IDENTIFICATION AND MANAGEMENT OF RISK IN PRODUCTION AGRICULTURE: THE CASE OF SASKATCHEWAN GRAIN AND OILSEED FARMERS

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ABSTRACT

Agricultural risks and uncertainty play a significant role in determining the stability of farm income. Successful farm managers are those who are able to identify and manage risks they face in the production process. Farmers have different perception of sources of risk and the risk management strategies adopted to manage risk also differ based on the perception of the importance the strategy in managing risk. Therefore, it is important to understand the risk perception of specific group of farmers to provide guidance in designing appropriate risk management strategies. This study uses survey of grain and oilseed farmers in Saskatchewan to identify their most important sources of risk, risk management strategies and model how farm and producer characteristics affect the perception and management of risks in production

Best-Worst Scaling and latent Class cluster analysis were the tools employed to analyse the data. The results suggest production and marketing risks such as variation in output prices, rainfall variability, change in input prices, diseases and pests, accidents and health/disability, natural disasters, unable to meet quality requirements and risk management strategies including producing at low cost, keeping financial reserve, pests and diseases control, reducing debt level, buying crop insurance, diversification, getting market information and forward contracting as important sources of risk and risk management strategies to grain and oilseed producers in Saskatchewan. The cluster analysis also showed the existence of two unique clusters based on perception of sources of risk and three unique segments in relation to their perception of important risk management strategies. The regression analysis also suggests farmers use different risk management strategies based on a particular risk faced. Several socio-economic variables including off-farm income, sales, experience, debt to asset ratio, education household income and age were found to influence farmers' perception of risks and risk management strategies. The study should guide policy makers and service providers for appropriate targeting in the design of risk management strategies to help producers cope with risks.

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DEDICATION

I dedicate this thesis to my family and all those on whose care and support I have come this far in life. Thank you for inspiring me to this end.

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CHAPTER ONE

INTRODUCTION AND BACKGROUND

1.1. Introduction

Risk and uncertainty are inevitable in every business enterprise and the agricultural sector is of no exception. Farm entrepreneurs face many risks and uncertainties that include production, marketing, financial, institutional among others (Guerin & Guerin, 1994). These risks, if not properly managed, may lead to increased losses to farmers in their production activities. Several studies have reported on production losses due to diseases, pests and adverse weather conditions (Oerke, 2006; Savary et al., 2012; Hwan et al., 2016) and the high cost imposed on farmers in an attempt to reduce events that threatens farm revenue (Beckie et al., 1999). Lei et al. (2013), reported that the probability of a 10% reduction in grain output due to flood catastrophe for most of the major-producing provinces in China is estimated to be over 90%. In Saskatchewan and Manitoba for example, the cost to grain growers of managing herbicide resistance wild oats using alternative herbicide is estimated to be over 4 million dollars annually (Beckie et al., 1999). Farm operators are confronted with volatile input and output price variations, unpredictable weather conditions and essential changes in technology inherent in their farming business. These volatility and radical changes affects fluctuation in farm profitability from season to season and year to year (Hossain et al., 2002).

According to Aditto et al. (2012), the sources of risk and the extent of severity can vary depending on the farming systems, geographic location, weather conditions, supporting government policies and farm types. This suggests that the perception of farmers on the type and severity of risk they consider important vary from place to place. Risk is a major concern to farmers because they do not have perfect knowledge to forecast events such as input prices, output prices and weather conditions that might affect the profitability of the farm business. According to Howden (2016), farmers in Saskatchewan face a unique set of production and economic risks ranging from drought, excess moisture, frost, hail, pest, and disease, increasing costs of operation, low margins,

and high fixed costs, which lead to fluctuations in farm income and threatens the sustainability of the agricultural industry. Saskatchewan is a major producer of grain and oilseed and most of the output from these sectors are exported. The 2015 statistics on Saskatchewan's agriculture exports shows an increase in exports for canola seed, non-durum wheat, canola oil and soybean (Government of Saskatchewan, 2015). This means that institutional risks such as changes in regional, national, and international trade regulations can put constraint on production or affects prices. For example, restriction of imports through quotas and tariffs can negatively affect market access for export and alter production decisions of grain and oilseed farmers or reduce prices domestically. A recent example is the imposition of 20% import tariff on wheat by the Indian Government (McMillan, 2017). These events can negatively affect farm revenue. Understanding the perceived sources of risk of grain and oilseed farmers in Saskatchewan will be beneficial to policy makers in developing strategies to help farmers manage the various risks they face to reduce their negative effects on farm revenue.

Farmers adopt various risk management strategies in response to the risks they face. In fact, there have been several studies that have investigated risk management practices of farmers. These studies have found that crop insurance, futures contracting, vertical integration, spreading of sales, diversification, off farm investments, producing at low cost, and maintaining financial reserves are among the strategies employed by farmers to manage and reduce risks (Ahsan & Roth, 2010; Hall et al., 2003; Harwood et al., 1999). However as indicated by Martin & Shadbolt (2000), risk analysts mostly presume a relationship between the type of risk and the management strategy that should subsequently be adopted to manage such risk. The authors suggest this situation may not necessarily be valid (Martin & Shadbolt, 2000). Although the various risk management strategies are conceptually plausible, the onus of risk management rests on farmers to select the particular combination of risk management strategies that suit the distinctive characteristics of their farm. The variety of management strategies adopted by farmers are controlled by their appreciation of the risk involved, ability to manage risk, and their relative risk aversion (Martin and Shadbolt, 2000). The authors pointed out that focusing

on a particular or class of strategies ignores the "whole farm context in which farmers manage risk" (Martin & Shadbolt, 2000 p. 68). This could create imperfect picture of the risk environment facing farmers and obscure understanding of how they may react to changing risk situations**.** The above discussions mean that risk management strategies adopted by farmers may not necessarily be homogenous.

Although farmers across the world face various types of risk in production agriculture, specific risks faced by farmers differ from country to country and from region to region and the risk management strategies used to manage risks are not essentially the same. Within the same industry, risk management strategies may differ depending on farm and farmer characteristics. The differences in perception of the sources of risk may be due to the differences in farmers' attitude towards risk, their experiences, marketing conditions, weather conditions, or even the institutional environment faced by a farmer. Martin and Shadbolt (2000) have mentioned that the transfer of risk through strategic alliances along the supply chain has become an attractive strategy, however, that also depends on the extent to which farm managers are able to identify which of these risks can be managed internally and which is beyond their internal control. Investigating the perceived sources of risks faced by grain and oilseed farmers in Saskatchewan and the kind of management strategies perceived by farmers to be important in controlling risk as well as the strategic weakness of farmers in managing risk will help inform farm advisors and provide the needed information to guide policy directions. The thesis uses the best-worst approach to identify and rank farmers perception on their most significant sources of risk and risk management strategies and analyse the factors that influence such perception.

1.2. Problem Statement

Every business enterprise faces risks that potentially affect business performance if the risks are not well identified and managed. Farmers face numerous risks ranging from production through to the market which have a significant effect on output and farm

income. Successful farmers are those who can identify these risks and adopt appropriate strategies to manage them.

