networks of people, institutions, and communities to foster trust and community learning (Carolan 2006).

Peer Led Collaboration and Extension

- Extension should lean more towards peer based cooperative learning (Fell 2000; Pannell et al. 2006; American Farmland Trust 2013; Presley 2014; Luymes 2017). Participation in collaboration has been shown to lead to different BMP strategies, with collaboration leading to more collective BMP strategies between farmers and traditional settings focusing on individual BMP strategies (Campbell et al. 2011).

- Increase producer awareness of environmental problems and then determine who is in the best position to provide education and technical assistance (American Farmland Trust 2013). Peer led solutions are important, particularly where there are issues around language and framing, and farmer needs can be determined by surveys and consultation as well as focus groups (Luymes 2017; American Farmland Trust 2013). Several studies recommend a participatory process where landowners can help to shape the research and extension process (Luymes 2017; Pannell et al. 2006).
Ensure that programs build credibility and trust

- Conservation Authority and ALUS (ALUS) programs, which respect property rights and are delivered locally are viewed favorably, and peer led engagement that increases the perceived control of farmers over their public image and support farmers’ attempts to build stronger connections to consumers will be important for motivating farmers and changing attitudes. Information sources can be significant for adoption (Weber and McCann 2015) so it is important to ensure advisor credibility and trust. (Pannell et al. 2006)

Create awareness of environmental impacts

- In order to change behavior, farmers must be aware that there is a problem (American Farmland Trust 2013). Although communication should have a positive tone and message, communication efforts should focus on the negative impacts of nutrient loss on farm profits and on environmental damage to increase awareness of the problem (Wilson 2014). McGuire et al. (2013) - Provide information about the polluting impacts of activities in a shared setting to leverage ethical motivations of producers. Clarify and promote practices that will reduce climate related risks at both field and landscape-scale to farmers that have confidence in their capacity to adapt to climate change (Roesch-McNally et al. 2017).

Use plain language

- Certain patterns of word usage that occur in institutionalised agricultural extension (directives and dogma, technical jargon, hiding behind formality, empty words, criticism, planning terminology and motherhood statements) are barriers to effective communication (Fell 2000)

Use conflict reducing value frames

- Consider value frame and contrast reinforcing frames; subjects can use the same value information but come to opposite conclusions (Andrews et al. 2013). For example, climate change impact information reinforces care for climate for climate change believers, and reinforces negative attitudes for non-believers. For non-believers, introduce BMPs from a different perspective; e.g. frame BMPs as good for society rather than good for greenhouse gas reductions (Andrews et al. 2013). Similarly, a small minority of skeptical or resistant producers can have large impact on political feasibility so it is important to be aware and sensitive to this group’s issues, particularly promoting dual-purpose practices could be an effective way to achieve both adaptation to and mitigation of climate change (Arbuckle et al. 2013). BMPs should be framed in terms of their practical and economic benefits rather than strictly environmental messages (Luymes 2017).
Increase Opportunities for Demonstrating Practice Efficacy

- Understanding practice efficacy, or the environmental and economic benefits for the farm and watershed is one of the most often cited factors for motivating adoption. Several studies recommend raising awareness of the on-farm and financial benefits, the environmental benefits, and compatibility of conservation practices with current farm operations (Reimer et al. 2012). Fostering perceived capacity and self-efficacy for individuals may be crucial for encouraging both intended and actual adoption of climate adapting and mitigating behaviors (Niles et al. 2016). If the environmental effects of practices and technologies are more observable to farmers, or can be made more observable by changes in technology, this should increase adoption. For those practices with large impacts that are not easily observable, increased educational efforts may be warranted (McCann et al. 2017). Greater effort is needed to improve the trialability and observability, decrease complexity, and investigate ways to better integrate practices into diverse farming systems (Connor et al. 2016).

Use demonstration sites

- Increase visibility of success by maintaining demonstration farms and observation sites for farmers to witness the dynamic impact of conservation practices (Tosakana et al. 2010; Presley 2014).

Provide financial incentives

- Financial incentives are important for overcoming risks and barriers to BMP adoption for potential adopters particularly if trialability is costly and to increase uptake (Presley 2014; Dupont 2010; Pannell et al. 2006; Stuart et al. 2015; Dring et al. 2016). Higher payments may be needed to incentivize broader BMP adoption, particularly those BMPs which are complex or novel (Connor et al. 2016).

Develop BMP Specific Programs

- The farming community is heterogenous, even within one catchment, and advice needs to be tailored to individual farmer needs. Determine what types of famers are represented in engagement processes, what capacity they have to participate and how their participation influences farmer to farmers transmission of information and advice (Blackstock et al. 2010). Sociodemographic information can be combined with regionally specific context to help target agri-environmental programs (AAFC 2012).

- There is no one-size-fits-all approach and the type of BMP that is being considered for adoption is an important factor to consider when attempting to predict behavior (Brick 2013; Pannell et al. 2006). It is important to pay attention to the regional geographies that impact the decision processes of
farmers (Knowler and Bradshaw 2007). In terms of policies, increase education, technical assistance, and financial assistance where BMP adoption incurs costs and there is substantial potential public benefit and consider regulation and taxes where certain BMPs are required (Knowler and Bradshaw 2007). Addressing specific BMPs should be done in geographical regions where they could be most beneficial. i.e. more geographically-specific programs may be beneficial (Stuart et al., 2015; Afari et al., 2008). Use multiple channels and segment the population (e.g. Pannell et al. 2006).

Develop separate engagement strategies for tenants and landlords
- Renters are willing to adopt some conservation practices especially those with short term benefits and they tend to use federal gov. employees as their primary sources of conservation information (Varble et al. 2016). Reaching out to non-operating landowners through marketing strategies could help accelerate the use of conservation practices (American Farmland Trust 2013). Varble et al. (2016) found that printed materials are useful for reaching out to landlords.

Target programs to increase efficiency
- Most farmers agree with targeted programs to maximize efficiency and increase adoption on lands that could significantly improve environmental outcomes. A minority of farmers feel that targeting is intrusive so be aware of their issues to ensure political feasibility (Arbuckle 2013).

Establish Baselines and Monitor Attitudes
- Voluntary programs require information about factors influencing landowners, particularly social and psychological factors. Genskow and Wood (2011) - New measurement approaches are needed to signal interim success including attitudinal data to better understand the relationship between social norms, knowledge, and attitudes that underpin landowner decisions. Performance measurement data need to be social and ecological (Genskow and Wood 2011).
### Table 3 Summary of Literature Reviewed for Factors of Adoption of BMPs

<table>
<thead>
<tr>
<th>Study</th>
<th>Objective</th>
<th>Country &amp; Region</th>
<th>Method</th>
<th>Sample Size</th>
<th>Year</th>
<th>Findings</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prokopy et al. (2008)</td>
<td>Synthesize research on statistically significant determinants of BMP adoption in the United States</td>
<td>US</td>
<td>Literature review using vote count method.</td>
<td>55 studies</td>
<td>2008</td>
<td>Several socio-economic factors are found to be determinants of adoption: education, income, farm size, existing capital, diversity, available labour, and access to information.</td>
<td>Understand how characteristics of the conservation practices interact with motivations. Focus beyond initial adoption and consider who will maintain practices over time. Map farm networks and target well-respected farmers who are willing to share successes and challenges. New farmer/agribusiness/conservationist networks can be cultivated and leveraged for success when facilitated by persons with both social and technical farming skills.</td>
</tr>
<tr>
<td>Baumgart-Getz et al. (2012)</td>
<td>Quantitatively synthesizes the literature on the statistical determinants of BMP adoption.</td>
<td>US</td>
<td>Meta-analysis</td>
<td>46 studies</td>
<td>2011</td>
<td>Factors with the largest impact on adoption of BMPs include: access to high quality information, financial capacity, and being connected to an agency, a local network of farmers, or watershed groups.</td>
<td>The study recommends a two-tiered approach, targeting farmers who are more likely to adopt first, combined with efforts to strengthen community-based social networks to encourage longer term BMP adoption for those less likely to adopt.</td>
</tr>
<tr>
<td>Knowler and Bradshaw (2007)</td>
<td>Aggregate and synthesize the state of knowledge on determinants of adoption of (primarily) conservation tillage.</td>
<td>Various</td>
<td>Frequency Analysis</td>
<td>23 studies</td>
<td>2007</td>
<td>Once various contextual factors (e.g. study locale or method) are controlled, the primary finding is that there are few if any universal factors that regularly and consistently explain the adoption of conservation practices.</td>
<td>Pay attention to the regional geographies that impact the decision processes of farmers. Increase education, technical assistance, and financial assistance where BMP adoption incurs costs and there is substantial potential public benefit; Use regulation and tax instruments for BMPs that are required.</td>
</tr>
<tr>
<td>Pannell et al. (2006)</td>
<td>Review of determinants of BMP adoption and develop a model of the BMP adoption decision process.</td>
<td>Various</td>
<td>Qualitative review</td>
<td>N/A</td>
<td>2006</td>
<td>Factors that are important for adoption include: complexity (negative impact), observability, and trialability; contact with extension agents and farm organizations as well as proximity of each BMPs must be treated differently in programs therefore encourage a participatory process where landowners can help to shape the research and extension process.</td>
<td>Each BMPs must be treated differently in programs therefore encourage a participatory process where landowners can help to shape the research and extension process.</td>
</tr>
</tbody>
</table>
other adopters; and access to information and external networks with universities and businesses. The percentage of income derived from the farm is also an important factor. Innovations are more likely to be adopted when they have a high 'relative advantage' or perceived superiority to the previous practice, and when they are readily trialable.

### Extension implications:
- Use multiple channels,
- Segment the population,
- Promote spill over effects and social norms,
- and ensure advisor credibility.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Title</th>
<th>Methodology</th>
<th>Number</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrews et al. (2013)</td>
<td>Test framing effects on adoption of conservation till and no till for carbon</td>
<td>USA</td>
<td>Survey / Experiment</td>
<td>1537</td>
</tr>
</tbody>
</table>

The following factors are identified as barriers to adoption: complexity of the practice and loss of flexibility; congruence with farm system; economics; trialability; social context; capital costs; risk and conflicting information.

Need to account for both physical and social context of farming, particularly farming social and marketing networks. Farmers like to share ideas and equipment and are unlikely to want to be seen as “mavericks” or acting alone.

The most important reasons and motivations for choosing conservation tillage are: concern about soil erosion; soil productivity; labor/fuel costs; capital costs; water quality; personal success/history; hearing about other farmers; concern about carbon; and access to carbon offset payments. Farmers that used conventional tillage did so for yield but they were worried about soil compaction. They had minimal concern about history/appearance of their farm.

Consider value frames and contrasting versus reinforcing frames. Subjects can use the same value information but come to opposite conclusions. Conflict reinforcing frames occur when the same message reinforces belief disparities between groups – e.g. climate change impact information reinforces care for climate for climate change believers, and reinforces negative attitudes for non-believers. Conflict displacing frames introduce new information or a different perspective; e.g. frame BMPs as good for society rather than good for greenhouse gas reductions.
<table>
<thead>
<tr>
<th>Study</th>
<th>Objective</th>
<th>Location</th>
<th>Method</th>
<th>N</th>
<th>Year</th>
<th>Key Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arbuckle et al. (2013)</td>
<td>Understand farmer attitudes and political feasibility of targeted programming</td>
<td>US – Iowa corn-belt</td>
<td>Survey</td>
<td>1262</td>
<td>2009</td>
<td>Specific factors associated with endorsement of targeted approaches include awareness of agriculture’s environmental impacts, belief that farmers should address water quality problems, having experienced significant soil erosion, belief that extreme weather will become more common, participation in the Conservation Reserve Program, and belief that farmers who have natural resource issues are less likely to seek conservation assistance. Some farmers concerned about government intrusion. Most farmers agree with targeted programs to maximize efficiency and increase adoption on lands that could significantly improve environmental outcomes. A minority of farmers feel that targeting is intrusive, however a small minority can have large impact on political feasibility so should be aware of this group's issues and understand how their interactions with institutions (e.g. legislators, watershed groups) Influence support for targeted approaches.</td>
</tr>
<tr>
<td>Arbuckle et al. (2013)</td>
<td>Understand the impact of beliefs about climate change on willingness to support adaptation and mitigative actions.</td>
<td>US corn-belt</td>
<td>Survey</td>
<td>4778</td>
<td>2012</td>
<td>The level of belief about climate change and its causes very considerably among farmers. Farmers who believe climate change is occurring and attributable to human activity were significantly more likely to support adaptive and mitigative action while farmers who attributed climate change to natural causes, were uncertain or did not believe it is occurring were less supportive of adaptation, and much less likely to support government and individual mitigative actions. Outreach should account for variations in farmer beliefs about climate change and their effects on attitudes about practices. Promote dual-purpose practices, i.e. practices that are healthy for soil health, water quality and climate change mitigation at the same time.</td>
</tr>
<tr>
<td>Carlisle (2016)</td>
<td>Understand factors that affect adoption of soil health practices (cover cropping/ crop rotation/conservation tillage)</td>
<td>US</td>
<td>Literature Review</td>
<td>NA</td>
<td>NA</td>
<td>Understanding the farming and agronomic system is key to adoption of soil health BMPs. Specifically, technical assistance, capital sharing and capital cost assistance, as well as working within the agricultural system to change barriers such as timing of winter crops and the business cycles of the supply chain. A complementary approach that combines education, research, policy, measures to overcome equipment barriers, and efforts to address the farm and food system context.</td>
</tr>
<tr>
<td>Niles et al. (2016)</td>
<td>Assess the role of attitudes, subjective norms, and perceived capacity in intended versus actual adoption of climate</td>
<td>New Zealand</td>
<td>Mixed Methods</td>
<td>490 surveys and 37 interviews</td>
<td>2012</td>
<td>Climate change attitudes and belief is only associated with intended not actual adoption. There is no evidence that subjective norms (climate change policy support) significantly influence results suggest a disconnect between intended and actual behavior change and that using data about intention as a guiding factor for program and policy design may not be prudent. Fostering perceived capacity and self-efficacy for</td>
</tr>
</tbody>
</table>
mitigation and adaptation strategies.

| Blackstock et al. (2010) | Examined social factors affecting behaviors to improve water quality | Various | Literature Review | NA | NA | Attitudinal change is induced by a combination of the source, the message, and the farmers motivations and ability to process information. | Link advice to desired behavioral change; use networks to exchange knowledge; and target approaches to different audiences and their decision processes (large versus small farm, corporate versus family farm, primary versus secondary income). Peer led knowledge exchange can be more powerful than expert driven approaches. |
| Varble et al. (2016) | Understand conservation practice adoption, information sources and communication channels for renters and owners | US Iowa | Survey | 143 | 2016 | Renters are more likely to practice conservation tillage than full-owners, though they are less likely to rotate crops | Renters use federal government employees as their primary sources of conservation information, while full-owners most frequently use neighbors, friends, and County Extension. Printed materials are the primary way that both renters and owners gain information. |
| Fell (2000) | Explore how words and media influence extension outcomes | Australia | Literature Review | NA | 2000 | Certain patterns of word usage that occur in institutionalised agricultural extension are barriers to effective communication including: directives and dogma, technical jargon, hiding behind formality, empty words, criticism, planning terminology and motherhood statements. | Avoid negative and technocratic communication patterns. Extension should be peer led and designed for cooperative learning. |
| Tamini (2011) | Identify how extension activities in Québec affect the adoption of BMPs | CAD Quebec | Survey | 190 | 2011 | Agri-environmental extension activities and advisory clubs play an important role in disseminating information, raising awareness of BMP adoption and ultimately affect the supply of ecological goods and services. | Government policies that invest in social capital such as clubs may help create a sufficiently enabling environment for the adoption of BMPs. |
| Roesch-McNally et al. (2017) | Examine farmer intentions to adapt to global climate change with no till, cover crop, and tile drainage BMPs | US corn-belt | Survey | 4778 | 2012 | 1/3 to 50% of surveyed farmers indicated they would adapt to climate change with these practices. Farmers who believe they should adjust their practices to protect their farm from the negative impacts of increased weather variability were more likely to indicate that they would increase their use of BMPs in response to climate change. Observing other farmers' practices was positively associated with | Engage with farmers who are willing and confident in their ability to adapt to more extreme weather through efforts that appeal to farmers' confidence and capacity to adapt. Actively engage farmers in efforts to expand the use and adoption of appropriate soil and water conservation practices now in anticipation of more variable and extreme weather events. Provide opportunities for farmers to observe and experiment to expand the use and adoption of adaptive strategies. |
intentions to increase use of BMPs. Farmers who were currently using BMPs were more likely to plan to increase their use of BMPs in response to increased weather variability. Farmers who reported high levels of confidence in their current practices were less likely to plan on changing their practices in response to climatic changes. Concerns about excess water or risk of soil erosion were significant factors, as was a positive attitude towards adaptation and higher levels of perceived risk.

