CHANGING CLIMATE, CHANGING FARMING: AGRICULTURAL ADAPTATION TO CLIMATE CHANGE IN SASKATCHEWAN

by

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Abstract

This study investigates agricultural adaptation to climate change in Saskatchewan through surveys and interviews with family farmers, farm leaders and Hutterite communal farmers. Half of Canada's total cultivated farmland is in Saskatchewan and the province accounts for a significant amount of national and international agricultural production. This region is warming at a faster rate than the global average. Projections for Saskatchewan include more heat waves, longer dry spells, and more extreme weather events. The net impact of climate change on Saskatchewan's agricultural sector will depend heavily on the adaptive capacity of farmers. Encouraging greater diversification, family farms, and organic production and providing both knowledge and financial assistance are important components of enhancing the resilience of Saskatchewan farmers. Accordingly, this study recommends the delivery of a program to encourage farmers to undertake beneficial management practices related to climate change adaptation.

Executive Summary

Saskatchewan is a major agricultural producer, with over half of Canada's total cultivated land and over 44,000 farms. Though Saskatchewan farmers have always contended with the weather, the magnitude of the projected effects of climate change threatens to overwhelm the adaptive capacity of Saskatchewan farmers. Saskatchewan's climate is already changing more rapidly than most other agricultural regions. Climate models project an acceleration of such changes in the years ahead with predictions including increased heat waves, longer dry spells, and more extreme weather events such as drought and periods of excessive moisture. Longer growing seasons, increased heat units and shorter, milder winters could bring some benefits to Saskatchewan farmers. However, losses from increased variability, greater frequency and intensity of climatic extremes, and the rapidity of change may counter any benefits. The net impact of climate change on Saskatchewan's agricultural sector will depend heavily on the adaptive capacity of farmers.

This study investigates agricultural adaptation to climate change in Saskatchewan through surveys and interviews with family farmers and Hutterite communal farmers. Family farmers are included because they control the vast majority of agricultural land, while Hutterite communal farmers are included because they are recognized for their agricultural innovation. Data was obtained through online surveys completed by 135 family farmers, in-person interviews with four family farm leaders and in-person interviews with three Hutterite communal farmers. Key findings from this research include the following:

- Farmers deem climate as a significant source of risk, rated slightly below commodity prices and input costs, but well ahead of trade concerns and government policy;

- Half of the family farmers believe that climate change will adversely affect their farms, while just 17 percent believe that climate change will be positive and that they will not have to adjust their farming operations;
- Farmers tend to characterize their abilities to minimize risks and seize opportunities associated with climate as either 'fair' or 'poor'. Smaller farms are significantly more likely to believe climate change will affect them negatively and they will be unable to minimize the risks and seize any opportunities;
- Farmers are inclined to rely on their past experience and other farmers for information to help them make farming decisions. Federal and provincial government ministries ranked the lowest on a list of information sources, trailing both producer associations and the Canadian Wheat Board;
- Encouraging greater diversification, family farms, and organic production and providing both knowledge and financial assistance emerged as key policy objectives for improving the adaptive capacity of Saskatchewan farmers.

The Canada-Saskatchewan Farm Stewardship Program (CSFSP) is not explicitly a climate change adaptation program but it focuses on some of the key policy objectives identified in this study. The CSFSP aims to encourage Saskatchewan farmers to adopt beneficial management practices that address on-farm environmental risks through cost-shared incentives of up to $50,000. While I acknowledge that it would be ideal to incorporate the new components directly into the CSFSP, rather than have a parallel program, the complexity of renegotiating a national policy framework less than two years into its five-year timeframe would render such an endeavour highly unfeasible. Accordingly, I developed three policy options to complement the CSFSP:

- *The Program for Adaptation and Resilience (PAR):* the PAR would be delivered in conjunction with the CSFSP. Farmers would be eligible to receive up to $20,000 in cost-shared incentives (in addition to the CSFSP funding) to undertake adaptation measures not currently funded by the CSFSP, including support for crop and livestock diversification and various techniques for moisture capture. Farmers would be required to attend two informational workshops and complete a confidential

environmental farm plan focused on minimizing climate-related risks and seizing climate-related opportunities;

- *The Organic Transition Fund (OTF):* farmers would be eligible to receive $10 per acre, to a maximum of $7,500 for each of the three years of the transition period to full organic production. Farmers must also attend two informational workshops and complete a confidential environmental farm plan focused on minimizing climate-related risks and seizing climate-related opportunities through organic production; and
- A final option which combines both the PAR and the OTF.

I assessed these three options using the following criteria: effectiveness, ease of implementation, acceptability, reach, public expenditure and equity. While significantly more affordable, the OTF would reach only a small percentage of Saskatchewan farmers and would disproportionately benefit those with land more amenable to organic production. The merged option of the PAR and OTF would add significant public expenditure without reaching additional farmers. Based on this analysis, this study recommends the implementation of the Program for Adaptation and Resilience, which would encourage farmers to undertake beneficial management practices related to climate change adaptation. This approach is rooted in the recognition of the importance of encouraging greater diversification, family farms, and sustainable and organic agriculture and providing farmers with both knowledge and financial assistance. It also builds on the finding of this study that farmers look to other farmers when making decisions about their own farming operations.

Dedication

To my grandparents—Helen & David H. Martens and Susan & John D. Reddekopp.

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Glossary

Small farms	Under 1,450 acres
Medium farms	Between 1,450 and 2,500 acres
Large farms	Over 2,500 acres

Acronyms

AAFC	Agriculture and Agri-Food Canada
AAFRD	Alberta Agriculture, Food and Rural Development
CPC	Canadian Pork Council
CSFSP	Canada-Saskatchewan Farm Sustainability Program
EDC	Export Development Canada
IPCC	Intergovernmental Panel on Climate Change
OTF	Organic Transition Fund
PAR	Program for Adaptation and Resilience
PFRA	Prairie Farm Rehabilitation Network
SAF	Saskatchewan Agriculture and Food
SCIC	Saskatchewan Crop Insurance Corporation
SEN	Saskatchewan Eco-Network
USDA	United States Department of Agricultural
WBCSD	World Business Council on Sustainable Development

1: Defining the Policy Problem

Saskatchewan's climate is already changing more rapidly than most other agricultural regions (Sauchyn et al., 2009). Climate models project an acceleration of such changes in the years ahead. Predictions for Saskatchewan's grassland region include increased climatic variability, specifically greater frequency and intensity of extreme weather events, drought and periods of excessive moisture (Sauchyn et al., 2009). The policy problem addressed in this study is this: **The increased climatic variability associated with climate change threatens to overwhelm the adaptive capacity of Saskatchewan farmers.** My research questions were as follows: **What are the specific risks and opportunities for farming posed by climate change in Saskatchewan? What can be done to enhance the resilience[1] of Saskatchewan farmers?**

To date, the main response to climate change has focused on mitigating it by reducing greenhouse gas emissions. Such a response is certainly crucial but it is far from adequate. Current atmospheric concentrations of greenhouse gasses and particles are substantial enough to mean that further climate change will occur regardless of our success at curtailing greenhouse gas emissions (Meehl et al., 2007; Field et al., 2007). As a result, there is increasing awareness of the need to adapt to the range of challenges climate change is bringing.

Agriculture is especially vulnerable to changes in the climate. Weather and climate conditions affect all aspects of farming: plant and animal performance, input use, yields, and ultimately economic returns. Though Saskatchewan farmers have always contended with the weather, the magnitude of the projected climate-related effects will strain their ability to continue

[1] I used the Intergovernmental Panel on Climate Change's definition of resilience: "The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change" (Parry, Canziani & Palutikof, 2007, p. 37).

doing so. Increased variability and greater frequency and intensity of climatic extremes will likely offset the benefits of a warming climate. The net impact of climate change on Saskatchewan's agricultural sector will depend heavily on the adaptive capacity of farmers. With 41 percent of all the farmland in Canada (Statistics Canada, 2007), enhancing the resilience of Saskatchewan farmers in the face of climate change is critical, especially because of the significant impact that agriculture has on food security, communities and the economy.

This study examines: (a) the capacity of Saskatchewan farmers to minimize the adverse effects of climate change and take advantage of any benefits it provides and (b) potential policy options to enhance their resilience. I begin the study by providing relevant information about farming in Saskatchewan and discussing key aspects of climate change and how it may affect Saskatchewan agriculture. Through online surveys of family farmers and interviews with Hutterite communal farmers and family farm leaders, I uncover farmers' varying perspectives on climate change – from those who have already identified changes and are worried about its future effects to those who deny the very validity of climate change science. I provide insight into how farmers perceive their ability to adapt to the potential effects of climate change. Five key policy objectives for improving the adaptive capacity of Saskatchewan farmers emerge from my study – greater diversification, family farms, organic production, knowledge assistance and financial assistance. These objectives form the basis of the policy options I explore and the recommendation I ultimately provide – a program to encourage farmers to undertake beneficial management practices related to climate change adaptation.

2: Farming in Saskatchewan

When Irish explorer John Palliser first saw the Prairies in the late 1850s, he declared this region ill suited for settlement or farming. Palliser found most of the area "deficient in moisture and only supporting a very scanty pasture" (Shaw, 1860, p. cliii). John Macoun, who travelled through the region as part of a Canadian Pacific Railway expedition in the 1870s, contradicted Palliser's reports. Macoun's travels occurred at a time of exceptionally high rainfall, which led him to report on the region's "exceedingly fertile land" (Macoun, 1883, p. 491). Macoun's assessment of the agricultural potential of the Prairies led the federal government to encourage agricultural settlement of this region (Marchildon, 2009).

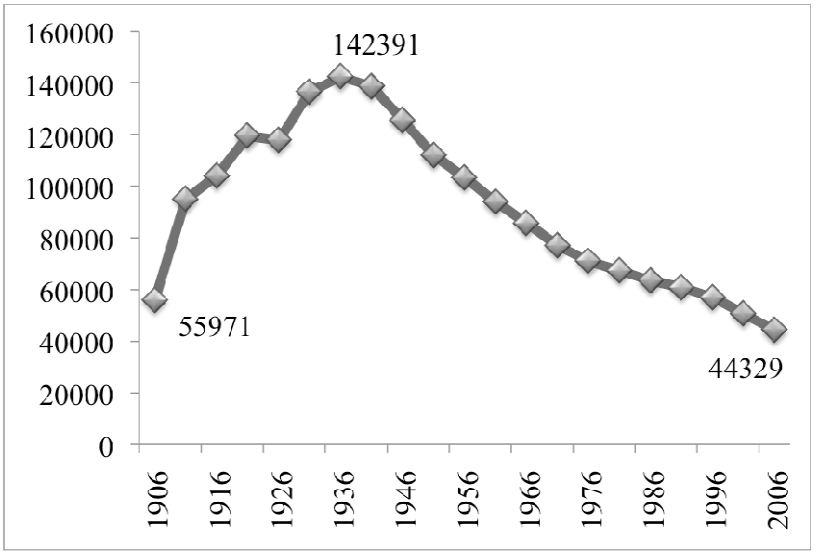
For well over one hundred years, farmers have been working the grassland region of Saskatchewan (see Appendix A for a map of the region) and raising crops and animals in Saskatchewan. In keeping with Palliser's sceptical assessment, farming here has been far from easy but Macoun's optimistic outlook for Prairie agriculture has also come true. This region has become a major agricultural producer in spite of the significant challenges it has presented to farmers.

2.1 A brief outline of farming in Saskatchewan

In 1906, one year after Saskatchewan became a province, there were nearly 56,000 farms in Saskatchewan. In the thirty years that followed, that number skyrocketed to over 142,000. Since that peak in 1936, the number of farms in Saskatchewan has declined by 69 percent; the 2006 census counted 44,329 farms in this province (SAF, 2007a; see Figure 1). Just 1.2 percent of farms are non-family corporations (see Appendix B for a breakdown of types of

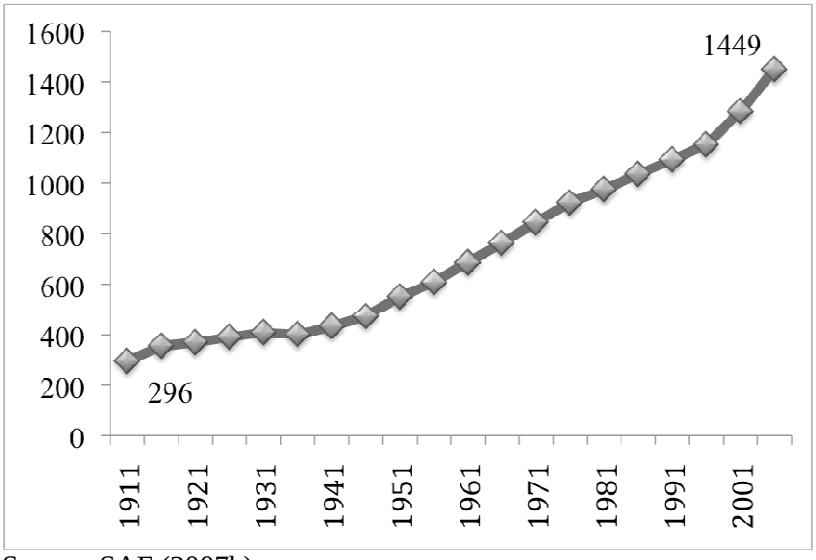
farming operations in Saskatchewan). While the number of farms has declined, the size of farms has increased substantially. Since 1911, the average number of acres per farm in Saskatchewan has increased by 390 percent (SAF, 2007b; see Figure 2).

Figure 1 - Number of farms in Saskatchewan



Source: SAF (2007a).

Figure 2 - Size of farms in Saskatchewan



Source: SAF (2007b).

This trend of a decreasing number of farms has not only been evident in Saskatchewan; across Canada, the number of farms has declined by 69 percent since 1941, from a peak of nearly 733,000 to just over 229,000 in 2006. Canadian farms have also been growing in size: since 1921, the average acreage per farm across Canada has increased by 268 percent, from 198 to 728 acres (Statistic Canada, 2009).

In addition to decreasing farm numbers and increasing farm sizes, several other agricultural trends are noteworthy:

- Farms have become increasingly *specialized*, particularly as a result of the higher grain prices caused by the oil crisis in the 1970s, which led many farmers who previously had mixed operations to stop livestock production and focus solely on grain production (Ilbery & Bowler, 1998; Bradshaw, 2007);
- Farms have also realized productivity gains through greater *intensification*, specifically through increased use of chemicals (Bradshaw, 2007);
- Due to their increased integration into the broader agri-food sector, farmers have increasingly become the small players in that sector. Less than 14 percent of the total GDP of the agri-food sector reaches primary producers (Bradshaw, 2007);
- Finally, farmers are increasingly *'pluriactive'*, meaning that many engage in gainful activity in addition to farming, usually taking off-farm jobs (Bradshaw, 2007).

2.2 Importance of Saskatchewan's agricultural sector

Saskatchewan's agricultural sector is important to Canada and the world. Half of Canada's total cultivated farmland is located in Saskatchewan and the province accounts for a significant amount of Canada's—and indeed the world's—crop production:

- 95 percent of Canada's lentils are grown in Saskatchewan and the province accounts for 32 percent of the world's lentil exports;
- 87 percent of Canada's mustard production occurs in this province, which amounts to 25 percent of global mustard production;
- 80 percent of Canada's durum wheat and 10 percent of the world's total exported wheat comes from Saskatchewan;

- 80 percent of Canada's chickpea exports are produced in this province;
- 75 percent of Canada's peas and 38 percent of the world's dry pea exports are grown in Saskatchewan;
- 70 percent of Canada's flaxseed production occurs in this province; and
- 45 percent of Canada's canola is grown in Saskatchewan (SAF, 2008).

This province is also the second-largest beef-producing province in Canada, with approximately 30 percent of the Canadian beef herd located here (SAF, 2008). Saskatchewan also leads the rest of Canada in organic production, with 60 percent of Canada's total land under organic production. The 2006 census found that 5.5 percent of the province's farms are organic (Borgerson, 2007). Saskatchewan farmers make a significant contribution to both Canada and the world.

Within Saskatchewan itself, agriculture is a critically important industry. Kulshreshtha and Thompson (2005) studied the economic impacts of Saskatchewan's 'agri-food cluster'—the combination of various activities that are significantly related to agricultural production. Kulshreshtha and Thompson argue that agriculture makes a much more significant contribution to the provincial economy than what its direct economic contribution indicates. While the direct impact of the agri-food cluster is small—at about 4 percent of the provincial economy—the total impact, including linkages with food processing, farm input manufacturing, and other non-agricultural sectors, is approximately 17 percent of the provincial economy. The social impact of Saskatchewan's agri-food cluster is also significant: nearly 12 percent of provincial employment directly stems from agricultural production with another 16 percent of jobs indirectly related to it (Kulshreshtha & Thompson, 2005). Exports of agricultural products account for 32 percent of Saskatchewan's total exports, second only to energy, which totals 38 percent of this province's exports (Export Development Canada, 2009). Agriculture is clearly a key component of Saskatchewan's economy.