As input prices and the costs of other key resources increase, farmers are subjected to various pressures to initiate strategies necessary to sustain income and remain competitive in production. There have been studies that have looked at risk management practices of farmers (Hall et al., 2003; Lien et al., 2004). However, as structural characteristics of farms and farm management strategies advances, strategies farmers may use to managing risk in agriculture will keep changing as well. Moreover, risks faced by farmers differ from one country to another and from region to region (Ahsan & Roth, 2010; Hall et al., 2003) depending on the climatic and other factors affecting production agriculture. For example, the South and the Western parts of the Prairies frequently experience drought and some areas in the Eastern and Northern Prairies are more prone to excess moisture during seeding and harvest compared to agriculture in the Eastern part of the country where farmers are less constrained by excess moisture (Antón et al., 2011). Delayed harvest due to excess moisture can significantly affect quality and price of yields. This suggests that weather risk which may affect quality and price (market risk) will be less severe in the East compared to that in Western Canada. Therefore, it is necessary to provide needed information on the risks Saskatchewan grain and oilseed farmers perceive as being more important and the strategies farmers rely on to manage these risks.

This study seeks to provide updated information on perceived sources of risk, specifically production, marketing and financial risks faced by grain and oilseed farmers in Saskatchewan and the tools perceived by farmers to be important in managing these types of risk. Research studies have revealed that farmers respond differently to policies and farm problems based on the personal values (Maybery et al., 2005) and production-oriented behaviour of farmers can be explained by their personal characteristics (Austin et al., 2001). According to Hansson & Lagerkvist (2012), "farmers' risk preferences may be more associated with their personal characteristics and how they manage their farms rather than with various external sources of risk" (pg. 749) and the authors suggested that

a confirmation of this results will be necessary to ensure that designing of farm risk management tools will consider the individual running of the farm. Beal (1996) also pointed out to the fact that farmers' personal preference or characteristics influence the risk management strategies they adopt. In view of this, Meuwissen et al. (1999) argue in favour of the need for developers and sellers of new management strategies to understand farmers' personal preferences or characteristics. Therefore, of interest also to this current study is to analyse how structural and personal characteristics of farmers influence the selection or adoption of risk management strategies.

1.3. Research Objectives

The main purpose of this study is to assess the sources, the process of risk identification and tools for risk management among grain and oilseed farmers in Saskatchewan. Specifically, the study seeks to:

a. Identify the perceived sources of risks faced by oilseed and grain farmers in Saskatchewan.
b. Identify and rank the most important risk management strategies farmers perceive to be important in managing risk.
c. Analyse how personal and structural characteristics of farmers and farms influence their perception of risk and risk management strategies.

1.4. Research questions

a. What are the perceived sources and risk faced grain and oilseed farmers in Saskatchewan?
b. What risk management strategies are perceived by farmers as important to manage risk in their production activities?
c. What relationships exist between the personal and structural characteristics of Saskatchewan's grain and oilseed farmers and the management tool adopted to manage risk?

1.5. Background

1.5.1. Saskatchewan grain and oilseed sectors and the risk environment farmers operate

The grain and oilseed sectors contribute significantly to farm income and Saskatchewan's economy in general. The province remains one of the significant grain producing regions in Canada supplying about 10% of world's total wheat exports and is also a significant player in canola exports (Government of Saskatchewan, 2014). Saskatchewan is a leading producer of canola producing about 45% of total canola production in Canada (Government of Saskatchewan, 2015). In 2014, the sector contributed about 6.5% to Saskatchewan's real GDP (Government of Saskatchewan, 2015) and employed about 40,000 people in 2015 (Statistics Canada, 2015). These aforementioned statistics echoes the importance of the grain and oilseed sectors to farmers in the province and the need to be more concerned and understand risks farmers face in their production and how they manage them.

Notwithstanding the positive outlook of the sectors in terms of their contribution to total production and farm income receipts, certain events or shocks both domestically and globally could significantly affect the economic contribution of the sector to both farmers and the province at large. Canada exports most of its grains and oilseed crops and therefore the global agricultural outlook or change in international trade regulations such as quotas and tariffs could restrict access foreign markets and significantly affect the sectors and farm profitability.

Moreover, a change in domestic yield variability resulting from adverse climatic factors and diseases could negatively impact the net cash income or the average net operating income of farmers. A typical example of such adverse effects of climatic conditions on yields is when in 2009 and 2010, there was a major drop in the production of the principal crops due to flooding in the prairie provinces; Manitoba, Saskatchewan and Alberta (AAFC, 2012). In 2002, production of principal crops (all grains and

oilseeds) dropped from about 2.2 billion bushels to about 1.8 billion bushels from the previous year due to the drought experienced in the prairies provinces, and flooding in 2010 left millions of acres of land in the prairie provinces unseeded. These events reduce the quantity of output available for sale and negatively affects revenue from the farm. In Saskatchewan, data from Statistics Canada shows that production of major field crops experience similar variations in crop yield. The chart below demonstrates the variability in production for some of the major field crops produced in Saskatchewan.

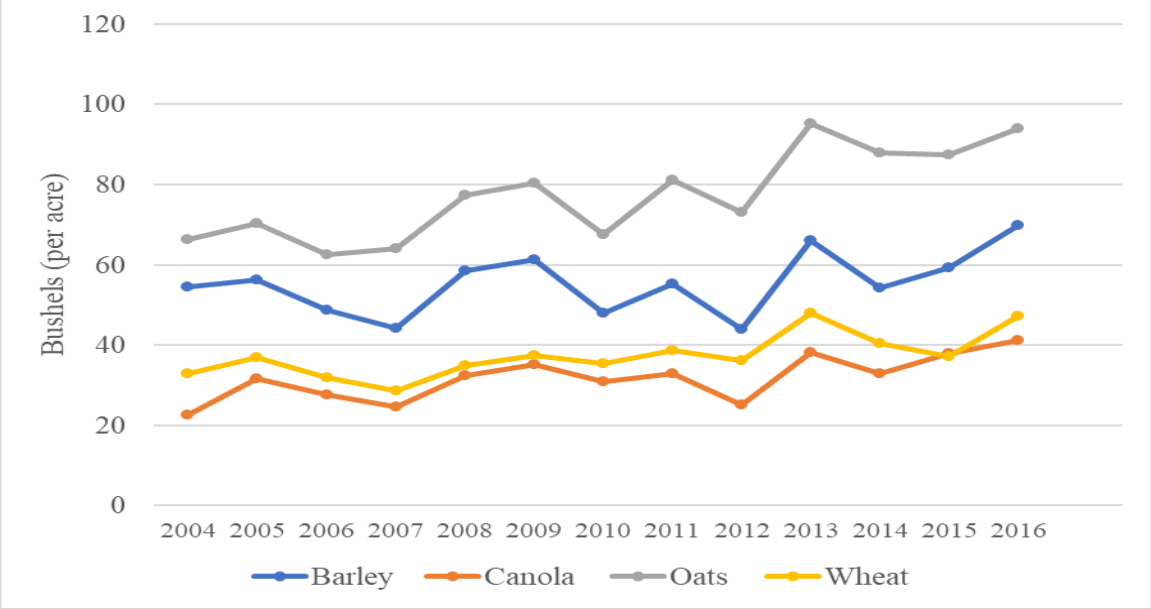

Figure 1.1: Trend of per acre yield of major field crops in Saskatchewan (Source: Statistics Canada Cansim table 001-0017).