Reimer et al. (2012) Determine perceived practice characteristics which make 4 BMPs (cover crops, conservation tillage, grassed waterways and filter strips) acceptable to producers.

<table>
<thead>
<tr>
<th>Study</th>
<th>Objective</th>
<th>Method</th>
<th>Sample Size</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reimer et al. (2012)</td>
<td>Perceived high levels of relative advantage (e.g., reduced inputs, time-savings, and on-farm and environmental benefits), compatibility with farm system and needs of producers; and observability of practice advantages are most important factors for increasing adoption of conservation practices. Perceived risk and complexity associated with specific practices were only found to limit adoption for a few practices, though it was an important barrier for conservation tillage.</td>
<td>US Indiana Survey interview</td>
<td>45</td>
<td>2012</td>
</tr>
</tbody>
</table>

To increase adoption, conservation promoters should focus on raising awareness of the on-farm and financial benefits, the environmental benefits, and compatibility of conservation practices with current farm operations.


<table>
<thead>
<tr>
<th>Study</th>
<th>Objective</th>
<th>Method</th>
<th>Sample Size</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reimer and Prokopy (2014)</td>
<td>Most participants indicated that public (or off-farm) environmental benefits were the most significant motive. The complexity of the practice may prevent participation by farmers with scarce time or resources. Incentives reduce financial and technical barriers to practice adoption. Major barriers to participation included: lack of knowledge and awareness about programs, lack of flexibility in program requirements and eligibility, and lack of motivation or perceived benefit. Incentives reduce financial and technical barriers to practice adoption.</td>
<td>US Indiana Mixed methods</td>
<td>127</td>
<td>2014</td>
</tr>
</tbody>
</table>

Outreach efforts should focus on increasing awareness of program options, while future policy must balance complexity of eligibility with incentive to participate. Incentives reduce financial and technical barriers to practice adoption.
<table>
<thead>
<tr>
<th>Study</th>
<th>Segments</th>
<th>Methodology</th>
<th>Sample Size</th>
<th>Timeframe</th>
<th>Findings</th>
<th>Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>McGuire et al (2013)</td>
<td>Understand how farmer’s identity influences environmental protection in the production of corn and soybean</td>
<td>Panel interviews and pre-post management intervention survey</td>
<td>9 interviews and 83 pre and 50 post surveys</td>
<td>2005-2009</td>
<td>Exploring farmer conservationist identities in a group setting tempered self-interest and profit motives, and increased farmers interest in public benefits and a willingness to adopt conservation practices that addressed soil and water vulnerabilities. When individuals received input from the social environment that defined them as polluters they took action to clean up their watershed</td>
<td>Provide information about the polluting impacts of activities in a shared setting.</td>
</tr>
<tr>
<td>McCann et al. (2017)</td>
<td>Test whether differences in observability of practices and results explains differential adoption rates for two manure management practices - manure testing versus manure application setbacks,</td>
<td>Survey</td>
<td>493</td>
<td>2006</td>
<td>A practice that has more obvious effects on water quality, manure application setbacks, is more likely to be adopted than a more complicated one with less visible effects, manure testing.</td>
<td>Increase the observability of the effects of beneficial practices and technologies. For practices with large impacts that are not easily observable, increased educational efforts may be warranted.</td>
</tr>
<tr>
<td>Wilson et al. (2014)</td>
<td>Examine effects of farm/farmer characteristics on attitudes towards adopting at least one additional nutrient management BMP</td>
<td>Survey</td>
<td>303</td>
<td>2011-2012</td>
<td>A belief that negative impacts to profit and water quality from nutrient loss were likely was the most consistent predictor of farmer willingness to adopt. Response efficacy significantly influenced attitudes especially for older farmers motivated by profit.</td>
<td>Communication efforts should focus on the negative impacts of nutrient loss on farm profits and on environmental damage. The minority of older profit oriented farmers require more specific information about the economic effectiveness of particular recommended practices.</td>
</tr>
<tr>
<td>Weber &amp; McCann (2015)</td>
<td>Examine factors that predict farmer adoption of three Nitrogen efficient technologies: N soil testing, plant tissue testing, and N transformation inhibitors for corn farmers.</td>
<td>Survey</td>
<td>1840</td>
<td>2010</td>
<td>Information source for N recommendations was significant in adoption. Farmers who did not obtain external recommendations were less likely to adopt all three practices than farmers who received recommendations from a crop consultant. Those who received recommendations from fertilizer dealers were less likely to adopt N soil testing and plant tissue testing. Those who adopted conservation tillage were more likely to adopt plant tissue testing and N inhibitors. Farmers interested in conservation and improving environmental quality are more likely to adopt these specific N practices as are farmers who received conservation</td>
<td>There are various reasons for non-adoption of N-efficient BMPs, and more research is required to understand how to best target these different segments based on audience, farm practice, and technology.</td>
</tr>
</tbody>
</table>
Adoption of conservation tillage was associated with adoption of other practices. Miller et al. (2012) examine barriers to cover crop adoption and identify resources that enable successful adoption. Examine in US North Carolina through survey plus key informant interviews with 288 surveys and 6 interviews in 2012. Three categories of challenges to adopt cover crops: agronomic, capital, and input costs, and knowledge transfer. Soil improvement was the most important motivation for planting cover crops. The greatest challenge to cover crops is timing a cover crop within a cash crop rotation. Although 50% received some form of information on cover crops from their extension agent, a majority cited self-directed learning as most influential in their decision to adopt. Program flexibility and targeted funding to reduce risks for early adopters. Increase incentives through cost-share programs, establishing equipment sharing cooperatives and low interest loans to cover capital costs. Invest in applied research to develop varieties that better complement common cash crop rotations.

Brick (2013) explores factors that affect a farmer’s decision to remove or restore conservation lands in SW Ontario. In Canada Ontario through survey with 3227 respondents in 2013. A significant positive correlation was found between property size and net change in conservation land. A significant positive correlation was found between length of farm ownership and net change in conservation land. This study did not find a strong significant relationship between Conservation Ethic Index score and conservation behavior. The local social context can have a significant impact on the behavior of farmers and should be considered in program design.

Dunn et al. (2016) examine factors associated with higher percentage of land and lower reliance on cost share for cover crop adopters in US through survey with 1759 respondents in 2014. Size of the farm is a significant predictor of the proportion of land in cover crop. Early adoption is associated with willingness to self-learn and experiment through trial and error. Internet was important for self learning, while talking to neighbors, visits by conservation advisors, crop cover workshops and meetings with retailers and agronomic advisors and experts were important sources of information. Cost of cover crops, and lack of integration with regular cash crop systems limit adoption. Also concerns that cover crops are difficult to terminate. Larger farms are Without the right combination of factors, cover crops can have negative economic outcomes. Farmers willing to learn by trial and error are most likely to adopt these practices in the long run. Portray cover crops as a long term investment with benefits that increase over area and time. Extension should showcase local examples where limitations of cover crops have been overcome.
correlated with discontinuing the practice. Many adopters are expanding their cover crop land without the use of cost-share funding.

<table>
<thead>
<tr>
<th>Study</th>
<th>Focus</th>
<th>Region</th>
<th>Method</th>
<th>Year(s)</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tosakana et al. (2010)</td>
<td>Examine factors affecting the adoption of gully plugs and buffer strips</td>
<td>US Pacific Northwest</td>
<td>Survey and regression</td>
<td>2006-2007</td>
<td>Key factors include: perceived effectiveness of the conservation practice; factors varied by practice. Size of farm was significant for gully plugs. Financial capacity and capital costs were less important for both practices however maintenance costs for practices was important. Leasing was a deterrent to adoption of gully plugs. Education and other demographic variables were insignificant.</td>
</tr>
<tr>
<td>Luymes (2017)</td>
<td>Understand how attitudes, norms and perceived constraints affect the motivation of Lake Erie basin farmers towards environmental BMPs</td>
<td>Canada Lake Erie</td>
<td>Literature review and interviews</td>
<td>2017</td>
<td>Lake Erie farmers are driven by yield. BMPs that pose a real or perceived threat to yield likely to have lower adoption rates. The unobservability and lack of perceived control over Phosphorous loadings in Lake Erie results in farmers feeling blamed and demoralized, hindering adoption. Cover crops are viewed as good for soil but perceived as a risk to yield especially by large producers. Knowledge about how to implement and terminate cover crops are a barrier. Considerations of timing, land tenure, lack of equipment and finances are also constraints. Barriers to reduced tillage are related to practical constraints. There is a lack of awareness of the relation between no till and soil health. Barriers to 4R nutrient management include cost and lack of understanding of precision technologies. Grassed waterways are perceived as simple, practical and cost-effective. Conservation Authority and ALUS (ALUS) programs, which respect property rights and are delivered locally are viewed more favorably than government programs such as Growing Forward which are viewed as complex and inequitable. Peer led engagement. Increase the perceived control of farmers over their public image and support farmers’ attempts to build stronger connections to consumers through public campaigns. Promote the positive environmental contributions being made by farmers. BMPs should be framed in terms of their practical and economic benefits rather than strictly environmental messages.</td>
</tr>
<tr>
<td>Genskow &amp; Wood (2011)</td>
<td>Identify barriers for improving voluntary environmental management</td>
<td>US Midwest</td>
<td>Literature review</td>
<td></td>
<td>A barrier to learning and adaptation is lack of suitable data and metrics to move beyond anecdotal information. Performance measurement data need to be social and ecological. Data should be supplemented with local knowledge and the</td>
</tr>
</tbody>
</table>
programs, (particularly non-point source water quality) and ways to overcome them.

Effectiveness of water quality programs has been tracked using physical and chemical measures related to ecological and public health but those measures are slow to respond to BMPs making practice efficacy and assessment of voluntary programs difficult. New measurement approaches are needed to signal interim success including attitudinal data to better understand the relationship between social norms, knowledge, and attitudes that underpin landowner decisions. A project should be flexible and responsive to findings. Voluntary programs require information about factors influencing landowners, particularly social and psychological factors.

<table>
<thead>
<tr>
<th>Study</th>
<th>Objective</th>
<th>Methodology</th>
<th>Sample Size</th>
<th>Year</th>
<th>Factors influencing adoption were: education, age, gender, farm residence, farm size, organic certification, membership in a watershed-based conservation group and price of labour.</th>
<th>Socio-demographic information can be combined with regionally specific context to help target agri-environmental programs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture and Agri-Food Canada (2012)</td>
<td>Determine factors affecting the probability of water quality BMP adoption including riparian buffer strips, reduced herbicide use, and liquid and solid manure management.</td>
<td>Canada Quebec Survey</td>
<td>269</td>
<td>2007</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dring et al (2016)</td>
<td>Investigate incentives and disincentives for adoption of controlled tile drainage in a region of eastern Ontario.</td>
<td>Canada Ontario Survey and informant interviews</td>
<td>102 surveys plus 20 interviews</td>
<td>2011</td>
<td>Farmers were motivated to adopt controlled tile drainage by: soil water retention benefits, increased crop yields, and gratification at improving the environment. Disincentives include capital cost, increased farm labor costs, and perceived lack of extension services.</td>
<td>Drainage contractors are an information source on drainage practices, as well as information from producer organizations and industry publications. Some financial incentives would be required to increase uptake.</td>
</tr>
<tr>
<td>Presley (2014)</td>
<td>Summarize adoption barriers most commonly cited in published studies as well as recommended strategies to overcome barriers.</td>
<td>Various Literature review</td>
<td>Literature review</td>
<td>Economic Factors: cost of transitioning to new practices including labor and capital, financial capacity, risk, and deferred economic and environmental benefits. Renting and leasing decreases adoption of practices with medium to longer term benefits; compatibility with existing system including increased labor and time and specialized equipment requirements, incompatibility with cash crop rotations and market constraints and site-specific factors related to climate, soils, etc. Lack of perceived skills to address these barriers is a concern.</td>
<td>Strategies to overcome barriers to practice change include: financial incentives, participatory learning opportunities, farmer-to-farmer education, and a focus on training and partnerships among change agents.</td>
<td></td>
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<tr>
<td>Study</td>
<td>Title</td>
<td>Methods</td>
<td>Participants</td>
<td>Year(s)</td>
<td>Summary</td>
<td></td>
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<tr>
<td>Conner et al. (2016)</td>
<td>Examine Vermont farmers’ underlying preferences and willingness-to-accept (WTA) payments for three common BMPs (cover crops, conservation till and riparian buffers) in a primarily mixed farming region</td>
<td>US Vermont, Survey, 85 (note sample not representative)</td>
<td>2013-2014</td>
<td>Farmers are more willing to adopt BMPs that are more familiar, simpler, and are integrated more easily in to existing management practices but higher monetary incentives can overcome farmer reluctance particularly if payment covers multiple practices. Meat producers more easily fit cover crops and buffer strips in their farm management - utilizing cover crop fields as pastures and buffer strips as grazing areas. Cover crop also benefits vegetable production and for these systems has low implementation costs. Higher payments may be needed to incentivize broader BMP adoption, particularly those BMPs which are complex or novel. Greater effort may also be needed to improve the trialability and observability, decrease complexity, and investigate ways to better integrate practices into diverse farming systems.</td>
<td></td>
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<tr>
<td>Carolan (2006)</td>
<td>Examines ways to make the ecological costs of conventional and benefits of sustainable agricultural systems more visible.</td>
<td>US Iowa, Focus groups and interviews, 107</td>
<td>2000-2003</td>
<td>Distant benefits, immediate costs; financial capacity; food system constraints that focus on short term returns (e.g. loans, marketing system etc.), opportunity costs and yield reductions; labor costs to address weeds; credibility of sources, contested science, and trust of information on sustainable production; Formation of new social ties and institutional arrangements that reveal novel ways of knowing and seeing the hidden costs of conventional agriculture, and which operate through existing social and marketing networks. These include labeling strategies such as organic certification, and food mile approaches which reveal whether pesticides and herbicides are used, or the embedded energy content of foods. New institutional arrangements are also needed, which involve the integration of farming systems with diverse networks of people, institutions, and communities to foster trust and community learning.</td>
<td></td>
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<tr>
<td>Campbell et al. (2011)</td>
<td>This study compares the adoption of BMPs for non-point source pollution within collaborative and non-collaborative settings</td>
<td>US Ohio, Survey and interview, 130 surveys and 11 interviews</td>
<td>2008</td>
<td>Farmers in the watershed with collaborative partnerships do not have higher rates of BMPs adoption than farmers in the watershed with a traditional, agency-based approach encouraging BMP adoption. However partnership participants exhibited higher levels of BMP adoption than nonparticipants in the same watershed. In watersheds where traditional means of BMP diffusion are successful, extensive collaborative work may not be necessary, however participation in collaboration led to different BMP strategies, with collaboration focusing on collective BMP strategies and traditional settings focusing on individual BMP strategies.</td>
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<tr>
<td>Barbercheck et al. (2012)</td>
<td>Develop a baseline of adoption of farm organization participation and conservation practices by women in Northeast US.</td>
<td>US Northeast, Survey, 815</td>
<td>2008</td>
<td>Over 85% of the respondents belonged to at least one organization: sustainable/organic agriculture organizations (53.5%) and general farm organizations (50.8%) and Educational and regulatory programs that attempt to reach women farmers need to consider the specific types of farms they operate since membership in organizations may reflect larger differences in farm production systems.</td>
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</table>
commodity-based organizations (1/3). Members of women’s and sustainable or organic agriculture organizations tended to be younger, have less farming experience, and more formal agricultural education than members of commodity-based, general farm and women’s agricultural groups. Practices supported were different for different groups with compost production/application, crop rotation, manure incorporation, and organic crop and livestock production more likely among members of sustainable/organic agriculture organizations, but less likely among members of general farm organizations. Integrated pest management was more likely with general farm organizations and for women motivated by profit and yield.

Carolan (2005) Examines how social dynamics among landlords, tenants, and agency professionals affect the adoption of sustainable practices on rented land US Midwest Interviews and focus groups 57 interviews and 4 focus groups (4-9 participants each) 2000-2001 Tenants worried about alienating landlords if pursuing sustainable practices; landlords preference/increase in cash rent leasing versus crop sharing means tenants can’t capture benefits of soil improvements and bear all of the risk; landlords also value ‘neat’ fields. Lack of technical expertise (especially amongst female landlords) and policies that favor and subsidize conventional cash cropping impede adoption of sustainable practices. Female landlords afraid of alienating tenants if requiring sustainable practices. Increase outreach to female landlords and operators; increasing the visibility of sustainable agriculture practices by individuals that possess social capital amongst conventional producers including through conventional sources of information such as university extension programs.

