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ENVIRONMENTAL STEWARDSHIP INITIATIVES IN THE CANADIAN AGRICULTURAL SECTOR UNDER GROWING FORWARD 1 AND 2

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Environmental Stewardship Initiatives in the Canadian Agricultural Sector under Growing Forward 1 and 2: A back-of-the-envelope evaluation in Alberta and recommendations for future evaluations

Summary

Background

Since 2003, Canadian agricultural policy has been driven by a series of five-year Agricultural Policy Frameworks (APF). Environmental stewardship programming, which largely relies on subsidizing the adoption of on-farm beneficial management practices (BMPs) to achieve environmental goals, has been a major component of each framework and the primary means under which provincial and federal governments address environmental issues in the agricultural sector. Upon the completion of the first APF, simply referred to as the APF, the Auditor General of Canada criticized the program for failing to measure the efficiency and efficacy of agri-environmental cost-share programs (Office of the Auditor General 2008). Over the course of the two following APFs, named Growing Forward 1 (2008-2013) and Growing Forward 2 (2013-2018), little publically available evidence can be found that these concerns raised by the Auditor General with respect to program evaluation were addressed. Using limited available data, this report outlines an attempt at evaluating the performance of environmental stewardship subsidies in Alberta. We present rudimentary evaluation results and emphasize shortcomings in current data availability in order to provide data collection recommendations for evaluating the next APF, the Canadian Agricultural Partnership (CAP), which will run from 2018-2023.

Key Findings

- The Federal and provincial governments hold a wealth of spatial, financial, environmental, and farm management data relating to BMP adoption. However, data is

rarely linked together and used to evaluate the efficacy or efficiency of agri-environmental policy. In addition, some of the important datasets are not available to researchers.

- More information must be gathered regarding Environmental Farm Plan (EFP) enrollment, particularly in Alberta. Farms must have completed an EFP to participate in cost-share programs, and effective program evaluation first requires an understanding of the pool of potential participants. In order to reach more farms, a better understanding of those who have not yet adopted EFPs is also recommended.
- The current first-come-first-served approach to providing environmental stewardship funding in Alberta tied to EFP enrolment does not seem effective at funding projects in accordance with environmental risk. Due to a lack of internal government program evaluation, especially across provincial and territorial borders, it is not possible to infer whether other program funding approaches administered by other organizations have achieved better outcomes than the Alberta GF case.

Agricultural Policy Frameworks and Environmental Stewardship in Canada

Every five years, Agriculture and Agri-Food Canada (AAFC) and its provincial and territorial counterparts unveil a new APF, under which agricultural priorities and government programs addressing these priorities are implemented. Provinces set individual goals relating to business risk management and income stabilization in agriculture, marketing opportunities, and how to address social and environmental issues. The general formula for environmental stewardship programs across the provinces under each APF is largely homogeneous: a list of BMPs is drafted and farms undertaking one of those BMPs can apply for a fixed percentage of the cost to be covered by the government up to a pre-defined limit. To be eligible for BMP funding, farms must possess an Environmental Farm Plan (EFP) – a largely self-directed program that guides a producer through potential environmental risks on their farm. Cost shares for BMPs typically fall between 25%-75%, with funding maximums ranging from $2,000-$100,000 depending on the BMP.

Aside from offering different BMPs, cost share percentages, or funding maximums, provinces have started to deviate from the usual agri-environmental policy formula in order to meet their unique needs. Provincial innovations in administering agri-environmental cost-share funding are outlined in Table 1. The different policy characteristics across the provinces present different implications for cost-effectiveness, administrative burden, and perceptions of fairness among agricultural producers.

For a policy to be cost-effective, proposed projects would be ordered from greatest to least amount of benefits provided per dollar spent, and those providing the most benefits per dollar would be funded until the budget is exhausted. A first-come first-served approach to administering project funding does not ensure cost-effectiveness, but policy innovations in

British Columbia, Manitoba, and Ontario should move closer to cost-effective funding allocations. The system in Manitoba is perhaps the most cost-effective method, where projects are ranked based on the benefits they provide to society and chosen for funding accordingly. The limitation in Manitoba is that public benefits are not easily observed or accurately measured, so the rankings may not truly represent the order from most to least beneficial. Further, the administrative burden of ranking thousands of projects is presumably high. In Ontario, using methodology outlined by the EFP, producers must explain that the proposed BMP will make a significant environmental impact and that the environmental risk being mitigated is relevant in the first place. In British Columbia, BMP funding and cost-share levels are higher in areas where relevant environmental risks are higher. The approaches in Ontario and British Columbia indirectly address cost-effectiveness by either reducing the number of BMPs that provide little to no public benefit and seem to encourage more projects that provide high public benefits.