It is evident from the chart above that though the average yield of oats has been fairly volatile between 2009 and 2013 but remain steady after 2013. Average yield of barley has been quiet volatile, increasing and decreasing over time. Canola yield has been mostly stable over time except a slight volatility from 2013 although seeded acres has increased continuously from 2007. However, average yield of wheat has been steady but

there was a decline between 2013 and 2015. The volatility in yield mostly due to weather factors, pest and diseases subject producers to risk in terms of their effect on farm income hence the need to understand such risks and how producers respond to them in order to offer the necessary support needed.

Changes in global production as well as increases in input prices could affect variability in commodity prices and the cost of production. These could have an adverse impact on the net farm income. Since 2000, diesel and fertilizer prices have fluctuated which created uncertainty among farmers in terms of making production decisions. For instance, after a decline in the price of diesel from about ¢100/litre to about ¢60/litre, the price has been increasing and stood at around ¢100/litre in 2014 (AAFC, 2016a). In fact, the AAFC indicates in their 2017 Canadian agricultural outlook report that net cash income is expected to decline by 7% in 2017 due partly to an expected increase in farm operating cost (AAFC, 2017). Moreover, according to the AAFC, the global stock of crops especially wheat and oilseeds are at its record high and this will continue to impose downward pressure on the prices of wheat, corn and soybeans (AAFC, 2016a).

A negative relationship has been found to exist between stocks and commodity prices. Piesse & Thirtle (2009), explaining the 2007-2008 food commodity price rises attributed it to the low stock to utilisation ratios during the period. The authors indicated that a lower stock to utilization ratio is likely to result in an increase in commodity prices and the opposite holds when the ratio is high (Piesse & Thirtle, 2009). Although the level of stocks may affect commodity prices, however variation in stocks which increases or decreases prices is influenced by the outcome of demand and supply. An increase in global supply which increases stocks coupled with low utilization (demand) creates excess supply which drives prices downward all things being equal. The opposite is also true with decrease supply and stocks coupled with higher utilization.

Farm Credit Canada (FCC) projections on the economic trends facing Canadian agriculture reiterate the predictions made by AAFC. Farm Credit Canada expects grains and oilseeds prices to fall due to high global stocks, rise in prices of input and a decline in

the purchase of farm equipment (Gervais, 2016). A look at Statistics Canada data on farm product monthly prices for wheat and canola from 2014 to 2016 indicates that prices have been very volatile. The charts below show the change in price index overtime for grains and oilseeds in Saskatchewan:

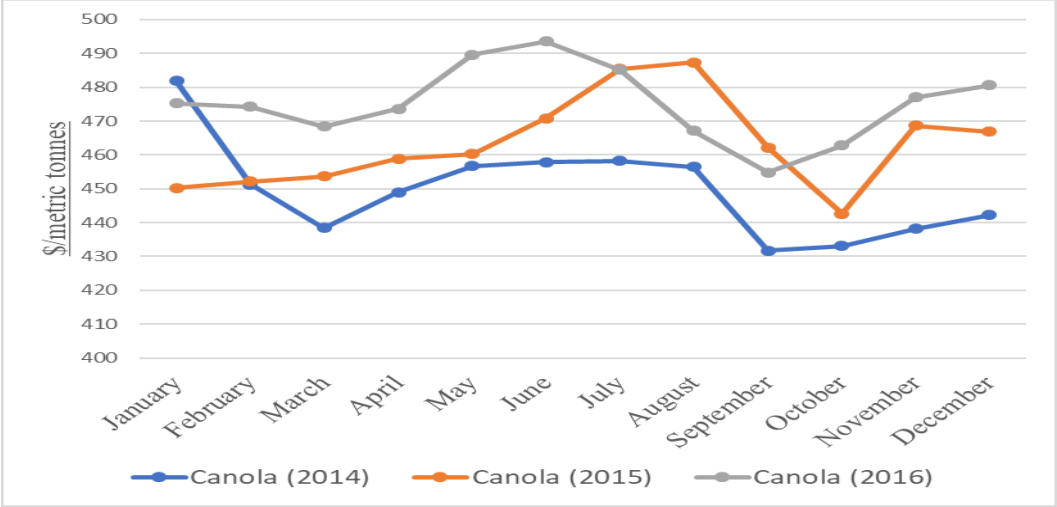

Figure 1.2: Trend of monthly prices of canola in Saskatchewan (Source: Statistics Canada Cansim table 002-0043)

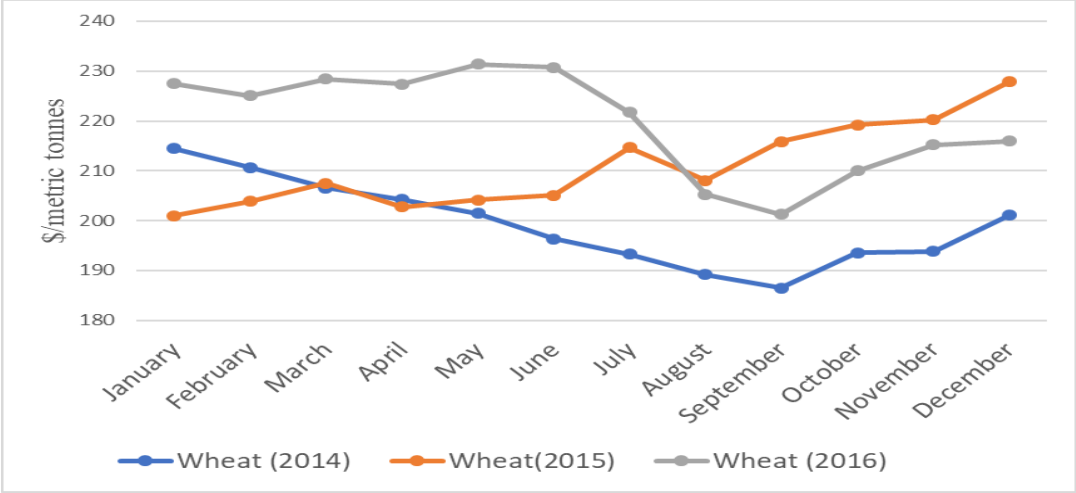

Figure 1.3: Trend of monthly prices of wheat in Saskatchewan (Source: Statistics Canada Cansim table 002-0043)

Prices of both canola and wheat have experience some variations over the period, especially canola. In 2014, the price of canola fell in the beginning of the year, became stable from April to August, and declined again in September. In 2015, prices continued to rise from the beginning of the year until August, when price started falling. Prices in 2016 shows similar variation; there was a fall in price between June and September. Wheat prices in 2015 and 2016 were quite stable compared to 2014. In 2014, price continued to decline from the beginning of the year until September where is started going up. As has been indicated earlier, both AAFC and FCC project prices to decline for these crops especially wheat and Canola.

Variability in output and input prices increase risk to farmers in terms of their likely effects on farm cash income. This therefore necessitate the need for a continual study of how farmers manage risk in the face of changing conditions. A look at Statistics Canada data on average farm income (oilseed and grain farming) demonstrate that income has been rising from 2005 to 2009 but remain stable after 2009. The chart below reveals the trend in average total income of grain and oilseed farming in Saskatchewan.