American Farmland Trust (2013) Review of factors affecting adoption of BMPs US Literature review NA 2013 Out of 170 variables, only education, farm size, income, rainfall, technical assistance, program participation and awareness of environmental threats correlate positively with BMP adoption. BMPs that are more challenging to manage, take time and cost money Producers need to be aware of and believe there is a problem. Determine who is in the best position to provide education and technical assistance. Provide education, flexible financial assistance and technical assistance. Survey farmers beforehand to find out what they need.
Higher education, outside expertise, a conservation plan and incentive payments help overcome the barriers for the adoption of more complex BMPs. Fewer conservation practices are generally used on leased land. Use focus groups to test language used in programs.

| Dupont (2010) | A review of financial incentives for encouraging BMP adoption participation for water quality programs | Canada Ontario | Survey | 1,134 | 1998-2004 | Cost-sharing incentive BMP adoption program for water quality that reimburse farmers for out-of-pocket expenses are shown to be effective. Program-specific cost sharing factors, farm income and computer usage are important determinants for BMP adoption. Higher participation rates in BMP adoption may occur if financial incentives to farmers increase, however, the financial incentives must be targeted at specific regions with the specific water quality problem and through local programs. |
| Filson et al (2009) | Attitudes towards regulation and government financial supports for implementing BMPs in SW Ontario | Canada Ontario | Survey | 481 | 2009 | The BMP adoption variables found to be significant were farm size, adoption rates (index), age and education. Large farms (with large gross sales) were predicted to have implemented more BMPs. Financial incentives, minimum regulation, and outreach/technical support for voluntary BMP adoption needs to be different for different farm sizes and types. The number of farmers who had a formal Nutrient Management Plan (NMP) was significantly associated with the number of BMPs adopted. Programs that target smaller farms may need to pay “more than half of the cost of BMPs”, whereas larger farms are willing to pay more themselves. Many small operations lack the funding and time to implement BMPs, as well as depend on off-farm employment, and thus targeted programs are more effective than one-size fits all programs. Different types of farming (crop versus livestock) as well as the size of the farms also need to have different types of extension programs to encourage BMP adoption. A combination of regulatory and voluntary approaches as well as most farmers prefer voluntary action for environmental goods and services. Compensation/subsidy methods seem to be the method most preferred for BMP adoption. Bottom-up approaches that involve farmers in the design and delivery of environmental goods are more effective. |
| Ipsos-Reid (2006) | A review of field crop producers’ reasons for BMP adoption in Canada | Canada | Survey | 1,000 | 2001 | 97% of farmers used at least one BMP for nutrient management. Soil testing and minimum tillage is most common BMP (73%). Reasons for using BMP are: 1) to improve soil quality, 2) make more efficient use of fertilizer. Reasons for NOT using BMPs are costs of adoption. Canadian farmers say it is important for the government to provide a financial incentive to assist with BMP adoption. The majority of farmers using a nutrient plan support the idea of a government financial incentive for manure management planning, since only a small percentage receive a government financial |
| Juhasz (2014) | A review of social network factors that increase awareness of changes in farming practices for dairy producers in Southern Ontario | Canada Ontario | Survey plus interviews & workshops | 239 survey respondents | 2009-2010 | Assumption was that more socially connected farmers would participate in agri-environmental programs, however, it was found that this is not necessarily true and that more emphasis should be on place-specific program designs to encourage environmental innovation. Government program designers, extension agents, and project managers need to be aware of the significant increase and capacity of ICT and how farmers are mobilizing “resources, collectives and information” that are useful/relevant for their location. |
| McCallum (2003). | A review of barriers (scope/type) to farmer participation in Environmental Farm Plan and agri-environmental program | Canada Ontario | Interviews, Focus groups, Census data | 33 | 2002 | A cost-sharing incentive program to make direct environmental payments to farmers would encourage environmentally-friendly practices, as funding is considered a major barrier to participation in these programs and most government involvement at all levels is financially constrained. There was no systematic difference between those who’s primary occupation is farming and those who farm as a secondary occupation in terms of desire for an environmental payment. |
| Nadeilla et al. (2014) | A review of whether there are differences in farmers willingness to adopt conservation practices (conservation tillage and cover crops) based on land ownership (owned v. rented) | Canada Ontario and Manitoba | Survey | 425 | 2013 | The study finds that the influence of tenure type (ownership) varies with the kind of conservation practices that are being implemented (namely conservation tillage and cover crops). Conservation tillage usage is not shown to be impacted by land tenure, however, cover crops are shown to be planted much less on rented land. Cover crops require site-specific investments that tend to payoff only in the long-term. Conservation tillage is |

incentive and this incentive could encourage higher BMP adoption. | Agri-environmental policy needs to include factors that include localize/place specific information, as well as information on applications and practices, and technical and management decisions needs to be understood. | Neither federal or provincial governments have a long-term financial commitment to economic and environmental rural sustainability policy which would be necessary before direct payments for environmental programs could be established. | Land tenure influences the usage of site specific conservation practices such as cover crops, and this needs to be taken into account when designing conservation policies. |
The study finds also that farmers who rent for more than 5 years do not treat their rented land differently than if they owned the land. 

Nebel et al. (2017)  
A review of factors that drive environmental behavior of landowners in SW Ontario including environmental attitude, pro-environmental behavior, and demographics  
Canada Ontario  
Survey 3256 2015  
Voluntarily setting aside land for conservation, enrolment in a conservation stewardship program, and financial considerations were significantly related to positive attitudes towards conservation. One example is that the biggest factor to enrol in a wetland enhancement program was gaining access to information on how the loss of a wetland would directly/personally affect the landowner. 

The study recommends that enrollment in a voluntary land stewardship program might increase if personal information is provided about the effects and by also providing a financial incentive for participation. Therefore, government outreach programs could focus on improving environmental attitudes, which will likely result in more environmentally-friendly behavior.

Prairie Research Associates (2011)  
A study on the effectiveness of Environmental Farm Plans (EFP) and the ways in which the program could be improved in terms of implementation, measurement of progress, and encouraging participation/implementation.  
Canada Ontario  
Literature review, interviews, surveys 8 interviews and 189 surveys 2010  
“Producers [most] commonly decided to attend a workshop to become eligible to apply for cost-share funding and for educational purposes. Producers reported overwhelming satisfaction with the workshops. One of the benefits of the EFP development process is that the Program increases producers’ understanding of environmental risks and mitigation practices, enables them to identify and examine areas of environmental concern, and raises their awareness of the impact of their operation on the environment. Almost half of the producers who participated in the Program said, because of attending the workshop, they changed their priorities for environmental project.”

The EFP program would be enhanced by:  
1) continuing educating producers (producers are very satisfied with educational outreach)  
2) continue cost-sharing and linking that to education; and assess if access to credit is an issue for smaller farms that are less active  
3) offer specialized services based on farm(er) characteristics such as age, size of operation, education, type of commodity etc.  
4) consider additional methods of encouraging farmers to implement such as tours of environmental practices, one-on-one farm visits, on-farm demonstrations, farmer discussion sessions, and supplemental workshops on specific topics/practices of interest  
5) encourage social interactions among farmers to discuss implementation practices  
6) conduct research on farmer motivations that are not participating in program to increase participation rates  
7) expand program performance measures to show successes (e.g. # of worksheets/activities included and implemented, length of time, % of action plans completed/ initiated,
and % of actions implemented that affect ecosystem services
8) link action plan data to cost-share data to show value of program
9) survey subsets of farmers (previous participants and random sample) to gain an understanding of the entire program and its ability to influence change
10) revise action plan to enable farmers to identify and reduce risks and ratings to make it easier for farmers to determine how individual actions can improve a particular risk rating
4. Segmenting approaches for encouraging BMP adoption

4.1 Narrative Summary

The previous section highlights the diversity of socio-economic and attitudinal factors that determine adoption behavior. Segmentation focuses on the sub-cultures of farming systems to better understand how to target programs to increase uptake, and is particularly important for voluntary programs which must address attitudes and motivations of individuals. Segmentation clusters farmers into groups with similar external biophysical and socio-economic contexts as well as similar internal motivations and perceptions of different practices to highlight social and psychological barriers to adoption. While external barriers such as lack capital can be addressed through program elements, internal barriers must be addressed through communication and engagement strategies that are socially accepted and influence attitudes and norms through the social context of farming (Pike 2008, Dwyer et al. 2007).

The concept of “habitus” refers to the attitudes and values that underpin farming decisions (Juhasz 2014; Dwyer et al. 2007). Attitudes develop over time and reflect successful strategies for interacting in the farm system until eventually they become so routinized and embedded that they become sub-conscious. The attitudes are formed in response to structural elements of farming, such as market and production technologies, as well as social structures. However habitus is not static and social dynamics create opportunities for practices and attitudes and values to change over time. Identifying the structural components in which attitudes and values exist helps identify opportunities to intervene (e.g. Pike 2008).

The key to understanding how to unlock “habitus” is to recognize that attitudes and beliefs represent “symbolic capital”. For example, the way a field looks, how productive the land is, how entrepreneurial and risk taking the farmer is, are attributes of sub-cultures of what it means to be a “good farmer” which leverage social and economic rewards for the farmer within different social networks. The idea is that by understanding and acting on symbolic attitudes and beliefs about what it means to be a good farmer, agri-environmental motivations and behaviors can be changed. Segmentation studies in Europe have attempted to categorize farms according to primary farming motivations and values, and then link these motivations to value orientations that could be leveraged to develop key messages or engage different groups. Some examples are provided below.

The “farm style” approach, which originated in the Netherlands, combines the social, economic, ecological and technological practices that underpin farm decisions into different farming subcultures using easy to measure external factors, such as the background factors of age, farm size, and farm type,
as well as internal perceptions and attitudes and external social factors. The latter are more difficult to measure and often require in-depth qualitative analysis to understand the diverse range of attitudes and motivations that drive behaviors in different farm styles.

Critics argue that farmers act as individuals and that segmentation is an artificial construct of researchers and policy makers that does not make sense to farmers. However Pike (2008) argues that while behaviors are complex, applying a common segmentation framework can help policy makers understand how to influence behavior. Complexity means that behavior change is uncertain and monitoring is required to evaluate whether interventions successfully change attitudes and behaviors. Common values and attitudes in different external contexts will still generate different farming styles due to different constraints, so it is important to adapt messages to diverse local conditions and constraints. An adaptive management approach to market segmentation would look at different ways to define and target farmer styles, learn what works, and then adapt.

4.2 Summary of segmentation approaches

Below we summarize various approaches to segmentation that were found in the literature. Our review focused on studies that incorporated social, attitudinal, and technological factors related to motivations. As a result we did not consider the segmentation model used by the USDA which focuses on observable economic and demographic characteristics collected by census and other data (e.g. Briggeman et al. 2007). We review 12 studies which use segmentation to understand practices and willingness to adopt BMPs. Each study classified the farmer population into 3-6 segments (4 segments was most common) using cluster analysis or literature review. Cluster types were derived from farm attributes and farmer characteristics. The most common variables were based on environmental practices, wealth or available resources, information networks, and high farm-as-a-business with low stewardship. Cluster types are summarized in Table 4 below.
Table 4 Summary of Segmentation Approaches

<table>
<thead>
<tr>
<th>Study</th>
<th>Region</th>
<th>Method: Interviews; sampled in 1978 and 1997 N=144</th>
<th>Segments</th>
<th>Lessons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frost (2000)</td>
<td>Australia</td>
<td></td>
<td>VALUE ORIENTATION</td>
<td>• Expressive value was most important followed by instrumental, intrinsic and social motivations. Leaving a legacy has become a more important factor in style.</td>
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<td></td>
<td></td>
<td></td>
<td>• Instrumental: farming as means for income and security</td>
<td>• Growing the business is seen as important to having freedom in farm decision making. Thus, the effect on business is an important issue to consider when changing natural resource management.</td>
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<td></td>
<td></td>
<td></td>
<td>• Expressive: farming for self-expression or personal fulfillment</td>
<td>• Social: farming valued for relationships in farming community</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>• Intrinsic: farming valued as purposeful activity</td>
<td></td>
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<tr>
<td>Thompson et al. (2015)</td>
<td>Western Illinois – La Moine River</td>
<td>Survey N=277</td>
<td>STEWARDSHIP vs BUSINESS MOTIVE</td>
<td>• No difference in participation or willingness to participate in agricultural BMPs was found between groups, but there were differences in their willingness to support rural conservation planning priorities that address agri-environmental challenges, with group 4 showing greatest support and group 1 least support.</td>
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<td>• low stewardship, moderate to high business motives</td>
<td>• Groups 2 and 3 were similar in willingness to use BMPs and rural conservation planning (high willingness), and represented most of the farmers in this area (60% respondents).</td>
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<tr>
<td></td>
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<td></td>
<td>• high stewardship, low business motives</td>
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<td></td>
<td></td>
<td>• high stewardship, high business motives</td>
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<td></td>
<td></td>
<td></td>
<td>• very high stewardship, very low business motives</td>
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<tr>
<td>Roucan-kane et al. (2011)</td>
<td>U.S.</td>
<td>Survey 2008 N=2575</td>
<td>SUPPLY PURCHASING FACTORS</td>
<td>• About half of respondents make decisions without input from others. Approach these decision-makers directly.</td>
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<td></td>
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<td>• Balanced (59%) - consider all factors below.</td>
<td>• The second largest set of respondents make decisions after extensive discussions</td>
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<tr>
<td></td>
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<td></td>
<td>• Price (18%)</td>
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<td></td>
<td></td>
<td></td>
<td>• Convenience (12%)</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>• Performance (12%)</td>
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</table>
with other family members and/or employees. Technical representatives and salespeople should engage more members of the farm operation

<table>
<thead>
<tr>
<th>Study</th>
<th>Location</th>
<th>Methodology</th>
<th>Sample Size</th>
<th>Findings</th>
</tr>
</thead>
</table>
• Conventional (78%) prioritize humans over nature and used chemicals.  
• Alternative (12%) prioritize nature and abstained from chemicals  
• Status (10%) conventional plus focused on maximizing efficiency | 86% of all producers found in the 3 producer categories of environmental attitudes had a worldview that consisted of a combination of both pro-environment and pro-profit, showing that producers are not ‘rigid’ in their beliefs.  
Segmenting producers based on attitudes is not straightforward and requires extension agents to be nuanced in their engagement strategies. |
• Pro-environmental conservationist vs. productivist  
• Optimism vs. pessimism  
• Traditional vs. technological practices | Conservationists, pessimists, and favoring technology over tradition are positively correlated with having an attitude of concern for the environment.  
Productivists, optimists, and traditionalist tend to be more accepting of unethical environmental practices.  
The conservationist relative to productivist identity appears to matter most in affecting ethical attitudes toward farming practices that have ethical implications. |
| Emtage et al. (2007)   | NA         | Literature Review | NA         | Develop a framework a priori for a nested set of typologies coordinated at national, regional and local scales  
Use repeated measurement over time to track the evolution of farmer practices, management values, and socioeconomic characteristics. |
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<tr>
<td></td>
<td></td>
<td>• <strong>Prime prospect</strong> - concerned but unengaged in BMPs</td>
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<tr>
<td></td>
<td></td>
<td>• <strong>Prime prospect</strong> - multiple motives, unengaged in BMPs</td>
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<td></td>
<td></td>
<td>• <strong>Potential defector</strong> - production focused, engaged in some BMPs</td>
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<td></td>
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<td>• <strong>Poor prospect</strong> - disconnected and conservative</td>
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<tr>
<td></td>
<td></td>
<td>• <strong>Model producer</strong> - progressive, engaged in multiple BMPs</td>
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<td></td>
<td></td>
<td>• Quantitative approaches which provide predictability and generalizability of segmentation approaches must be combined with qualitative methods which provide greater understanding of the style and how to use styles to target behaviors.</td>
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<td></td>
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<td>• The ‘multiple objectives’ group and the ‘concerned but unengaged’ group have high interest in vegetation management which could be used to initiate engagement.</td>
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<td></td>
<td>• Members of these two groups have high levels of trust for ‘environmental groups’ who could engage them.</td>
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<td></td>
<td>• The large ‘disconnected and conservative’ group requires resources to raise their awareness and knowledge about the broader natural resource management implications of their practices.</td>
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<thead>
<tr>
<th>Pike (2008)</th>
<th>English Farmers Survey and Interviews N=750</th>
<th>MOTIVATION</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>• <strong>Custodians</strong> (23%) way of life. Social capital includes, pride, heritage, environment</td>
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<td>• <strong>Lifestyle choice</strong> (6%), not main source of income, motivated by tradition and pleasure</td>
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<td>• <strong>Pragmatist</strong> (22%) mainstream, traditional, and family oriented, with mixed motivations from heritage to business</td>
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<td>• <strong>Modern family business</strong> (41%) value family success and income</td>
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<td>• Custodians and Lifestyle farmers respond to emotive issues and messages that focus on inclusion, protecting the future, and working in partnership.</td>
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<td></td>
<td></td>
<td>• Modern family business and Challenged Enterprise types are more focused on the bottom-line while Pragmatists are mainstream, traditional, family farms and are a mixture of the other types.</td>
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</tbody>
</table>
|             |                                            | • Segments only differed when attitudinal factors were included and only a small number of attitudinal statements were
<table>
<thead>
<tr>
<th>Challenged enterprises (7%) view farming as a burden, they are isolated and pessimistic</th>
<th>significant for assigning respondents to segments.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barnes et al. (2011)</td>
<td>England</td>
</tr>
<tr>
<td>Defra segmentation types above tested on adoption of climate change mitigation BMPs</td>
<td>Dairy and arable farms had higher rates of adoption of climate mitigation BMPs due to their reliance on purchased fertilizers and efficiencies realized.</td>
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<td></td>
<td>Most producers did not view climate change as an important consideration for their business. This result was consistent across segmentation categories even where adoption of mitigation BMPs was high.</td>
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<tr>
<td></td>
<td>Market segmentation categories were not significant for adoption of climate change BMPs</td>
</tr>
<tr>
<td>Dagolu (2014)</td>
<td>American corn belt</td>
</tr>
<tr>
<td>Literature Review</td>
<td>SIZE and INCOME SOURCE LITERATURE REVIEW</td>
</tr>
<tr>
<td></td>
<td>Traditional - small operations relying primarily on on-farm income;</td>
</tr>
<tr>
<td></td>
<td>Supplementary - small operations relying primarily on off-farm income;</td>
</tr>
<tr>
<td></td>
<td>Business-oriented - medium to large operators relying on on-farm income and well connected to information networks;</td>
</tr>
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<td></td>
<td>Non-operator - absentee and/or investor farmland owners with limited connection to local information networks</td>
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<td></td>
<td>Different farmer types may adopt different conservation practices depending on the relative importance of tenure arrangements, size, income source, and information networks.</td>
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<td>Non-operators (absentee landowners) have limited involvement in on-farm decision-making but surveys indicate their willingness to adopt conservation practices and they can be expected to increase as a factor in the future.</td>
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<tr>
<td></td>
<td>Supplementary farmers are more willing to use conservation practices that reduce the area that must be cultivated such as filter strips and land retirement.</td>
</tr>
<tr>
<td></td>
<td>Traditional farmers have less financial capacity and require longer time periods to</td>
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</table>
pay off conservation investments which could discourage adoption of practices like cover cropping, grassed waterways, and filter strips which have long pay off periods but favor practices that reduce labor requirements.
- Business oriented farmers are limited in their willingness to adopt practices which reduce yield and revenue.