The emphasis on conservation auctions (see Hill et al. 2011, for example) in Manitoba also encourages cost-effectiveness of BMP spending. While it is difficult to accurately measure the public benefits of each proposed project across the province at the current time, conservation auctions focus on smaller regions and less BMP categories so that project benefits can be more easily measured and ranked. For instance, hydrologic models can be used to measure the resulting nutrient abatement of a specific farm adopting a certain BMP (e.g. Boxall et al. 2013), and projects can be ranked based on the mass of nutrients abated per dollar spent to maximize the environmental improvements achieved by the budget. Boxall et al. (2013) discuss other ranking approaches given limited environmental information.The Investment Framework for Environmental Resources (INFFER) is another tool that helps program administrators rank projects by factors such as value per dollar or the likelihood of achieving environmental goals

(Pannell et al. 2011). While the suite of approaches taken in Manitoba, British Columbia, and Ontario presumably improve policy efficiency, each likely increases administrative burden and could decrease farmers' perceptions of fairness.

Table 1: Provincial policy innovations for administering agri-environmental cost-share funding under Growing Forward 2 (2013-2018).

Province	Policy Innovation
British Columbia[1]	• Spatial Targeting: Different cost shares and funding caps exist for different regions based on environmental risk and provincial goals.
Alberta[2]	• Social and Spatial Networks: Groups can apply for funding for larger-scale projects of regional interest (specifically for watersheds).
Saskatchewan[3]	• Social and Spatial Networks: Groups can apply for funding for larger-scale projects of regional interest.
Manitoba[4]	• Funding is allocated based on ranking system where an environmental benefit assessment index, provincial priorities, and project planning quality are considered. • Social and Spatial Networks: Groups can apply for funding for larger-scale projects of regional interest. ◦ Additional support is available if novel funding allocation mechanism is used, such as a conservation auction or the Investment Framework for Environmental Resources (INFFER).
Ontario[5]	• BMP must be identified in farm's Environmental Farm Plan Action Plan, and project must effectively move farm's risk rating in this area from a "1" or "2" to a "3" or "4". ◦ Avoids spending on projects where risk is already low or where no meaningful improvements would be made.
New Brunswick[6]	• For BMPs providing high public benefits that are currently prioritized by the province, cost share increases by 20% and funding cap increases by $20,000.

Sources: [1]Government of British Columbia 2017; [2]Government of Alberta 2017; [3]Government of Saskatchewan 2016; [4]Government of Manitoba 2016; [5]Government of Ontario 2016; [6]Government of New Brunswick 2014.

In Alberta, Saskatchewan, and Manitoba, group applications are also accepted for certain BMPs in order to address larger-scale environmental problems (see Boxall 2018). It seems that these programs are attempting to harness the influence of group norms or social networks in facilitating pro-environmental behaviour. In Alberta, group applications are restricted to watershed enhancement projects and funding was typically administered to exclude cattle from large waterbodies. In this program, applicants are not required to hold an EFP. In Saskatchewan and Manitoba, group applications are available for a wide range of BMPs.

Evaluating Environmental Cost-Share Programs in Canada

To date, minimal research and impact evaluation material has been released regarding APF environmental stewardship programs running from 2003-2018. This is surprising given the concerns raised by the Office of the Auditor General outlining a need for concrete performance measurement regarding the impact of BMP spending on environmental quality - a concern which AAFC responded to with assurances that future BMP cost-share programs would be evaluated based on changes to environmental quality as of Spring 2009 (Office of the Auditor General 2008). Available Government evaluations have largely failed to objectively measure program success based on environmental outcomes. For instance, a more recent report from the Office of Audit and Evaluation at Agriculture and Agri-Food Canada (2014) evaluating Growing Forward 2 focused mostly on program administration rather than outcomes: the program was described as efficient because the federal and provincial set up a system to share data, and effective because the number of farms adopting BMPs and enrolling in the EFP program increased. Perhaps the first result indicates that more intensive plans for objectively measuring BMP funding in the future are underway. However, the measure of efficacy that was used does not speak to whether funding was spent effectively or efficiently.

Between AAFC and the provincial and territorial governments, most of the data required for a rigorous evaluation of environmental stewardship policy under the APFs exists. At the provincial level, records of each BMP that received funding have been retained, often including GIS coordinates, total producer and government expenditure, and a short project description.

Federally, numerous research teams have measured a series of environmental risk indicators regarding the potential impacts of agricultural production on wildlife, soil, water, and air quality (Clearwater et al. 2016). While some evaluation projects of cost-share funding programs have been conducted, they have largely relied on farmers' levels of satisfaction with the program or perceptions of whether the BMP will improve environmental quality rather than tangible outcomes that actually affect society (e.g. Ontario Ministry of Agriculture, Food and Rural Affairs 2017). Results of these analyses are largely positive since they tend to survey successful program participants who recently received cost-share support and exclude producers who were eligible to participate but chose not to, or who may have unsuccessfully applied for funding.