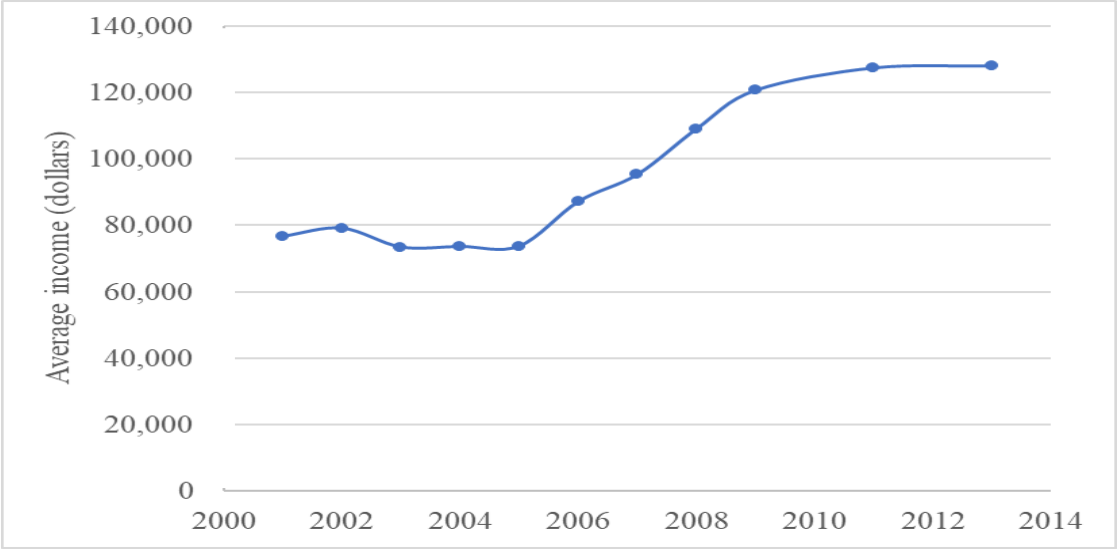

Figure 1.4: Trend of average income for farm families in Saskatchewan

Source: Statistics Canada (CANSIM Table No 002-0027)

The variability in yield and output prices pose a greater risk to farmers in terms of their farm business performance.

However, Kimura et al. (2010) note that risk may not be systematic and therefore may not be correlated across farms. For example, while several farmers may experience similar price variability risk, yield risk may be less interrelated depending on farm and farmer characteristics (Kimura et al., 2010). This warrants the need to investigate the specific sources of risks of individual farmers and how they manage or are expected to manage these risks to ensure the design of optimum risk management strategies premised on the characteristics of the risk environment individual farmers face.

1.6. Significance of the Study.

It is estimated in 2014, the grain and oilseed sectors contributed about 6.5% to Saskatchewan's real GDP (Government of Saskatchewan, 2015) and employed about 40,000 people in 2015 (Statistics Canada, 2015). In 2016, canola and wheat contributed about 66.4% of total crop receipts in Saskatchewan (Cansim table 002-0001). These statistics underscore the significant contribution of the grain and oilseed crops to farm income and the provincial economy in general. As is the case in all businesses, what can significantly affect the performance of these sub sectors is risk if not well identified and properly managed. Although there are existing programs in place to support farmers in their risk management efforts, there is evidence of a significant number of participants withdrawing from the program while others do not see the capacity of these risk management programs meeting their operational needs going into the future (Howden, 2016). Against the background of a process to develop a new risk management framework to replace the current one going forward, there is the need to closely understand specific needs in terms of their exposure to risk and their management strategies. Findings from the study will provide useful information to policy makers, regional service personnel, and farm mangers as to how farmers are managing production, financial, and marketing risk in their farms and how effective farmers perceive these management strategies to be. This will provide policy directions in terms

of developing new policy tools to manage risk and improving the efficiency of the existing risk management tools to better deal with risks faced by grain and oilseed farmers in Saskatchewan.

1.7. Organization of the study

The remainder of the study is organized as follows; Chapter Two covers a review of the related literature. Specifically, the chapter provides overview of the types of risk in the agricultural sector; examples of some business risk management programs provided by the federal and provincial governments to support farmers to cope with risk; farmers' perception of sources of risk; farmers reported use of risk management practices or strategies and the relationship between farm and farmer characteristics and how that influence their selection of risk management strategy. Chapter Three describes the research methodology employed to collect data to evaluate farmers risk concerns and the management strategy they choose to adopt. Chapter Four presents and analyses data to provide results on grain and oilseed producer survey. Chapter Five provides summaries, conclusions, recommendations limitations to the study as well as suggestions for further research.

CHAPTER 2

LITERATURE REVIEW

2.1. Introduction

This study focuses on the risk management practices among grain and oilseed farmers in Saskatchewan. Particularly, the study seeks to understand their sources of risk, their risk management strategies and how farm and farmer characteristics influence their choice of strategies in the management of risk in their farm business. Much work has been done on the effects of risk in the uncertain and unpredictable environment farmers face and how that influences farmers' production decision. Research has shown that production risk such as drought increases yield losses (Oerke, 2006) and negatively affects farm income (Kossaibati & Esslemont, 1997).

The effects of risk in agriculture have been of special interest to agricultural researchers and studies have provided information on the various sources of risk to farmers, the management strategies reported to have been used by farmers to manage risks as well as government specific programs and policies aimed at assisting farmers to manage and cope with risk. This chapter presents literature relating to the types and sources of risk in agriculture, farmers reported use of risk management strategies, the factors that influence farmers' choice of a strategy, and some business risk management strategies of the Canadian government.

The chapter is organized as follows; literature on the types of risk in agriculture is presented first followed by that on farmers' perception of their sources of risk. Next will be a review of the literature on farmers reported use of risk management strategies which will be followed by a review of the literature on the relationship between farm and farmer characteristics and how it influences their choice of a risk management strategy. The business risk management strategy of the Canadian government aimed at assisting farmers to manage and cope with risk was also reviewed, and the final sections covered the theoretical and conceptual frameworks for the study.

2.2. Risk in Agriculture

Risks in agriculture have been classified differently by various authors in the literature. According to Hardaker et al. (2004), two most important types of risk can be distinguished; business risk and financial risk. The authors indicate that business risk includes production, market, institutional and personal risks. Production risk relates to weather uncertainties, market risk is due to price variability, institutional risk relates with government policies and rules, contracts, legal issues etc. and personal risks are due to events such as injuries and illness (Hardaker et al., 2004). Musser & Patrick (2002), characterize five major types of risk; production, marketing, financial, legal and environmental, and human resource risks. The OECD (2000), on the other hand, provided a distinction between production risk due to weather conditions, pest, diseases and technology, ecological risk, market risk due to price uncertainty, and institutional risk. Unlike other authors, Moschini and Henessy (2001) spoke of uncertainties and proceeded to characterize four different kinds of uncertainties faced by the agricultural sector. The authors identify production, price, technological, and policy uncertainties as the major risks or problems facing the agriculture sector.