<table>
<thead>
<tr>
<th>Source</th>
<th>Country</th>
<th>Year</th>
<th>Method</th>
<th>Sample Size</th>
<th>Attitudes Towards Regulation</th>
<th>Attitudes Towards Innovation</th>
</tr>
</thead>
</table>
| Barnes et al. (2011)    | New Zealand | 2007 Survey N=187 | ATTITUDES TOWARDS REGULATION | - Resistors (29%) had negative attitudes towards regulations due to perceptions that regulation increases farmer workload and negatively impacts income;  
- Apathists (32%) neither agree nor disagree with regulations;  
- Multi-functionalists (39%) agreed with environmental regulations. | Multi-functionalists favour both agricultural advisors and Government sources for information concerning water pollution management highlighting the importance of government in forming attitudes and decisions related to nitrogen management for this group  
- There is a need to target information that emphasizes favorable information about water quality management to change the attitudes of apathists |
| Dwyer et al. (2007)     | England   | Interviews 2006 78 interviews with farmers and farmer families | ATTITUDES TOWARDS INNOVATION | - Older Traditional use traditional technologies; poor understanding of environmental impacts;  
- Older Innovative early adopters and experimenters;  
- New Innovators younger family farmers or new entrants looking to change;  
- Large Agro-business Managers focus on yield and profit maximization  
- Reclusive and Isolated farmers who farm involuntarily and are not motivated to change; | Styles were not confined to specific farm types, situations or locations except through size.  
- Traditional, part time, and isolated farmers should be targeted through one-one visits and advice, while innovators and agri-business farmers should be engaged through farming and agri-business networks. |
|   |   | Part-time and Hobby lifestyle choice, part time, unaware of policies, less time and resources to seek advice |   |
4.3 Summary of studies reviewed

Frost et al. (2000)

Value orientations were examined as influencing factors in farmer decision-making in Australia. Interviews were conducted with 141 farmers, breaking practices down according to 4 value orientations:

- **Instrumental** – farming as a means for income and security;
- **Expressive** – farming as a means to self-expression or personal fulfillment;
- **Intrinsic** – farming valued as an activity in its own right-enjoyment of work, purposeful activity;
- **Social** – farming for the sake of interpersonal relationships, belonging to a farming community.

Expressive values were the most important followed by securing income, and social value orientation was the least important. There is a shift in value orientation between the 1970s and 1990s - leaving a legacy is more important, still with a focus on short-term security and investment. Farmers in 1997 placed greater importance on feeling considerable pride of ownership compared to those respondents in 1978. Intrinsic value changed - fewer people in 1997 experienced enjoyment in work tasks preferring purposeful activity (or work for works sake). There was an increase in the percentage of individuals in 1997 who preferred a healthy farming lifestyle. The instrumental value of ensuring the future income of the farm, was greater in 1997. On the other hand, there was a decrease in the 1997 study of those placing importance on securing a satisfactory income from farming. Business expansion was important because it conferred freedom from supervision and independence. Age was an important influencing factor in business expansion, as the young were more likely to expand their business. How the business aspect is affected is thus an important question that should be related to any required behavior change in natural resource management.

Thompson et al. (2015)

In Western Illinois, farmers’ views of the environment were analyzed to develop new measures of farmers’ environmental attitudes and examine their influence on use of agricultural best management practices. With survey data collected from 277 farmers in the La Moine River watershed in western Illinois, results revealed two separate attitude frames are relevant for farm decision making: a stewardship frame emphasizing the environment and a business/profit maximization frame resulting in four clusters:

- low stewardship, moderate to high farm as-business attitudes,
• high stewardship, low business,
• high stewardship, high business
• very high stewardship, very low business

No difference in participation or willingness to participate in agricultural BMPs was found between groups, but there were differences in their willingness to support rural conservation planning priorities that address agri-environmental challenges, with group 4 showing greatest support and group 1 least support. Soil management-willingness was higher than current use for no-tillage, reduced tillage, grass waterways, vegetated buffers and cover crops. Highest currently used practices were grass waterways, no-tillage and reduced tillage. The low stewardship, moderate business group had largest average acreage and very high stewardship, very low business group had the least acreage (ca. 100 acres or <1/3 size of other groups). They could be lifestyle or hobby farmers, and while willing to participate in conservation, their small holdings may limit their impact. Groups 2 and 3 were similar in willingness to use BMPs and rural conservation planning (high willingness), and represented most of the farmers in this area (60% respondents).

Roucan-kane et al. (2011)

In North America, large commercial producer market segments were produced based on 2,575 US commercial producers to assist practitioners and researchers understand buying preferences Cluster analysis was used to segment the market based on survey data and yielded 4 buying segments (in order of size):

• Balanced (59%) consider all criteria (below). They are less educated, older, mostly crop farmers
• Price (18%) focus on getting the best price and are the 2nd most educated group as well as the youngest and primarily in the crop sector;
• Convenience (12%) prioritize location of the dealer and convenience. This group is the least educated, has the smallest farms and gross sales, and is primarily in the livestock sector;
• Performance (12%) focus on maximizing productivity, are the highest educated and largely in the crop sector.

Dividing the marketplace based on the four segments can help marketers use their resources to reinforce aspects of the value bundle that are most meaningful to the segments they are targeting. In terms of information sources, local dealers were rated as the most useful information providers,
followed by other farmers, manufacturer salespeople, extension services, and lenders. Manufacturer technical specialists and independent paid consultants were rated the least useful. In terms of communication media, farmers rated general farm publications as the most useful, followed by crop/livestock specific publications, agricultural newspapers, agricultural newsletters, farm shows, field days, supplier’s meetings, direct mail, agricultural websites, agricultural radio programs, agricultural TV programs, and telephone contact. Given the amount of money manufacturers and dealers spend on advertising, farm shows, and websites, the lack of usefulness of this information across all segments is concerning. About half of respondents make decisions without input from others. Thus it is important to approach these farmers directly. The second largest set of respondents make decisions after extensive discussions with other family members and/or employees. For these producers, it is important for technical representatives and salespeople to engage more members of the operation. The Price segment was the least likely to be brand loyal, while balance buyers were most likely.

Mitchell (2006)

Rural sociological barriers to adoption were investigated in a survey of 64 producers, administered between March 15 and May 6, 2006 in Alberta’s agricultural communities to examine methods to improve delivery of extension programs (Mitchell, 2006). Mitchell focuses on barriers to BMP adoption as well as delivery methods for extension programs. The New Environmental Paradigm (Albrecht et al. 1982) was used to assess producer attitudes toward nature and use of chemicals. The results revealed three worldviews or value systems about the relationship between nature and society: eco-centric (26%) value nature for its own sake, think it should be protected, and that current agricultural practices are harmful; anthropocentric (8%) believe humans are separate from and dominant over nature; mixed (66%) group expressed contradictory beliefs mixing eco-centric and anthropocentric values. When combined with approaches to chemical use, three producer types emerged from the study:

- **Conventional** (78%) prioritized humans over nature and used chemicals;
- **Alternative** (12%) prioritized nature and abstained from chemicals;
- **Status** (10%) are conventional producers focused on maximizing efficiency.

Key factors influencing adoption include: access to capital (economic, social, cultural), belief and attitudes (worldview), access to different types of technology, policy environment, as well as demographic and ecological factors. Individual factors are not as important as combinations of factors, for example education and attitude, or economic and trust factors. Producer segments do not reveal
important nuances in their farming beliefs that could influence decisions to adoption BMPs; some conventional farmers have strong environmental beliefs and would reduce chemical applications while others are more likely to adopt chemical applications which means that many producer’s willingness to adopt BMPs cannot easily be associated with broad producer types. These mixed views that need to be taken into account when designing extension programs for types of producers. Extension agents may also be influenced by their own biases and make assumption of producers’ worldviews that are counterproductive. In terms of messages, 94% of conventional producers trusted their neighbors for information, which was about 30% higher than for either alternative or status producers. The research showed that the needs of alternative producers are not met by government extension programs. Status producers preferred structured settings for receiving information. Status producers also prefer detailed, thorough information as opposed to simplified messages meant to sell a practice. These producers communicated an aura of success and affluence through their immaculate yards, many bins, and overall professionalism.

Sulemena & James (2014)

In a 2006 survey of 3000 farmers in Missouri USA, Sulemana & James (2014) investigate how farmer identity affects attitudes towards environmental management. Three identities factors are examined:

- Pro-environment/conservationist versus productivist;
- Optimism versus pessimism;
- Traditional versus technology based practices.

Results show that conservationists, pessimists, and favoring technology over tradition are positively correlated with having an attitude of concern for the environment. In contrast, productivists, optimists, and traditionalist tend to be more accepting of unethical environmental practices. The conservationist versus productivist identity is the most important factor in determining attitudes toward farming practices that have ethical implications.

Emtage et al. (2007)

The article explores the potential for using typologies for natural resource management (NRM) and rural and regional development applications. Studies have investigated relationship between socioeconomic characteristics of farmers and their values, characteristics of their farms, and their NRM behavior. However, it is not feasible to target the individual circumstances and values for every
landowner when designing and applying programs. The authors advocate for a nested set of typologies that are coordinated at the national, regional, and local scales. The lack of theory to guide the scope, focus and potential applications of developing farm styles has limited the applicability of this approach in practice. Challenges in developing typologies include:

- Researcher subjectivity when defining typologies and determining weights for cluster variables.
- Validity, predictability, and practicality of the typology
- Risk of over simplification and stereotyping of producer types
- Difficult selection of criteria to classify farmers
- Single versus multiple farming sectors and issues – too narrow a focus limits applicability in rural development and NRM programs and policies while detailed information is expensive to collect and can overgeneralize.
- Criteria for selecting farming populations to categorize - scale of operations or land size?
  Coordinating and nesting data across scales can make the most of detailed local studies and complement broader NRM programs.
- Whether values are sufficiently distinct between styles or whether there is a continuum of values. There is general agreement that social and cultural factors have strong relationships with land-management behavior, but further research is needed to decipher relationships between personalities, values, resources, and behaviors.
- How to incorporate variations in styles over space and time. Generating insights into the changes that occur in rural communities with time is a vital if methods are to be consistent and repeatable.

Recommendations include developing a framework a priori for a nested set of typologies coordinated at national, regional and local scales, with repeated measurement over time to track the evolution of farmer practices, management values, and socioeconomic characteristics. Quantitative approaches which provide predictability and generalizability of segmentation approaches must be combined with qualitative methods which provide greater understanding of the style and how to use styles to target behaviors.

*Emtage & Herbohn (2012)*
Use “Prime prospect analysis” to segment the market by actual versus potential adopters in order to target farmers who are aware of natural resource management issues but have not yet adopted BMPs (prime prospects). The cluster analysis revealed 5 groups:

- **Concerned but Unengaged** – producers who are interested in conservation but not engaged in BMP’s (‘prime prospects’ for targeting in NRM). These producers tend to have small land holdings, and often agriculture is not the primary purpose for owning land. This group generates the lowest proportion of income from agriculture, tend to be educated, and have lived on the farm for less time than other groups. This group accesses information from media and environment groups.

- **Multiple Objective** – producers with moderate levels of interest in natural resource management, use land primarily for agriculture and have limited education. Their primary sources of information are financial institutions and family member. This group is also considered prime prospects.

- **Production Oriented** – producers who have adopted BMPs but are not concerned about natural resource management issues (potential defectors). Agriculture is primary land use and the farm is the primary source of income. Landowners work long hours, have lived on the property for a long time, and tend to attend extension and training. Information sources include financial institutions and family. This group adopts BMPs in order to save costs.

- **Disconnected and Conservative** – producers with low levels of interest and engagement with natural resource management activities (poor prospects). This is the largest group in the sample (40%). 50% of this group listed agriculture as the primary land use but have small land holdings and are not considering expansion. Often the land has some area under native vegetation. This group is not dependent on land for income generation, and typically has not lived on the property long. Large proportion of females.

- **Well-Connected and Progressive** – producers that are highly motivated and using BMPs (model owners). 90% of this group list agriculture as the primary purpose of ownership. They value information and trust multiple all sources. They have lived the longest on their properties, have the largest property sizes and agricultural incomes, and support the largest number of people living on property. They are educated and value both improving the environment and expanding their business and had a high adoption rate for BMPs, particularly minimum till and soil testing, which are associated with economic benefits.
Converting high levels of interest in improving the environment for unengaged producers will be challenging as this group does not pay attention to common information sources and typically is not involved in farming networks, and are also not available during standard work hours. Contact with this group could be made through ‘media’ information sources (including newspapers, radio and the internet) given the high level of ‘usefulness’ they attributed to these sources. Both the unengaged and multiple objective groups have high trust for ‘environmental groups’ which could be utilized to engage them. For the large ‘disconnected and conservative’ group, the focus should be on increased awareness and knowledge about the broader NRM implications of their property management to influence long run behavior change.

Pike (2008)

In the mid-2000s, Defra characterised styles of English farming based on a review of the literature on categorising farmers and measuring attitudes and farming objectives, as well as expert interviews a farm survey. An initial survey of 683 farmers was used to cluster farms into 5 typologies (Figure 2) based on their responses to 25 farming objectives and 26 value statements: family orientation; business / entrepreneur; enthusiast / hobbyist; lifestyler; and independent/small. However, the segmentation was only framed for a particular policy resulting in gaps including non-responses and non-representation of some types. A follow up study built on this methodology to provide a more robust segmentation model that was supported by additional qualitative work and focussed on communication. It included a survey of 750 farmers using 17 objective and value questions that were significant from the first study and resulted in 5 segments (see Figure 2 below).

- **Custodians** (23%) way of life, pride, heritage, environment;
- **Lifestyle Choice** (6%) farming not main source of income, farm for tradition and pleasure;
- **Pragmatist** (22%) mainstream, traditional, and family oriented, with a mixture of motivations from heritage as well as business. They have an emotional connection to the farm but with a business focus
- **Modern Family Business** (41%) value family success and income but financial planning not important
- **Challenged Enterprise** (7%) view farming as a burden. They are isolated and pessimistic.

The typology was used to identify approaches to target messages for each type. Custodians and Lifestyle farmers respond more to emotive issues and messages that focus on inclusion, protecting the
future, working in partnership rather than directive and mutual benefits. The other segments need more concrete reasons related to farm outputs or economic productivity to be change behavior. Modern family business and Challenged Enterprise types are more focused on the bottom-line while Pragmatists are mainstream, traditional, family farms and are a mixture of the other types. An important finding is that segments were similar when profiled by size, region and farm type and only differed when attitudinal factors were included. Only a small number of statements were significant for assigning respondents to segments.