Some provinces have evaluated the efficacy of their environmental stewardship funding programs on environmental and financial grounds. In British Columbia, numerous reports outlining financial and business aspects of BMP adoption, such as cost benefit and SWOT analyses, have been conducted (e.g. Kitchen et al. 2014). These reports have focused on producer decision-making and are unable to evaluate Growing Forward cost-share assistance more broadly. For instance, the cost-benefit analyses are unable to incorporate public benefits or private, non-market benefits associated with BMP adoption, which are presumably the main reasons for the existence of these programs.

The Government of Ontario, AAFC, and a group of agri-environmental NGOs examined the uptake of nutrient management BMPs in Ontario between 2005 and 2010 (Woyzbun 2011). Using a series of bivariate regressions, the amount of BMPs adopted in Ontario municipalities was modeled as a function of the amount of phosphorus produced by manure, area of land that was fertilized, total net farm income, or the total number of farms, finding a positive significant relationship in each case. While these results may seem promising for policy administrators, the lack of control variables, large spatial extent of each observation and small number of observations suggest that BMPs are simply being adopted where farms are located rather than where risks are relatively higher.

Numerous challenges must be overcome to effectively evaluate environmental stewardship components of the APFs. To understand the true impacts of agri-environmental policy, baseline levels of BMP adoption rates and trajectories of environmental quality must be well understood. Producers' privacy must be balanced with the need for providing individuals' data to policy evaluators to determine who the program is successfully reaching, how to reach a wider range of producers, and how to entice specific landowners to adopt BMPs that provide the highest public benefit per dollar invested. Next, we provide an overview of an attempt at evaluating environmental stewardship funding in Alberta under Growing Forward 1 and 2, keeping in mind that overcoming the challenges listed above would require careful program evaluation planning prior to implementing each APF.

Evaluation Case Study: Growing Forward 1 and 2 in Alberta

We evaluated environmental stewardship components of Growing Forward 1 and 2 in Alberta using what limited data was available. First, we will examine descriptive statistics of BMP adoption under Growing Forward 1 and 2. Next, a spatial autoregressive model examining BMP adoption rates under Growing Forward 1 will be presented. Growing Forward 2 data was excluded from this component of the analysis because the program had not yet closed when we received these data, and because the majority of the variables from the 2011 Census of Agriculture were not released at the Soil Landscape Classification (SLC) level.

Under Growing Forward 1, the Government of Alberta provided cost-share assistance to producers for three broad environmental stewardship categories: integrated crop management, manure management, and grazing and winter feeding management. In Growing Forward 2, many of the same BMPs were offered under the On-Farm Stewardship program, while additional programs aimed at confined feeding operations (CFOs; more commonly known as feed-lots) and watershed groups were developed. Total BMPs adopted and expenditures across the programs are outlined in Table 2. Projects aimed at CFOs and manure were typically more expensive than others.

Table 2: Number of BMPs funded in Alberta under Growing Forward 1 and 2.

Program	**# of Projects**	**Cost (2017 $)**	**Cost/Project (2017 $)**
Growing Forward 1			
Grazing & Winter Feeding Management	834	2,833,057	3,397
Integrated Crop Management	687	3,648,690	5,311
Manure Management	218	5,334,152	24,469
Growing Forward 1 Total	**1,739**	**11,815,899**	**6,795**
Growing Forward 2			
On-Farm Stewardship: Grazing Management	1,062	5,775,676	5,438
On-Farm Stewardship: Manure and Livestock Facilities Management	37	755,658	20,423
On-Farm Stewardship: Crop Input Management	362	2,874,574	7,866
On-Farm Stewardship: Agricultural Waste, Fuel Storage	244	664,415	2,723
Confined Feeding Operation Stewardship	134	4,946,426	36,914
Agricultural Watershed Enhancement	74	931,849	12,593
Growing Forward 2 Total	**1,913**	**15,921,598**	**8,323**

Note: these numbers were provided by program delivery agents, so some inaccuracies likely exist with respect to total projects completed or costs.

A range of popular and unpopular BMPs offered under Growing Forward 1 and 2 are outlined in Table 3. Cost-share percentages and funding caps varied across BMPs, perhaps providing higher shares and caps for BMPs with higher benefits to the public and less benefits to the producer, and lower shares and caps for BMPs providing high producer benefits and low public benefits. BMPs that provide perhaps the highest levels of public benefits, such as wetland restoration, were adopted at a very low rate. It is noteworthy that BMPs that presumably provide large private benefits were adopted more often even than those primarily providing public benefits. Further, it seems that adoption rates of BMPs providing more private benefits were less responsive to changes in cost shares or funding caps than those providing less private benefits but higher public benefits. For instance, cost-share for double-walled fuel tanks decreased from 50% up to a limit of $20,000 in Growing Forward 1 to 20% up to $3,000 in Growing Forward 2, yet the total number of tanks purchased with government assistance only declined from 307 to 216, respectively. That is, the government's portion of the adoption cost decreased by 60%, the funding cap decreased by 85%, yet adoption only declined by 30%.