It is evident from the above literature that different authors have given different classification of the types of risk the agriculture sector faces. However, from the literature, the following types of risk are evident: production/yield risk, market/price risk, financial risk, institutional risk, and personal/health risk. Each of these risks is explained below.

2.2.1. Production/Yield risk

Production risk arises from uncertain consequences of events connected to weather which negatively affects yield. Examples of such events include floods or drought in a crop year, hail, frost, or fire. Crop production significantly depends on weather conditions and in an event, that they become unfavourable, crop yields can be negatively affected, which consequently may affect the performance of the farm business.

Production risk is not only weather related but is also related to technology. Technology plays a significant role in production risk faced by farmers. The introduction and adoption of new technologies such as new crop varieties, chemicals, and techniques though provides a greater potential to enhance efficiency in production, they may not necessarily produce the expected results more significantly in the short run (Viatte, 2001). Their benefit usually depends on the varying conditions on a given farm.

Pest and diseases as well as wild animals can negatively affect crop yield which poses risks to farmers. These unpredictable events can significantly reduce production and create losses to farmers in terms of making their farm income more unstable.

2.2.2. Market/Price risk

Price risk relates to the fluctuations or variations in the price of inputs and output during the production process or after the farmer has committed to production. Agricultural producers mostly have little control over the forces that determine the prices of inputs and that of output. As has been suggested by Fulton (2005), the price farmers receive for their produce is determine by forces of aggregate demand and supply. Production in agriculture is a lengthy process and farmers usually understand that prices at harvest are typically low, however, they do have a reference price which affects expected profit per acre. Production levels, market supply, as well as demand changes, creates unpredictable fluctuations in prices which places the producer in a riskier position. As indicated by Drollette (2009), global trends in commodity markets (both domestic and foreign), government policies, as well as fluctuations in exchange rates all contribute to the uncertainty of market prices for farm production. These uncertain circumstances make the forecasting of prices difficult which presents greater risk to producers because they are not sure if prices of their production will be enough to enable them to earn economic profit especially in situations where prices are low, and the cost of production is relatively high.

2.2.3. Financial Risk

Financial risk relates to the means through which farm business capital is acquired and financed. As noted by Drollette (2009), farmers need to finance farm operations and maintain cash flow levels adequate to repay debts and meet other financial obligations. The ability to access capital from other sources, especially borrowing, is significant to farm business operations. However, such sources of securing capital introduce risks to the famer in many ways.

The availability and willingness of lenders to supply loanable funds to farmers creates uncertainty to farmers and their farm business operations. Moreover, fluctuations in interest rates pose risks to farmers in terms of their ability to repay creditors. As indicated by Harwood et al. (1999), the usage of borrowed funds by farmers means that a share of their returns from the business must be allocated to meeting debt payments. In the event that returns from their farm business operations are not sufficient to repay debt, farmers may face cash flow difficulties which impedes their ability to sustain business operations. Thus, issues of interest rates, value of financial assets, and access to credit constitute the financial risk faced by the farmer-entrepreneur.

2.2.4. Institutional risk

Institutional risk relates to changes in local, regional, national, or international regulations and policies that have effects on how the farm business operates. According to Harwood et al. (1999), these risks manifest most as the unanticipated constraints in production or changes in output or input prices due to policy changes. For instance, a government decision to introduce or alter trade bills can significantly alter payments to agricultural producers; changes to international trade regulation and policies may also affect farmers negatively**.** For example, decisions by foreign governments to restrict imports through quotas and higher import tariffs of certain crops can potentially reduce market access for exporters and reduce prices for domestic producers. A typical example is the imposition of 50% tariff on pea imports by the Indian government (McMillan, 2017).

Again, government regulations to restrict the use of certain pesticides; prohibit cropping practices or changes in income tax or credit policy may have negative effects on output and income of farmers. The ban of dicamba herbicides which have been used by farmers to control weeds by Arkansas and Missouri could potentially deny farmers from one option of preventing weeds from reducing yield (Britt, 2017). Institutional risk also includes transaction costs which results from the opportunistic behavior of transacting partners. According to Dorward et al. (2009), such institutional risk represents losses that arise due to failure to enforce exclusive property rights, enforce required attributes, enforce completion of intended transaction, or protect transaction benefits from third party predation.

2.3. Farmers' perception of sources of risk

Risks in agriculture and their role in making production decisions cannot be overlooked. Research has shown that risk management is of strategic significance to producers (Barry, 1984; Hardaker et al., 2004). Extensive work has been done on sources of risk that impact the performance of farm enterprises, however, particular risks faced by specific farmers influence the development and adoption of strategies to manage risk in their production. Perceived risks differ across specific type of production, product, and among farmers.

Yield and output price variability are major risk concerns to farmers in their production activities. A 1996 survey in the United States by the USDA's Agricultural Resource Management Study of farm operators on their concerns of factors affecting their farm operations revealed that wheat and corn farmers consider yield and price variability as major sources of risk to their farm business (Harwood et al., 1999). Similar results were reported by Knutson et al. (1998) in their study of the impact of the 1996 farm bill in the United States. Farmers in the Southern U.S. ranked price and yield variability as the most significant source of risk (Knutson et al., 1998). A study to assess the risk environment faced by individual crop farmers producing mainly wheat in Australia, Estonia, Germany, Italy, the Netherlands, New Zealand, and UK revealed that,

in Estonia, more than half of farmers consider yield risk more important than price risk (Kimura et al., 2010).

However, in Australia and Italy, price risk is equally important to farmers as yield risk (Kimura et al., 2010). This means that respondents consider marketing and production risks and their effects on revenue more important to their farm business. Anton & Kimura (2009), in their analysis of risk exposure at the farm level in Germany also revealed that yield and price variability are higher at the farm level than at the aggregate level. However, perceived yield risk is higher than that of price risk due to location specificity of yield risk. Similar results were found among Swiss crop farmers. Farmers consider negligible the role of cost in determining income variability, however price and yield risks are important risk sources to farmers (El Benni & Finger, 2012). The authors noted that while wheat and sugarbeet farmers consider price risk as more important, corn and barley producers are more concerned with yield or production risk (El Benni & Finger, 2012). Unlike Swiss farmers who considered cost as less important, farmers in Bío, La Araucanía, and Los Lagos Regions of Chile who are mainly cereal, dairy and cattle producers regard cost and price variability as the most important risk factors, however climate, which affects yield, is the least important source of risk to farmers (Toledo et al., 2011). The authors explained that the greater use of artificial irrigation especially in the Bio region may account for the low weighting of climatic risk (Toledo et al., 2011). In Austalia, Upper Eyre Peninsula of South Australia and southwest Queensland farmers both ranked marketing and financial variability as the most important risk sources (Nguyen et al., 2005).