2.3 Vulnerability of Saskatchewan's agricultural sector

Farmers face much uncertainty and many risks in their farming operations including: weather and climate conditions, changes in agricultural commodity prices; changes in the costs of inputs such as fertilizer; changes in the policy and regulatory environment; and animal diseases, food safety concerns, and subsequent restrictions on trade (Coble & Barnett, 2008). While each of these elements of uncertainty and risk are undoubtedly significant for farmers, weather and climate conditions are perhaps the most fundamental and far-reaching of them all. Weather and climate affect all aspects of farming: plant and animal performance, input use, yields, and ultimately economic returns (Belliveau et al., 2006).

Saskatchewan has one of the most variable climates in the world, with a high degree of seasonal, annual and decadal variability (Sauchyn et al., 2009). Droughts are prevalent, including numerous instances of localized drought conditions and significantly widespread drought during the Great Depression and in 1961, 1988, and 2001-02 (Sauchyn et al., 2009; Smit, 2009).

Climatic extremes and variability have significant impacts on Saskatchewan farmers, as illustrated by the 2001-02 drought. Net farm income was negative in 2002 (Wheaton et al., 2005); crop production in 2002 was 45 percent below the ten year average (SCIC, 2003); reduced crop production led to estimated losses of $925 million in 2001—an average of $18,280 per farmer[2]—and $1.5 billion in 2002—an average of $26,980 per farmer (Wheaton et al., 2005); and crop insurance payments were the highest ever at $1.1 billion in 2002, exceeding the previous record of $466 million in 1988 (SCIC, 2003).

[2] The 2001 Census counted 50,598 farmers in Saskatchewan (Statistics Canada, 2002).

3: Climate change

There is broad consensus in the scientific community that our climate is changing. The most recent report by the Intergovernmental Panel on Climate Change (IPCC) concluded that, "warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising average sea level" (IPCC, 2007, p. 5). The global average surface air temperature has increased by 0.6°C since 1900 and climate models project an increase between 1.4°C and 5.8°C by 2100, relative to 1990 (IPCC, 2007). Recent scientific studies indicate that a global average increase of 2°C would be a tipping point, beyond which irreversible damage to the global climate would occur (WBCSD, 2009).

The most recent IPCC report stated that "most of the observed increases in global average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic greenhouse gas concentrations" (IPCC, 2007, p. 10). Greenhouse gas emissions related to human activities have grown steadily since pre-industrial times (IPCC, 2007). To date, the main response to climate change has focused on mitigating it by reducing greenhouse gas emissions, but even if that effort were to be successful, it would not halt climate change entirely: a certain level of damage has already been done (Field et al., 2007). Current atmospheric concentrations of greenhouse gasses and particles are substantial enough to mean that more climate change will occur regardless of our success at curtailing further greenhouse gas emissions (Meehl et al., 2007). Table 1 outlines various global emissions scenarios, commonly used by the Intergovernmental Panel on Climate Change, and the projected temperature changes for Saskatchewan that are associated with each scenario.

Table 1 – Global emissions scenarios and projected temperature change for Saskatchewan at 2090-2099, relative to 1980-1999

Scenario	Description	Best estimate	Likely range
–	Constant year 2000 concentrations	0.6°C	0.3 – 0.9°C
B1	Rapid change in economic structures, 'dematerialization', introduction of clean technologies, and the lowest rate of population growth	1.8°C	1.1 – 2.9°C
B2	Intermediate levels of economic development, emphasis on local solutions to economic, social and environmental sustainability, and a lower population growth rate than A2	2.4°C	1.4 – 3.8°C
A1B	Very rapid economic growth, and a mix of technological developments and fossil fuel use	2.8°C	1.7 – 4.4°C
A2	Moderate economic growth, more heterogeneously distributed and with a higher population growth rate than in A1	3.4°C	2.0 – 5.4°C
A1F1	Very rapid economic growth and intensive use of fossil fuels	4.0°C	2.4 – 6.4°C

Source: Barrow (2009).

Saskatchewan, along with the rest of the Canadian Prairies, has already been warming at a faster rate than the global average (Sauchyn et al., 2009). Weather stations in Saskatchewan have recorded a consistent temperature increase since established in 1895. Since just 1960, average daily maximum temperatures in Saskatchewan have increased by more than 3.0°C in both winter and spring and the number of frost days and instances of extreme low temperatures over most of this province has also decreased (Sauchyn et al., 2009). The noticeable warming trend in Saskatchewan is consistent with broader studies that have identified a similar trend across the Prairies (Bonsal et al., 2001; Bonsal & Regier 2007).

3.1 Climate change projections for Saskatchewan

Global climate models consistently project increases in Saskatchewan's average annual temperature while also leaning towards an increase in Saskatchewan's average annual precipitation (Barrow, 2009). Table 2 outlines the projected effects over three periods, spanning 2010 through 2099.

Table 2 - Range of projections for Saskatchewan's prairie region for 2010-99

Period	Range of projections for Saskatchewan's prairie region
2010-39	• Changes in average annual temperature between +0.5°C and +3°C • Changes in average annual precipitation between -10 and +25 percent
2040-69	• Changes in average annual temperature between +1°C and +5°C, with the largest increase occurring in winter and spring (between +1 and +6°C), compared to summer and fall (+1 to +4°C). • Changes in average annual precipitation between -10 and +25 percent. For summer and fall, approximately half of the scenarios project precipitation changes by up to -20 or -30 percent.
2070-99	• Changes in average annual temperature between +2°C and +6.5°C • Changes in average precipitation between -5 and +35 percent

Source: Barrow (2009).

According to Sauchyn et al. (2009), most of the increase in temperature will likely occur in winter, leading to a longer frost-free growing season and less moisture accumulation from snowpack. A warmer climate could lead to a northward shift in the ranges of certain crops, weeds, pests and diseases. Increased evaporation from soil and transpiration from plants will also occur in response to the warmer climate. The bulk of the increase in average annual precipitation will likely occur in winter and spring, with most of it falling in the form of rain, rather than snow. Climate models are less consistent with regard to precipitation during the summer months, but generally include significantly decreased precipitation in the mid-to-late stages of summer. Along with changes in average temperature and precipitation, climate model projections include greater

variability from year-to-year and increasing frequency and severity of several types of extreme weather events, including increases in both drought and periods of excessive moisture. (Sauchyn et al., 2009). Table 3 outlines the projected effects of climate change in Saskatchewan.

Table 3 - Overview of projected effects of climate change

Category	Specific Changes
Thermal	• More frequent and intense heat waves • Increased heat accumulation (degree-days) • Increased growing season length • Decreased cold spells • Decreased cold accumulation (degree-days)
Moisture	• Longer dry spells • Longer and more intense potential evapo-transpiration season resulting in more water loss • Less water in dugouts, reservoirs, streams, lakes and wetlands related to increased potential evapo-transpiration amounts and seasons and snowpack decreases • Increased winter rainfall and snowmelt events • Decreased snowfall and depth of snow cover • Decreased duration of snow season
Extreme Events	• Increased frequency, duration and intensity of droughts • Increased wind speed, peak wind events, and damage • Increased risk of intense rainfall, excessive moisture and flooding • Increased risk of soil erosion by wind and water • Decreased risk of frosts
Other	• Increased demands for water • Northward shifts of the range of crops, weeds, insects and diseases • Decreased water and air quality related to higher temperatures

Adapted from Sauchyn et al. (2009).

3.2 Effects of climate change on agriculture in Saskatchewan

Some aspects of the warming climate could prove advantageous for farming operations; longer growing seasons, increased heat units and shorter, milder winters could bring some benefits to Saskatchewan farmers. However, losses from increased climatic variability and the rapidity of changes may counter any benefits (Sauchyn & Kulshreshtha, 2008). Sauchyn et al. (2009) recognize that research focused on the effects of climate change on Saskatchewan's agricultural sector are scarce, but draw on research from similar regions to reach the following conclusions:

- Crop production will initially increase due to longer growing seasons and increased greenhouse gas concentrations in the atmosphere. Once certain thresholds, which vary by crop and soil type, are reached, crop production will decline. Intermittent, significant losses in crop production will also occur as a result of increased extreme weather events, including drought and periods of excessive moisture;
- Livestock production and management will generally be favoured by warmer winters however increased heat stress and water scarcity in the spring and summer may offset any gains. Extreme weather events will tend to be detrimental for livestock production and management; and
- Warmer winters will increase the risk of pests and diseases; however the effect of this on crop and livestock production remains uncertain (Sauchyn et al., 2009).

While uncertainties remain, the general consensus is that climate change will have a long-term negative effect on the supply of agricultural products. At the same time, the extent of the adverse effects of climate change in other regions around the world could affect demand for agricultural products from Saskatchewan; if competitors experience the worst of the adverse effects, world commodity supplies would decline which would lead to higher incomes for farmers who are still able to produce (Runnalls cited in Wilson, 2009.) The net impact of climate change on Saskatchewan's agricultural sector will depend heavily on the adaptive capacity of farmers.

3.3 Agricultural adaptation

Homer-Dixon describes climate change as "perhaps the most severe adaptive challenge humankind has ever faced" (Homer-Dixon cited in Wall et al., 2006, p. 12). The sub-sections that follow examine past agricultural adaptation, look at contemporary understandings of adaptation, and explore the barriers to adaptation.

3.3.1 A key historical example of agricultural adaptation

The drought of the 1930s has been characterized as the "the greatest environmental and economic crisis to face Canada in the twentieth-century" (Marchildon, 2009, p. 276). The Prairies were particularly hard hit. Conservative Prime Minister R.B. Bennett knew that incremental changes to existing programs would not be sufficient. Instead, he sought a way to address the drought so that farmers would not be continually reliant on government relief.

> Despite [the Agriculture Minister's] clear instructions to his department officials on the need for a radically new approach, they responded with a highly incremental plan … Insulated from the political turmoil facing the political tier of government, senior federal bureaucrats assumed that the proposed act would simply amount to a 'welding together' of existing programs. These civil servants soon discovered how wrong they were. The Bennett government needed the program to be as visible and effective as possible … (Marchildon, 2009, p. 287).

In April 1934, the Bennett government established the Prairie Farm Rehabilitation Administration (PFRA) with the following aim:

> … to secure the rehabilitation of the drought and soil drifting areas in the Provinces of Manitoba, Saskatchewan and Alberta, and to develop and promote within those areas, systems of farm practice, tree culture, water supply, land utilization and land settlement that will afford greater economic security. (AAFC, 2007).

During the Great Depression, the PFRA invested in key projects such as dozens of community pastures, thousands of dugouts and dams and a comprehensive soil survey of 90 percent of the affected region (Marchildon, 2009). The program also relocated many farmers to more suitable land (Balkwill, 2002). In 1957, Fowke declared that the PFRA "has worked for

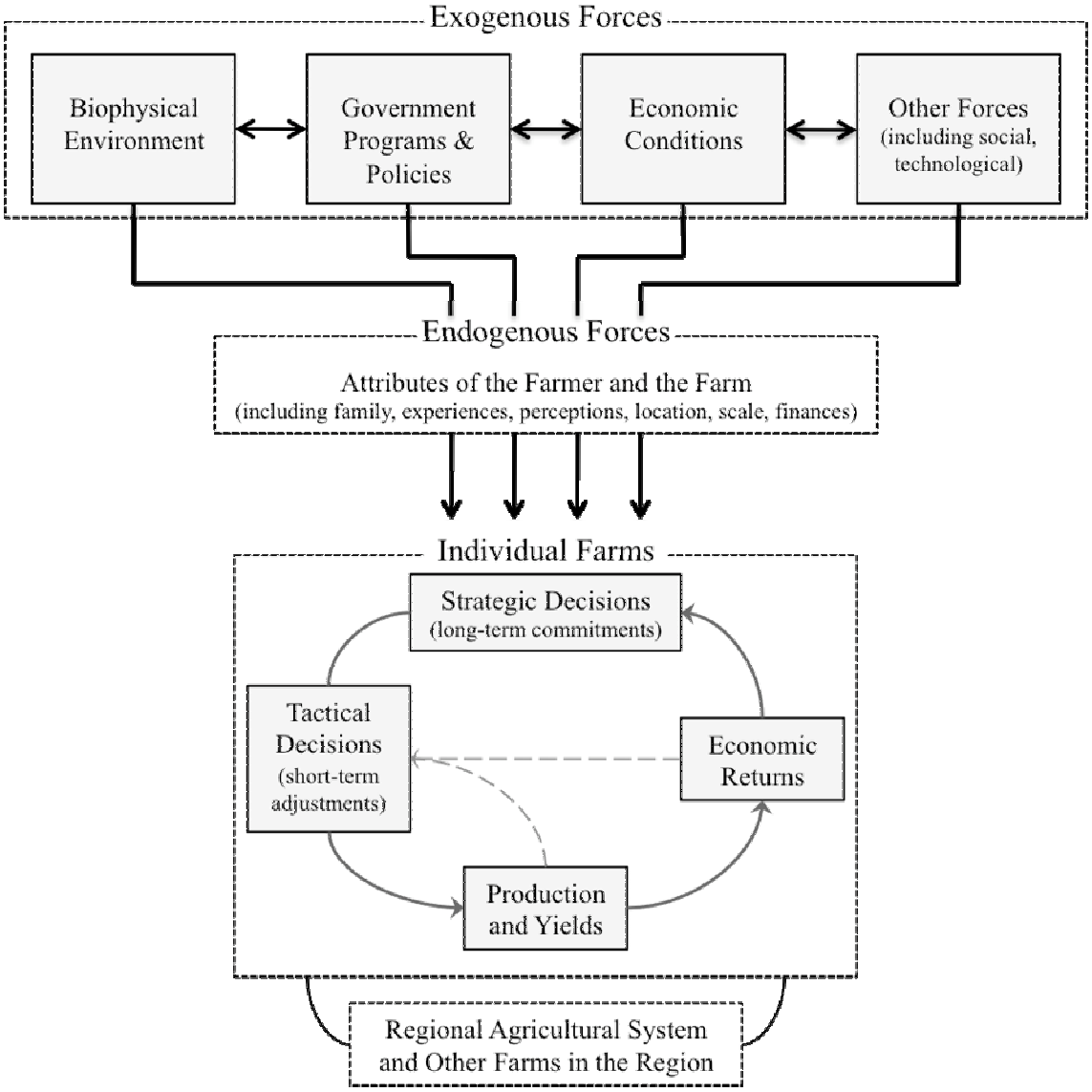
twenty years […] correcting the mistakes of the homestead period" (Fowke cited in Balkwill, 2002, p. 17). Friesen (1987, p. 392) reports that the PFRA's soil reclamation projects were an "undoubted success" and the Saskatchewan Eco-Network declares PFRA's "epic conquest of widespread soil erosion" as one of "Canada's great success stories" (SEN, 2009).

3.3.2 Contemporary understandings of adaptation

Climate is one element among many others, which influence farming decisions. Other such elements include: changes to government programs and policies; downturns in commodity markets; fluctuations in currency or other macro-economic conditions; contagious livestock diseases; and trade restrictions (Belliveau et al., 2006). Despite being just one of many factors considered by farmers, climate risks are highly significant because they are closely linked to many farming decisions related to production levels, yields, input costs and environmental factors (C-CIARN Agriculture, 2003).

Smit et al. (1996) developed a conceptual model of agricultural adaptation to climate change (adapted in Figure 3). This conceptual model acknowledges that farmers base their production decisions on a range of exogenous forces, including the biophysical environment, government programs and policies, economic conditions, and other factors including social and technological forces. Endogenous forces—experiences, perceptions and farm characteristics—are also at play in the decision-making process of farmers. When farmers make their strategic decisions—long-term commitments that affect their farming operation beyond a single year, including changing a crop or livestock management system—they do so with significant uncertainties. Farmers do not know what the climatic conditions, cost of inputs or prices of commodities will be in the months and years ahead. Responding to this uncertainty, farmers make short-term adjustments when new information becomes available (Smit et al., 1996).

Figure 3 - Agricultural adaptation



Adapted from Smit et al. (1996).

The strategic and tactical decisions made by farmers affect their production, yields and economic returns, which, in turn, affect farmers' further strategic and tactical decision-making (Smit et al., 1996). Research indicates that economic considerations are the main factor in influencing changes in farming practices (Smit et al., 1996; Bradshaw, 2007). Weber (1997), in a study in the midwestern region of the United States, found that these strategic and tactical decisions are often made from a 'single-action bias'. The term 'single-action bias' refers to the

tendency of farmers to respond to an external source of risk through the use of a single action, rather than a multipronged approach. This is not inconsistent with the model developed by Smit et al. (1996): farmers may take a single strategic or tactical action and determine its effect on production, yields and economic returns; if the effect is not desirable, farmers will revisit their strategic and tactical decisions and take a different action.

3.3.3 Barriers to adaptation

Communities can successfully meet challenges when they are able to supply the necessary level of ingenuity at the right time. Homer-Dixon identifies several characteristics of adaptive communities: a sense of identity; social capital; norms of social responsibility, trust and reciprocity; and cross-disciplinary knowledge. Combined, these characteristics influence the level of technical and social ingenuity within the community. Not only are missing characteristics a barrier to adaptation, two types of denial also act as barriers to adaptation: (1) existential denial—the belief that climate change is not even happening; and (2) consequential denial—the belief that climate change will not make much of a difference (Homer-Dixon cited in Wall et al., 2006).