Unfortunately, it was not possible to formally analyze adoption rates based on changes to funding details because changes to cost shares and funding caps have been made in the middle of APFs for different BMPs. In addition, applications would open and close throughout the 5-year period, and total budgets for BMPs sometimes differed in the same period. Further, for privacy reasons, we did not receive the date of BMP adoption, so it was not possible to understand how variation in BMP adoption was in response to changes in cost shares or funding caps within or between APFs. However, the provincial government has access to dates of BMP adoption and changes to funding details, so such an analysis would be possible.

Table 3: Most and least adopted BMPs in Alberta under Growing Forward 1 and 2.

Program	No. of Projects	Cost per Project ($)	Funding Cap ($)	Cost Share (%)
Growing Forward 1				
Most Adopted BMPs				
Safe Product Storage (Fuel Tanks)	307	5,330	20,000	50
Watering Systems	288	3,633	15,000	50
Portable Shelters/Windbreaks	216	3,524	15,000	50
Least Adopted BMPs				
Native Upland Range Establishment/Restoration	3	9,369	15,000	50
Riparian Health Assessment	0	0	15,000	50
Wetland Restoration	0	0	2,500	50
Growing Forward 2				
Most Adopted BMPs				
Watering Systems (Total)	474	6,382		
CFOs	432	5,765	15,000	50
Breeding Herds	42	12,720	30,000	100
Portable Shelters/Windbreaks	368	4,045	10,000	50
Improved Pesticide Management	253	5,255	10,000	50
Least Adopted BMPs				
Manure Composting	4	28,813	30,000	50
Wetland Restoration	2	10,554	50,000	70

Analyzing producers' responses to changes in cost shares and funding caps are useful to governments for two main reasons. First, a better understanding of how farmers respond to different sets of funding details would help the provinces and territories understand how to maximize the number of projects or benefits per dollar spent, rather than setting cost shares and funding caps based on best guesses and altering them over time. Second, analyzing the linkage between adoption and financial support would help establish baseline adoption levels for each BMP; that is, the number of farmers who would adopt each BMP if no support was offered. Understanding baseline adoption levels is crucial when evaluating the performance of environmental stewardship under each APF, as it should not be assumed that every BMP that was adopted was solely due to the funding offered. However, this approach seems to be current practice in the few program evaluation documents that exist (e.g. Agriculture and Agri-Food

Canada Office of Audit and Evaluation 2014). While financial supports do tend to incentivize adoption in certain cases, there is also a wealth of evidence suggesting that farmers adopt BMPs for reasons other than receiving government-sourced financial assistance (e.g. Rollins et al. 2017).

Statistical Methods – Spatial Autoregressive Model

To comprehensively evaluate environmental stewardship programming under Growing Forward 1 in Alberta, we estimated a spatial autoregressive model of BMP adoption. We combined three data sets in order to estimate this model: Census of Agriculture data interpolated to the SLC level, GIS coordinates of BMPs adopted under Growing Forward 1 in Alberta, and environmental risk indicators estimated at the SLC level by NAHARP. Since applications for some Growing Forward 2 programs were still open when we received the adoption data and because of incomplete data availability for the 2011 Census of Agriculture, we restricted this portion of the analysis to Growing Forward 1.

The basis of our regression model assumes that program effort should be in response to the intensity and size of an environmental risk, as outlined in equation 1.

$$Effort = f(Environmental\ Risk \cdot Area) \quad (1)$$

Given the available data, we used the number of BMPs adopted in an SLC as our measure of effort. For environmental risk, the standardized value of an array of NAHARP risk indicators, as well as the change in each risk indicator of the past 5 years, were used. Changes in each risk indicator were included as a simple attempt to introduce baselines for each environmental risk, or whether risks were declining or improving prior to implementation of Growing Forward 1. Since multiplying the land area of each SLC with each environmental indicator resulted in collinearity, we divided BMP adoption in each SLC by the total land area to measure BMPs adopted per unit of land. Since adoption between SLCs may be spatially linked, we estimated the following equation:

$$\frac{Effort}{Area} = \alpha + \beta \cdot Risk + \gamma \cdot Controls + \rho \cdot \boldsymbol{W} \cdot \frac{Effort}{Area} + \lambda \cdot \boldsymbol{W} \cdot u + \varepsilon$$

where controls are census variables relating to averaged farm characteristics in an SLC, **W** is a spatial weights matrix, u and ε are error terms, and α, β, and γ are coefficients. The spatial weights matrix was employed to estimate the impact of spatial lags of adoption. That is, we estimated how adoption in neighboring SLCs and neighbors-of-neighboring SLCs impacted adoption in each SLC. We also applied the spatial weights matrix to an error term under the assumption that errors in neighboring SLCs could be correlated. This spatial autoregressive model was solved using two-stage-least-squares (Anselin 2013).