Climatic and weather changes, cost of inputs, institutional factors as well as pest and diseases have also been reported in the literature as risk concerns to some farmers. Holst et al. (2013) reported that a 1^0C increase in annual average temperature in China could reduce national grain output by 1.45%. A study by Boggess et al. (1985) that investigated causes of and farm managers' response to farm risk indicated that Crop farmers in Alabama and Florida rank rainfall variability, pests (insects, weeds and

diseases), price inconsistency, and the cost of operating inputs as their major sources of risk. Although mixed farming and small grain producers in some selected states in the U.S. consider pests and diseases as major risks to their production, cotton farmers have less concern to such risks but rather regard cost of operating inputs as their major source of risk (Patrick et al., 1985). An investigation into risk management among Argentina's rice farmers in the states of Curuzu and Cuatia revealed that, although weather factors, more importantly rainfall during the wrong time of the season, are regarded as the major source of risk concern to farmers (Pellegrino, 1999). Moreover, unlike grain farmers in the United States and China, changes in the economic and political situation are also among the major risk concerns of Argentina's rice farmers (Pellegrino, 1999). A study to investigate the perception of conventional and organic cash crop farmers in Norway reported that crop price, yield variability and institutional risks were rated as the major sources of risk to farmers (Koesling et al., 2004). Climatic variability was ranked among the most significant risk concern to farmers in both Upper Eyre Peninsula of South Australia and Southwest Queensland, however, government policy was also important risk source to those in the Southwest Queensland (Nguyen et al., 2005). Peterson & Kastens (2006) reported in their study of organic grain farmers in the United States that farmers consider production risks resulting from weather, weeds, insects and deer and institutional factors such as non-severity of the USDA standards and non-enforcement of the organic standards across industry participants as their major risk concerns. However, farmers did not consider marketing risks such as low prices, and contracts not being honoured as major risk factors (Peterson & Kastens, 2006). Similar results concerning climatic changes was expressed by Polish farmers. In their study of Polish farmers' perception of risk, Sulewski & Kłoczko-Gajewska (2014) disclosed that farmers regard drought as their most significant source of risk. Tables 2.1 a and b summarize farmers' perception of the various sources of risks they face in their productions agriculture

Table 2.1a: Summary of the various sources of risks faced by crops

Authors	Data Source	Location	Crops	Major Risks
Harwood et al., (1999)	USDA Survey	United States	Wheat, Soybean, Corn	Price and Yield Variability
Knutson, Smith, Anderson, & Richardson, (1998)	Focus Group discussion	United States (Texas, Kansas)	Corn, Wheat, Sorghum, Rice, Soybean	Price and Yield Variability
Kimura, Antón, & LeThi (2010)	Historical data from individual farms from seven Countries	Australia, Italy, Germany, Netherlands, Estonia, New Zealand, UK	Wheat, Barley, Oilseed, Oat, Sugarbeet, Rye	Price and Yield risks (differ across Countries)
Anton & Kimura (2009)	Statistical information of historical individual farm level data from German FADN data	Germany	Oilseeds, Rye, Spring Barley, Sugarbeets, Winter Barley, Wheat	Yield Variability
El Benni & Finger (2012)	Swiss farm accountancy network Data	Switzerland	wheat, corn, barley, rapeseed, sugar beet and potatoes	Price and Yield risks (vary across crops)
Toledo, Engler, & Ahumada, (2011)	Interview of selected producers and agricultural consultants	Chile	Fruit trees, berries, cereals, vegetables, crop for industrial use (canola, sugar beet)	Price and cost variability
Nguyen et al., 2005)	2000 Cropping survey and selected interview	Australia		Unpredictable weather, Marketing and financial variability, personal risk government policy

Table 2.1b: Summary of the various sources of risks faced by crops farmers

Authors	Data Source	Location	Crops	Major Risks
Boggess, Anaman, & Hanson (1985)	Statistically random survey	United States (Florida, Alabama)		Rainfall Variability, pest and diseases, price inconsistency and cost of operating inputs
Patrick, Wilson, Barry, Boggess, & Young, (1985)	Survey of producers	United States	Corn, soybean, small grain	Weather, output prices, input cost, diseases and pest, world events, safety and health
Pellegrino (1999)	Interview of rice farmers	Argentina	Rice	Rainfall Variability, change in the economic and political environment
Koesling et al. (2004)	Questionnaire survey of farmers	Norway	Grains, potatoes, vegetables, fruit, berries	Crop price, yield variability and institutional risk
Peterson & Kastens (2006)	Nationwide survey of organic grain producers	United States	Grains	Weather, weeds, insects, non-severity and non-enforcement of organic standards
Sulewski & Kłoczko-Gajewska (2014)	Polish Farm Accountancy Data Network (FADN)	Poland		Drought

These studies reveal that, although some level of similarity exists concerning the risks farmers face, there is also heterogeneity in farmers' perceived sources of risk depending on the type of farm, product produced, and the region of operation. This makes it necessary to investigate the specific sources of risks faced by grain farmers in Saskatchewan in order to obtain better information needed for designing risk management programs aimed at helping farmers to manage risk.

2.4. Farmers reported use of risk management practices or strategies

Empirical studies have been done examining the risk management strategies farmers rely on to mitigate the varied risks they face (Aditto et al., 2012; Flaten et. al., 2005; Kahan, 2013). However, the literature on risk management tools reveals differences in the risk management strategies adopted by farmers. For example, farmers in the Upper Eyre Peninsula of South Australia and those in Southwest Queensland consider diversifying crop varieties, using marketing experts, minimising tillage, minimising area of risky crop and maximising area of less-risky crops, off farm income, having high equity and farm management deposit as the most significant marketing, production, and financial risk management tools (Nguyen et al., 2005). However, risk management strategies among farmers in New Zealand focus on prevention of pests and diseases incursions, use of market information and off-farm income (Melyukhina, 2011a). Studying the risk perception and risk management related with value-enhanced grain production in Illinois, Bard et al., (2003) also found that production contracts, legal counsel and crop insurance are among the tools used by farmers to manage risk. Likewise, Indian farmers resort to taking credit, self-insurance in the form of selling assets to manage shocks and smooth income, crop diversification, off-farm income, and tenancy contracts such as share cropping to manage yield shocks (Ramaswami et al., 2008).

An OECD report on risk management in Spain showed that, at the farm level, irrigation, diversification, off-farm income, selling through cooperatives, and borrowing are among the most significant strategies farmers adopt to manage production and marketing risks (Antón & Kimura, 2011). While borrowing, crop rotation, drainage, technological improvement are typical risk-coping strategies among farmers in the Netherlands however, diversification and off-farm income are less favoured strategies among Dutch farmers (Melyukhina, 2011b).

Unterschultz (2000) investigated how market risk is managed in Western Canada and reported that futures, forward contracts, and options are among the strategies adopted by farmers to manage short run market risk, especially by grain farmers. Off-farm income was also reported as important risk management strategy for farmers (Unterschultz, 2000). Rice producers in Argentina consider using a system of incentives and reward structure, planting more than one variety of rice and buying machines to substitute labour as the most important strategies used in managing production risks such as pest and diseases and problems with hired labour (Pellegrino, 1999).