![Figure 2 DEFRA Farmer segmentation model (Pike, 2008)](image)

The DEFRA model was applied to identify the most relevant farm types, sizes, behavioral segments, attitudes and motivations for uptake of low carbon opportunities (Barnes et al. 2010). Dairy and arable farms had higher rates of adoption of climate mitigation BMPs due to their reliance on purchased fertilizers and efficiencies realized. However, there was little uptake by upland livestock farms that used fewer inputs and were further removed from end markets. This group feels that abatement opportunities and efforts are confounded by market and weather conditions. Most producers did not view climate change as an important consideration for their business. This result was
consistent across segmentation categories even where adoption of mitigation BMPs was high (see Figure 3 below).

<table>
<thead>
<tr>
<th>Farm type</th>
<th>Priority of climate change (majority)</th>
<th>Uptake of MMa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arable</td>
<td>Not very to fairly important</td>
<td>1 to 10</td>
</tr>
<tr>
<td>Dairy</td>
<td>Not very to fairly important</td>
<td>4 to 9</td>
</tr>
<tr>
<td>Livestock</td>
<td>Not very to fairly important</td>
<td>2 to 10</td>
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</table>

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<tr>
<th>Farm size</th>
<th>Priority of climate change (majority)</th>
<th>Uptake of MMa</th>
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</thead>
<tbody>
<tr>
<td>Small</td>
<td>Not very to fairly important</td>
<td>1 to 8</td>
</tr>
<tr>
<td>Medium</td>
<td>Not very to fairly important</td>
<td>2 to 8</td>
</tr>
<tr>
<td>Large</td>
<td>Not very to fairly important</td>
<td>5 to 10</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Segmentation</th>
<th>Priority of climate change (majority)</th>
<th>Uptake of MMa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Custodian</td>
<td>Not very to fairly important</td>
<td>2 to 8</td>
</tr>
<tr>
<td>Challenged business</td>
<td>Not very to fairly important</td>
<td>4 to 9</td>
</tr>
<tr>
<td>Lifestyle choice</td>
<td>Not very to fairly important</td>
<td>8 to 9</td>
</tr>
<tr>
<td>Modern family business</td>
<td>Not very to fairly important</td>
<td>6 to 10</td>
</tr>
<tr>
<td>Pragmatist</td>
<td>Not very to fairly important</td>
<td>5 to 9</td>
</tr>
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Figure 3 Uptake of mitigation methods based on farmer segmentation (A. Barnes et al., 2010)

In delivering BMPs related to climate change, there was significant uptake of mitigation methods based on economic rationale. Most farmers were willing to consider abatement if it did not affect their core business. A poor level of understanding of climate change in relation to farming was generally reported; most did not view climate change as an important consideration in their business. Extension could focus on how climate change affects farming. Priority sectors to target are large farms dairy, cereal, general cropping, and mixed farms due to their size-related and sector-specific abatement potential. Multi-objective farm visits should be conducted to avoid farmer fatigue with extension.

Daloglu et al. (2014)

A typology for the American corn belt was developed from a literature review to develop ‘agent types’ to parameterize an agent based model to examine the impact of conservation policies on weather quality. Tenure arrangements, farm size, source of income, and information networks were significant factors in conservation practice decisions. Four types of farmers were identified:

- **Traditional** - small operations relying primarily on on-farm income;
- **Supplementary** - small operations relying primarily on off-farm income;
- **Business-oriented** - medium to large operations relying primarily on on-farm income and well connected to information networks;
- **Non-operator** - absentee and/or investor farmland owners with limited connection to local information networks.

Different farmer types may adopt different conservation practices depending on the relative importance of tenure arrangements, size, income source, and information networks. Non-operators, including both absentee landowners and investors, can be expected to have an increasing influence on conservation as they own increasing amounts of farmland. Non-operators have limited involvement in on-farm decision-making but surveys indicate their willingness to adopt conservation practices and they can be expected to increase as a factor in the future. Supplementary farmers are more willing to use conservation practices that reduce the area that must be cultivated such as filter strips and land retirement. Traditional farmers have less financial capacity and require longer time periods to pay off conservation investments which could discourage adoption of practices like cover cropping, grassed waterways, and filter strips which have long pay off periods. On the other hand, these farmers have higher enrollment rates in land retirement programs and in practices that reduce labor requirements. Business oriented farmers are limited in their willingness to adopt practices which reduce yield and revenue.

**Barnes et al. (2011)**

A typology based on attitudes towards environmental regulations for water quality management was developed using factor and cluster analysis techniques for farmers in designated Nitrate Vulnerable Zones (NVZs) in Scotland. Three types were identified:

- **Resistors** (29%) had negative attitudes towards regulations due to perceptions that regulation increases farmer workload and negatively impacts income;
- **Apathists** (32%) neither agree nor disagree with regulations;
- **Multi-functionalists** (39%) agreed with environmental regulations.

Multi-functionalists (the largest group) favour both agricultural advisors and Government sources for information concerning water pollution management highlighting the importance of government in forming attitudes and decisions related to nitrogen management for this group. The resistors and the multi-functionalists had similar approaches to land use management, but differed in their attitudes towards the environment, water management and the NVZ regulations. Apathists were indifferent towards the aims of the regulation and to water quality management. They did not participate in
voluntary measures for improving water quality. The lack of engagement from apathists is problematic for policy makers. There is a need to target information that emphasizes favorable information about water quality management to change the attitudes of apathists.

Dwyer et al. (2007)

Advice needs for six farm styles were developed for farmers in England.

- **Older Traditional** – farmers who are comfortable with their existing farming system, have a poor understanding of the impact of practices on the environment, and tend to use ‘traditional’ technologies. Their economic capacity is low and they may seek to enhance income through other sources. They tend to not actively engage in broader farm networks, shut down if there are multiple advice channels, and can’t afford consultants. They are more dependent on family and other farmers for advice. They have strong social networks and concerned about peers. Local initiatives with one to one peer advice is favored for this group.

- **Older Innovative** – farmers who are early adopters and experimenters. They are confident and motivated by passion for farming. They are also well connected with advisory systems and have a network of like minded farmers. Recommended advice style is demonstration farms and discussion groups that work through a common area of interest such as soil health or animal care. This group could act as champions in situations that overlap with their interest.

- **New Innovators** – younger family farmers or new entrants to agriculture who are looking to change and restructure the farm and explore market niches such as organic agriculture and local markets. They are new to farming and less tied to traditional ideas about farming. They are open to new ideas and developments, highly flexible and willing to engage with consumer and conservation authorities. They co-operate with other farmers as well as consumers and conservation groups/authorities. They have a positive attitude toward the environment and nature conservation. They will respond to invitations to engage in advisory groups.

- **Large Agro-business Managers** – are focussed on yield and profit maximization, have low margins and high intensity production systems. They have a professional rather than vocational attitude towards farming. They are interested in growing the farm, optimizing inputs and use technology to maximize profits. They are policy aware and have time and resources to seek advice. They are well connected to agronomic advisory systems and use commercial consultants.
for advice therefore they can be influenced through industry channels, the commercial consultancy system, business breakfasts, and short seminars.

- **Reclusive and Isolated** – farmers who stay on the farm involuntarily. Their farm requires restructuring but they are not motivated to initiate change, and are isolated from the farming community. They are heavily dependent on advice from family members. They may have one trusted source of information, such as a vet or commercial feed or fertiliser representative and would benefit from one-to-one advice from a trusted source or could also be influenced by raising awareness with a trusted family member.

- **Part-time and Hobby** - farm as a lifestyle choice, tend to be part time, tend to be unaware of policies, and have less time and resources to seek advice. They are not engaged in local farming networks. This group requires assistance in identifying sources of environmental advice and may need a strong time or financial incentive to get involved in environmental initiatives. They would benefit from direct assistance for conservation work due to lack of time and capacity.

Styles were not confined to specific farm types, situations or locations except through size. Large farms were more likely to be associated with agro-business styles while smaller businesses covered all other styles. Isolated farmers were more likely to be within the livestock sector. In general, traditional, part time, and isolated farmers should be targeted through one-one visits and advice, while innovators and agri-business farmers should be engaged through farming and agri-business networks.

### 5. Program Review and Jurisdictional Scan

#### 5.1 Overview

A search of agri-environmental stewardship programs across the US, Canada, Australia and Europe was conducted in order to better understand how different elements of environmental programs can be used to create behavior change among farmers (Objective 3). In order to address the key issues identified in the terms of reference for the study, the review focussed on the following elements:

- program design elements, including elements designed to target different groupings of farmers;
- Knowledge and Technology Transfer (KTT) approaches for different groups of farmers, both past, current and future;
- New ideas for program elements; and
Factors for success (why some programs succeed and others fail).

Program design elements included: Eligibility; Engagement between producers and funders; Recruitment and information; and Extension elements. We also assessed whether programs addressed the broader farm context such as business risk management, marketing, etc. Programs were identified through a search of published and grey literature. The Literature search was conducted using two different search engines: Google Scholar and the Primo - Online Catalog through the University of Guelph Library. Commonly searched key words included (but were not limited to): BMP adoption, agricultural BMP, agro-environmental program, agricultural stewardship, and agricultural conservation. Programs that were reviewed within peer-reviewed journals were also searched in Google to find the program website in order to get additional information on elements such as program eligibility, participant requirements, and engagement methods. Each program was then searched for through social media platforms (twitter, instagram, facebook) to better understand program KTT. Programs were also searched in the 'NEWS' search tab of Google to find articles with first-hand farmer feedback on programs. While there are numerous stewardship programs, we confined our analysis to those in the US and Australia because of similarity in farming systems and attitudes towards government. We excluded programs for which there was no feedback on program successes and failures. In total 15 programs were evaluated. These included cost share programs, social advisory clubs, accreditation programs, farm plan programs, and one market based ecosystem services program. Most program reviews did not look specifically at how program design elements other than cost share and extension affected participation. We do not include the reviews that were included as part of the Ontario Current State Summary.

5.2 Design Elements and Lessons Learned

Eligibility

• All programs were voluntary. Most programs, aside from social advisory clubs, were merit based. Participants needed to complete specific guidelines for consideration. Many programs required the creation or existence of a certified farm plan to be eligible for participation. One program (Conservation Security Program), paid for past practices (BMPs already implemented). None of the programs were first-come-first-serve. The majority of programs had an educational component. On program (Landcare Australia) was open to the general public. All others were only open to rural-landholders.
Financial Incentives

- Programs used a variety of financial incentives including: reduced crop insurance costs (ALUS); a waiver of civil fines and penalties during future pollution events (MAEAP); and financial payments for future or past BMP implementation.

Enrollment

- Only two programs, those with a social networking focus, did not require an application for participation (Clubs conseils en agroenvironment and Landcare Australia). Enrollment was funneled through a local coordinator/consultant for six of the reviewed programs.

KTT Approaches

- Programs varied greatly in their use of and presence on social media. Most programs involved partnerships with local groups and had a meeting component, even if just for initial recruitment. One program (SmartCane BMP) created its own smartphone app to assist farmers in the accreditation process.

Messengers and Delivery Agents

- While most programs were at least, in part, government funded, local program coordinators with extension/agrology experience were the primary messengers. Sometimes these advisors were fellow farmers. In some programs, political tensions can strongly impact the trust between participants and local program coordinators (e.g. MAEAP). Collaboration with all stakeholders (including farmers) during the program development phase was shown to increase trust during program participation (e.g. Northern Everglades (Shabman and Lynch (2013) and Shabman et al. (2013)). In some cases, miscommunication between levels of government has resulted in misinformation to participants, which can act as a deterrent for participation (e.g. CRP). In terms of building trust, programs that focus on social networking, which relies heavily on local knowledge exchange, have created an atmosphere of trust among participants.

Financial Payments

- Payment programs, particularly geography-specific cost-share initiatives, have been praised for their effectiveness (e.g. the Northern Everglades Payment for Ecosystem Services (PES) program (Shabman and Lynch (2013) and Shabman et al. (2013)). Some payment criteria which limit incentives, such as payment caps, limit the extent to which larger and smaller farms will participate.
(e.g. payment caps disproportionately affect larger and smaller farms for different reasons).

Adequate funding is critical for cost-share programs.

- Cost-shares are not high enough in areas of intense agricultural production or areas where farmers face pressure from urban development. Payments based on acreage tend to benefit farmers with larger land-holdings and fail to properly value in ecological goods and services produced, suggesting payments should be based on the environmental value of the BMP/land retirement and not on acreage where possible. Paying farmers for BMPs already implemented (e.g. US Conservation Security Program, Cox (2007)) was not effective.

**Compliance**

- Some programs without a financial component have zero to few performance standards or repercussions, which does not hold participants accountable. Some question if stewardship can truly be improved at the ground level without accountability. Some programs lack on-the-ground staff to ensure project commitments are being fulfilled properly (e.g. EQIP, USDA (2017)).

**Motivations and Barriers to Program Participation**

- The key reasons cited for program participation include: regulatory pre-emption (e.g. Environmental Farm Plan (Robinson, (2006)); prominence of environmentally sensitive areas on participant lands; program flexibility with opt out and contract renegotiation opportunities; public perceptions and relations; how information was disseminated.

- Barriers to Participation include concern over time commitments for implementation; long waits for funding application approval; complicated record keeping needed for some accreditation programs; poor economic justification; perception of insufficient government support; and worries about confidentiality.

**Value of Social Capital**

- Social capital can have a large impact on program success. In particular, the dispersal of trusted knowledge through community networks (involving local extension officers, advisors and farmers) has a positive impact on environmental stewardship. For example, participation in a local agro-environmental club has had a statistically significant positive impact on BMP implementation in Quebec (Tamini, 2011).
• Trusted ground-level technical support was the most important factor for program success. The technical support offered through social networks is particularly valued in areas that lack formal extension services.

• Programs should not be ‘one-size-fits-all’. Programs are more successful when they cater to different farm types. Programs should be catered, if possible, to different farm sizes. Currently most programs disproportionately benefit larger farms.

• Programs are successful when they include farmer input about actions (e.g. ALUS, Campbell, 2014; Mackenzie, 2008; Caldwell and Dodds-Weir, 2007; ALUS, 2017)

5.3 Summary of Case Studies

Case Study: Alternative Land Use Services (ALUS)

Jurisdictions: Canada -- 6 provinces (Alberta, Manitoba, Ontario, PEI, Quebec, Saskatchewan)

Background: voluntary program offering financial incentive to rural land-owners for producing ecological services (e.g. air/water quality, flood mitigation, carbon sequestration, species at risk). Cost-share payments correlate with average land rental rates. The program uses both land-sharing and land-sparing approaches to conservation (Campbell, 2014; Mackenzie, 2008; Caldwell and Dodds-Weir, 2007; ALUS, 2017)

Program Design:
Eligibility: voluntary with cap of 20% of landowner’s holdings eligible. Environmentally sensitive areas are a focus. Applications reviewed by Partnership Advisory Committees (e.g members from municipalities and farmers)
Delivery: Integrated with existing delivery systems (e.g. crop insurance programs; municipal programs).

*ALUS is a private org. that receives money from various sources to pay farmers. The ALUS model relies on partnership w/ municipalities. Farmer contact is made through local ALUS coordinators who may be a municipal employee or an extensionist working in a municipality. Some areas have ALUS Liaisons (fellow ALUS participants).