Results – Spatial Autoregressive Model

Results from the spatial autoregressive model are presented in Table 4. To test for robustness of the signs and significance levels of coefficients for the environmental indicators, other model specifications were estimated but not presented[1] as the results are generally constant across model specifications. The model explained 53% of the variance in adoption rates across SLCs, and the spatial components of the model were jointly statistically significant (χ^2=19.76, p=0.0001).

Looking at average farm characteristics by SLC, only farm density was significant. This result is not necessarily surprising for two reasons. First, many determinants of BMP adoption have been studied at the individual farm level, which is not possible in this case. Second, the county level fixed effects likely encompass many of the average farm traits that might affect

[1] Other specifications include: without county-level fixed effects, without variables representing changes in environmental indicators, and different specifications of spatial lags and spatial errors.

adoption, as well as political traits, such as extension efficacy and expenditure or financial resource availability from local governments and non-governmental organizations. The coefficient on farm density suggests that when there are more potential BMP adopters, higher levels of BMP adoption occur, which is a logical outcome. However, this inference assumes that EFP enrollment is uniform across SLCs in Alberta, which may be a heroic assumption, as spatial or geographic trends of EFPs are not available.

Table 4: Spatial autoregressive model of BMP adoption per section of land in each SLC as a function of averaged farm characteristics and environmental risk indicators.

Variable	Coefficient	SE	p
Average Farm Characteristics			
% Owned Land	0.0022	0.0133	0.868
Farm Density	0.0023***	0.0005	0
Total Farmland Area	0.0000	0.0000	0.346
Avg. Farm Profits	0.0001	0.0005	0.836
Environmental Indicators			
Soil Organic Matter	0.0022*	0.0011	0.056
Salinization	-0.0009	0.0013	0.488
Erosion	-0.0048***	0.0013	0
Water: Pesticides	0.0022	0.0022	0.306
Water: Nitrogen	-0.0001	0.0018	0.948
Water: Phosphorus	0.0123***	0.0040	0.002
Biodiversity: High Risk	0.0036	0.0027	0.188
Changes in Environmental Indicators			
Soil Organic Carbon	0.0016*	0.0009	0.069
Salinization	-0.0008	0.0010	0.404
Erosion	-0.0001	0.0009	0.898
Water: Pesticides	-0.0005	0.0021	0.808
Water: Nitrogen	0.0019	0.0012	0.121
Water: Phosphorus	-0.0088**	0.0036	0.016
Spatial Components			
Spatial Lag	0.4904***	0.1736	0.005
Spatial Error	-2.4804***	0.6027	0
R^2=0.53; N=377			

Note: County-level fixed effects were estimated but are not presented.
*Significant at 10% level; **significant at 5% level; ***significant at 1% level

In terms of environmental indicators, only three coefficients are statistically significant, and two of the significant coefficients are the opposite sign of what effective targeting of environmental risks would suggest. The effects are somewhat more apparent when the coordinates of where BMPs were adopted are plotted on environmental risk maps (Figures 1 – 3). SLCs with higher levels of soil organic carbon (Figure 1) and lower risks of erosion (Figure 2) have a greater amount of BMPs adopted within them, controlling for SLC size. Thus, more BMP funding is being spent per acre on lower-risk land. However, a higher risk of water pollution by phosphorus is linked to increased BMP funding per acre (Figure 3), suggesting that an approach that involves no formal targeting is able to target this one water pollutant at least somewhat effectively. In this case, the results seem to be heavily driven by a small area in southern Alberta in which there is a heavy concentration of CFOs, and is the only place where the risk of water pollution by phosphorus is classified as *very high*.