Although a study by Aditto et al. (2012) that investigated sources of and strategies to manage risk of smallholder farmers in Thailand indicated farmers regard purchasing farm machinery to replace labour, having feed or seed reserve, having farm reservoir for water supply in the dry season as relevant production risk management strategies, however, unlike rice producers in Argentina, having a diversified crop or planting different varieties of crop were considered the least important risk management strategies by farmers in Thailand (Aditto et al., 2012). With regards to financial and marketing risk strategies, Thailand farmers rate holding cash, off-farm income, reducing debt level, obtaining market information, spreading sales and selecting crops or animals with low price variability as the most important (Aditto et al., 2012). While Polish farmers consider crop insurance as the most significant strategy for coping with risk (Sulewski & Kłoczko-Gajewska, 2014), organic and conventional cash crop farmers in Norway regard prevention and reducing crop diseases and pests as well as having a good liquidity as the most important strategies to cope with risk (Koesling et al., 2004). Table 2.2 a and b summarizes farmers reported use of risk management strategies in their productions agriculture

Table 2.2a: Summary of Farmers Reported Use of Risk Management Strategies

Authors	Data Source	Location	Crops	Major Risk Strategies
Nguyen et al. (2005)	2000 cropping survey and selected interview	Australia		Diversification of sales, minimizing tillage, minimizing area of risky crop and maximizing area of less risky crops, off-farm income, having high equity and farm management deposits
Melyukhina (2011)	OECD data on risk management in agriculture in different countries	New Zealand	Forage and seed crops, grains	Obtaining information on pests and disease, market information and off-farm income
Bard et al. (2003)	Two producer focus group, review of contracts for corn and soybean production, mail survey of producers	United States	Value enhanced Soybean and corn	Production contracts, legal counsel and crop insurance
Ramaswami et al. (2008)	Relevant literature	India	Sorghum, castor, pearl, millet, rice, wheat, barley, pea, maize, groundnut	Credit, sales of asset, crop diversification, off-farm income, share cropping
Anton & Kimura (2011)	OECD data on risk management in agriculture in different countries	Spain	Fruits, cereals, vegetables, citrus	Irrigation, diversification, off-farm income, selling through cooperatives, borrowing
Melyukhina (2011b)	OECD data on risk management in agriculture in different countries	Netherlands	Onion, sugarbeet, wheat, potatoes	Borrowing, crop rotation, drainage, technological improvement

Table 2.2b: Summary of Farmers Reported Use of Risk Management Strategies

Authors	Data Source	Location	Crops	Major Risk Strategies
Unterschultz (2000)	Historical data of commodities	Canada	Soybean, corn, wheat, barley, canola	Futures, forward contracts, options, off-farm income
Pellegrino (1999)	Interview of rice farmers	Argentina	Rice	Incentives and rewards, planting different varieties, use of machines.
Aditto, Gan, & Nartea (2012)	Face-to-face interviews of farmers	Thailand	Rice, cassava, sugar cane	Use of machinery, farm reservoir, seed reserve, holding cash, sale of assets, off-farm income, reducing debt level, market information, spreading sales
Sulewski & Kłoczko-Gajewska (2014)	Polish Farm Accountancy Data Network (FADN)	Poland		Crop Insurance
Koesling et al. (2004)	Questionnaire survey of farmers	Norway	Grains, potatoes, vegetables, fruit, berries	Good liquidity, pest and diseases prevention, off-farm investment, business insurance, producing at lowest cost, enterprise diversification

It is evident from the literature on farmers reported use of risk management strategies that there are differences in the perceived importance of the various risk management strategies adopted by farmers depending on the type of product, region or the farmer or unavailability of risk management strategies to different farmers. Therefore, to better understand and give valuable advice tailored to the needs of grain and oilseed farmers in Saskatchewan, it is necessary to for policy makers to be aware of the risk management strategies farmers perceived to be important in managing risks they face**.**

2.5. Relationship between farm/farmer characteristics and selection of risk management strategies

Research has shown that the farm structure and personal characteristics of individual farmers significantly influenced the kind of risk management strategy or strategies they may adopt (Martin, 1996; Hall et al., 2003; Sherrick et al., 2004). Martin (1996), noted that the apparent difference in the preferred risk strategy among New Zealand farmers may be due to product characteristics and climate realities. The author finds that while vegetable producers consider irrigation as an important risk reduction strategy, pastoral farmers manage inadequate rainfall by ensuring short term flexibility to adapt to circumstances and maintaining feed reserves. The regulatory environment in which farmers operate also accounts for the difference in strategies farmers adopt. For instance, while Martin (1996) did not find government commodity programs as a risk strategy alternative for New Zealand farmers which she attributes to the deregulated environment, Patrick et al., (1985) found that to be an important risk strategy option among U.S. crop farmers. Hall et al. (2003), in their study of beef producer's perception of risk management in Texas and Nebraska reported that about 51% of respondents indicated less use of futures and options as a risk management strategy because of inadequate knowledge of these strategies. This underscores the importance of education in determining the risk management strategy farmers choose to adopt.

Age, farm size, risk perception, and debt to asset ratio have been found to be significant determinants of crop insurance use the United States. Sherrick et al. (2004),

from their study of farmers in Illinois, Iowa, and Indiana, found that farmers of older age, larger acreage, higher debt to asset ratios, and higher perceived risk are more likely to use crop insurance. The authors recommended the pattern of results be tested in other agricultural regions to validate their applicability. A study by Velandia et al. (2009) on Illinois, Iowa and Indiana farmers also reported similar results. The authors purported that proportion of owned acres, off-farm income, education, age, and level of business risk significantly affect farmers' adoption of crop insurance, forward contracting and spreading sales. Interestingly, farmers who operate more owned acres as well as those with off-farm income more than $50,000 do not use crop insurance. Farmers with off-farm income less than $5,000, more education, and larger farms use forward contracting, however, older farmers tend not to use forward contract (Velandia et al., 2009). With spreading of sales, younger farmers and those with more education tend to use spreading of sales as a risk management strategy compared with older farmers and those with less education (Velandia et al., 2009).

The literature reveals that although there are similar sources of risk and management strategies across regions, it is also true that there are differences in perceived sources of risk and risk management strategies farmers tend to adopt. Therefore, an investigation into the specific sources of risk and tools used by Saskatchewan farmers in managing risk and how personal and structural factors influence these selections of particular tool or combination of tools will be useful in providing the needed information to guide policy directions. Moreover, while these studies identify some sources of risks, they fail to provide information on the process used by farmers in identifying these risks. Information on the process of risk identification will be important in determining if the perceived risks are indeed the major risks farmers face. Again, previous research works have studied risk from a silo approach which is perceived to reduce efficiency in risk management. This study therefore departs from that and proposes to examine risk management from an integrated perspective which has been touted as a new approach in examining risk management.

2.6. Business Risk Management Strategies in Canada

Governments recognize the risks farmers face in their production and therefore initiate programs aimed at assisting farmers to control or manage risks. An example of such framework in Canada is the Growing Forward 2 introduced in 2013 as a five-year policy framework to help Canadian farmers and processors to be more innovative, competitive and take advantage of global emerging markets. The framework is supported by the federal, provincial, and territorial governments. A part of the framework are the business risk management programs **(**AgriInvest, AgriStability, AgriInsurance and AgriRecovery) designed to help farmers in managing risk emanating from extreme market volatility and disaster situations (AAFC, 2016b).