As demonstrated in Figure 3, a range of interrelated exogenous and endogenous forces affect farmers' decision-making. Whichever particular force concerns farmers the most at a given time is shown to have a more significant effect on their risk management decisions (Balstad et al., 2009). A study of Argentine farmers by Hanson et al. (2004) found that when farmers have multiples worries, whichever concern is most dominant has a strong tendency to crowd out other worries in farmers' minds. This leads to a diminished level of concern about other problems, and reduces the likelihood of the farmer actively seeking to tackle them. While this may serve as a barrier to getting farmers to adapt their operations to climate change, the interrelatedness of the exogenous forces—and the fact that climate affects all other aspects of farming—minimizes the likelihood of climate being entirely ignored in favour of other worries.

With new risks and opportunities associated with a changing climate, understanding the adaptive capacity of farmers and potential mechanisms for enhancing their resilience is important. The section that follows will outline the focus and methodology of this study.

4: Examining Farmers' Adaptive Capacity

The policy problem addressed in this study is this: the increased climatic variability associated with climate change threatens to overwhelm the adaptive capacity of Saskatchewan farmers. The key questions that guided my research are: (1) what are the specific risks and opportunities for farming posed by climate change in Saskatchewan? And (2) what policy approaches could enhance the resilience of Saskatchewan farmers? To answer these questions, this study focuses on both family farmers and Hutterite communal farmers. Family farmers are included because they manage the vast majority of agricultural land in Saskatchewan (see Appendix B for a breakdown of types of farming operations in Saskatchewan). Hutterites are pacifist Christians, who are religiously and socially conservative and live and work on colonies of approximately 100 people (Anderson, 2006). Despite their conservative lifestyles, Hutterites are highly advanced in their use of agricultural technology. While the 64 Hutterite communal farms in Saskatchewan control only two percent of the province's farmland (Laverdure, 2006), Hutterites are included in this study because they are known for their innovative farming practices. Moran and Gillet-Netting (2000, p. 250) say, "there are probably no better examples of the adaptiveness of [farming methods] for the exploitation of the Plains than the operations of the Hutterites."

The two-pronged focus of this study allows for a comparison of the entrepreneurial nature of individual family farms with the coordinated group action of Hutterite communal farms. It allows for consideration of the impact of generational differences because Hutterites tend to retain their young people while most family farms do not. Finally, it presents a unique approach to examining the adaptive capacity of the agricultural sector in Saskatchewan.

I conducted an online survey of family farmers and in-person interviews with Hutterite communal farmers with the following aims:

- Gauge the awareness of participating farmers to the projected impacts of climate change on their farming operations;
- Examine the effects of past climate-related events on their farms;
- Explore the actual adaptive responses used historically by participating farmers;
- Investigate how participating farmers assess their current capacity to manage the risks and seize any opportunities associated with climate change; and
- Determine participating farmers' preferred adaptation approaches.

I also undertook in-person interviews with family farm leaders to focus on what needs to happen in order to increase the resilience of Saskatchewan farmers.

4.1 Online survey

I developed online surveys and distributed electronic links to family farmers throughout Saskatchewan, with a request that they forward the survey link to other Saskatchewan farmers as well. I emailed the survey link to my own contacts in the agricultural sector and to the reeves and council members of the 298 rural municipalities throughout Saskatchewan.[3] The survey link was also distributed to the members of various farming organizations, including: Chicken Farmers of Saskatchewan; the Family Farm Foundation; the National Farmers' Union; the Saskatchewan Beekeepers' Association; the Saskatchewan Broiler Hatching Egg Producers; the Saskatchewan Cattlemen's Association; the Saskatchewan Soil Conservation Association; and Sask Pork.

The online survey consisted of 26 separate questions, focused on:

- Demographic information;
- Past decisions related to farm production practices and farm financial management;
- The impact of the 2001-02 drought and any operational changes made as a result;
- The level of understanding and concern about climate change;

[3] Eight emails returned due to incorrect addresses listed on the Government of Saskatchewan's online municipal directory.

- Whether farmers have already experienced the effects of climate change;
- Whether farmers have made operational adjustments because of climate change; and
- Farmers' preferred adaptation approaches (see Appendix C for the survey).

The questions dealing with preferred adaptation approaches allowed for open-ended responses about government programs and policies, technological innovations, and farming practices that would help farmers to minimize risks and seize opportunities arising from climate change.

A questionnaire used by Stroh Consulting (2005) in a study conducted for Alberta Agriculture, Food and Rural Development (AAFRD) informed the creation of my survey. I made the following changes:

- I added demographic questions about age, gender, farm location, and the percentage of total household income obtained from farming;
- I asked where farmers obtain information to help them make decisions about their farming operations;
- I broke some questions down to allow for better analysis. For example, rather than asking if participants consider climate-related risks more or less difficult than other risks, I listed five key risks that farmers manage and asked respondents to rate the significance of each;
- I asked about the significance of the 2001-02 drought on the operations of participating farmers and any operational changes made as a result;
- I asked farmers to rate their level of agreement with several statements about the potential effects of climate change on their farms;
- To gauge awareness about climate change, I asked respondents to identify the projected effects of climate change in Saskatchewan and whether they have already experienced some of those effects; and
- If farmers identified that they have not made changes because of climate change, I asked them to identify why not.

4.2 Semi-structured interviews

I conducted semi-structured interviews with Hutterite communal farmers and family farm leaders. I chose a semi-structured approach to these interviews because it allows for a more

fluid conversation between the interviewer and the interviewee, with new questions arising based on answers provided (Griffiths, 1996). I considered a flexible, free-flowing conversation, rather than a rigid set of questions, more effective when meeting with farmers and farm leaders.

A basic interview schedule served as a guide for the semi-structured interviews. Such interview schedules facilitate the conversation but do not dictate its flow or structure (Sixsmith, 2009). Rather than listing specific questions, I based my interview schedule on the broad themes used in my online survey:

- The general risks and opportunities currently associated with farming;
- The specific risks and opportunities associated with climate change; and
- What needs to happen in order to increase the adaptive capacity and resilience of Saskatchewan farmers.

Based on initial responses to the online survey of family farmers, I chose to simplify the types of questions used in the interviews. I also sought to avoid much use of the term ‘climate change’ during the early stages of the discussion, due to the sensitive and controversial nature of the term, which was evident in several responses to the online survey. I transcribed all interviews and undertook thematic analysis of the transcripts to draw out the key themes and perspectives from within each of the interviews.

5: Characteristics of Participating Farmers

Understanding the perspectives held by people requires some insight into the various attributes that have shaped those individuals. This section outlines various characteristics of those who responded to the online survey and those who participated in interviews for this study.

5.1 Online survey

The online survey received 137 responses between October 17, 2009 and November 26, 2009. I discarded two responses from the sample because the respondents answered only the first few questions. The remaining 135 responses were adequately completed and, therefore, were included in this study. Survey responses were received from across southern Saskatchewan, the grassland region of the province in which agricultural production occurs (for a map of responses, see Appendix D).

The survey sample is generally reflective of the broader Saskatchewan farming population except for two characteristics: gender and farm size (see Table 4). Male farmers comprised 91 percent of responses, with only 9 percent of responses coming from women. This is a significant over-representation of male farmers as only 76 percent of Saskatchewan farmers are men (Statistics Canada, 2007). As well, the sizes of farms in the sample tended to be larger than the average Saskatchewan farm. The 2006 Census of Agriculture found that the average farm size in Saskatchewan was 1,449 acres, while the average size of farms in the sample is 2,497 acres, with the median size being 1,880 acres. The fourteen farms larger than 5,000 acres in the sample skew the average farm size. While the average and median farm sizes within the sample are larger than the average recorded in the Census of Agriculture, neither are out-of-line with the current reality in Saskatchewan. According to Hursh, “typical grain farm operations in Saskatchewan are

now somewhere between 2,000 and 5,000 acres … increasingly, there are operations with 10,000 or even 20,000 acres. Often they involve multiple family members as well as hired employees." (Hursh, 2009). I expected larger farms and smaller farms to have different perspectives on a range of issues; I explore this further in Section 6 when discussing study findings.

Table 4 - Online survey sample characteristics

	Respondents		Saskatchewan Farmers*
	N	%	%
Gender			
Male	123	91	76
Female	12	9	24
Age			
Mean	51.7	-	52.6
Median	53	-	53
Under 35	16	12	10
35-54	62	46	48
55 and over	57	42	42
Farm Size			
Small (less than 1,450 acres)	46	34	-
Medium (1,450 to 2,500 acres)	46	34	-
Large (greater than 2,500 acres)	43	32	-

*Note: Source is Statistics Canada, 2007

The vast majority of survey respondents have a significant level of farming experience: nearly half – 47 percent – stated that they have farmed for 31 years or more; another 30 percent have farmed between 21 and 30 years. The amount of income derived from farming ranged from 0 percent of income (N=1)—which presumably indicates a farming operation that is not profitable—to 100 percent of income (N=33). The average percentage of income from farming was 66 percent while the median was 75 percent. Finally, survey respondents produce a diverse range of crops and livestock (for a list of commodities produced, see Appendix E). When asked to identify the various crop and livestock types they currently produce, 24 percent of survey respondents identified themselves as mixed farmers, indicating production of both crops and

livestock. The most common crop produced by respondents was wheat (73 percent), while the most common livestock produced by respondents was beef cattle (28 percent).

The most recent significantly widespread drought in Saskatchewan occurred in 2001-02 (Sauchyn et al., 2009). That drought devastated many farms across the province. To understand the effects of the drought on survey respondents, and to assess whether that experience has led to increased resilience, I asked respondents to indicate the extent of the impact of the 2001-02 drought on their farming operations and whether or not they changed their operations as a result. Respondents indicated a significant effect on their farm income and crop production while not registering a large effect on their livestock herds (for a breakdown of responses, see Appendix F). When asked if they made changes as a result of the drought, 43 percent of respondents replied in the affirmative (for a list of changes, see Appendix G). The most popular changes identified were to use alternative fallow and tillage practices, diversify crop types and varieties, and change the intensification of production.

5.2 Hutterite communal farmers

I conducted three interviews with key decision makers from Hutterite communal farms in different regions of Saskatchewan. The colonies range in size from 60 to 80 individuals, and 6,000 to 12,000 acres. Each colony has significantly diversified their production, including various crops and a range of livestock types, including beef, poultry and hogs. To maintain confidentiality—only 64 Hutterite colonies exist in Saskatchewan—I do not reveal specific identifying characteristics of the participating colonies while discussing findings from the interviews.

5.3 Key family farm leaders

I conducted four interviews with key leaders in the family farm sector. Each individual currently farms and currently or previously served in a leadership capacity in the farming sector,

including in farming organizations, federal or provincial advisory boards, and in agricultural consulting firms. To maintain confidentiality, I do not reveal specific identifying characteristics of the interview participants while discussing findings from the interviews.

6: Details Emerging from Study

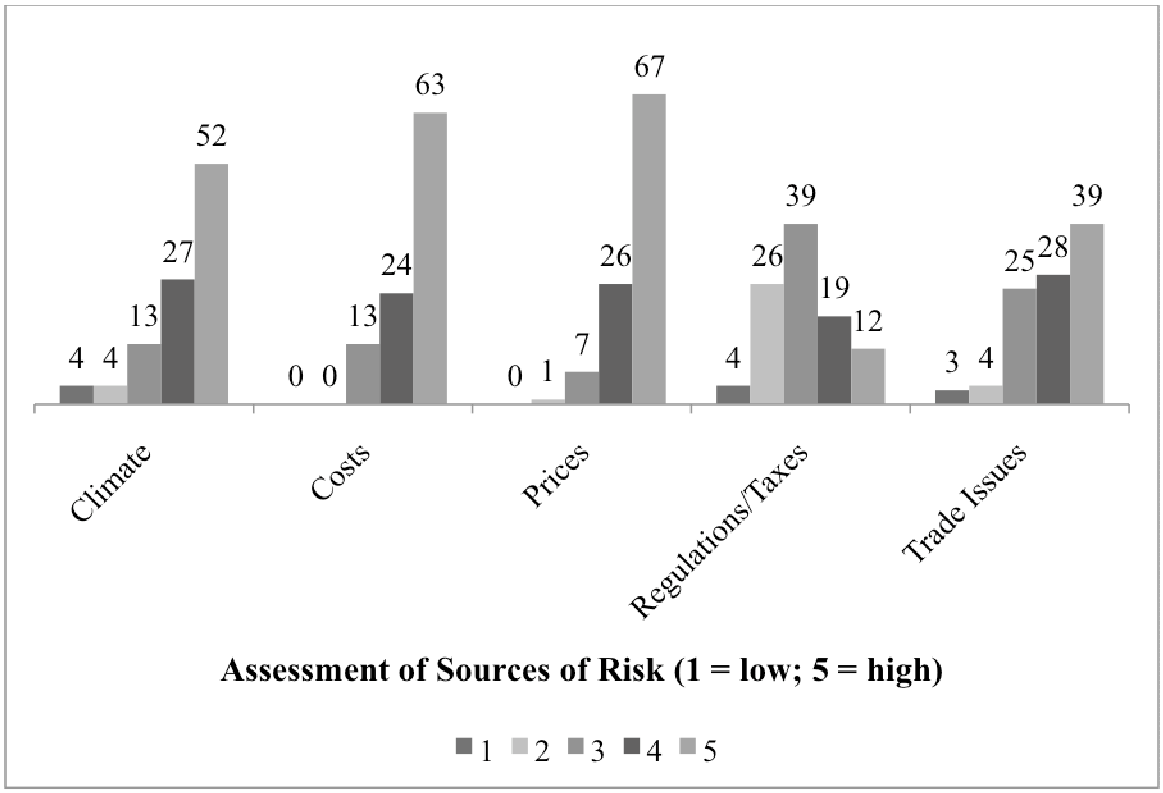
The broad aim of this study is to understand the specific risks and opportunities for farming posed by climate change and to examine the policy approaches that could enhance the resilience of Saskatchewan farmers. This section outlines the findings from the online survey and interviews. I use cross-tabulations to illustrate the relationship between variables and Pearson's chi-square and Fisher's exact tests to determine whether the relationship between those variables is statistically significant.[4] I report only statistically significant relationships ($P \leq 0.05$).

6.1 Various sources of risk

As mentioned in previous sections, farmers face many risks (Belliveau et al., 2006; Bradshaw, 2007). To understand the significance of climate risks in relation to other sources of risk, I asked respondents to rate the importance of five sources of risk (see Figure 4). Respondents ranked commodity prices as their highest source of risk with input costs as a close second. Climate ranked as the third most significant source of risk, with trade issues and regulations and taxes trailing well behind.

[4] In this study, I use SPSS statistical analysis software (version 17) to conduct cross-tabulations, Pearson's chi-square test and Fisher's exact test. Pearson's chi-square and Fisher's exact tests determine if the relationship between two categorical variables is non-random. The P-value resulting from each of the tests represents the likelihood of obtaining the statistic by chance. Specifically, a p-value of 0.05 would mean that there is only a 5 percent probability of obtaining such the statistic by chance. Results are considered 'statistically significant' if there is a low likelihood of obtaining them by chance. Unlike Pearson's chi-square test, Fisher's exact test accurately evaluates the significance level even with a small number of observations. However, Fisher's exact test exists only for use with 2 by 2 contingency tables (SPSS, 2007).

Figure 4 - Assessment of sources of risk



A Hutterite farmer interviewed for this study, speaking particularly of the pork component of his colony's farming operation, characterized the various risks faced by farmers as follows:

> We used to feel 10-feet tall and bullet-proof … we could weather anything, and then comes along a combination of stuff that if they'd come one at a time, we could've dealt with them. Most of our infrastructure was built with 68-cent dollars, when currency goes to par, it peels a lot of money off your bottom line by not doing anything, just because of currency differences. We thought we had adjusted to that and in 2008 feed prices doubled, now feed prices are 70 percent of your gross budget in raising a pig … we got to a point where we thought we were dealing with that and along comes the worldwide economic downturn which, if you're a consumer going out there, meat is probably the first thing stripped from your budget … then along comes this boondoggle that we're still dealing with at this point, H1N1. We have a situation that has cost the pork industry billions of dollars and not one pig has died. So you've got a combination of bang bang bang bang, and everytime you think 'okay, I can lift my head up now', you feel like a gopher that's getting another whack on the head.

6.2 Various sources of information

The survey results show that farmers turn to a variety of sources for information to help them make decisions (for a list of identified sources of information, see Appendix H). Most respondents said they rely on past experience and other farmers to guide their decision-making. About half of respondents said they get information from producer associations and the Canadian Wheat Board (CWB). Notably, about 24 percent of respondents indicated that they turn to Saskatchewan Agriculture's Agriculture Knowledge Centre—a telephone resource for farmers—and the Regional Service Offices located throughout the province. I found a statistically significant relationship between farm size[5] and reliance on Saskatchewan Agriculture's Regional Service Offices as a source of information ($P \leq 0.00$): 42 percent of large farms identify Regional Service Offices as an important source of information, compared to 22 percent of medium farms and just 7 percent of small farms. A statistically significant relationship ($P \leq 0.03$) also exists between farm size and reliance on the CWB as an information source: 58 percent of large farms identified the CWB as an information source compared to 44 percent of medium farms and 30 percent of small farms. The Hutterite farmers interviewed for this study identified their sources of information as follows, in this order: past experience, other colonies, the Canadian Wheat Board, industry and the government.