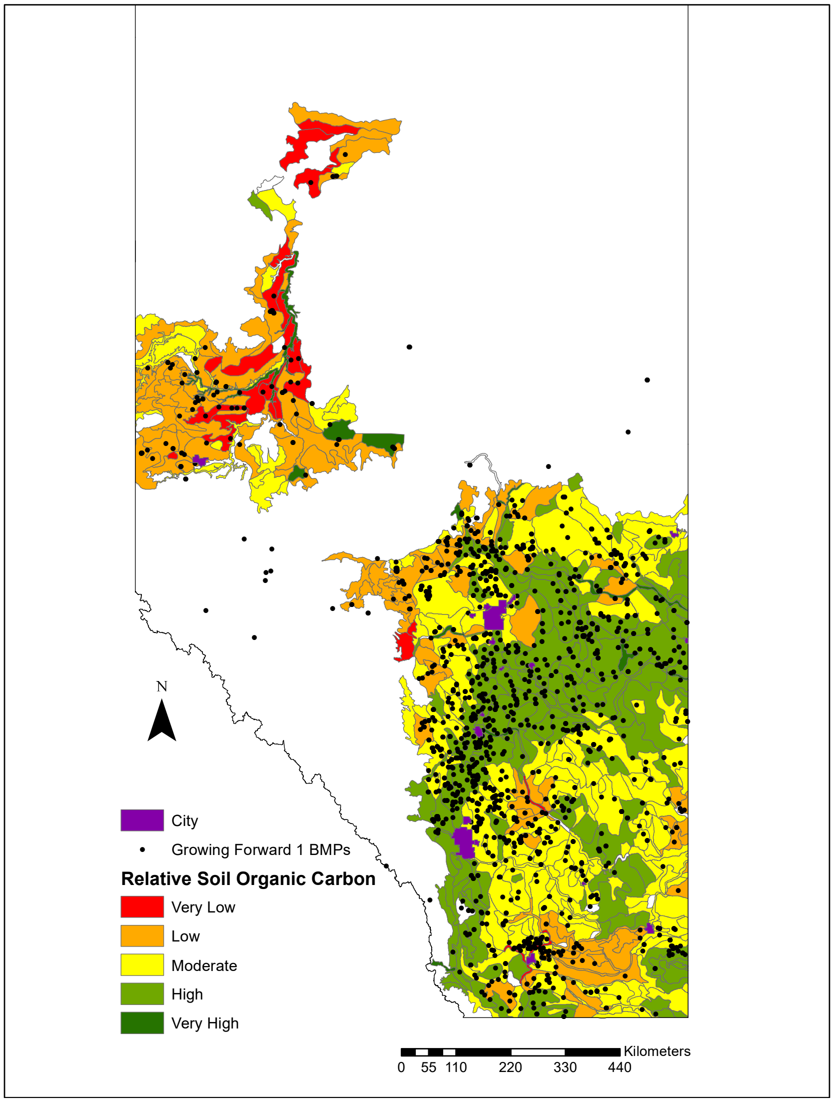

Figure 1 – Map outlining relative soil organic carbon and sites where BMPs were adopted in Alberta under Growing Forward 1.