Contracts and Financial Incentives: ALUS offers flexible contracts. They are 9 years in length; modifiable every 3 years with an opt-out clause. Financial incentives include direct payments and reduced crop insurance costs (Mackenzie, 2008)

Knowledge Transfer:
Newsletters, demonstration farms, large social media presence (twitter, Facebook, Instagram)

New Program Ideas:
(no recommendations)

Lessons Learned:
:none mentioned

Successes:
• 722 farmers and ranchers have participated in ALUS, in 6 provinces (Campbell, 2014).
• ALUS has received wide support from land owners, conservation groups, governmental and non-governmental organizations (including CFA, OFA, Christian Farmers of Ontario, Green Party of Canada)
- Has been praised for successfully engaging farmers in environmental stewardship and for truly being a bottom-up approach that involves farmers at the grassroots-level (Mackenzie, 2008)
- Has provided farmers with technical support, especially in areas lacking extension services (Mackenzie, 2008)

**Challenges:**
- Lack of baseline and monitoring data to evaluate environmental impacts
- Program’s payments are inadequate for protection of farmland facing pressure from urban development (Mackenzie, 2008; Caldwell and Dodds-Weir, 2007)
- ALUS’s use of financial payments does not solve the root behavioral issues driving agri-environmental challenges (Mackenzie, 2008)
- Payment rates are based on land rental rates and are not specific to the value of the environmental service provided/protected (Mackenzie, 2008)

**Case Study:** Canada-Saskatchewan Farm Stewardship Program (CSF)

**Jurisdictions:** Saskatchewan, Canada

**Background:** A voluntary cost-share government program that offers financial compensation for the adoption of BMPs. Compensation varies by BMP from 30-70% of activity cost. (Bassett; Government of Saskatchewan, 2017)

**Program Design:**
**Eligibility:**
To qualify for funding applicants must: complete a Saskatchewan Environmental Farm plan OR be a member of Agri-Environmental Group Plans (AEGP) (Bassett); own at least 320 acres of farmland in Saskatchewan; earn a minimum of $35,000 of farm income during year of application; and meet individual BMP criteria

**Knowledge Transfer:**
(none mentioned)

**New Program Ideas:**
(no recommendations)

**Lessons Learned:**
(none mentioned)

**Successes:**
- Has been praised for increasing farmers awareness of environmental issues and BMPs (Bassett)

**Challenges:**
- Participants have been frustrated with the application system for compensation (which can take up to 20 weeks to be reviewed). Additional application reviewers are needed.
- Ineffectively communicated changes in the program over the years (reduced budget, removal of some BMPs) has led to land-owner confusion and the submission of ineligible applications
- AEGP members receive information about workshops and field training more than other individuals
- The environmental impact of the program has not been researched
- Reduced budgets in recent years is estimated to reduce participation rates

**Case Study:** Conservation Reserve Program
Jurisdictions: United States of America

Background: A voluntary program in which landowners are paid rental income to take environmentally-sensitive cropland out of production for 10-15 years to improve soil and water quality and increase wildlife habitats (Hellerstein, 2017; Karlen et al., 1999; Stubbs, 2014).

Program Design:
Enrollment and Eligibility:
Landowners of marginal pasture, highly eroded cropland, or ecologically significant grassland can apply to the program. There are two routes of application: continuous and competitive enrolment. The vast majority of applications go through competitive enrolment once per year, where land is ranked according to an Environmental Benefit Index. Those lands whose removal from production is most environmentally beneficially are chosen. Continuous enrolment happens year round, and is not competitive. The most environmentally sensitive land is accepted into this category automatically if it meets basic requirements (Karlen et al., 1999; Stubbs, 2014).

Payments: There are multiple kinds of payments participants can receive, including a yearly rental payment (average of $63.65 per acre), up to 50% cost-share for establishing BMPs, and other one-time incentives for certain environmental practices (ex. installing riparian buffer) (Stubbs, 2014).

Knowledge Transfer:
Video

Delivery Agent: Farm Service Agency (FSA) at the U.S. Department of Agriculture (USDA)
Messenger: Local country Farm Service Agency (FSA)

New Program Ideas:
(no recommendations)

Lessons Learned:
- Decrease in program interest in recent years is thought to be due to lower rental rates (due to budget cuts) and higher commodity prices (Stubbs, 2014).
- Disconnect between the USDA, State and local FSA agencies have led to rental rates that were against policy for some participants (Stubbs, 2014).
- The IRS’s changing opinion on how rental money should be taxed has discouraged many participants (Stubbs, 2014).
- This program is highly dependent on the decisions of the US Congress, and recent reductions in budgets have led to concerns that the environmental impact of this program will decrease in the near future (Stubbs, 2014).

Successes:
- As of 2014, 25.6 million acres were enrolled in the program. It is the largest federal, private-land retirement program in the United States.
- Program has successfully reduced soil erosion, improved water quality through decreased fertilizer applications and increased vegetation cover, and improved wildlife habitats (Hellerstein, 2017; Karlen et al., 1999; Stubbs, 2014).

Challenges:
(no recommendations)

Case Study: Conservation Security Program
**Jurisdictions:** United States of America

**Background:** A voluntary conservation program that paid farmers primarily for conservation practices already in existence on their operations. Its intention was to intensify existing conservation practices and motivate other farmers to start implementing environmental practices. Successful applicants were placed in one of 3 tiers of available funding, according to the practices they had in place (Bergtold and Molnar, 2010; Cox, 2007; Soil and Water Conservation Society and Environmental Defense, 2007).

**Program Design:**
- **Eligibility:** Land must be located in particular watersheds (as decided by the USDA) and must be privately owned. Participant must be in compliance with the highly erodible and wetland provisions of the Food Security Act of 1985. Applicant must share the risk involved in program compliance (Soil and Water Conservation Society and Environmental Defense, 2007).

**Application Process** (Soil and Water Conservation Society and Environmental Defense, 2007):
- Completion of a self-assessment of conservation activities that have been in place on operations for the last 2 years. Activities that, at a minimum, must already be in place include conservation tillage, crop rotations, and soil testing.
- Submit application to local NRCS office.
- Be interviewed by local NRCS agent who will determine eligibility and category, which the applicant can participate in based on the conservation activities they have noted in their assessment.

**Program Payments** (Cox, 2007; Soil and Water Conservation Society and Environmental Defense, 2007):
- Most payments are made for practices ALREADY in place. Total payment amounts were determined by the tier the participant qualifies for (< $20,000 a year for Tier I, <$35,000 a year for Tier II, and <$45,000 a year for Tier III)
- Producers can be eligible for one or more of the following 4 payment types:
  - **Stewardship Payment:**
    - Based on land rental rate. Rental rate is higher for those in higher tiers.
  - **Existing Practice Payment:** Payment that is 25% of the Stewardship Payment
  - **Enhancement Payment:** For activities that exceed the basic standards of the program
  - **New Practice Payment:**
    Cost-share percentage of implementing a new conservation practice (note: this payment type was rarely received)

**Knowledge Transfer:**
- (none mentioned)

**New Program Ideas:**
- (no recommendations)

**Lessons Learned:**
- (none mentioned)

**Successes:**
- (none mentioned)

**Challenges:**
- This program has been widely criticized and has since evolved into the Conservation Stewardship Program. Criticisms of the original program include:
- Widely deemed inaccessible to small, lower-resource farms. While farms of any land/production size can apply, eligibility requirements of having multiple conservation practices in effect for two years previous to enrolment tends to limit participation by smaller farms because they simply do not have the resources needed (Bergtold and Molnar, 2010; Cox, 2007; Soil and Water Conservation Society and Environmental Defense, 2007).
- Primarily funding activities already in place did not motivated further conservation (as was intended), but rather solidified the ‘status quo’ (Bergtold and Molnar, 2010; Cox, 2007; Soil and Water Conservation Society and Environmental Defense, 2007).
- There was not enough on-the-ground technical assistance available to farmers (Bergtold and Molnar, 2010; Cox, 2007; Soil and Water Conservation Society and Environmental Defense, 2007).
- Program criticized for having too broad of a focus (includes soil/water/air quality, biodiversity and more). Focusing on the most environmentally sensitive issues may bring more success (Cox, 2007; Soil and Water Conservation Society and Environmental Defense, 2007).
- Congress capped the program budget multiple times over, severely limiting its capabilities. (Cox)
- Research suggests that farmers tend to implement BMPs one at a time, but this program, in its eligibility alone, follows a systems approach, thus limiting participation and program impact (Bergtold and Molnar, 2010)

Deterrents to Program Participation (Bergtold and Molnar, 2010):
- Limited access to NCRS agencies for support
- Perceived risk of adoption
- For low-resource farmers: Historical large-farm bias in federal farm programs

<table>
<thead>
<tr>
<th>Case Study:</th>
<th>Clubs conseils en agroenvironment</th>
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<tbody>
<tr>
<td>Jurisdictions:</td>
<td>Quebec, Canada</td>
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<tr>
<td>Background:</td>
<td>Local agri-environmental advisory clubs that promote sustainable agricultural practices through social networking. Participation is voluntary and is free of charge.</td>
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<td>Club activities:</td>
<td>Local clubs, each with an ‘eco-advisor’, receive guidance on topics such as fertilizer management, pesticide use, water quality and conservation, and integrated pest management. Activities include field demonstrations days, workshops and training, and assistance with the creation of farm management plans. Individuals learn from their club advisor and from each other (Tamini, 2011).</td>
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<tr>
<td>Program Design:</td>
<td>(none mentioned)</td>
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<td>Knowledge Transfer:</td>
<td>(none mentioned)</td>
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<td>New Program Ideas:</td>
<td>(no recommendations)</td>
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<tr>
<td>Lessons Learned:</td>
<td>(described in successes)</td>
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<tr>
<td>Successes:</td>
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- The social capital aspect of this program has been crucial to its success. Participation in a club has had a statistically significant positive impact on BMP implementation in Quebec.
- The progress in agri-environmental sustainability in the province is largely attested to the knowledge exchange between individuals and advisors/experts, particularly in farm planning.
- Research suggests government funding social capital projects such as this could have a large impact on BMP implementation.

**Challenges:**

(none mentioned)

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**Case Study: Environmental Quality Incentives Program (EQIP)**

- **Jurisdictions:** United States of America

**Background:** A voluntary cost-sharing assistance program for farmers and landholders who are willing to implement BMPs or structural changes on their farms to address soil and water conservation (USDA Natural Resource Conservation Service (2017)).

**Program Design:**

- **Cost Share Payments:**
  - Contracts are merit-based and can last 1-10 years.
  - Farmers can have up to 75% of incurred expenses covered or up to 100% of the estimated income foregone to implement a new practice.
  - Payments are made after the completion of projects (verified by an on-site inspection).

**Knowledge Transfer:**

- Delivery Agent: USDA
- Messenger: agents from local NRCS offices

**New Program Ideas:**

(no recommendations)

**Lessons Learned:**

(none mentioned)

**Successes:**

- Has the highest rate of participation of any of the USDA’s conservation program (Stubbs, 2014).

**Challenges:**

- It has been difficult to accurately evaluate the outcomes of the program. Due to a lack of staffing resources, it is difficult to know if a contract has been carried out as planned and often a farmer’s word is taken that their project commitments are being fulfilled throughout the process (Miller, 2014).
- There has been no evidence that EQIP has improved measurable water conservation at the farm-level (Wallander et al., 2011).

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**Case Study: Environmentally Sensitive Areas Scheme**

- **Jurisdictions:** United Kingdom

**Background:** A voluntary, tax-payer funded cost-share program in which UK farmers enter contracts (up to 10 years in length) to cut stocking rates, reduce fertilizer/pesticide use, and other practices in exchange for a land rental payment. The goals of the program are to improve wildlife biodiversity and habitat, improve landscape quality, and aid in historical land preservation (Wilson, 1997; Morris and Potter, 1995; Dobbs and Pretty, 2008).
**Program Design:**
Participants could receive between £5 and £500 per hectare. Contracts are conditional on compliance, and improper compliance can result in fines and penalties (Dobbs and Pretty, 2008).

The program is now closed to new applications (Department of Environment Food & Rural Affairs, 2004).

**Knowledge Transfer:**
Delivery agent: UK government and EU

**New Program Ideas:**
(no recommendations)

**Lessons Learned:**
Factors that influenced farmer participation in program (Wilson, 1997):
- Farm Size
- Size and prominence of wildlife habitats on participant’s land-holdings
- Dispersal of program information by the Agricultural Development and Advisory Service
- Program flexibility
- District dynamics

The following was found to NOT influence farmer participation (Wilson, 1997):
- Program duration
- Dependence on farmland for income
- Provision of environmental education

Farmer Attitudes: Environmental improvement from the program has been found to be critically dependent on farmer attitude. It has been suggested that the positive impacts of the program cannot be sustained beyond program contracts without shifts in farmer attitude. Research suggests that these attitudinal changes have not been achieved as of yet (Dobbs and Pretty, 2008).

**Successes:**
- One of the most successful and established agri-environmental programs in the EU. The program design has now been adopted in many other countries in the EU (Wilson, 1997).
- By 2003, 1.2 million hectares (>10%) of UK agricultural land was enrolled in the program (Dobbs and Pretty, 2008).
- Has helped to reduce farm input costs (Wilson, 1997).
- Has expanded the size and extent of conservation lands in the U.K (Morris and Potter, 1995).

**Challenges:**
- Some have reported that payments are based more on size of land holding rather than value of conservation service, leading to larger farms disproportionately benefitting regardless of conservation value (Wilson, 1997).
- Enrolment rates have been lower in areas of intensive agricultural production because payment rates are not high enough to offset potential income from cultivation (Dobbs and Pretty, 2008).
- Some argue that a greater emphasis on social capital through the improvement of networking, marketing institutions and support groups is necessary for the program to meet its environmental goals. Financial incentives are not enough – attitudes must be changed (Dobbs and Pretty, 2008).
## Case Study: Landcare Australia Program
### Jurisdictions:
Australia

### Background:
Program consists of community based environmental farm management groups (5000+ groups currently in existence).

### Program Design:
- Many groups have come together to form larger Landcare Networks.
- Program is an informal cooperative approach to knowledge transfer in communities.
- Participation is voluntary and inclusive to all community members.

### Knowledge Transfer:
Group activities take place on both public and private land. Activities includes meetings, farm tours, organizing conferences, property planning seminars, preparing submissions for government funding, and field days with group tree planting and fencing activities.

**Delivery Agent:** Australian Government

**Messenger:** Local Landcare Networks (Committees made up of smaller community groups)

### New Program Ideas:
(no recommendations)

### Lessons Learned:
- ‘Social capital’ has had large impact on program success. Relying on a basis of local knowledge exchange has created an atmosphere of trust among participants (Compton and Beeton, 2012).
- Some deem it a success due to program impact on landholder knowledge and some increased adoption of BMPs. Some criticize that improvements to sustainable land management practices have been mediocre at best and that the ‘bottom-up’ approach of these community groups tend to reinforce existing practices rather than make significant change in land management practices (Compton and Beeton, 2012).
- Research questions if small community groups who lack large budgets can really make an impact on a landscape level (Curtis and De Lacy, 1996).

### Successes:
- The larger networks have been very successful in building the trust of rural land owners, leading to the continual spread of the organization across the country through social networking (Sobels et al., 2001).

### Challenges:
- One major criticism of the Landcare movement has been ownership. While it was initially developed by the government (in partnership with rural landholders), leadership and ownership of it is often called into question (Compton and Beeton, 2012).

## Case Study: Michigan Agriculture Environmental Assurance Program (MAEAP)

### Jurisdictions:
Michigan State, USA

### Background:
MAEAP is a voluntary environmental stewardship verification program for farm operations of all sizes and commodities, aiming to minimize pollution risks on farming operations. Farmers are assessed under four systems: Farmstead System, Cropping System, Livestock System and Forest, Wetlands and Habitat System. (An operation can be verified under one or more systems)

### Program Design:
The verification process has 3 steps:

1) Attend an educational MAEAP meeting in your district.
2) Work with local conservation district to create a farm-specific risk assessment to lower pollution potential. Information on cost-share funding for practice implementation (funds from EQIP) is usually provided by the district as well.

3) Inspection from a MDARD (Michigan Department of Agriculture and Rural Development) MAEAP auditor verifies that sustainable practices and management plans have been implemented. Verified farms get signs for their operations.

### Knowledge Transfer:
- signs, meetings, social media (twitter)

**Delivery Agent:** MDARD  
**Messenger:** MAEAP technician from district conservation office

### New Program Ideas:
The Government of Michigan offers incentives for MAEAP verified operations, such as a waiver of civil fines and penalties after accidental discharges and pollution events, if they are properly reported and responded to (Chippewa Luce Mackinac Conservation District (2017)).

### Lessons Learned:
(none mentioned)

### Successes:
- To date there have been 2,300 MAEAP verifications done across the state (MAEAP, 2017)
- Program has been deemed successful. Interviewed livestock producers who were early adopters of the program were able to reduce phosphorous pollution on their operations among other benefits and overall felt the benefits outweighed the costs of the program. In livestock operations, researchers have found that willingness to participate was correlated with herd size (Vollmer-Sanders et al., 2011).
- Researchers have noted regulatory preemption to be the key motivator in MAEAP participation (Chantorn, 2013; Joshi et al., 2013).
- Some producers have felt the program too demanding and not worth their time. Political tensions have caused some hesitancy in producers (Miller et al., 2012).

### Challenges:
- Political tensions in the creation of MAEAP between government departments have caused some hesitancy in producers. (Department of Environmental Quality consultants, from whom farmers must also get permits from, felt under minded in its creation and have openly not supported it) (Miller et al., 2012).

### Case Study: Northern Everglades PES project

**Jurisdictions:** Northern Everglades, Florida, USA  
**Background:** Started in 2011, the program incentivizes BMP adoption by creating a market-value for ecosystem services provided by ranchers. The Everglade ranchers were ‘sellers’ and state agencies were the ‘buyers’. The two parties enter into a 10-year contract where the ‘goods’ being purchased were water retention and nutrient loading (phosphorous/nitrogen) (Bohlen et al., 2009; Council of Canadian Academies, 2013; Shabman and Lynch, 2013; Shabman et al., 2013).