6.3 Recent financial management and production adjustments

Recognizing that past behaviour can be an indication of future behaviour, I asked respondents to identify financial management practices and production practices, which they engaged in over the past five years (for a list of recent practices, see Appendices I and J). The most popular farm financial management practices were participation in income stabilization programs (82 percent) and purchasing crop insurance (81 percent). Just over half of respondents

[5] For easier reading, I have broken farms down into three categories of size: 'small farms' refers to those less than 1,450 acres (the average size in Saskatchewan); 'medium farms' refers to those between 1,450 and 2,500 acres, and 'large farms' refers to those over 2,500 acres.

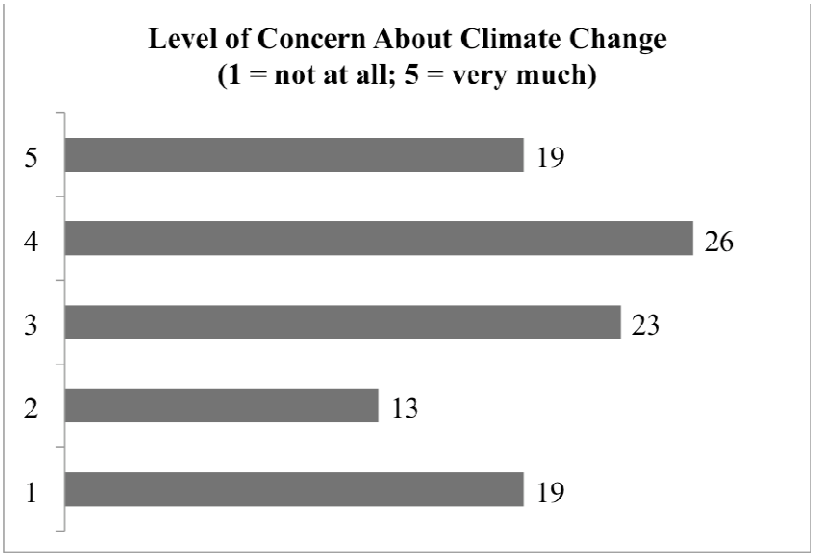
indicated that they had diversified the sources of their household income over the last five years. I found a statistically significant relationship ($P \leq 0.05$) between farm size and diversification of household income: 40 percent of large farms, compared to 65 percent of medium farms and 55 percent of small farms diversified their household income in the last five years. The most frequently mentioned changes in terms of production practices were using new technology (73 percent) and diversifying crop types and varieties (57 percent). I found a statistically significant relationship ($P \leq 0.00$) between farm size and use of new technology: 91 percent of large farms and 83 percent of medium farms used new technology in comparison to just 46 percent of small farms. Notably, small farms were also more likely to choose "none of the above" than other farmers: 30 percent of small farms, compared to 11 percent of medium farms and just 2 percent of large farms indicated that they had not implemented any of the listed production practices over the past five years ($P \leq 0.00$).

A study conducted for Alberta Agriculture, Food and Rural Development in 2005, in which 53 farmers participated in focus groups, found similar results: the most commonly identified farm financial management practice was participation in income stabilization programs and the most frequently mentioned farm production practice was diversification of crop types and varieties (Stroh, 2005).

6.4 Perception of climate change

45 percent of respondents demonstrated a high level of concern about climate change, rating their concern at either a 4 or 5 out of 5; 32 percent rated their level of concern at a 1 or 2 (see Figure 5). This is in line with a study in Alberta, which found that 40 percent of participating farmers indicated they were either 'very concerned' or 'extremely concerned' about climate change (Stroh, 2005).

Figure 5 - Level of concern about climate change



I did not ask respondents whether they are sceptical of the science of climate change, however I analyzed the responses to the four open-ended questions for clear indication of such scepticism. 29 percent of respondents expressed scepticism about the science of climate change. One respondent wrote: “Stop spreading poor information, the ocean levels never were rising, glaciers all over the world are growing.” Another farmer said:

> We can't even trust the weekly weather forecasts but you expect us to trust some hoity-toity academics and scientists and washed-up politicians? No thanks. Farmers have managed weather changes and weather crises since the dawn of farming and we've done a damn good job!

I found a statistically significant relationship between age and level of scepticism about climate change ($P \leq 0.02$): 36 percent of those aged 52 and older expressed scepticism about climate change, whereas just 19 percent of those aged 51 and younger expressed scepticism.

Notably, but understandably given lower levels of education, each of the Hutterite farmers interviewed for this study expressed scepticism about climate change. One Hutterite farmer stated: “I don’t want to trivialize [climate change], because at heart I’m an environmentalist, but I think there’s so much misinformation out there and how much of it is just

political?" Another Hutterite farmer said: "I can't comment on climate change much. I was brought up to believe there was one Creator and he knows what he's doing." Despite being sceptical of the science of climate change, each of the Hutterite farmers interviewed for this study readily admitted to noticing changes in the climate. Over half of the respondents to the online survey (52 percent) also stated that they have already experienced some effects of climate change.

When asked to identify the impacts of climate change in Saskatchewan (past, current or future), the most common response was "more frequent droughts and heat waves." Only 24 percent of respondents identified "longer growing seasons" and just 10 percent selected "less frequent cold waves and frost days" (see Table 5). 30 percent of respondents stated that climate change will have "no significant effects" in Saskatchewan.

Table 5 - Identified impacts of climate change

"What impacts do you think climate change had had or will have in Saskatchewan? (Select all that apply)"	N	%
More frequent droughts and heat waves	68	50
More intense storms and more frequent hail	58	43
More pests and diseases	56	41
Longer growing seasons	32	23
More frequent flooding	30	22
Less frequent cold waves and frost days	13	9
No significant effects	*40*	*30*

The responses to the question about the impacts of climate change were coded to assess respondents' level of knowledge about climate change in Saskatchewan; respondents who correctly selected three of the impacts, and who did not select "no significant effects", were deemed knowledgeable about the projected effects; those who selected "no significant effects" or

who failed to correctly identify three of the effects from the list were deemed not to be knowledgeable. Just over half of respondents (52 percent) failed to demonstrate sufficient knowledge about the effects of climate change in Saskatchewan. I found a statistically significant relationship between age and level of knowledge about the projected effects ($P \leq 0.05$): 57 percent of those aged 51 and under demonstrated knowledge of the effects of climate change compared to just 41 percent of those 52 and over.

Many survey respondents tend to believe that climate change will be more negative than positive for agriculture. However, a significant proportion of respondents were unable to decide whether climate change will be advantageous or hurtful to their farms (see Figures 6 and 7).

Figure 6 - Perception of climate change as a driver of positive outcomes for farmers

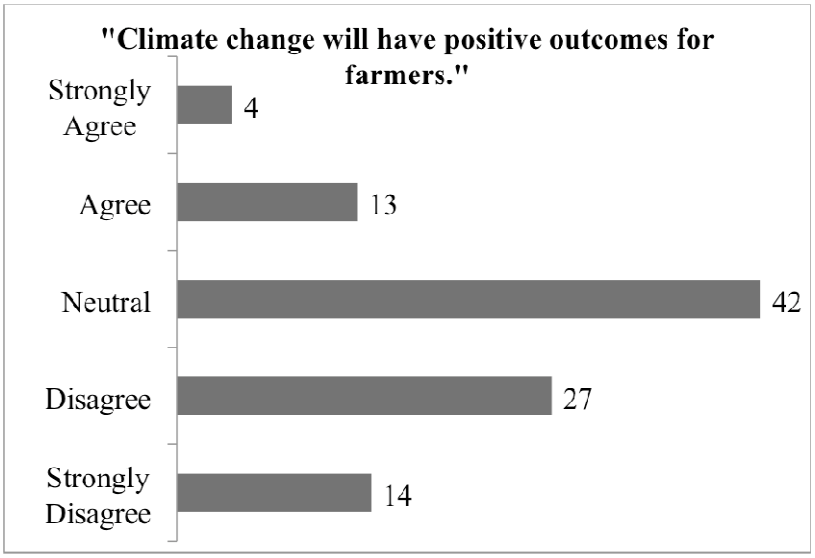
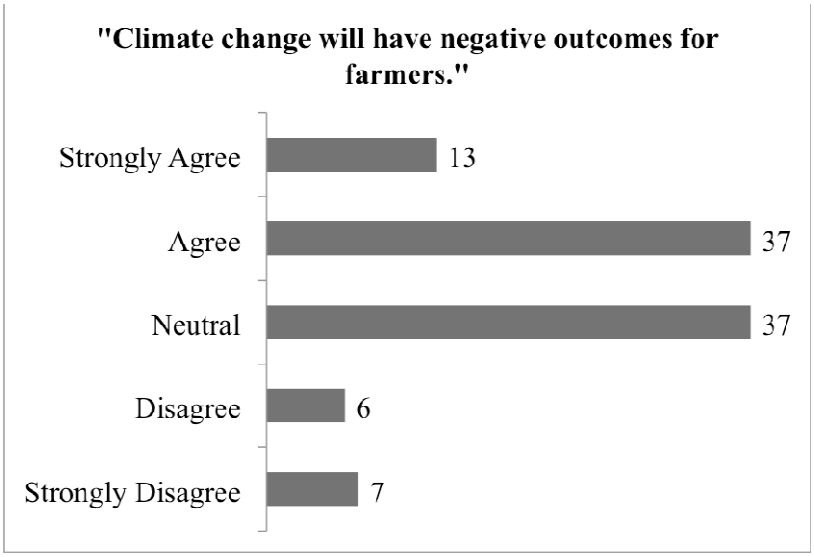


Figure 7 - Perception of climate change as a driver of negative outcomes for farmers



These findings differ from the study carried out by Aubin et al. (2003), who surveyed 223 farmers from Saskatchewan. 23 percent said climate change will positively affect farming, compared to 17 percent in my study; 26 percent said climate change will have negative effects, compared to 50 percent in my study; and 37 percent were neutral, similar to my study.

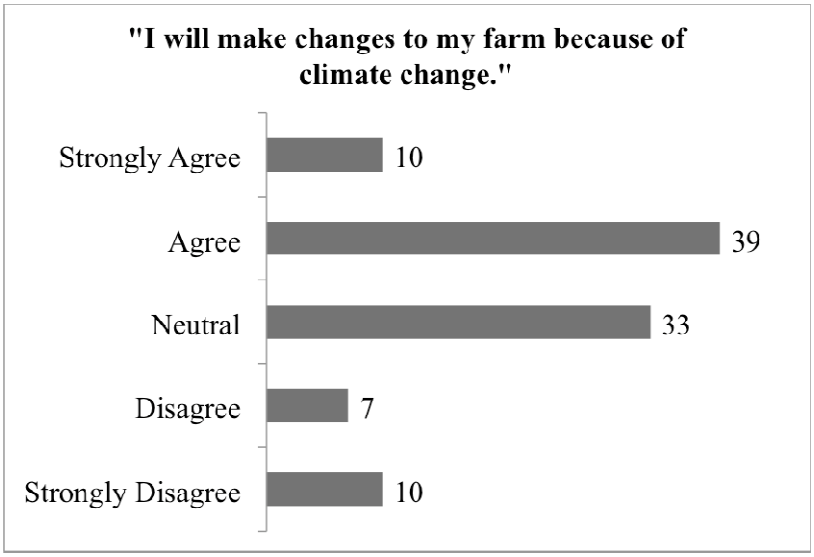
A statistically significant relationship ($P \leq 0.01$) exists between the size of one's farm and the belief that climate change will have negative outcomes for farmers. 30 percent of small farms strongly agree that climate change will lead to negative outcomes for farmers. In contrast, just 6 percent of medium farms and merely 2 percent of large farms agreed that climate change will result in negative outcomes for agriculture. While one explanation for this finding may have been differing ages, there is not a correlation between age and farm size in this sample. Another possible explanation for this finding is differing worldviews between those with large farms and those with small farms: the expansionist approach used by farmers with large operations likely requires a greater level of confidence and sense of invincibility than one would find in farmers with small operations.

6.5 Changes induced by climate change

A solid majority of survey respondents (65 percent) indicated that they have not adjusted their farming operations because of climate change. Of those who have *not* made changes, 58 percent stated that no changes were required because climate change has not affected their farms. The remaining farmers who have not made changes identified knowledge and financial constraints: 25 percent said that they did not know what changes to make; 7 percent said they could not afford to make needed changes; and 10 percent identified *both* knowledge and financial constraints.

Of those who have already made operational adjustments as a result of climate change, the most frequently cited change was to use alternative fallow and tillage techniques, followed by changing the timing of production and using new technology (see Appendix K for a breakdown of identified changes). On the need for future operational adjustments because of climate change, 49 percent of respondents agreed that they will make changes because of climate change (see Figure 8). 17 percent of respondents indicated that they do not expect to make any adjustments.

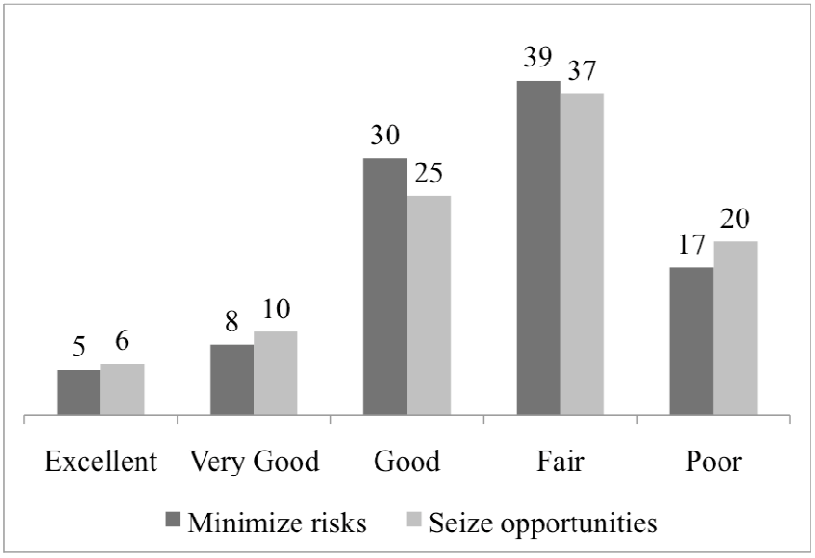
Figure 8 – Perception of future need to make changes because of climate change



6.6 Self-assessed level of resilience

The Hutterite farmers interviewed for this study identified a strong ability to minimize risks and seize opportunities associated with climate change. One Hutterite farmer said: “If [the climate] were to change, you’d have to change with it, you’d have to do things different. We have the capability to change it and we’re ready to change it if we need to.” Family farmers did not express a similar sentiment (see Figure 9). The most frequently cited response when asked about the capacity to minimize risks and seize opportunities was ‘fair’. More respondents rated their capabilities as ‘fair’ or ‘poor’ than chose ‘good’, ‘very good’ or ‘excellent’ combined.

Figure 9 - Self-assessment of capacity to minimize risks and seize opportunities associated with climate change



A statistically significant relationship ($P \leq 0.00$) exists between farm size and self-assessed ability to minimize risks: 33 percent of small farms rated their capabilities to minimize climate-related risks as ‘poor’, while just 13 percent of medium farms and 5 percent of large farms followed suit. I also found a statistically significant relationship ($P \leq 0.00$) between farm size and self-assessed ability to seize opportunities: 35 percent of small farms rated their

capabilities to seize opportunities as ‘poor’, with just 17 percent of medium farms and 7 percent of large farms doing the same.

6.7 Farmers’ preferred adaptation options

Four open-ended questions concluded the online survey:

- What would you like to see governments (federal, provincial, municipal) do to help you and other farmers in your area to minimize risks and seize opportunities associated with climate change?
- What technological innovations would you like to see that could help you and other farmers in your area minimize risks and seize opportunities associated with climate change?
- What do you think farmers in your area could do to minimize risks and seize opportunities associated with climate change?
- Is there anything else you would like to add with regard to farming and climate change?

I coded the responses to each of these questions for statistical analysis. Respondents identified a broad range of preferred adaptation options (see Tables 6, 7 and 8). The greatest consensus that emerged is with regard to what governments should do: improvements to crop insurance, more research, more education, and more grants or interest-free loans to farmers were the most frequently mentioned options. No other options received the support of more than 10 percent of survey respondents.