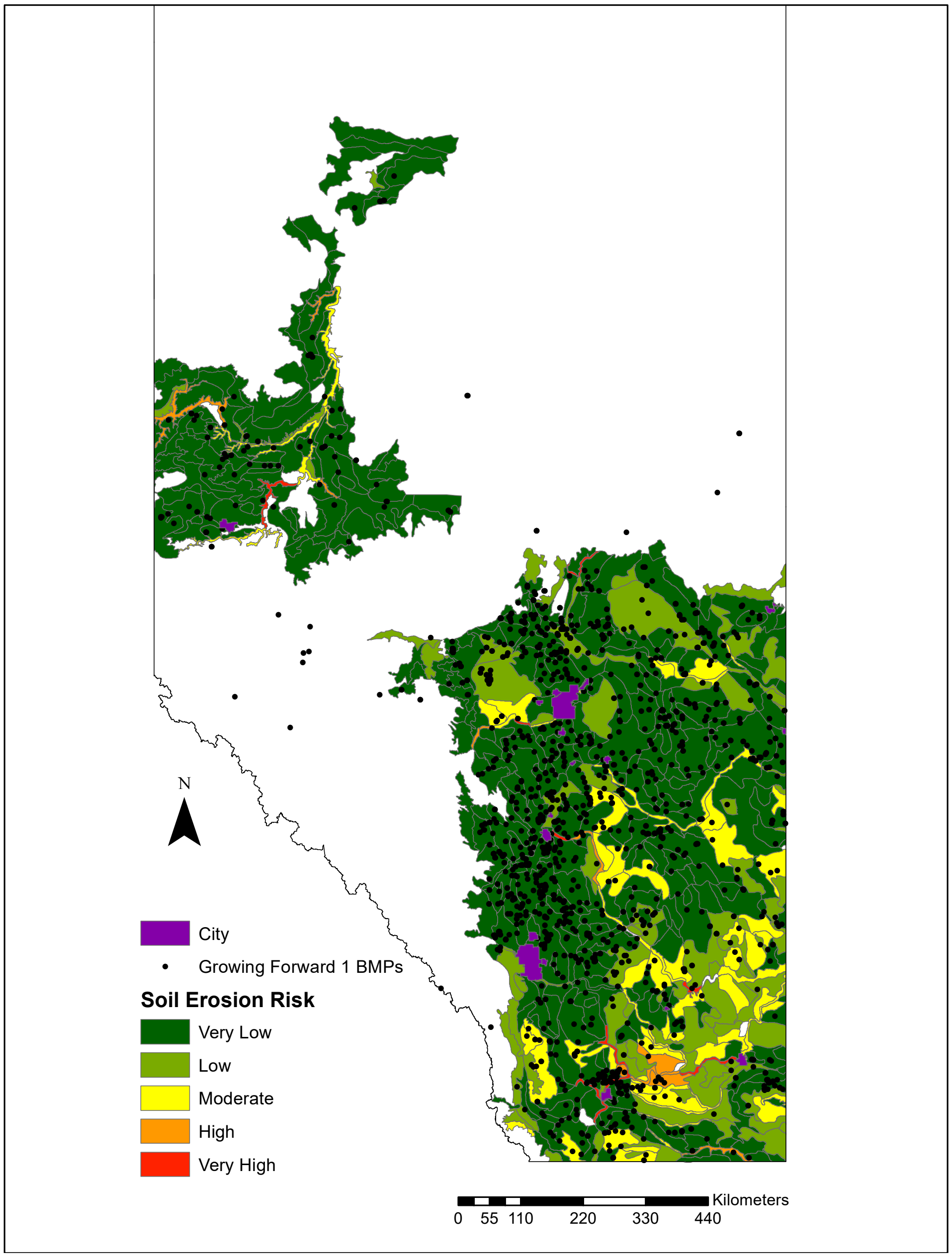

Figure 2 – Map outlining soil erosion risk and sites where BMPs were adopted in Alberta under Growing Forward 1.

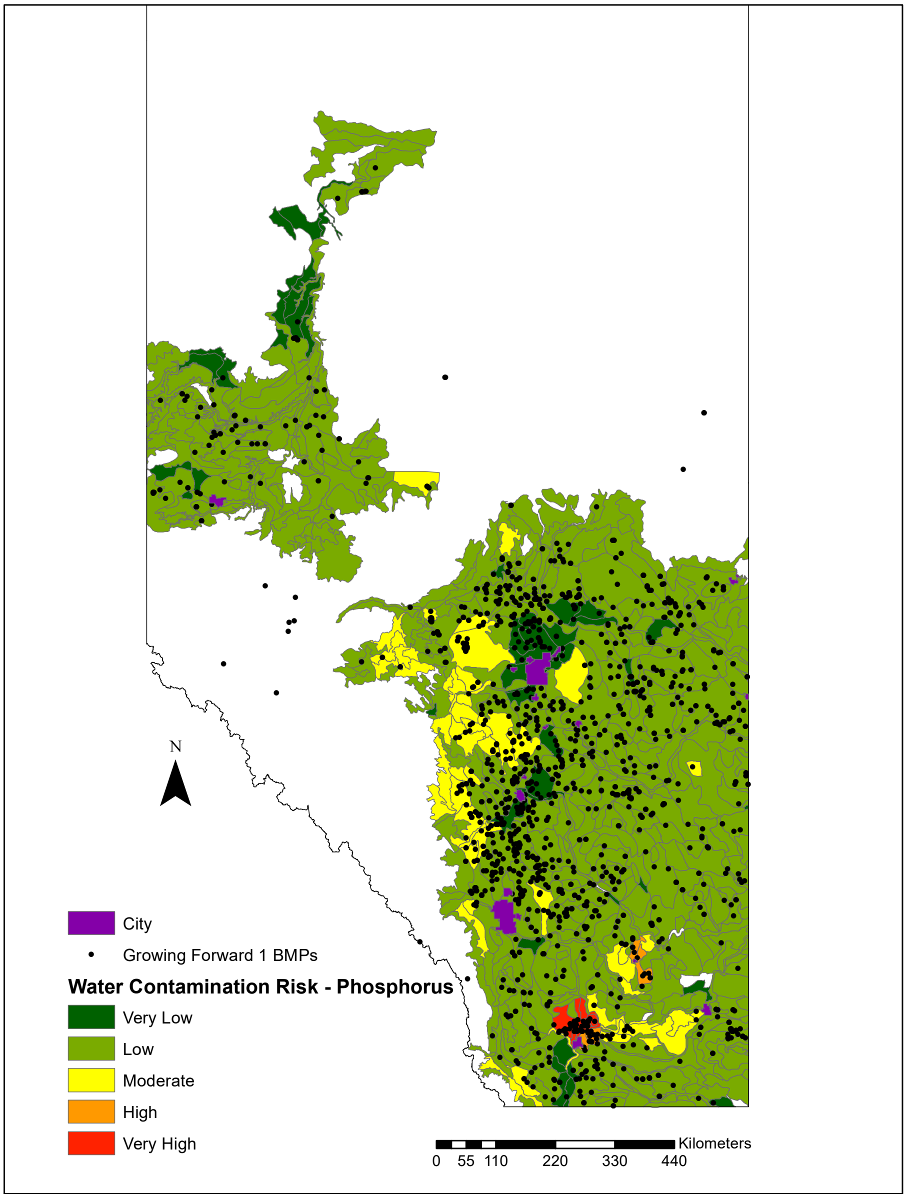

Figure 3 – Map outlining water contamination risk from phosphorus and sites where BMPs were adopted in Alberta under Growing Forward 1.