**Program Design:**
Key Contract Characteristics (Shabman and Lynch, 2013; Shabman et al., 2013):
• Buyer requests proposals from ranchers
• Ranchers compete for funding by submitting their proposals to the state, which includes the price of an upfront implementation fee and an annual payment.
• Price and measurement method must be agreed upon by both parties before the BMP can be implemented.
• Once a contract is agreed upon, ranchers begin BMP implementation.
• Thorough documentation of contract compliance is needed. Contract compliance monitoring was conducted by third party agents, using both physical inspection methods, and technological monitoring tools.

Knowledge Transfer:
Delivery Agent: Florida State Government (South Florida Water Management District)

Comments On Trust and Messenger: Since the initial ideas for this program were brought forth by the WWF, ranchers were consulted and included during program design. Trust was built as common ground was found amongst the many stakeholders (Government, non-profit, ranchers, commodity groups), and the BMPs of focus were mutually agreed upon (Shabman and Lynch, 2013; Shabman et al., 2013).

New Program Ideas:  
(no recommendations)

Lessons Learned:
There are many challenges to the PES approach, as highlighted by the example of the Northern Everglades:
• Reviewers note that building trust amongst stakeholders can be very challenging, but is critical to program success. Trust is particularly important so that sellers (farmers) know that the value of their services is being fairly assessed (Shabman and Lynch, 2013; Shabman et al., 2013).
• Environmental services are often difficult to quantify, therefore verifying the delivery of a service that has been paid for is challenging (Council of Canadian Academies, 2013).
• Creating reliable payment contracts and schemes somehow need to reflect the fact that often up-front investment is needed for ecosystem services which creates financial risks for farmers (Council of Canadian Academies, 2013).
• Conflict can arise from the various parties involved. Often times the activities the farmers need to do to provide the ecosystem service are regulated by regulatory agencies and programs (Bohlen et al., 2009).
• A ‘social entrepreneur’ or neutral party is needed to help establish contract guidelines and mediate conflict (Bohlen et al., 2009).
• PES is a relatively new approach to BMP adoption, and its transferability to Canadian agriculture needs to be further researched (Council of Canadian Academies, 2013).
• Proper and thorough documentation is critically important to both the buyer and sellers in this type of program. Contract compliance monitoring can be an expensive barrier to program success (Shabman and Lynch, 2013; Shabman et al., 2013).
• Fixed annual payments throughout the 10-year contract were mutually decided on to account for fluctuations in services that may be out of the seller’s control. Example: Increased rainfall
one year will increase ranch runoff. The next year the farmer could exceed their commitment to run-off reduction (Shabman et al., 2013).

**Successes:**
Improved ecosystem quality (Council of Canadian Academies, 2013).
- The successful implementation of this project is largely credited to its highly collaborative creation process, which involved many different stakeholders (Shabman and Lynch, 2013; Shabman et al., 2013).

**Challenges:**
(none mentioned)

**Case Study: Nova Scotia Environmental Farm Plan Program**

**Jurisdictions:** Nova Scotia, Canada

**Background:** A voluntary, free, and confidential environmental assessment program for Nova Scotian farmers, with a goal of minimizing agricultural environmental impacts. Farms of all sizes and types are eligible.

**Program Design:**
Participation in the NSEFP program involves 5 steps (Atari et al., 2009; Yiridoe et al., 2010):
1) A farm visit from an EFP program coordinator, where the farmer’s expectations and goals are documented.
2) An on-farm environmental review of operations and potential risks which includes the farmer, a provincial agricultural engineer and an EFP program coordinator.
3) Findings from the review are thoroughly documented, and an environmental action plan is created.
4) Documented findings from the review, including recommended and realistic changes, are formally presented to the farmer.
5) Program coordinator makes follow-up visits to the farm. It is the responsibility of the farmer to implement recommended changes, but the program coordinator is available to assist with technical and educational resources.

Other aspects include networking meetings, information services, and opportunities for professional development. Focuses include water use and management, farm waste management, manure storage and handling, fertilizer management and livestock production, pest management practices, pesticide storage and application practices.

**Knowledge Transfer:**
Workshops, local partnerships, yearly awards

**Delivery Agent:** NS Federation of Agriculture
**Messenger:** EFP program coordinators, agricultural engineers
*While funding is through provincial and federal governments, program control is largely through the NS Federation of Agriculture, which represents individual producers, as well as 13 commodity groups. For this reason it is often viewed as a ‘farmer-run’ program (Atari et al., 2009).

**New Program Ideas:**
(no recommendations)
### Lessons Learned:
- Participation has increased under the current model; the program’s beginnings as a workshop/workbook self-assessment program had low participation rates (Atari et al., 2009).
- An increased interest in generating ecological goods and services, as well as increased public concern about agricultural pollutants has been a participation motivator (Yiridoe et al., 2010).
- Small-scale operations less-likely to participate than larger operations due to income (Yiridoe et al., 2010).
- Formal education is not correlated with participation rates but has been noted to improve stewardship performance (Yiridoe et al., 2010).
- Participation in EFP program-run workshops in community significantly influenced the likelihood of participation by a farmer (Yiridoe et al., 2010).

### Successes:
- Increased environmental awareness (Atari et al., 2009).
- Increased efficiency of on-farm inputs (Atari et al., 2009).
- Program model supports long-term continuous improvement on farms (Atari et al., 2009).
- Reviewers have praised its flexibility and adaptability to different farming systems (Atari et al., 2009; Yiridoe et al., 2010).

### Challenges:
- Farmers do not receive direct benefits for their participation (Atari et al., 2009).
- Its flexible structure with no performance standards or repercussions does not hold participants accountable (Atari et al., 2009).
- Its broad structure to accommodate all farm types may not offer the specific expertise certain farm systems need for success (Yiridoe et al., 2010).

### Case Study: Ontario Environmental Farm Plan

**Jurisdictions:** Ontario, Canada

**Background:** A voluntary program that facilitates the creation of individual environmental farm plans alongside Ontario farmers. The program is based of farmer self-assessments and farmer-guided education that covers a wide range of topics. Farmers determine what action items will be of focus in their plan, although their plan is subject to peer review (Robinson, 2006).

**Program Design:**
The Ontario EFP consists of 6 stages (Robinson, 2006):
1. Introductory Workshop: site evaluation
2. Farm Review: complete relevant workshops and the farm review
3. Second Workshop: learn about plan development
4. Action Plan: Create farm plan, identifying actions via a timeline to address ‘poor’ situations
5. Peer Review
6. Plan Implementation

**Financial Benefits** (Robinson, 2006):
- Participants can receive up to $1500 towards plan implementation costs
- Financial prizes are given to the best plans each year

**Knowledge Transfer:**
includes workshops, development of local champions, meetings, on-site signs, social media

**Delivery Agent:** AAFC and OMAFRA  
**Messengers:** local facilitators from farm organizations

**New Program Ideas:**  
(no recommendations)

**Lessons Learned:**
- Water contamination and soil degradation noted by participants as top concerns (Smithers and Furman, 2003)
- Greater farmer engagement in the program was noted with farmers with previous community organization experience and/or post-secondary schooling (Smithers and Furman, 2003)
- Although the program has been praised for trust levels between participants and facilitators, it is an issue that reviewers note with continue to have a major impact on program success (Smithers and Furman, 2003)

**Successes:**  
Praised for having a truly bottom-up approach, by having the farmers facilitate each step of their plan. Outside facilitators are well-trusted members of the farming community (Robinson, 2006; Smithers and Furman, 2003).
- Increased environmental awareness amongst participants (Smithers and Furman, 2003)
- Praised for confidentiality (Smithers and Furman, 2003)

**Key motivators of participation:**
- Cross-compliance with other programs: many cost-share programs require that farmer have a valid EFP
- Government and regulations preemption (Robinson, 2006)
- Public perception of agricultural environmental issues (especially with livestock production, ex. Walkerton) (Robinson, 2006)

**Challenges:**  
**Program Participation:**  
A high drop-out rate and non-participation rate were noted in the first 10 year of the Ontario EFP (Robinson, 2006; Smithers and Furman, 2003):
- Over 14,000 individual plans created
- <1/4 of Ontario farmers had entered the last stage
- 2/5 of farmers had attended workshops (38% of these did not proceed with plan creation)

**Key deterrents of participation:**
- Financial barriers - Estimated that for every 1$ received for participation, farmers have spent $5-6 in implementation (Robinson, 2006)
- if farmers felt sufficient environmental measures were already in place (Robinson, 2006)
- if suggested activities BMPs were deemed ‘not normal’ by a farmer (Robinson, 2006)
- Perception of risk (Smithers and Furman, 2003)

**Case Study:** Rural Environment Protection Scheme (REPS)  
**Jurisdictions:** Ireland

**Background:** A voluntary payment program for Irish farmers which encouraged the implementation of environmentally friendly practices. Farmers entered into 5-year contracts with the Department of
Agriculture, Food, and Rural Development and received annual payments for program compliance according to hectarage (Emerson and Gillmor, 1999; Gorman et al., 2001; Murphy et al., 2014).

<table>
<thead>
<tr>
<th>Program Design:</th>
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<tbody>
<tr>
<td>Eligibility:</td>
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<tr>
<td>Open to all Irish farmers who have owned/leased at least 3 ha of land for at least 5 years (Emerson and Gillmor, 1999; Gorman et al., 2001).</td>
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</table>

**Participation (Emerson and Gillmor, 1999; Gorman et al., 2001):**

1. A five-year environmental farm plan is created with a government-approved planner to outline issues that need to be addressed.
2. The farm plan, a farm map, and a program application are sent for approval by the Department of Agriculture, Food and Rural Development.
3. Participants must meet the specifications of 11 program measures, which cover various aspects of farm operation. (These measures are taken into account during the creation of the farm plan)

**Program Measures (Emerson and Gillmor, 1999):**

1. Waste management, liming and fertilization plan,
2. Grassland Management Plan,
3. Protection and maintenance of water courses and wells,
4. Retention of wildlife habitats,
5. Maintenance of farm and field boundaries,
6. Ban on chemicals near hedge groves and water bodies,
7. Protection of historical and archaeological features,
8. Maintenance and improvement of the visual appearance of the farm and farmyard,
9. Production of tillage crops without growth regulators,
10. Knowledge of environmental farm issues – fulfilled through 20 hours of workshop/demo days with a qualified planner.
11. Keeping of farm and environmental records (Emerson and Gillmor, 1999).

*Particular requirements of each measure may change depending on location. Measure 10 is only required when mandated by the approved farm planner.

**Payments (Emerson and Gillmor, 1999):**

Farmers who comply with all 11 conditions qualify for an annual payment of 151 euro/ha up to a maximum of 6040 euro/year (max 40 ha). When government inspectors find participants failing to comply with measures/their farm plan, financial penalties can be applied, ranging from 5-100% (10-15% is most common). Farmers are paid an additional 124 euros for the workshop attendance outlined in Measure 10.

**Knowledge Transfer:**

Workshops, demo days

**Delivery Agent:** National Government

**Messenger:** government-approved planners and state inspectors

**New Program Ideas:**

(no recommendations)

**Lessons Learned:**

Demographics of Participants
Participants were more likely to have the following characters than non-participants (Murphy et al., 2014):

- Low-income
- Spent larger proportion of their time working on the farm
- Younger and married
- Had poorer quality soil and produced less organic nitrogen on their farms

Successes:
Reviewers have generally deemed this program to be highly successful. The program has been praised for:

- High participation rate. One–quarter of all farmers were participants within the program’s first 5 years (Emerson and Gillmor, 1999).
- Universal availability to all farmers regardless of location (Emerson and Gillmor, 1999).
- Payment cap of 40ha – This helps to limit the extent to which larger farms (likely with more resources) can disproportionally benefit financially over smaller farms (Emerson and Gillmor, 1999)
- Comprehensiveness: the 11 measures help address nearly every aspect of a farm’s operation (Emerson and Gillmor, 1999)
- Educational aspect: mandatory 20h of paid workshop attendance for all participants has been praised (Emerson and Gillmor, 1999; Gorman et al., 2001)
- Rates of inorganic phosphorous use have fallen (Gorman et al., 2001)
- Has improved awareness about the value of environmental services (Gorman et al., 2001)
- Has enhanced farmer livelihoods (Gorman et al., 2001)

Challenges:
- Payments should be more flexibility between individual farms, as some (particularly smaller operations), will have to invest more financially to meet program requirement. For example, participation rates were higher among sheep farmers than dairy farmers; because the costs to implement changes were much lower (Emerson and Gillmor, 1999).

Case Study: Rural Water Quality Program

Jurisdictions: The Grand River Watershed, southern Ontario, Canada

Background: A voluntary cost-share program with farmers.

Program Design:
Farmers can receive 30-70% of BMP implementation costs to improve water quality in the Grand River Watershed (or can be combined for 80-100% cost-share total with funding from Canada Ontario Farm Stewardship Program) (Grand River Conservation Authority (2017).

Application process:
1. Attend EFP workshop and create/or have a valid EFP
2. Contact Rural Water Quality Program representative from local conservation district to submit application
3. Applications are judged based on potential to positively impact water quality in their district by Rural Water Quality Program Review Committee (merit-based)
4. Successfully applicants will receive a site inspection after project completion, and money will be received 5 weeks after this inspection.
Approved activities include but are not limited to manure storage, well decommissioning, tree planting and fencing. Qualifying BMPs and cost share proportion varies by county.

**Knowledge Transfer:**
Booth, flyers, many local partnerships

**Delivery Agent:** Grand River Conservation Authority
**Messengers:** Local conservation district officials (application approval/performing site inspection)

**New Program Ideas:**
(no recommendations)

**Lessons Learned:**
(see Challenges)

**Successes:**
- 3,150+ applications have been approved since the program began in 1998 (Loefffer)
- The EFP requirement and relationships formed with conservation authority staff have increased farmer awareness of water quality concerns (Dupont, 2010). The program has done well to maximize results by making BMPs and cost-share amounts district dependent (Dupont, 2010; Weersink et al., 2001).
- The watershed-specific program has been viewed as more successful than other water quality program that are geographically broader (Weersink et al., 2001).

**Challenges:**
- In the past, compensation for some activities has been inadequate, and therefore some activities are rarely selected by applicants (example: conversion of cropland to buffer strips) (Weersink et al., 2001).
- Some have criticized that only funding the most cost-effective activities instead of such a large variety of activities would lead to more effective conservation by the program (Weersink et al., 2001).

**Case Study: SmartCane BMP**

**Jurisdictions:** Queensland, Australia

**Background:** Voluntary BMP program for sugar cane producers, with goals of reducing the industry’s impact on the Great Barrier Reef. (Canegrowers, 2017)

**Program Design:**
Producers receive SmartCane accreditation through the completion of 3 steps:
1) Producers complete 7 modules to assess their practices (either online or in group session with facilitator)
2) An action plan is created with a local facilitator to implement changes.
3) Farm is audited by independent auditors and could be subjected to industry auditor at random.

**Knowledge Transfer:**
Includes YouTube videos, farm demonstration days, case studies, newsletters. Successful producers are largely celebrated in local news.
**Delivery Agent:** Canegrowers Australia, Queensland Government  
**Messenger:** local facilitators (includes agrologists, extension officers and other farmers), industry auditors, independent auditors.

**New Program Ideas:**  
SmartCane BMP smartphone app allows cane growers to track and record irrigation, fertilizing, and cultivation events (created to appease the above mentioned challenge)

**Lessons Learned:**
(none mentioned)

**Successes:**
- 1574 farms benchmarked, 215 farms currently accredited

**Challenges:**
- Feedback from growers included that the record keeping needed for accreditation was very challenging and a significant barrier to their participation.

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**Case Study: Ecological Goods and Services Program in Manitoba**

**Jurisdictions:** Manitoba, Canada

**Background:** Not an existing program. Researchers studied the potential for ecological goods and services programs in the province of Manitoba, through interviews and focus groups of stakeholders. This research gives thorough insight into stakeholder needs and concerns about such a program. (Richard and Hodgson, 2008)

**Program Design:**
(n/a)

**Knowledge Transfer:**
(n/a)

**New Program Ideas:**
(n/a)

**Lessons Learned:**
The following were noted concerns in program creation mentioned by local stakeholders:
- Level of funding and any uncertainties surrounding funding
- Landowner perceptions
- Public perceptions and relations
- Uncertainty in terms of program design with respect to science and market realities
- Difficulties in selecting areas to target for potential EG&S program deliver
- Administrative costs
- Program delivery

The following are payment options suggested by local stakeholders:
- Opportunity cost plus incentives for key areas (e.g., sensitive or high risk)
- Bidding system
- Multifunctional market based program
• Annual long term payments
• Based on environmental outcomes
• Premiums for longer term contracts

Conclusions from interviews and focus groups with stakeholders:
• Environmentally sensitive areas that should be considered for program include riparian areas, wetlands, lakes and escarpments.
• Top environmental concern for stakeholders was water quality and quantity, followed by soil health.
• Deterrents from program participation include a perception of improper government support and poor economic justification. Some mentioned poor farmer awareness of environmental issues.