Table 6 - Farmers' preferred adaptation options in the area of government policies and programs

"What would you like to see governments (federal, provincial, municipal) do to help you and other farmers in your area minimize risks and seize opportunities associated with climate change?"	N	%
Improve crop insurance	27	20
Fund more research	26	19
Provide more education	18	13
Provide grants or interest-free loans	16	12
Improve support programs and disaster assistance	12	9
Nothing	12	6
Implement and encourage carbon trading	7	5
Provide tax incentives	6	4
Promote local markets	4	3
Provide subsidies	2	2
Improve extension services	2	2
Promote organic	2	2
Other	*11*	*8*

Table 7 - Farmers' preferred adaptation options in the area of technological developments

"What technological innovations would you like to see that could help you and other farmers in your area minimize risks and seize opportunities associated with climate change?"	N	%
Develop drought-tolerant crops	14	10
Improve weather forecasting	11	8
Develop more/better zero-till technology	10	7
Provide technology to farmers at a lower-cost	5	4
Develop more/better irrigation technology	4	3
Develop more/better harvesting technology	4	3
Improve global positioning system (GPS) technology	3	2
Develop more/better weeding technology	3	2
Develop more genetically modified organisms (GMOs)	2	2
Develop more/better technology for organic farming	2	2
Enhance rail transport	2	2
Other	*2*	*2*

Table 8 - Farmers' preferred adaptation options, in the realm of their own control

"What do you think farmers in your area could do to minimize risks and seize opportunities associated with climate change?"	N	%
Less cultivation	14	10
Seek information	13	10
Moisture capture	10	7
Use new technology	7	5
Diversify crops	6	4
Change timing	4	3
Crop rotation	3	2
Local	3	2
Organic	2	2
Better associations	2	2
Other	*2*	*2*

I analyzed the responses to the open-ended questions to determine the statistical significance of the relationship between various demographics and preferred adaptation options. As can be expected with a small sample, most results are not significant ($P \leq 0.05$). These are the statistically significant results:

- Only small farms suggested that governments promote local markets ($P \leq 0.02$);
- Large farms had a higher tendency to discuss the need for farmers to use new technology while small farms did not mention it at all ($P \leq 0.03$);
- Only farmers 51 years and under identified the need for new irrigation technology ($P \leq 0.03$);
- Similarly, only farmers with less than 25 years experience identified the need for new irrigation technology ($P \leq 0.05$). There is a high level of correlation between age and farming experience ($r = 0.86$).

I asked each of the Hutterite farmers interviewed for this study for suggestions on how to enhance the resilience of Saskatchewan farmers. The most frequent response, brought up on all three colonies, was the importance of greater diversification. Hutterite farmers pointed out that the success of their operations is due, at least in part, to their broad diversification. One Hutterite said: "Diversification is more than just a buzz word … for us it has been the difference between being profitable or going under." Another Hutterite said:

> We've got a little bit of everything on the colony, and if this thing doesn't make it, we'll make a little bit on this end. Combine that all together, and you're okay. See, you take an ordinary farmer who just seeds crops, that's pretty tough … if you've got a bit of everything, you're going to at least try to make it anyway.

Each of the Hutterite farmers also touched on the need for increased education, with one Hutterite farmer in particular stressing its importance by saying: "You may not see it from the outside but there are a lot of colonies hurting … I think it's because of poor management. We don't have education. The old folks have been against education and I think it's hurting us right now." Other suggestions by Hutterite farmers included the need for crop-insurance improvements; the need for more support of the red-meat industry; and the need for more interest-free loans. Other areas that two Hutterites identified as key elements of their success, but which are not policy-related issues per se, are their built-in labour force and the retention of their young people. Suggestions by family farm leaders were as varied as those received from survey respondents and Hutterite farmers (see Table 9).

Table 9 - Options identified by family farm leaders

Option	Number of family farm leaders who mentioned option
Irrigation	1
Support programs for livestock producers	1
More genetically modified crops	1
New technology	2
More organic production	3
Marketing boards, including maintaining the CWB and establishing new marketing boards for other commodities	3
More focused research	3
Focus on family farmers	3
Improve education and information-provision	4
Increased diversification	4

6.8 Summary of key findings

While farmers deem commodity prices and input costs as their most significant risks, climate–related risks rank a close third, well ahead of trade concerns and government policy. More farmers are concerned about climate change than are not concerned about it, and over half state that they have already experienced some effects of a changing climate. 50 percent of farmers believe that climate change will negatively affect their farming operations and that they will make changes to their operations as a result. On the other hand, 17 percent demonstrate "consequential denial" (Homer-Dixon cited in Wall et al., 2006, p. 13), believing that climate change will be positive for farming and that they will not have to make any adjustments to their farms. Farmers tended to characterize their abilities to minimize risks and seize opportunities associated with climate as either 'fair' or 'poor'. Smaller farms are significantly more likely to believe climate change will affect them negatively and they will be unable to minimize the risks and seize any

opportunities. Both knowledge and financial constraints emerged as key barriers to agricultural adaptation.

This study elicited intriguing findings about where farmers turn to for information. Farmers tend to draw from their past experience and other farmers for information to help them make decisions. Federal and provincial government ministries ranked the lowest on a list of information sources, trailing both producer associations and the Canadian Wheat Board. This study also found that climate change remains a contentious issue for many farmers: 27 percent clearly expressed denial that it is even happening while a handful of others expressed their dissatisfaction with my reference to potential opportunities associated with climate change.

While Hutterite farmers expressed considerable scepticism about climate change, they also expressed a high level of confidence that they will be able to adapt as required. Hutterite colonies satisfy all of the characteristics identified by Homer-Dixon as key to adaptive organizations: they have a strong sense of identity, social capital, norms of social responsibility, trust and reciprocity, and a broad base of knowledge (Homer-Dixon cited in Wall et al., 2006). They also benefit from a built-in labour force and the retention of their young people, but it is clear that a key component of Hutterites' success is their strong emphasis on crop and livestock diversification.

The section that follows discusses the array of suggestions by family farmers, farm leaders and Hutterite farmers on how best to enhance the resilience of the agricultural sector. It also outlines the criteria used to evaluate policy options.

7: Narrowing Down the Possibilities

The process of selecting policy objectives is complicated by the number and diversity of potential approaches identified by survey respondents and interview participants. Understandably, given the multiple challenges faced by farmers, many of their suggestions focused on solving the broader 'farm crisis' and were not limited to adapting to climate change. I readily acknowledge that a more secure, robust and profitable farm sector would be significantly more resilient in the face of climate change, however it is beyond the scope of this study to make recommendations on how best to address the whole range of challenges facing farmers. To remain focused on enhancing the resilience of farmers in the face of climate change, I used a screening process to select the most appropriate policy objectives emerging from this study. Building on the work of Benioff and Warren (1996), Mizina et al. (1998) use a similar screening approach in their evaluation of agricultural adaptation options in Kazakhstan. This section outlines the screening process used to select policy objectives from the array of suggestions received in this study; it then discusses the criteria that will be used for the evaluation of policy options.

7.1 Screening policy objectives

Based on the work of Benioff and Warren (1996), I selected several screening criteria to ensure that the policy objectives in this study focus on enhancing farmers' resilience to climate change (see Table 10). Policy objectives must satisfy *all* of the selected criteria to pass the screening stage.

Table 10 - Screening criteria

Criterion	**Question**
Flexible	Does the option have the capability to address a range of climate change effects (as opposed to just one projected effect)?
Not a mal-adaptation	Is the option free of secondary, adverse consequences for the environment that outweigh its benefits (for example, draining water resources to offset dryer conditions)?
Ease of implementation	Are there relatively few barriers to implementing the option?
Ex-ante	Does the option involve enhancing adaptive capacity (as opposed to solely providing ex-post cushion against shocks)?
Pertinent	Does the option aim to affect farmers' behaviour *now* (as opposed to merely promoting future changes)?

I first established a minimum threshold to determine which of the options identified by survey respondents and interview participants would proceed to the screening phase: those options that were mentioned by more than 5 percent of survey respondents and/or were identified by a majority of the Hutterite farmers and family farm leaders were included in the screening matrix. Those policy approaches that met the minimum threshold are listed in Table 11.

Table 11 - Screening matrix

	Screening Criteria					
Policy objective/focus	**Flexible**	**Not a mal-adaptation**	**Ease of implementation**	**Ex-ante**	**Pertinent**	**Pass?**
Carbon trading	✓	✓	✗	✓	✓	**No**
Crop insurance	✓	✓	✓	✗	✗	**No**
Disaster support programs	✓	✓	✓	✗	✗	**No**
Financial assistance (grants, loans)	✓	✓	✓	✓	✓	**Yes**
Focus on family farmers	✓	✓	✓	✓	✓	**Yes**
Greater diversification	✓	✓	✓	✓	✓	**Yes**
Guaranteed cost of production	✓	✓	✗	✓	✓	**No**
Irrigation	✗	✗	✗	✓	✗	**No**
Knowledge assistance	✓	✓	✓	✓	✓	**Yes**
Marketing boards/supply management	✓	✓	✗	✓	✗	**No**
Organic and sustainable production	✓	✓	✓	✓	✓	**Yes**
Research focused on adaptation	✓	✓	✓	✓	✗	**No**
Revamped trade agreements	✓	✓	✗	✓	✗	**No**

Eight policy approaches did not pass the screening phase. Both carbon trading and guaranteeing farmers their cost of production failed on ease of implementation because there are many legal and political barriers to implementing these options. Crop insurance and disaster assistance programs failed because they provide ex-post cushion rather than enhancing adaptive capacity and they do not aim to affect farmers' behaviour now. Revamping trade agreements and

implementing new marketing boards and supply management practices failed because of the implementation complexity required; as well, these options do not aim to affect farmers' behaviour now. Irrigation failed because it focuses only on one impact of climate change, it involves a mal-adaptation because it exacerbates water scarcity, it is difficult and costly to implement, and it does not involve affecting farmers' behaviour now. Finally, research failed to pass the screening phase because it too does not involve affecting immediate changes in farmers' behaviour.

While I recognize the wisdom of including many of the policy objectives listed above in a comprehensive agricultural adaptation strategy, this study does not aim to simply ensure that there is adequate cushion against climate-related shocks. Ex-post relief typically involves significant public expenditure and may be counterproductive in having farmers *proactively* adapt to climate change. One Hutterite farmer demonstrated this, saying: "I think with the weather, you're pretty much protected through insurances and such … so it's not a big concern." Rather than placating farmers by focusing only on expanding ex-post relief, this study focuses on enhancing farmers' resilience. To that end, the five broad objectives that successfully passed the screening stage aim to strengthen the ability of farmers to minimize risks and seize opportunities associated with climate change.

7.2 Policy objectives

Policy makers frequently wish to satisfy multiple objectives when it comes to agricultural policy. For that reason, I have sought to clarify from the outset the broad policy objectives that will guide my evaluation of potential options and inform my recommendation. The key objectives – which emerged from survey responses and interviews and which passed the screening phase outlined in section 7.1 – are as follows: (1) encourage greater diversification; (2)

support the family farm model[6]; (3) promote organic and sustainable agricultural production; (4) include knowledge assistance components; and (5) include financial assistance components.

7.2.1 Diverse family farms

All family farm leaders and Hutterite farmers interviewed for this study emphasized that increased diversification would serve to enhance farmers' resilience. Three farm leaders also identified the need to support family farms (see Appendix L for further research that supports family farms). One family farm leader pointed to the pork industry as an example of the greater level of resilience found within mixed family farms as opposed to intensive, single-commodity corporate operations. This quote also illustrates the example of the costs borne by society when there is a lack of resilience in the agricultural sector:

> I think there is very good evidence that small-scale agriculture is much more resilient and adaptive than large-scale, intensive, heavily invested agriculture. … Just look at the pig market now: we've always had … cycles and up-price and down-price and when there's the down price … with those small pig barns, farmers and neighbours of ours even just cut back on the pigs and sometimes they took a winter when they had no pigs. Fine, the farm stayed on the rails. Often there was something counter-balancing such as grain prices would be up … When the pig price came back, they'd buy a few sows and fill their barn again and on it went. And we had that kind of a pig market for decades and decades and decades. And then when we concentrated the production, about 15 years ago here in Saskatchewan, … we now have these massive, intensive barns and two things happened: one is that the small producer was shut out completely, by the destruction of the marketing system and that was a public policy decision … and subsidizing the intensive hog operations with public money in the interest of trying to lure a massive processor into Saskatchewan. They failed on that last bit, it went to Manitoba, but that was the project. … Now just watch the results, when you're talking about what's resilient, now that the price has bottomed out—the price of barley was a little higher and the price of pigs went down—those big barns are entirely unviable. There is no resilience in that system whatsoever. The only saving grace now is massive amounts of public, federal money buying out

[6] In Appendix L, I present support for the family farm model and for the concept that small and medium-sized family farms are efficient and productive.

> those failed operations.[7] This is not resilience. This is dealing with massive failure. And it's a public policy failure.

An article in the Western Producer, a widely read weekly agricultural newspaper, echoed that sentiment: "… with Big Sky Farms [an intensive, corporately-owned hog operation] entering bankruptcy protection, *mixed family farms no longer seem so outdated* … unlike the specialized, investor-based hog networks, family farms are hedged across a number of commodities and willing to hunker down for the long term" (White, 2009; emphasis mine).

Smaller, diverse farms are more resilient to a range of risks, including risks of reduced yields due to climatic conditions and risks of reduced prices due to volatile commodity markets (Hardaker et al., 1997; Devendra, 2002). A high level of efficiency and productivity characterizes family farms (see Appendix L for a discussion of the efficiency and productivity of family farms). Family farms also have considerable "public value" (USDA, 1998, p. 12):

- Family farms tend to have an increased level of environmental stewardship;
- Decentralized land ownership leads to broader economic opportunities and higher levels of social capital in rural areas;
- Family farms lead to increased personal connection to food production;
- Rural areas dominated by family farms are more economically viable and culturally vibrant[8] than areas where corporate farms are predominant (USDA, 1998; Rosset, 1999);

As such, encouraging diverse family farms is a promising agricultural adaptation policy objective.

[7] The Government of Canada's Hog Farm Transition Program allocates $75 million to reduce Canadian pork production and "ease a glut of pork on the North American market" (CPC, 2009) Registered farmers who wish to exit the hog production industry can submit a bid specifying the compensation they would require to stop producing pigs for at least three years. The program aims to reduce the Canadian pig herd by 250,000 (CPC, 2009).

[8] Rosset (1999, 10) concludes: "In … corporate-farm towns, the income earned in agriculture was drained off into larger cities to support distant enterprises, while in towns surrounded by family farms, the income circulated among local business establishments, generating jobs and community prosperity. Where family farms predominated, there were more local businesses, paved streets and sidewalks, schools, parks, churches, clubs, and newspapers, better services, higher employment, and more civic participation."

7.2.2 Organic agricultural production

Three family farm leaders mentioned organic agricultural production as an important way of enhancing the resilience of family farms. Wall and Smit (2005, p. 115) point to the "obvious connection" between sustainable agricultural practices—including organic production—and climate adaptation. Organic farming is recognized as a lower-risk approach to agriculture for the following reasons:

- Diverse, organic farms can be as productive—in terms of quality, quantity, and yield per acre—as conventional farms (Posner et al., 2008).
- Higher farm incomes are achievable through organic production because of significantly reduced input costs as well as higher sale prices (Muller, 2009);
- Organic agriculture increases soil organic matter content, while avoiding the nutrient depletion that typically results from conventional agriculture, thereby enhancing resilience to a range of climate-related impacts including drought and flooding (Mader et al., 2002); and
- Organic agriculture performs better than conventional agriculture during periods of water scarcity (Hepperly et al., 2006; Badgley et al., 2007).

Organic agriculture has significant potential to enhance the resilience of farmers in the face of climate change (Borron, 2006; Kotschi & Müller-Sämann, 2004; Muller, 2009). Adding to its appeal is its significant potential for both emissions avoidance and carbon sequestration—due to reduced fossil fuel-based pesticides and fertilizers, lower nitrogen input, more organic manure application, improved soil structure and increased plant cover (Muller, 2009). The potential to enhance the resilience of farmers while also reducing environmental degradation makes the promotion of organic agriculture an appealing policy objective.

7.2.3 Knowledge and financial assistance

Successful adaptation requires knowing what to adjust and being able to afford those adjustments. Mendelsohn (2000) identifies the need for government to: (1) provide information to individuals about what adjustments to make, where lack of knowledge hampers adaptation; and

(2) subsidize desirable adjustments, where lack of financial resources impedes adaptation. Family farm leaders and Hutterite farmers echoed that call; all of them identified the need for both knowledge assistance and financial assistance to help enhance farmers' resilience. As well, when survey respondents who are not yet adapting their operations identified the reason for their lack of action, 25 percent identified a lack of knowledge about what to do, 7 percent identified a lack of finances, and 10 percent identified both knowledge *and* financial constraints. To ensure that agricultural adaptation policies are effective, it is clear that there is a need to include knowledge and financial assistance components.

7.3 Evaluation criteria

To arrive at a recommendation, I evaluated the policy options based on the criteria of effectiveness, ease of implementation, acceptability, reach, public expenditure and equity (see Table 12).

Table 12 - Evaluation criteria

Criterion	**Definition**
Effectiveness	Does the option focus on the five key policy objectives identified by survey respondents and interview participants in this study? (1) Encouraging greater diversification; (2) Focusing on family farms; (3) Promoting organic production; (4) Including knowledge assistance components; and (5) Including financial assistance components.
Ease of implementation	Does the option require the establishment of a new program? Does the option require intergovernmental cooperation?
Acceptability	The extent to which the option is deemed feasible by policy makers, based on the following characteristics: (1) Preserves freedom of choice for farmers; (2) Ensures confidentiality/privacy of farmers; (3) Has a positive effect on the rural economy; and (4) Is largely acceptable to the broader citizenry.
Reach	The percentage of farmers who are likely to adjust their operations

Criterion	Definition
	and behaviour because of the option.
Public expenditure	The projected change in public expenditure relative to the status quo.
Equity	The extent to which the option could benefit all family farmers, irrespective of size or other characteristic.