Effects of changes in environmental indicators from 2001 to 2006 were also examined in an attempt to incorporate baselines of environmental risks into the model. While areas of high environmental risk are likely in need of environmental stewardship funding relative to low risk areas, degrading areas of increasing risk may also be of interest to program managers even if conditions are currently favorable. Similar to the static environmental indicator results, more BMPs were being adopted where soil organic matter was already improving. Further, less BMP adoption occurred in SLCs where water quality risk from phosphorus was increasing. These two results, in conjunction with statistically insignificant coefficients on the other variables representing changes to environmental risk, suggest that Alberta's BMP funding approach under GF1 did not effectively target areas of public or government interest. It seems that BMP spending may have been wasted on areas where environmental quality was already high and already improving since no notion of targeting or cost-effective analysis was built into the policy.

The significant spatial components of the model not only control for unobserved, spatially driven factors, but also provide policy significance. The positive and significant spatial lag implies that, regionally, BMP adoption is positively linked. This is likely driven by two factors. First, empirical research suggests that farmers are more likely to adopt BMPs when others nearby or in their social networks also do so (e.g. Prokopy et al. 2008). Second, extension efforts are spatially linked, and although the county-level fixed effects may control for a portion of this effect, extension efficacy is not necessarily confined to political borders in rural settings.

Conclusions

This report examined environmental stewardship components of the APFs with a focus on program evaluation. Overall, minimal meaningful evaluation seems to have taken place thus far despite commitments made by AAFC to do so. Using BMP adoption data obtained from the Alberta Ministry of Agriculture and Forestry, we attempted to conduct a rudimentary evaluation of environmental stewardship programming under Growing Forward 1 and 2 in Alberta. Overall, it seems that public spending on BMPs in Alberta has failed to target regions and issues of public importance. Due to data limitations, we were unable to make such claims with much conviction. However, we were able to highlight potential avenues for evaluation using data that is currently held by governments but is not externally available, or data that could easily be collected during the CAP.

Establishing Baselines

In order to estimate the impacts of environmental stewardship programs, the state of the world in the absence of these programs must first be established. Thanks to NAHARP, baselines of and trends in environmental quality are being established across the country at the SLC level. On the social sciences side, further research must be conducted to understand the number of farmers who would adopt each BMP without the assistance provided under the APFs. Attributing all BMP adoption to the APFs is likely overstating the impact of the program.

Data Linkages

More effective analysis of policy efficacy and efficiency can be achieved by linking different data sources held by the provincial and federal governments. The provinces hold rich data regarding BMP adoption over the past 15 years of APF administration, including the cost share and funding cap offered, the type of BMP adopted, and GPS coordinates of the adopted

BMP. AAFC has measured environmental quality at a fine scale across the country over decades under NAHARP. It seems logical that these data sets would be linked to understand whether environmental stewardship funding has contributed to tangible, positive outcomes for Canadian society. Further, given the changes in environmental stewardship policy over time and across the provinces, impacts of policy attributes on environmental performance could be discerned by facilitating inter-provincial data linkages.

As a relatively low-effort exercise, the maps provided in this report could be produced with only the relevant BMPs plotted over a given environmental indicator. This method would provide a quick look at whether different methods of funding administration for environmental stewardship seem to be addressing regions where improvements are necessary. At the other end of the spectrum, the tools and data necessary for complex optimization models that could predict how and where money would be spent most efficiently exist.

<u>BMP Adopter Data</u>

When a producer applies for and/or receives cost-share funding to implement a BMP, contact is made with provincial/territorial government agents and information about the producer and the project is collected by the government. It is recommended that program managers collect more data from producers prior to granting funds to better understand the BMP adoption decision. Farm and farmer characteristics, such as educational attainment, farm size, and types and amounts of crops or livestock grown are common predictors BMP adoption (Baumgart-Getz et al. 2012). For instance, relatively simple information such as the size of the farm, the types and amounts crops or animals produced, or participation in agricultural organizations would be simple to collect, significantly improve BMP adoption models, and provide valuable information of how to better engage with a wider range of farmers.

Further, since participation in APF programs are restricted to EFP participants, further information regarding EFP participation must be understood. In Alberta, there is very little information regarding the potential pool of APF participants, hindering all research relating to APF performance measurement. If AAFC and the provinces are to continue to require program participants to hold an EFP, further research should be conducted to better identify which farmers have not developed EFPs, why they have not done so, and how more producers can be motivated to take part in EFP and APF programs, since current participation rates in Alberta and the prairie provinces are low.

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