Main conclusion: An EG&S program would have the highest value of net benefits if its structure included ALUS payments, long-term 10 year contracts, and 100% adoption rates.

| Successes: | (n/a) |
| Challenges: | (n/a) |

**Case Study: Socioeconomic factors affecting BMP Adoption in Chaudiere, Quebec**

**Jurisdictions:** Chaudiere, Quebec

**Background:** Study Objective: To study the impact of socio-economic factors on BMP adoption in the Chaudiere region on Quebec (Ghazalian et al., 2009).

**Data Set:**
Hog, beef and dairy producers
269 questionnaires
completed May-September 2007

**Method:** Socioeconomic characteristics were entered into a BMP adoption model, based on random utility theory

**Program Design:**
(n/a)

**Knowledge Transfer:**
(n/a)

**New Program Ideas:**
(n/a)

**Lessons Learned:**
• Adoption rates vary by BMP
• Higher education significantly increased the probability of BMP adoption
• Belonging to an agro-environmental club positively influenced participation in most BMPs
• Older producers are more likely to create buffer strips.
• While older producers may not be planning as far into the future as younger ones, they are better able to implement financially demanding BMP due to lower cost-equity ratios.
• Farm size influences BMP adoption: the larger the crop production, the greater the chance that crop-related BMPs will be practiced (ex. Crop rotations, herbicide management).
- Access to machinery is positively correlated with BMP adoption (reviewers link machinery ownership with overall wealth)
- Female producers and producers who live on their farming property are more likely to adopt manure control practices
- Researcher suggests more financial support go to agro-environmental clubs

**Successes:**
(n/a)

**Challenges:**
(n/a)

<table>
<thead>
<tr>
<th>Case Study: Watershed Evaluation of Benefical Management Practices (WEBS)</th>
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<tbody>
<tr>
<td><strong>Jurisdictions:</strong> Watershed in 7 provinces in Canada (British Columbia, Alberta, Manitoba, Ontario, Quebec, New Brunswick, Nova Scotia)</td>
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<tr>
<td><strong>Background:</strong> This was a collaboration of government agencies, NGOs, research scientists, and individuals to evaluate both the environmental and economic impact of 22 BMPs on 7 small watersheds across Canada. The goal of this project was to quantify the on and off-farm impacts of BMP, in order to make future BMP policy and programming recommendations (Stuart et al., 2015).</td>
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<tr>
<td>Evaluations of the 7 watersheds included:</td>
</tr>
<tr>
<td>1. Biophysical evaluations</td>
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<tr>
<td>2. Economic Assessments (done through various economic models and use of farmer surveys)</td>
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<tr>
<td>3. Hydraulic Modelling</td>
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<td>4. Integrated Modelling</td>
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<tr>
<td><strong>Program Design:</strong> (n/a)</td>
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<td><strong>Knowledge Transfer:</strong> (n/a)</td>
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<td><strong>New Program Ideas:</strong> (n/a)</td>
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<tr>
<td><strong>Lessons Learned:</strong></td>
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<tr>
<td>Biophysical (Stuart et al., 2015):</td>
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<tr>
<td>• Many inconclusive results</td>
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<tr>
<td>• &gt;50% of BMP have the potential to reduce surface water contamination, but to what degree has yet to be quantified</td>
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<td>• South Nation: Tile Drainage BMP significantly reduced nutrient loading to water</td>
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<tr>
<td>• Some BMPs showed both negative and positive impacts, making it difficult to assess the cumulative impact of the activity. Example: South Tobacco Creek Watershed. Zero till BMP reduced sediment and N loading but increased P in runoff. High costs were involved in the implementation of most BMPs studied</td>
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<tr>
<td>Economic:</td>
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<tr>
<td>• Most BMPs had high costs associated with implementation and maintenance (Stuart et al., 2015; Afari et al., 2008)</td>
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Little to no net on-farm benefit from implementation was found but needs to be further quantified (Stuart et al., 2015).
Some BMPs resulted in marginal economic benefits that could help offset costs (Stuart et al., 2015; Afari et al., 2008).
Off-farm benefits could not be quantified (Stuart et al., 2015).

Hydraulic Modelling:
- Found to be a good resource for modelling the impacts of BMPs. Researchers hope modelling information can be scaled-up for use in larger watersheds (Stuart et al., 2015).

Farmer Considerations for BMP Implementation (from Thomas Brook Watershed Study) Afari et al., 2008
- Financial burden
- Increased on-farm equipment traffic
- Improving eligibility for future subsidies
- Location-specific attributes

Policy Implications:
- As a result of this study, South Nation Conservation Authority has included the tile drainage BMP as an eligible practice for cost-share in the Clean Water Program (Stuart et al., 2015).
- Due to the high cost of implementation and maintenance of BMPs, and a lack of quantifiable on-farm economic benefits, financial compensation of some kind is likely critical to future programs (Stuart et al., 2015; Afari et al., 2008).
- Addressing specific BMPs should be done in geographical regions where they could be most beneficial. i.e. more geographically-specific programs may be beneficial (Stuart et al., 2015; Afari et al., 2008).

Successes:
(n/a)

Challenges:
(n/a)

Case Study: Farmer Participation in Water Quality Programs in Ontario

Jurisdictions: Watersheds in 5 locations in Ontario, Canada

Background: This study combined data from two land-owner surveys to find out what motivates farmers to adopt BMPs in 5 Ontario watersheds: Ausable, Maitland Valley, Raisin Region, Grand River, Lake Simcoe (Filson et al., 2009).

Program Design:
(n/a)

Knowledge Transfer:
(n/a)

New Program Ideas:
(n/a)

Lessons Learned:
- Most farmers surveyed were aware to some degree that agricultural management practices were having an impact of the environment in their area.
- EFP was the most popular management program of farmers surveyed, although <50% had completed the program up to the peer evaluation stage.
- Smaller farms with fewer resources are less likely to adopt BMPs. Therefore, programs that are ‘one size fits all’ can leave these farms behind. Future programming should be specific in their target farm size.
- Different farming systems will likely require different BMP programs.
- BMP adoption could increase in study watersheds if there were better relationships built between government agencies and farm organizations.
- Over 90% of farmers surveyed stated that they would be in favour of receiving payments for ecosystem services
- This study recommends that future programs be a combination of voluntary and regulatory control, which would include some financial incentive. Future program participants should also have access to technical support.

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<th>Successes:</th>
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<th>Challenges:</th>
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**Case Study: Producer Perceptions of BMP programs in Great Plains**

**Jurisdictions:** Great Plains Area in the United States

**Background:** The objective of this study was to survey Great Plains producers about their perceptions of BMPs, water quality and conservation programs. A 3-page survey of 136 producers was completed. Participants were paid $50 for their time, to encourage more thorough answers (Smith et al., 2007).

**Conservation Programs**
- High percentage of producers were aware of conservation programs they could enroll in, but < 50% had ever been enrolled in one.

**Preferred BMPs among Surveyed Producers**
1. Terracing (72.4% adoption rate among those surveyed)
2. Minimum Tillage (55.2%)
3. Rotational no-till (43.3%),
4. Subsurface application of fertilizer (35.8%),
5. Contour farming (33.6%),
6. 100% no-till (27.6%),
7. Filter strips (18.7%)
8. Other (9.7%).

- 98% of producers said they use 1+ BMP on their operation, while 36% used 4 + BMPs. indicated that they use one or more BMPs in their farming operation

**Program Design:**
(n/a)

**Knowledge Transfer:**
(n/a)

**New Program Ideas:**
(n/a)

**Lessons Learned:**
• Encouraging BMP adoption is complex due to varying farmer perceptions, farm characteristics, and other external forces such as policy and economics.
• There is a knowledge gap about the severity of water quality issues between government and producers. Many farmers appear to be aware that their actions can influence water quality, but are not fully aware that there is a ‘problem’
• Some producers noted skepticism in government regulations/program control as a deterrent to participate in a BMP adoption program
• This study recommends that programs need to be flexible in order to encourage participation.
• Many producers noted that reluctance to participate in BMP adoption programs included skepticism about complex paperwork and record-keeping.

**Successes:**
(n/a)

**Challenges:**
(n/a)

**Case Study: Neuse River North Carolina Water Quality Management**

**Jurisdictions:** Neuse River Basin, North Carolina, United States

**Background:**
Concerns over high P and N levels in the Neuse River Watershed lead to mandated nutrient loading rules by the local county. Farmers were given two options: (1) Take part in the county level plan by reducing N run off by 30% or (2) implement one of five BMPs: a) a 15.2 m buffer of 9.12 m trees and 6.08 m buffer of grass or vegetation, b) a 6.08 m forest riparian buffer and nutrient management, c) a 6.08 m grass or vegetative riparian buffer and nutrient management, d) water control structures and nutrient management, or e) water control structures and riparian buffers (Hindsley, 2002; Wossink and Osmond, 2002).

Two studies have researched BMP adoption in the Neuse River Watershed (1) a statistical analysis of how economic and other farm characteristics influence BMP adoption and (2) a study of local economics to identify how to better select cost-effective BMPs

*Note: These studies were not reviews of the mandated nutrient management by the county, but independent studies of general BMP adoption in the area.

**Program Design:**
(n/a)

**Knowledge Transfer:**
(n/a)

**New Program Ideas:**
(n/a)

**Lessons Learned:**

**Farm Size**
• Size had a significant, positive impact on BMP adoption up to a point (Hindsley, 2002).
• For each BMP, there was a farm size after which adoption did not increase (average size that after which adoption was no longer affected was 519 acres) (Hindsley, 2002).

**Financial Assistance**
• Financial assistance had a mostly significant and positive impact of BMP adoption (Hindsley, 2002).
• The following BMPs were particularly impacted by farm income: cover crops, fertilizer management, inclusion of legumes in crop rotations, controlled drainage systems and grass waterways (Hindsley, 2002).

Other Lessons:
• BMP adoption was influenced by specific geographic location. Economics of BMP implementation differed by region along the river focused (Hindsley, 2002; Wossink and Osmond, 2002).
• Perception of water quality issues appeared to have little to no influence on adoption (Hindsley, 2002)
• Effective BMP adoption policy will need to be flexible and yet selective, particularly in regards to geographic range. i.e. Multiple BMP adoption options available, but ones that are geographically focused (Hindsley, 2002; Wossink and Osmond, 2002)
• Proper funding is likely imperative to program success. Cost-share funding may need to differ by region (Hindsley, 2002; Wossink and Osmond, 2002).

Successes:
(n/a)

Challenges:
(n/a)

Case Study: Effects of Extension on Adoption of Lupins Western Australia

Jurisdictions: Western Australia

Background: This paper attempted to analytically measure the influence that extension had on the adoption of a new cultivar of lupins in Western Australia, by studying the influence of farm and extension variables on adoption start time (temporal diffusion). Study data was analyzed by multivariate regression analysis using MICROFIT (Marsh et al., 2000).

Results:
• Extension sped up the adoption start time of lupins by 1-2 years
• Four variables accounted for 70% of the variability in adoption start time. Two of these variables are extension related:
  1. Squared field days (extension activity)
  2. Distance to adviser (extension activity)
  3. Percentage of farmers with previous technical experience with introduced technology
  4. Profitability of cropping lupins compared to alternative grazing opportunities
• Adoption rates varied by district

Program Design:
(n/a)

Knowledge Transfer:
(n/a)

New Program Ideas:
(n/a)
**Lessons Learned:**
- Extension work and the support of private consultants contributed to the start time of cultivar adoption.
- Extension work focused on farm demonstrations, connecting farmers and researchers.
- Enthusiasm of extension workers was noted as an important factor.
- Extension is most effective when it is geographically focused (in this case by district).
- It was not found that research trials impacted adoption start time.

**Successes:**
(n/a)

**Challenges:**
(n/a)
6. References


Bassett, E. An Examination of the Canada-Saskatchewan Farm Stewardship Program in the Redberry Lake Watershed (Doctoral dissertation, University of Saskatchewan, Saskatoon, Saskatchewan).


Campbell, J. (2014). *A Case-study Analysis of the Alternative Land Use Services Program (ALUS)*. (MSc Thesis. Dalhousie University, Halifax, Nova Scotia)


Shabman, L., & Lynch, S. (2013). Moving from Concept to Implementation: The Emergence of the Northern Everglades Payment for Environmental Services Program.


Appendix 1

The adoption of agricultural best management practices (BMPs) can be conceptualized using several different but overlapping frameworks. These include the community capitals framework (C. B. Flora, Flora, & Gasteyer, 2015), the expected utility theory (Batz & Peters, 1999), the epidemic diffusion theory (see Mahajan & Peterson, 1985), the adoption-diffusion theory (Pannell et al., 2006; Rogers, 2003), and the reasoned action approach (Fishbein & Ajzen, 2010). Each framework is reviewed for comparison.

The community capitals framework states that for sustainable economic development to occur at a community scale, the community must have sufficient capacity, which is quantified as various forms of capital (C. B. Flora et al., 2015). Forms of capital included are natural, financial, built, political, social, human, and cultural capital (Figure 4). The interaction of these factors is used to explore and explain how communities develop, and why some BMPs are common in some rural communities, and not in others (Jermalowicz-Jones, 2017). This approach allows for a holistic survey of a region or community, and can identify regional or sub-regional trends. However, the community capitals framework does not explain why some individuals within a community may adopt, while others do not. Since it is not designed to explain an individual landowner’s decision to adopt a BMP, it is not suitable for the current project.

Figure 4 Community capitals framework, adapted from Flora, Emery, Fey, & Bregendahl (2005).

Expected utility theory attempts to characterize the decision to adopt BMPs or other management practices in terms of the expected change in future utility (Batz & Peters, 1999). This theory assumes that decisions occur after a comparison of the utility of all present and future options.
In this framework, the decision to adopt is most sensitive to the perceived risk to farm net returns. Econometric models, such as probit or logit models, can be used to explore the impact of empirically measured variables on the final adoption decision. This framework is a simplification, and often well suited to complex modeling exercises, but can be criticized for reducing the decision process to an overly-simplified utility maximization problem. Since the focus of this project includes social and psychological attributes, expected utility theory alone is insufficient to review the literature on BMP adoption. However, this theory is reflected in other frameworks.

The epidemic diffusion model postulates that the adoption of an innovation is a function of (and limited by) the spread of information about the innovation (Mahajan & Peterson, 1985). As such, as the availability of information increases, the adoption of an innovation increases, generally leading to an S-shaped adoption curve. This framework segments populations based on when they adopt: frontrunners adopt early, and laggards adopt late or do not adopt (Diederen, Meijl, Wolters, & Bijak, 2003). These groups can be divided further into innovators (the first to adopt an innovation), early adopters, late adopters, and non-adopters. Empirical work suggests that structural characteristics, such as farm size, solvency, and valuation can explain some of the difference between frontrunners and laggards (Diederen et al., 2003). However, within those categories, behavioral characteristics can explain some of the differences between innovators and early adopters (Diederen et al., 2003). While this framework provides convenient analytics, its main limitation is its narrow scope: it is fundamentally driven by the diffusion of information. Since this project is more interested in the determinants of adoption than the timing, segmenting the population in a manner consistent with this framework is insufficient.

The adoption-diffusion model of BMP adoption is an adaptation of Rogers (2003) model of technology diffusion within a population, which employs elements of the epidemic diffusion model and expected utility theory. Pannell et al. (2006) postulate that the adoption of a BMP is both a population-level and an individual-level process, and use a six-step progression to describe the individual’s decision process to adopt a BMP: awareness, non-trial evaluation, trial evaluation, adoption, maintenance, and dis-adoption (Figure 5). During the information collection stage (awareness and non-trial evaluation), uncertainty is high, and the landowner relies on finding information from others, similar to the epidemic diffusion model. However, once trial evaluation begins, the landowner relies more on experience, and skill development begins. The decision to adopt is a consequence of the characteristics of the BMP itself (trialability and relative advantage), its alignment with pre-existing goals (such as income generation, environmental stewardship, social acceptance, integrity, work life balance), information from peers, and
the results of the trial. The decision is also impacted by structural traits of the farm and demographic traits of the landowner.

The strength of the adoption-diffusion theory is that it incorporates information spread and a multiplicity of landowner characteristics, while also describing the decision process as many small decisions through time. It also accounts for the different characteristics of both landowners and BMPs, and final adoption is a combination of both landowner characteristics, farm characteristics, and the characteristics of the BMP itself. This framework may be suitable to this project, though it incorporates an element of time (the speed of adoption) which is not necessarily relevant. It may also be difficult to segment landowners by their goals, and compare programs from different regions in this framework.

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**Figure 5** The adoption-diffusion framework, adapted from Pannell et al., 2006.