I assigned a numerical score for ‘effectiveness’, ‘ease of implementation’ and ‘acceptability’, the basis for which I explain in the discussion of each criterion. I recognize the subjectivity inherent in using such scores in a multi-criteria evaluation process. However, such an approach can be helpful for policy makers to assess the comparative advantages and disadvantages of each policy option.

7.3.1 Effectiveness

As a criterion for evaluation, ‘effectiveness’ measures the success of achieving the policy goal that, in this case, is the enhanced resilience of farmers. The measures for effectiveness are given in Table 12. To evaluate the effectiveness of each potential policy option, I determine whether the policy option focuses on each of these objectives through a basic analysis of its components. To be transparent in my evaluation of the options, I outline how each option meets, or fails to meet, the policy objectives. I evaluate each option out of 5, with one point assigned for each policy objective it satisfies.

7.3.2 Ease of implementation

I evaluate each policy option for its level of implementation complexity: whether it requires the establishment of a new program and whether it requires intergovernmental cooperation. Options will be less feasible if they require a higher degree of policy adjustment or intergovernmental cooperation to implement them. I outline the specific details of policy

adjustment and intergovernmental cooperation required. I then assign each option a score out of 2, with one point assigned for each of the elements of this criterion.

7.3.3 Acceptability

The acceptability of a policy option is an important criterion considered by policy makers. In this case, the perceptions of farmers, other rural residents, and the general citizenry are paramount in determining the feasibility of agricultural policy options. Options receive one point for each of the following characteristics: preserving freedom of choice for farmers, ensuring privacy and confidentiality of farmers' operational details, a positive effect on the rural economy, and a generally positive perception among the broader public.[9] Because this study focuses on *agricultural* policy, two of the four elements that comprise this criterion focus on acceptability among farmers, with the remaining two points divided between other rural residents and the general citizenry. I outline how each option satisfies, or fails to satisfy, each of the elements listed above. I then assign one point for each element, up to a total of 4 points.

7.3.4 Reach

'Reach' refers to the ability of the policy option to affect change on farms. Those options that have a higher level of reach will be more attractive. I evaluate each option based on the estimated percentage of farmers that it could reach. To estimate the potential reach of each option, I make assumptions based on the status quo or on relevant literature. To be transparent, I explicitly outline those assumptions.

[9] I recognize that a proper evaluation of acceptability should include consideration of the state of the province's finances. Currently, the Government of Saskatchewan is running a summary deficit of approximately $1 billion and will likely cut back on public spending as a result (Wood, 2009). Such cutbacks would undoubtedly impede the ability of the Government to implement a new program. However, in order to evaluate the policy options on their own merits, I am not considering the province's current fiscal state in my analysis of the options; I will address this in the final section of this paper.

7.3.5 Public expenditure

Incremental cost to taxpayers is an important criterion to consider when evaluating public policy options. The estimated cost is included in the evaluation of each policy option. To estimate the cost, I make assumptions based on the status quo or on relevant literature. As with the other criteria, I detail these assumptions and their basis.

7.3.6 Equity

As a criterion for policy evaluation, 'equity' can focus on the allocation of both benefits and costs among those who are relatively equal ('horizontal equity') or unequal ('vertical equity'). In this study, I assess horizontal equity based on the extent to which the option could benefit *all* family farmers, irrespective of size or other characteristic. I evaluate each option based on a scale of low, medium or high equity and outline the justification for each rating. Due to the complexity of this criterion, I do not translate these ratings into a score. Rather, the equity ratings stand on their own, separate from the numerical scoring, for policy makers to take into consideration when assessing the relative trade-offs of each option.

8: Opportunities for Enhancing Adaptive Capacity

Based on the policy objectives that emerged from my study and the evaluation criteria outlined in the previous section, I conducted a scan of current policies and programs in Saskatchewan to determine what program represented the 'status quo'—defined as currently meeting the most objectives and satisfying the most criteria. A follow-up conversation with one of the family farm leaders interviewed for this study brought to my attention the Canada-Saskatchewan Farm Stewardship Program (CSFSP), which, while not explicitly a climate change adaptation program, includes many of the desirable components outlined in Section 6.[10] This section will evaluate the CSFSP and several additional policy options. An evaluation matrix, which provides an overview of this discussion, is shown in Table 13, Section 8.5.

8.1 Status quo

The CSFSP, in existence since 2005, aims to encourage Saskatchewan farmers to adopt beneficial management practices (BMPs) that address on-farm environmental risks. In Saskatchewan, the Provincial Council of Agriculture Development and Diversification Boards (PCAB) administers the CSFSP. Farmers can obtain up to $50,000 through the program in cost-shared incentives to implement BMPs; projects are required to be either 50 or 70 percent funded by farmers. BMPs are farming practices with the following key characteristics:

[10] The Canadian Agricultural Adaptation Program (CAAP) may also initially appear applicable. The CAAP focuses on initiatives at the national, regional and multi-regional levels to help the broader agri-food sector "adapt and remain competitive" (AAFC, 2010). The CAAP fails to provide funding for specific initiatives that are consistent with the policy objectives identified in this study. For example, the CAAP does not support knowledge assistance, as "information sharing and/or general awareness activities" (AAFC, 2010). are not eligible for funding. The CAAP also fails to support on-farm adjustments, as "activities that are deemed to be part of normal business practice for any recipient" (AAFC, 2010) are ineligible for support.

- Reduces adverse effects on the environment, by maintaining or improving soil, water and air quality as well as biodiversity;
- Ensures the long-term health and sustainability of agricultural lands;
- Represents a practical approach; and
- Does not adversely affect "the long-term economic viability of farmers and others in the agricultural industry" (CSFSP, 2009).

Eligible BMPs include improvements in the following areas:

- Cropping systems, including low disturbance seeding and fertilizing as well as precision farming applications (global positioning system technology);
- Livestock site management, including remote watering systems and farmyard runoff control;
- Manure management, including manure nutrient planning;
- Land management, including re-vegetating waterways and riparian areas, protecting marginal soil areas, and establishing shelterbelts;
- Water well management, including protecting existing wells;
- Irrigation management, including equipment modification; and
- Pest management, including native plant re-establishment and integrated pest management planning (CSFSP, 2009; see Appendix M for a full list of eligible BMPs).

Though not explicitly climate change adaptation practices, it is clear that each of the BMPs aims to enhance the resilience of farmers, while also protecting the environment.

The first step for farmers to obtain cost-shared incentives through the CSFSP is to complete an environmental farm plan (EFP). EFPs are "voluntary, confidential, self-assessment tools used by producers to raise awareness about environmental risks and opportunities on their operations. As part of their EFP, farmers develop their own action plans to identify management practices that can reduce environmental risk on their operations" (CSFSP, 2009). To complete an EFP, a farmer must attend two free, informational workshops—facilitated by one of 13 farmers who function as workshop facilitators—and undertake an assessment of the soil and site characteristics of their farms. With the help of the EFP workshop facilitators, farmers develop

action plans to manage any identified risks. Farmers then submit their completed actions plans to a confidential, anonymous peer review process conducted by a panel of farmers. Upon endorsement of the action plan by the peer review committee, farmers become eligible to apply for cost-shared funding under the CSFSP.

Scholarly analysis of the performance and outcomes of the CSFSP is not available. However, Smithers and Furman (2003) study participation and involvement in a similar program, the Ontario Environmental Farm Plan Program (OEFPP), and conclude that: "In the majority of cases, participation in the EFP resulted in a significant outcome" (Smithers & Furman, 2003, p. 354). Statistics for the CSFSP indicate a substantial level of participation: from the program's inception in 2005 to December 31, 2009, 10,600 farmers—about 24 percent of all Saskatchewan farmers—completed an EFP. The program has approved 13,800 BMPs. In the 2009-10 fiscal year, farmers will receive approximately $7 million through the CSFSP[11] compared to $42.2 million in the previous four fiscal years.[12] Despite a cap of $50,000, the average payment between 2005 and 2009 was just $3,585[13] (CSFSP, 2009).

8.1.1 Evaluation of the status quo

Effectiveness: While the CSFSP is available to all farms in Saskatchewan, including large corporate farms, the structure of the program largely ensures that family farms can readily benefit:

[11] Between April 1st, 2009 and December 31st, 2009, 2,030 applications received approval through the BMP program, representing $6.3 million ($700,000 per month) in CSFSP funding to farmers (PBAD, 2009). Assuming a similar number of projects will receive approval in the remaining three months of the 2009-10 fiscal year, it is likely that total public expenditure through the CSFSP for BMPs will be $7 million. The Government of Saskatchewan will contribute $2.8 million towards the total CSFSP expenditure, based on a 60/40 funding split between the federal and provincial governments.

[12] The $42.2 million in funding from the CSFSP from 2005 to 2009 was matched by $80.3 million in cash or eligible in-kind contributions from farmers, for a total of $122.5 million.

[13] Approximately $42.2 million spent on 11,771 projects.

- The two mandatory workshops help to facilitate knowledge-sharing among participating farmers, an important component given this study's finding that family farmers rely heavily upon other farmers for information to help them make decisions;
- The six-page application for funding is user-friendly and program representatives are available to assist farmers with the application process; and
- The cap of $50,000 reduces the ability of richer farmers to drain the benefits.[14]

The CSFSP also includes knowledge and financial assistance components. Because it stops short of explicitly encouraging organic production and increased diversification, it loses two points: the status quo receives a score of 3 out of 5 for effectiveness.

Acceptability: The CSFSP preserves farmers' freedom of choice, because it does not regulate behaviour, and it ensures the confidentiality of farmers, through an anonymous peer review process and a guarantee that regulatory agencies will not receive information provided to the program. The CSFSP has a moderate potential to positively affect the rural economy, through increased investments (as a result, I assign half a point for this sub-criteria). Since this is an existing program and requires no additional funding, I consider the public perception of it as neutral and do not award an additional point. As a result, the status quo receives a score of 2.5 out of 4 for acceptability.

Equity: All family farmers are able to access cost-shared incentives contained in this option and no particular types of farms are unfairly advantaged. As such, the status quo receives a rating of 'high' for equity.

8.2 Status quo + Program for Adaptation and Resilience

The Government of Saskatchewan could fund a three-year Program for Adaptation and Resilience (PAR), which PCAB would deliver in conjunction with the CSFSP.[15] The PAR would

[14] Two family farm leaders raised this point during interviews, pointing to the cap for the AgriStability program—now at $3 million per year—as an example of caps that do not make sense for most family farmers.

expire at the same time as the CSFSP, at which time the Government of Saskatchewan could seek to include its components in a renegotiated multilateral framework, essentially merging the PAR with the CSFSP and reducing the need for a program that is solely funded by the province. This timing would also allow for consideration of the effectiveness of the program—at least in terms of farmer participation and early outcomes.

Criteria to receive funding through the PAR would be identical to the CSFSP: a farmer must attend two informational workshops and complete a confidential environmental farm plan. In this option, farmers would also be required to assess the impacts of climate change on their farming operations and use their action plan to address how they will mitigate risks and seize opportunities associated with climate change. Upon the peer review committee's approval of the action plan, the farmer would be eligible to apply to the PAR for between 30 and 50 percent of cost-shared funding, for a maximum of $20,000 (in addition to the maximum of $50,000 available under the CSFSP).[16] Eligible BMPs under the PAR would include any effective adaptation measures not funded under the CSFSP, including crop and livestock diversification and various moisture capture techniques.

8.2.1 Evaluation of the status quo + PAR

Effectiveness: Like the status quo, this option focuses its benefits on family farms through assistance with applications, a relatively low cap on potential benefits and a knowledge-

[15] While I acknowledge that it would be ideal to incorporate the new components directly into the CSFSP, rather than have a parallel program, the complexity of renegotiating a national policy framework less than two years into its five-year timeframe would render such an endeavour highly unfeasible. The CSFSP is part of the Growing Forward Multilateral Framework (GFMF), which replaced the Agricultural Policy Framework. The federal, provincial and territorial Ministers of Agriculture signed the GFMF in July 2008 and it will expire in 2013.

[16] The maximum amount available under the PAR was determined as follows: the CSFSP is funded based on a 60/40 split between the federal and provincial governments; the maximum funding under the CSFSP is $50,000, of which $20,000 is funded by the Government of Saskatchewan. The PAR would be solely funded by the Government of Saskatchewan; providing equal amounts to both the CSFSP and the PAR ensures greater administrative ease while also ensuring the total cap under the CSFSP/PAR remains sufficiently strenuous to guarantee its benefits are not unfairly skewed to the largest farming operations.

sharing component, which builds on the high level of trust between farmers identified in this study. In particular, this option builds on the finding of this study that farmers are inclined to look to one another for information to help them make farming decisions; the workshops, which are led by specially trained farmers, will help to facilitate important knowledge-transfer between participating farmers. Unlike the status quo, this option explicitly encourages increased diversification. Though it does not specifically support organic production, the PAR would allow organic producers to access additional funding, which would help offset the costs of transitioning to organic production; as such, this option loses only half a point. The status quo + PAR option receives a score of 4.5 out of 5 for effectiveness.

Ease of implementation: The PAR does not require the establishment of a brand new program because PCAB will deliver it as a parallel program in conjunction with the CSFSP. This option does not require intergovernmental cooperation for its implementation. The status quo + PAR receives 2 out of 2 for ease of implementation.

Acceptability: Like the status quo, this option preserves freedom of choice because it does not regulate farmers' behaviour. It also ensures the privacy and confidentiality of farmers through an anonymous peer review process and a guarantee that regulatory agencies will not receive information provided to the program. The PAR would have a positive effect on the rural economy through increased investment. As well, I anticipate that a substantial proportion of citizens would view the PAR positively, because of its support for family farmers and more environmentally friendly practices. However, I anticipate that another substantial portion of citizens would be dissatisfied with public funding directed towards farmers, given the perception that farmers are already heavily subsidized. As a result, I assign only half a point for the public perception sub-criterion. Since it fully satisfies the remaining sub-criteria, this option receives a score of 3.5 out of 4 for acceptability.

Equity: All family farmers are able to access cost-shared incentives contained in this option and no particular types of farms are disadvantaged. The status quo + PAR option receives a rating of 'high' for equity.

Reach: 10,600 farmers have accessed funding under the CSFSP, amounting to an average of 2,650 per year since the program began in 2005. If a similar trend continues until the program expires in 2013, an additional 7,950 farmers will access the CSFSP. A total of 18,850 farmers (42.5 percent of Saskatchewan farmers) would then be part of the program. Due to the PAR's expanded list of eligible projects, it is plausible that it would attract the following: those who have already accessed funding under the CSFSP; those who will access funding under the CSFSP before 2013; and those who were not interested in the CSFSP due to the limited eligible projects. Based on these considerations, I assume that PAR could reach up to 50 percent of Saskatchewan's farmers.[17]

Public expenditure: (1) Program costs: Based on the estimated reach discussed above, PAR costs will be calculated based on 50 percent of farmers accessing cost-shared incentives over the life of the program (three years). The average payment under the CSFSP has been $3,585. I assume that the average payment under the PAR will be $4,000. Based on these assumptions, $88.6 million would be required for the PAR over three years,[18] amounting to $29.5 million per annum. (2) Administrative costs: The infrastructure for program delivery is already in place. At present, 13 facilitators exist and numerous workshops occur throughout the year. Additional facilitators would need to be hired and additional workshops would need to occur. The

[17] I recognize that some farmers who may have engaged in adaptive measures without any incentives will receive financial benefits from this program, essentially acting as free riders. I address this concern in part by requiring farmers to participate in two workshops and complete an environmental farm plan. The workshops and environmental farm plan include a focus on climate change adaptation, ensuring that farmers have accurate information about the effects of climate change on their farming operations and the best approaches to minimize risks and seize opportunities in light of those effects. Because of this knowledge-sharing component, I anticipate that farmers will have more success at adapting their operations appropriately.

[18] 22,165 farmers * $4,000 = $88,660,000

CSFSP websites and various publications would require updating and funding would also be required for marketing to ensure farmers are aware of the new program. Out of fiscal caution, I have calculated a public expenditure increase of $500,000 in upfront administrative costs, and $250,000 per annum in ongoing administrative costs, amounting to $1.3 million over three years. (3) Total public cost: I estimate the total public cost over three years for the PAR at $89.9 million.

8.3 Status quo + Organic Transition Fund

Organic production is an effective agricultural adaptation approach. However, it involves an abrupt shift in farming practices and a three-year transition period before a farmer can reap premium commodity prices. To address the challenges associated with the transition period, the Government of Saskatchewan could fund an Organic Transition Fund (OTF). To reduce confusion for farmers, criteria to receive funding from the OTF would be similar to the CSFSP. A farmer must attend two new informational workshops focused on organic production and complete a confidential environmental farm plan. The plan would include an assessment of the risks and opportunities associated with transitioning his or her particular farm to an organic operation. Once the new organic peer review committee approves the action plan, the farmer would be eligible to receive $10 per acre, to a maximum of $7,500 for each of the three transition years, which is a funding amount recommended in a 2007 study for the Government of Saskatchewan.[19]

8.3.1 Evaluation of the status quo + OTF

Effectiveness: The status quo + OTF encourages greater diversification because organic farms tend to be more diverse than conventional farms (Posner et al., 2008). It also supports family farms through a knowledge-sharing component, information provision and assistance with

[19] This funding amount is from *Going Organic: A Report on the Opportunities for Organic Agriculture in Saskatchewan* (2007), written by the Saskatchewan Legislative Secretary for Organic Farming, Lon Borgerson. Borgerson conducted extensive discussions with farmers—organic and conventional—and studied other jurisdictions and made a series of recommendations to the Government of Saskatchewan.

applications. This option promotes organic agricultural production and includes knowledge and financial assistance components. As such, the status quo + OTF receives a 5 out of 5 for effectiveness.

Ease of implementation: This option requires the establishment of a new program including a new peer review committee, new workshops and new facilitators. This option does not require intergovernmental cooperation for its implementation. The status quo + PAR receives a score of 1 out of 2 for ease of implementation.

Acceptability: This option preserves freedom of choice and ensures the privacy and confidentiality of farmers. It does not have a significant effect on the rural economy due to the limited number of farmers who would receive funding. While there is increasing public support for organic agriculture, it may be viewed by some, especially conventional farmers, as support for a fringe movement: only two of 135 survey respondents mentioned organic agriculture and only 5.5 percent of Saskatchewan farmers have transitioned their farming operations. As a result, the status quo + OTF receives a score of 2 out of 4 for acceptability.

Equity: In theory, all family farmers could choose to transition to organic production and be eligible for funding through the OTF. However, some farmers may have land that is more suitable than other farmers' land for organic production (Mader et al., 2002). The status quo + OTF option receives a rating of 'medium' for equity.

Reach: Approximately 60 farms per year are currently entering the transition period. Based on the assumptions made in a 2007 report for the Government of Saskatchewan on organic agriculture, I assume that the OTF could quadruple the number of farms transitioning to organic

production, resulting in 240 farms per year becoming eligible for OTF funding.[20] Over the next three years, this would amount to 720 additional farms or 1.6 percent of Saskatchewan farms.[21]

Public expenditure: (1) Program costs: There are currently 184 farms in the three-year transition process. Assuming 1/3 of those farmers are in each year of the three-year transition, and based on the assumptions made in the 'reach' analysis above, total incremental increases in public cost would amount to approximately $10 million (see Appendix N for this calculation). (2) Administrative costs: This option requires the establishment of a new program including a new peer review committee, new workshops and new facilitators. The program's websites and various publications would require updating and increased marketing would need to occur. Out of fiscal caution, I have calculated a public expenditure increase of $750,000 in upfront administrative costs, and $400,000 per annum in ongoing administrative costs, amounting to $1.9 million over three years. (3) Total cost: I estimate the total public cost over three years for the OTF at $11.9 million.

8.4 Status quo + Program for Adaptation and Resilience + Organic Transition Fund

The Government of Saskatchewan could implement both the PAR and the OTF. The PAR would expire at the same time as the CSFSP, at which time the Government of

[20] In *Going Organic: A Report on the Opportunities for Organic Agriculture in Saskatchewan* (2007), Borgerson anticipates that this transition funding amount could lead to 1,980 more farmers transitioning to organic production by 2015 (approximately 283 per year). Borgerson's assumption is also contingent upon other policy initiatives: the creation of a mentorship program, provincial reimbursement of annual certification fees, enhanced funding for the Saskatchewan Organics Directorate, and the creation of an Organic Agriculture Branch. Because I am not including these additional policy initiatives, I have lowered the anticipated participation from 283 per year to 240 per year.

[21] As with the Program for Adaptation and Resilience (PAR), I recognize that some farmers who may have transitioned to organic production without any incentives will receive financial benefits from this program, essentially acting as free riders. I address this concern in part by requiring farmers to participate in two workshops and complete an environmental farm plan. The workshops and environmental farm plan include a focus on organic production as a climate change adaptation, ensuring that farmers have accurate information about the effects of climate change on their farming operations and the best approaches to minimize risks and seize opportunities through organic production. Because of this knowledge-sharing component, I anticipate that transitioning farmers will have greater success.

Saskatchewan could seek to include its components in a renegotiated multilateral framework, essentially merging the PAR with the CSFSP and reducing the need for a program that is solely funded by the province.

8.4.1 Evaluation of the status quo + PAR + OTF

Effectiveness: As discussed in the PAR and OTF explanations above, this merged option would receive a score of 5 out of 5 for effectiveness.

Ease of implementation: As discussed above, the status quo + PAR + OTF option would receive a score of 1 out of 2 for ease of implementation.

Acceptability: Based on the discussion above, this option receives 3.5 out of 4 for acceptability.

Equity: All family farmers are able to access cost-shared incentives contained in this option and no particular types of farms are disadvantaged. While benefits under the OTF may be more accessible by those with more suitable soil types, such disparity is not significant enough to lower the equity score of this merged option from 'high'.

Reach: PAR could reach 50 percent of Saskatchewan farmers and OTF could reach only 1.5 percent over the next three years. Because it is likely that the PAR would reach the 1.5 percent of farmers reached by the OTF, I do not add these numbers together. The estimated reach of this merged option is 50 percent.

Public expenditure: I estimate the total public cost over three years for the OTF at $101.8 million.

8.5 Evaluation results

I recognize the subjectivity inherent in a multi-criteria evaluation process, especially one that involves scoring of criterion. For that reason, I present the evaluation matrix below as an

overall picture of the comparative advantages and disadvantages of each option (Table 13). Options receive numerical scorings with one point assigned for each of the specific factors that compose each criterion. To allow for ease of comparison, I include the elements that comprise the effectiveness, ease of implementation and acceptability criteria within the matrix. I also provide a cumulative total for these three criteria. Due to the complexity of the equity criterion, I do not translate it into a point system; instead, it stands on its own. To calculate the efficiency index, I deducted the annual percentage of ministry expenditures, represented by the option, from the estimated reach of the option. To easily compare the relative trade-offs and merits of each option, one can compare the cumulative criteria score, the efficiency index, and the equity rating.

Table 13 - Evaluation matrix

	Status quo	**Status quo + PAR**	**Status quo + OTF**	**Status quo + PAR + OTF**
Effectiveness (_/5)	**3**	**4.5**	**5**	**5**
Greater diversification (_/1)	*0*	*1*	*1*	*1*
Family farms (_/1)	*1*	*1*	*1*	*1*
Organic production (_/1)	*0*	*0.5*	*1*	*1*
Knowledge assistance (_/1)	*1*	*1*	*1*	*1*
Financial assistance (_/1)	*1*	*1*	*1*	*1*
Ease of implementation (_/2)	**2**	**2**	**1**	**1**
Does not require the establishment of a new program (_/1)	*1*	*1*	*0*	*0*
Does not require inter-governmental cooperation (_/1)	*1*	*1*	*1*	*1*
Acceptability (_/4)	**2.5**	**3.5**	**3**	**3.5**
Preserves freedom of choice (_/1)	*1*	*1*	*1*	*1*
Ensures confidentiality (_/1)	*1*	*1*	*1*	*1*
Effect on rural economy (_/1)	*0.5*	*1*	*0.5*	*1*
Public perception (_/1)	*0*	*0.5*	*0.5*	*0.5*
CUMULATIVE CRITERIA (_/11)	***7.5***	***10***	***9***	***9.5***
Reach (%)	**-**	**50**	**1.5**	**50**
Public expenditures (over 3 years)	**-**	**$89.9 M**	**$11.9 M**	**$101.8 M**
% of Ministry's annual budget[22]	*-*	*6.2*	*0.8*	*7.0*
EFFICIENCY INDEX *(Reach - % of annual budget)*	**-**	***43.8***	***0.7***	***43***
EQUITY *(Low; Medium; High)*	**High**	**High**	**Medium**	**High**

[22] The annual budget for the Saskatchewan Ministry of Agriculture was $481.1 million in 2009-10.

While I readily acknowledge the subjectivity of multi-criteria evaluations that utilize numerical scoring, the results of this evaluation appear robust: the options generally tie one another in terms of effectiveness, ease of implementation and acceptability. The significant difference lies in reach and public expenditures. Were the OTF to reach 50 percent of farmers, the public expenditures required would be $251.5 million over three years (see Appendix O for this calculation). This would result in an annual expenditure equal to 17.4 percent of the Ministry of Agriculture's budget, which would result in this option obtaining an efficiency index score of 32.6, still significantly lower than the PAR. Since the status quo + PAR + OTF is a combination of the other two options, its efficiency index rating and total score would fluctuate with any adjustments to those options. Finally, different assumptions regarding reach or public expenditure would not affect the equity ratings because the OTF would continue to reach only those whose land is more suitable to organic production.

Despite the apparent robustness of these results, it is clear that the OTF is relatively disadvantaged from the outset due to the low level of reach associated with the option. The minimal reach likely results from a range of factors: (1) the longer a farmer has used chemicals to grow crops, the more difficult it is to imagine farming without them; (2) the transition phase can be frightening for farmers, because it often involves reduced yields without the benefit of premium prices; and (3) there is often a sense of isolation, as organic farms are scattered throughout the province (Borgerson, 2007). Any policy that aims to encourage increased organic production would have to address the range of barriers that keep farmers from transitioning their farming operations. Addressing these barriers may include mentorship programs, providing organic production manuals relevant to the region, promoting local organic markets, and providing financial assistance.

When looking to enhance the resilience of Saskatchewan farmers, it is critical to reach as many farmers as possible. Unfortunately, it is challenging to determine what combination of

policy approaches would be required to reach 50 percent of Saskatchewan farmers with an organic transition program. However, it is fair to assume that getting half of Saskatchewan farmers to transition to organic production would be very difficult and would require significant public expenditure. After all, despite the fact that most of the family farm leaders mentioned organic production as a key approach to enhancing the resilience of farmers, only two survey respondents mentioned it as a possibility. For many conventional farmers, adjustments to their farming operations are acceptable but a whole-scale transition to organic production is not considered a plausible alternative.

9: The Way Forward

Farming has changed significantly over the last 100 years. In many ways, it has changed for the better. However, one broad finding from my study is that there are certain lessons from the past that we would do well to remember. In the face of the impacts of climate change, encouraging greater diversification, supporting the family farm model, and promoting organic production – as was much more common in the past – hold great promise to enhancing the resilience of Saskatchewan farmers. Knowledge and financial assistance are important components of helping to support diversified, family farms and increase organic production.

Current agricultural policy is inadequate in that it focuses heavily on ex-post relief rather than enhancing resilience. The aim of this study was solely on finding helpful ways to improve the adaptive capacity of Saskatchewan farmers. Two policy options emerged from my study in what is practically a tie: adding the Program for Adaptation and Resilience (PAR) to the Canada-Saskatchewan Farm Sustainability Program (CSFSP) and adding *both* the PAR and the Organic Transition Fund (OTF) to the CSFSP.

Given the results of this study, I recommend that the Government of Saskatchewan implement the PAR, which the Provincial Council of Agricultural Development and Diversification Boards (PCAB) would deliver in conjunction with the CSFSP. The program should last for three years, expiring at the same time as the CSFSP. This timing would allow for consideration of the effectiveness of the program—at least in terms of farmer participation and early outcomes. The Government of Saskatchewan could then seek to include the PAR components in a renegotiated multilateral framework, essentially merging the PAR with the CSFSP and reducing the need for a program solely funded by the province. Though this option has a significant price tag—$89.9 million over three years—it represents just 6.2 percent of the

Ministry of Agriculture's total annual expenditures. Such an increase in spending is not out-of-the-ordinary: between 2008-09 and 2009-10, the Ministry of Agriculture increased their spending in the area of 'Business Risk Management' by $155.3 million, from $221.3 million to $376.6 million (Saskatchewan Finance, 2009).

While adding the OTF could encourage more farmers to transition to organic production, it would involve a significant public expenditure while influencing a minimal number of farms. As well, it must be noted that the eligible benefits under the PAR, including funding for increased livestock and crop diversification and moisture capture, would be of significant assistance to any farmers who choose to transition to organic production.

Adding the PAR to the CSFSP will help to reorient how many people—farmers and policy makers alike—view adaptation to climate change. It is not enough to build in a cushion against shocks; rather, we need to build up resilience on farms across Saskatchewan. As well, the PAR acknowledges that farmers are often the ones who know best what course of action to take on their farms; the PAR supports farmers by providing both knowledge and financial assistance. Recognizing this study's findings that farmers trust other farmers more than they trust the government, the PAR workshops will be delivered by trained farmers. Finally, the PAR will essentially create thousands of 'demonstration projects' throughout the province, which is an effective means of encouraging behavioural change given this study's findings that farmers tend to rely most heavily on past experience and the viewpoints of *other farmers* when making decisions about their own farming operations.

Unfortunately, given the current state of the province's finances and the summary deficit of over $1 billion for the 2009-10 fiscal year (Wood, 2009), it is unlikely that the Government of Saskatchewan would choose to follow my recommendation due to the difficult trade-offs that would be required to avoid increasing spending. Due to financial constraint, I would suggest that the Government of Saskatchewan implement a pilot project in regions recently

hard hit by drought and extreme weather.[23] This would involve significantly reduced public expenditure relative to a province-wide program while still allowing for the creation of many demonstration projects, which could serve an important role in information sharing with farmers throughout the province. This approach would also allow the Government of Saskatchewan to point to examples of success when negotiating the inclusion of adaptation components in the next version of the Canada-Saskatchewan Farm Sustainability Program.

During the Great Depression of the 1930s, Prime Minister Bennett knew that it was inadequate to simply provide relief to farmers; rather, the government sought to enhance the resilience of farmers by promoting better farm management practices and providing support for key initiatives that would provide greater economic security to farmers. Today, such an effort is needed once again. The potential challenges for Saskatchewan farmers because of climate change are many, and the opportunities may be few. It is important that agricultural policy aim to enhance the resilience of farmers through encouraging greater diversification, supporting the family farm model, and promoting organic production.

After all, when the climate is changing, farming must change.

[23] The west-central region of the province, specifically the areas around the towns of Kindersley and Rosetown, experienced a regional drought in 2009 (Kyle, 2009). This region could be the target of a PAR pilot project.

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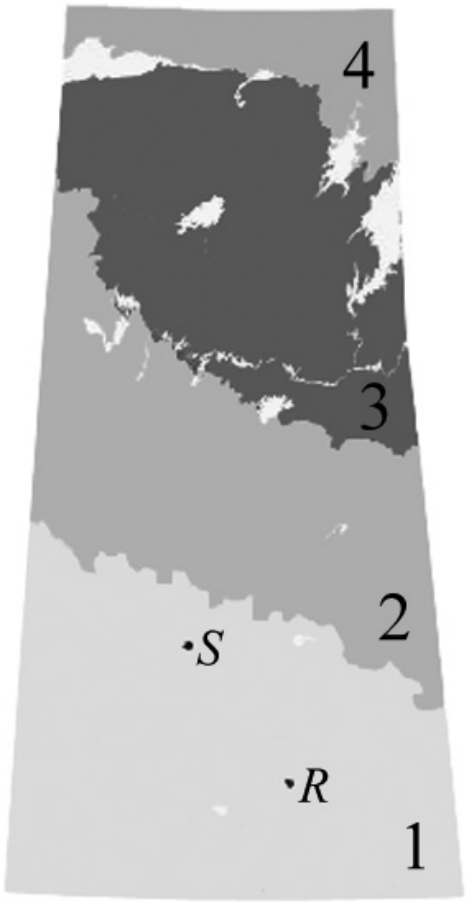
Appendices

Appendix A: Saskatchewan Ecozones



Eco-zones: 1 = Prairie; 2 = Boreal Plain; 3 = Boreal Shield; 4 = Taiga Shield

Largest cities: S = Saskatoon; R = Regina.

Adapted from Canadian Plains Research Centre (2006).

Appendix B: Types of farming operations in Saskatchewan

	N	%
Family farm (incorporated or unincorporated)	34,240	77
Partnership	9,381	21
Non-family corporation	525	1
Other	183	0.4
Total	44,329	100

Source: SaskTrends Monitor (2007).

Appendix C: Online survey

SURVEY INFORMATION: This survey is being conducted for the purposes of gathering information about agricultural adaptation to climate change in Saskatchewan. The information gained will be used to inform a public policy report being undertaken by a Simon Fraser University graduate student as part his degree requirements. The report will assess the adaptive capacity of Saskatchewan farmers and examine what policy approaches might enhance that adaptive capacity.

Your answers are CONFIDENTIAL. This online survey tool runs on a secure website at Simon Fraser University (SFU). Aggregate data will be retrieved from the secure website by the researcher and will be stored on a flash drive, which will be kept in a locked container when not in use. As per university policy, the data will be stored for a period of two years following the completion of the study. It will then be destroyed. Though IP addresses that visit the SFU website are automatically tracked, that information will not be available to the researcher and it is not possible to relate any given IP address back to a specific submission. If you have any concerns or complaints, please contact Dr. Hal Weinberg, Director of SFU's Office of Research Ethics, at hal_weinberg@sfu.ca or 778-782-6593.

The principal researcher for this study is Linsay Martens, a Master of Public Policy candidate at Simon Fraser University. Linsay is supervised by Dr. Nancy Olewiler (olewiler@sfu.ca). To obtain a copy of the final report, please email Linsay at: ldm4@sfu.ca

There are 26 separate questions in this survey. Please note that if you are uncomfortable with any question, you don't have to answer it. As well, you may stop the survey at any time. To stop the survey without submitting your answers, simply close the window.

By filling out this survey, you are consenting to participate in this study. If you wish to exit without participating, simply close the window. If you wish to continue, please start answering the questions below. When you wish to submit your answers, please click the "Submit" button at the bottom of the survey. Thank you.

What year were you born? _____

What is your gender? ☐M ☐F

How many years have you farmed? _____

In which Rural Municipality do you farm (if more than one, provide only one RM's name) _____

What type of farm do you operate? (list main crops and/or kinds of livestock) _____

What is the size of your farm? (in acres) _____

How many head of livestock do you have? (if more than one type, please list the amount of each) _____

Approximately what percentage of your household income comes from farming? _____

Where do you get information that helps you make farming decisions? (Select all that apply)

- ☐Agriculture Knowledge Centre
- ☐Agriculture and Agri-Food Canada
- ☐Canadian Wheat Board
- ☐Other farmers
- ☐Past experience
- ☐Producer Associations
- ☐Sask Agriculture Regional Service Offices

Recognizing that you manage many risks, please indicate how significant you consider each of the following risks to your operation. (1=not significant; 5=very significant)

	1	2	3	4	5
Climate:	☐	☐	☐	☐	☐
Costs:	☐	☐	☐	☐	☐
Prices:	☐	☐	☐	☐	☐
Regulations or taxes:	☐	☐	☐	☐	☐
Trade issues:	☐	☐	☐	☐	☐

In terms of farm financial management, which of the following have you done over the last five years? (Select all that apply)

- ☐Purchased crop insurance
- ☐Invested in crop shares and futures
- ☐Participated in income stabilization programs
- ☐Diversified source of household income
- ☐None of the above

In terms of farm production practices, which of the following have you done over the last five years? (Select all that apply)

- ☐Changed the intensification of production
- ☐Changed the location of production
- ☐Changed the timing of production
- ☐Diversified crop types and varieties
- ☐Diversified livestock types and varieties
- ☐Implemented irrigation practices
- ☐Used alternative fallow and tillage practices
- ☐Used new technology

☐None of the above

What was the extent of the impact of the 2001-02 drought on each of the following: (1=not a significant impact; 5=very significant impact)

	N/A	1	2	3	4	5
Your farm income:	☐	☐	☐	☐	☐	☐
Your crop production:	☐	☐	☐	☐	☐	☐
Your livestock herd:	☐	☐	☐	☐	☐	☐

If you made any changes to your operation because of the 2001-02 drought, could you briefly list the changes you made? _____

How concerned are you about climate change? (1=not at all; 5=very much)

	1	2	3	4	5
Level of concern:	☐	☐	☐	☐	☐

Would you say you have changed your operation because of climate change? ☐Yes ☐No

If you have made changes to your operation because of climate change, could you briefly list the changes you made? _____

If you have NOT made changes to your operation because of climate change, could you identify why not? (Select all that apply)

☐My operation has not been affected by climate change
☐I could not afford to make needed changes
☐I did not know what changes to make

What do you think of the following statements?

1. Climate change will provide POSITIVE outcomes for farmers:

☐Strongly agree
☐Agree
☐Neutral
☐Disagree
☐Strongly disagree

2. Climate change will provide NEGATIVE outcomes for farmers:

☐Strongly agree
☐Agree
☐Neutral
☐Disagree
☐Strongly disagree

3. I will make changes to my operation because of climate change:

☐Strongly agree
☐Agree
☐Neutral
☐Disagree
☐Strongly disagree

What impacts do you think climate change has had or will have in Saskatchewan? (Select all that apply)

- ☐Less frequent cold waves and frost days
- ☐Longer growing seasons
- ☐More frequent droughts and heat waves
- ☐More frequent flooding
- ☐More intense storms and more frequent hail
- ☐More pests and diseases
- ☐No significant effects

Would you say you have already experienced some impacts of climate change in your area?
☐Yes ☐No

Please rate the following:

1. Your capabilities to minimize risks associated with climate change:

- ☐Excellent
- ☐Very good
- ☐Good
- ☐Fair
- ☐Poor

1. Your capabilities to seize opportunities associated with climate change:

- ☐Excellent
- ☐Very good
- ☐Good
- ☐Fair
- ☐Poor

What would you like to see governments (federal, provincial, municipal) do to help you and other farmers in your area to minimize risks and seize opportunities associated with climate change?
_____

What technological innovations would you like to see that could help you and other farmers in your area minimize risks and seize opportunities associated with climate change? _____

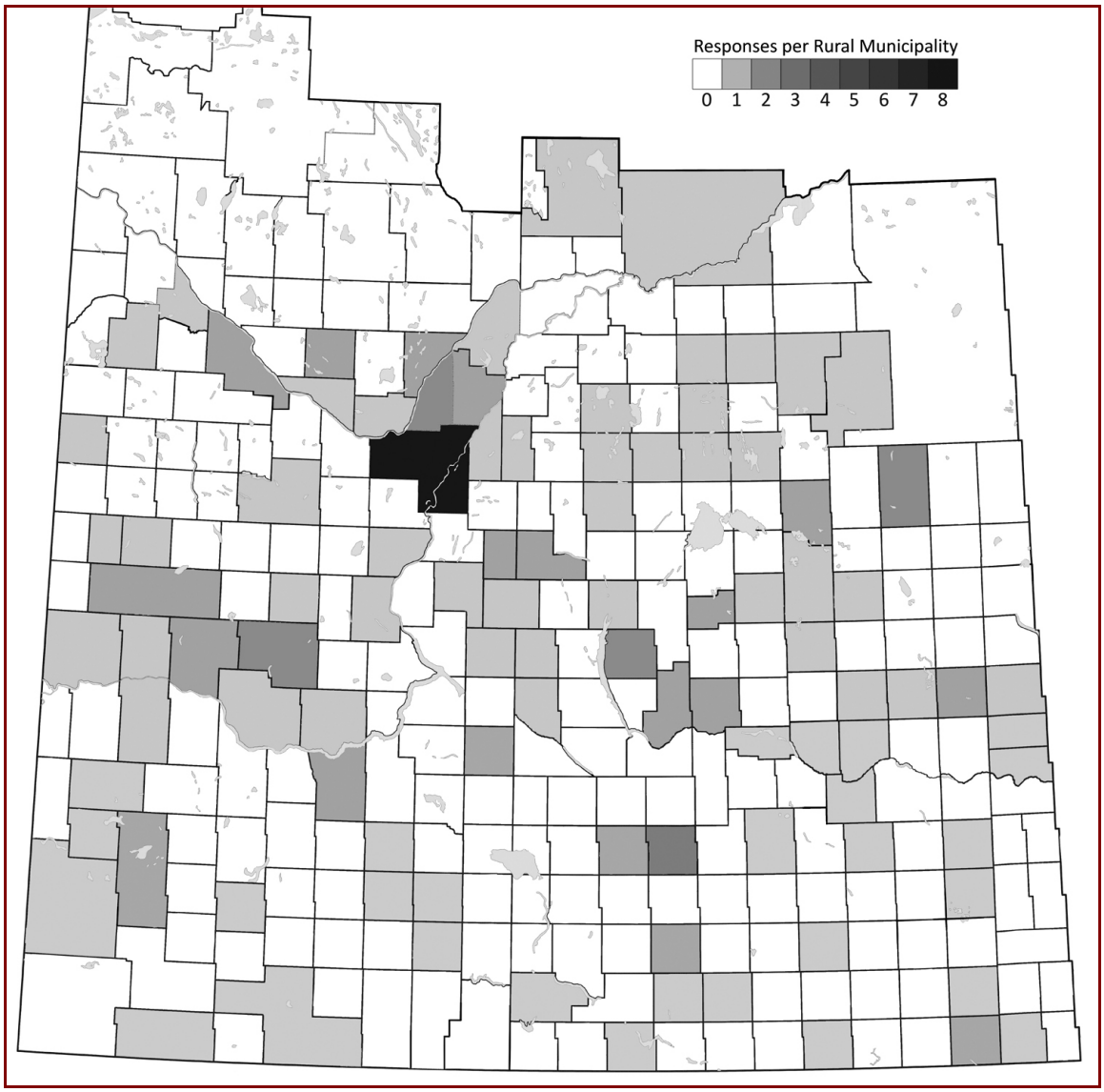
What do you think farmers in your area could do to minimize risks and seize opportunities associated with climate change? _____

Is there anything else you would like to add with regard to farming and climate change?
_____

Thank you for taking part in this survey.

Appendix D: Map of survey responses

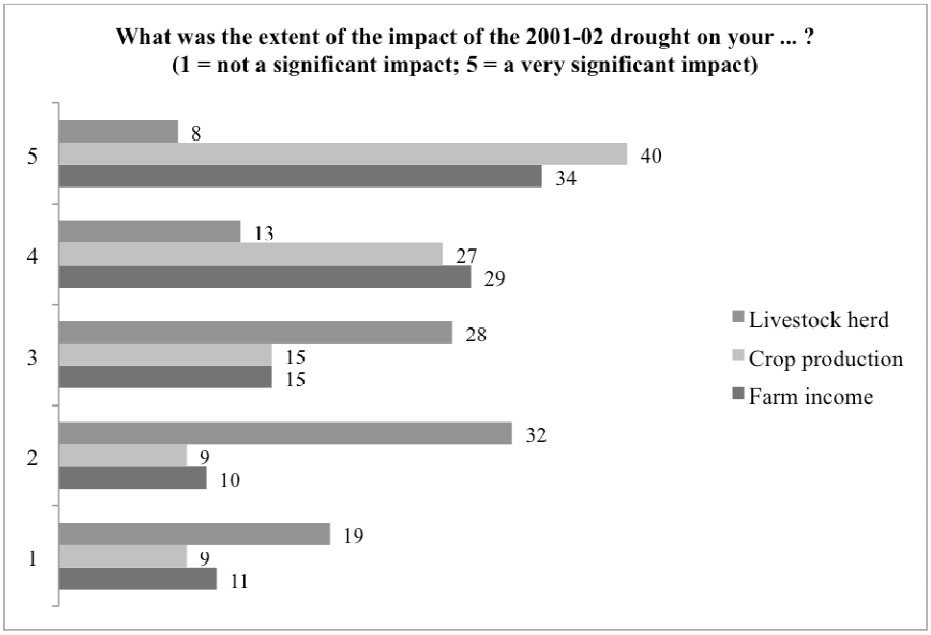
Map of survey responses, based on southern Saskatchewan rural municipality boundaries



Appendix E: Types of crops grown by survey respondents

	N	%
Wheat	99	73
Oilseed	73	54
Canola	67	50
Pulses	58	43
Peas	49	36
Barley	48	34
Flax	36	27
Beef	32	24
Oats	30	22
Lentils	27	20
Poultry and egg	6	4
Mustard	4	3
Rye	3	2
Canary Seed	3	2
Sheep	3	2
Dairy	2	2
Horticulture	2	2
Apiculture	2	2
Other	*5*	*3*

Appendix F: Extent of the impact of the 2001-02 drought



Appendix G: Changes as a result of 2001-02 drought

"If you made changes to your operation because of the 2001-02 drought, could you briefly list the changes you made?"	N	%
Used alternative fallow and tillage practices	19	14
Diversified crop types and varieties	10	7
Changed the intensification of production	9	7
Used new technology	6	4
Implemented moisture capture practices	5	4
Diversified livestock types and varieties	4	3
Implemented irrigation practices	3	2
Changed the timing of production	2	2
Stopped raising cattle	2	2
Stopped grain farming	1	0.7
Other	*12*	*9*

Appendix H: Sources of information

"Where do you get information that helps you make farming decisions? (Select all that apply)"	N	%
Past experience	121	90
Other farmers	110	82
Producer associations	72	53
Canadian Wheat Board	59	44
Agriculture and Agri-Food Canada	51	38
Saskatchewan Agriculture's Ag Knowledge Centre	33	24
Saskatchewan Agriculture's Regional Service Offices	31	23

Appendix I: Farm financial management adjustments

"In terms of farm financial management, which of the following have you done over the last five years?"	N	%
Participated in income stabilization programs	111	82.2
Purchased crop insurance	109	80.7
Diversified source of household income	72	53.3
Invested in crop shares and futures	28	20.7
None of the above	*8*	*5.9*

Appendix J: Farm production practices adjustments

"In terms of farm production practices, which of the following have you done over the last five years?"	N	%
Used new technology	98	72.6
Diversified crop types and varieties	77	57.0
Changed the intensification of production	54	40.0
Used alternative fallow and tillage practices	54	40.0
Changed the timing of production	36	26.7
Diversified livestock types and varieties	14	10.4
Changed the location of production	9	6.7
Implemented irrigation practices	1	0.7
None of the above	*20*	*14.8*

Appendix K: Adjustments as a result of climate change

"If you made changes to your operation because of climate change, could you briefly list the changes you made?"	N	%
Used alternative fallow and tillage practices	21	16
Changed the timing of production	12	9
Used new technology	10	7
Diversified crop types and varieties	7	5
Implemented moisture capture practices	6	4
Changed location of production	1	0.7
Implemented weed control practices	1	0.7
Sell carbon credits to increase income	1	0.7
Stopped grain farming	1	0.7
Stopped raising cattle	1	0.7
Switched to organic farming	1	0.7

Appendix L: Literature review on the productivity and efficiency of family farms

Qualman and Tait (2004) argue that family farms are the most efficient link in the agri-food chain. Drawing on data from Statistics Canada, Saskatchewan Agriculture and the Canada Grains Council, Qualman and Tait point out that family farmers have essentially continued to produce without a price increase since 1975, despite substantial increases in their costs and despite considerable increases in food prices, which have benefited packers, processers, and retailers. Qualman and Tait also reference the Agriculture and Agri-Food Canada report, *An Overview of the Canadian Agriculture and Agri-Food System*, which indicates that the 'multifactor productivity growth' of agriculture was 3 percent per year between 1981 and 1997. This 3 percent growth rate is 10 times the rate achieved by food processors, and 30 times the rate achieved by the broader Canadian business sector (AAFC, 2003, pp. 8 and 45).

Rosset (1999, p. 9) states that: "Surveying the data we indeed find that small farms almost always produce far more agricultural output per unit area than larger farms" and "small farms make more efficient use of land. Large farms generally have higher labour productivity due to [increased] mechanization." Rosset (1999)concludes that peak efficiency is likely achieved on mid-sized farms. Hallam (1991) reviews numerous empirical studies and concludes that economies of size or scale may exist in some livestock operations but do not exist in crop production operations and that few differences in efficiency can be directly related to economies of size or scale in farming operations. Peterson (1997) concludes that there is evidence of diseconomies as farm size increases.

Appendix M: Eligible Beneficial Management Practices under the Canada-Saskatchewan Farm Sustainability Program (CSFSP, 2009).

1. Improved Livestock Site Management
    a. Relocation of Livestock Confinement Facilities
    b. Fencing to Protect the Environment
    c. Fencing to Prevent Damage by Wildlife
    d. Utilizing Portable Windbreaks and Shelters
    e. Remote Watering Systems
    f. Farmyard Runoff Control

2. Improved Manure Management
    a. Manure Storage Improvements
    b. Manure Storage Increases
    c. Manure Application Equipment and Technologies
    d. Manure Nutrient Planning

3. Improved Land Management
    a. Modifying and Re-vegetating Waterways
    b. Planting Vegetation to Protect Riparian (Steambank and Shoreline) Areas
    c. Improved Steam and Creek Crossings
    d. Protecting Marginal High Risk Soils
    e. Shelterbelt Establishment

4. Water Well Management
    a. Decomissioning (Sealing) Abandoned Wells
    b. Protecting Existing Wells

5. Improved Product Storage and Waste Management
    a. Agricultural Product's Safe Storage and Handling
    b. Agricultural Waste's Safe Storage and Handling

6. Improved Pest Management
    a. Pesticide Application Systems (Improved Drift Reduction and In-field Handling Technology)
    b. Information Collection and Monitoring
    c. Integrated Pest Management for Insect, Non-vertebrate or Vertebrate Pests
    d. Integrated Pest Management for Invasive Plants
    e. Native Plant Re-establishment
    f. Integrated Pest Management Planning

7. Improved Irrigation Management
    a. Irrigation Equipment Modification
    b. Irrigation Management Planning

8. Improved Cropping Systems
    a. Low Disturbance Placement of Seed and Fertilizer
    b. Chaff Collectors and Chaff Spreaders
    c. Precision Farming Applications-GPS

Appendix N: Organic Transition Fund participation calculations (1.5%)

	Transition Yr 1	Transition Yr 2	Transition Yr 3	Total $
OTF Yr 1	61.3	61.3	61.3	$1,379,250
OTF Yr 2	240	61.3	61.3	$2,719,500
OTF Yr 3	480	240	61.3	$5,859,750

Total participation over three years: 781 farmers
Total expenditure over three years: $9,958,500

Appendix O: Organic Transition Fund participation calculations (50%)

	Transition Yr 1	Transition Yr 2	Transition Yr 3	Total $
OTF Yr 1	61.3	61.3	61.3	$1,379,250
OTF Yr 2	11,052	61.3	61.3	$83,809,500
OTF Yr 3	11,052	11,052	61.3	$166,239,750

Total participation over three years: 22,165 farmers
Total expenditure over three years: $251,428,500