2.6.1. AgriInvest

The AgriInvest program is a self-managed producer-government savings account that provides the opportunity to reserve money to be used to help farmers recover in an event of small income shortfalls. Through this initiative, farmers receive support for investments to reduce risks and enhance their market income (AAFC, 2016b). Farmers build their AgriInvest account by sending their information of deposit to their designated financial institution and then receive a matching contribution from the government, of which they may withdraw to a maximum limit of $15,000 (AAFC, 2016b). That is, participants can withdraw up to a maximum of $15,000 of government matched contribution if they choose. Deposits are based on the Allowable Net Sales (AAFC, 2016b). According to the AAFC, "accounts are subject to a balance limit of 400% of the amount of the Participant's average ANS for the Program Year and two preceding Program Years, excluding any years for which ANS was not calculated under AgriInvest" (AAFC, 2016b pg. 4). Farmers have the opportunity to deposit up to 100% of their Allowable Net Sales (ANS) and receive a matching government contribution on 1% of their allowable net sales; however, as indicated, government matching contribution does not exceed a maximum of $15,000 per year (AAFC, 2016b). Thus, the AgriInvest account of farmers has two components; fund 1 and 2 components. Fund 1 holds all

deposits made by the participant who has permission under the program while fund 2 components holds all contributions made by the government as well as interest payment on both fund 1 and 2 deposits. All interest payments are paid into the fund 2 account (AAFC, 2016b). Withdrawals from the account is first applied to any excess deposit made into the account by the participant; then to the fund 2 account until account balance reduces to zero before any withdrawal is applied to the fund 1 deposits (AAFC, 2016b). The Allowable Net Sales is estimated by subtracting purchases of eligible agricultural commodities from revenues generated from the sale of eligible agricultural commodities (AAFC, 2016b).

All agricultural commodities whose revenues are submitted to Canada revenue service as farming income with the exception of Supply-Managed Commodities, commodities generated through aquaculture, trees produced or harvested for use in reforestation, firewood, construction material, poles or posts, fibre, or pulp and paper are eligible for the program (AAFC, 2016b). Moreover, Peat moss, Livestock sold in the operation of a wild game reserve, and Commodity sales and purchases related to farming activities outside of Canada are excluded from the program (AAFC, 2016b). Also, commodity income qualifies for the program only when any added value happens within the participant's control (AAFC, 2016b).

Participants or entities qualify to partake in the program if they have undertaken farm business operations in Canada within the current program year and have reported farming income or loss for income tax purposes (AAFC, 2016b). The regulations established under the program allows the administrator to withdraw or close the account of participants who fail to report sales of qualified commodities for two successive years or fail to withdraw excess deposits held at a financial institution at the required time.

2.6.2. AgriStability

Unlike AgriInvest, which offers support for small income shortfalls, the AgriStability program provides support to participants to protect them from large farm income shortfall

resulting from events such as low prices, high input prices and market losses (AAFC, 2016b). The program uses margins to determine benefits for producers. Program and reference margins are compared to determine the eligibility of participants to receive payments from the program. Since the program takes into account the entire farm operation, payments can be induced by combined effects of different factors which may not prompt payment independently (SCIC, 2016). Program payments are not triggered if the program margin is above 70% of the reference margin (SCIC, 2016). AgriStability is meant to support producers for large income losses compared with AgriInvest which supports farmers for smaller losses. Participants qualify to receive payments when their program' margin falls below 70% of their reference margin (AAFC, 2016b).

The program margin constitutes the financial profile of the current year's farming operations and it includes allowable expenses and income directly linked to the farming operation's production in a program year (SCIC, 2016). The program margin also accounts for adjustment in inventory. Inventory adjustments include changes in the value of accounts receivable, accounts payable, purchased inputs, deferrals and commodity inventories (SCIC, 2016). The reference margin is the participant's average program margin for three of the previous five years excluding the lowest and the highest margins within the period (AAFC, 2016b). Benefits from AgriStability are estimated using the reference margin or the average allowable expenses in the years used to calculate the reference margin. According to the Saskatchewan Crop Insurance Corporation (SCIC), to determine whether the limited reference margin is used in calculating benefits, the total allowable expenses in each of the three years used in estimating the reference margin are averaged and compared to the reference margin; if the average of the allowable expenses is used, the reference margin is limited (SCIC, 2016). Participants in AgriStability are required to pay an annual fee. Participants are subject to $4.50 program fee for every $1,000 of covered Contribution Reference Margin, multiplied by 70 per cent which translates to $315 for every $100,000 of reference margin (SCIC, 2016). Moreover, participants are subject to an administrative cost of $55 per participant. Eligibility to participate in the program is based on undertaking a farming business in Canada and have

reported farming income or losses to revenue Canada for purposes of taxes; have undertaking a minimum of six consecutive months of farming; completed a production cycle and have fulfilled the program and provincial requirements (AAFC, 2016b).

It is possible for producers to record negative margin and AgriStability provides protection for such margins. A negative margin for a program year happens when a producer's allowable expenses exceed the allowable income after adjustments for changes in inventory valuation, receivables, payables and purchased inputs (SCIC, 2016). To qualify for negative margin coverage, participants need to provide proof to show that a negative margin resulting from any peril beyond the participant's control was recorded within the program year; sound management practices have been followed; or recorded a production margin greater than zero in at least two of the three previous program years used to determine the reference margin (AAFC, 2016b). Participants can receive an interim or targeted advanced payment based on satisfying the requirement set out in the program.

Program payments such as AgriInsurance and unsubsidized insurance payments on eligible agricultural commodities, wildlife damage compensation payments, Canadian food inspection payments reported for income tax purposes are included in the estimation of both the program and reference year margins (AAFC, 2016b).

2.6.3. AgriInsurance

The government of Canada through the Crop Insurance Act agreed to support provincial governments to provide affordable crop insurance to farmers. The federal government provides support to any province that introduces crop insurance program to assist farmers. The federal crop insurance program became AgriInsurance under the Growing Forward 2 which is guided by the Canada Production Insurance Regulations.

The AgriInsurance program is a Federal, Provincial and Producer cost-shared program aimed at stabilizing the income of producers by minimizing the financial impact from production losses emanating from natural hazards such as drought, flood, hail, frost,

excessive moisture, and disease (AAFC, 2013). Both government and producers contribute to the total premium however, the administrative cost of the program is borne by governments. The federal and provincial government contribute 60% of the total premium on a 60/40 cost sharing basis and the remaining 40% is borne by the producers (AAFC, 2013). The cost sharing premium arrangement is to make the program more affordable to ensure a wider coverage of more producers.

The AgriInsurance program is administered by the provincial governments. They are responsible for the design, marketing and delivery of insurance plans to producers, setting premiums, claims adjustments and payments, and all related administrative and planning tasks (AAFC, 2013). Part of the AgriInsurance program is the Administration Research and Pilot Initiative Fund which provides funding to the provinces to cover 80% of the costs to undertake research to improve administration practices (AAFC, 2013). Producers are free to select their own insurable agricultural product, the type of insurance plan, and the coverage level. This arrangement allows producers to tailor the insurance towards their specific needs based on the risk they are exposed to and their level of risk tolerance. The insurance plan covers traditional crops such as wheat, corn, oats and barley and horticultural crops such as lettuce, strawberries, carrots, and eggplants (AAFC, 2016b).

2.6.4. AgriRecovery

AgriRecovery is a framework that seeks to provide the structure and clarity on how federal, provincial, and territorial governments react to disasters encountered in the agricultural sector. According to AAFC, previously unplanned risk programs, although provided the opportunity for tailored responses to disasters, lacked a clear framework to speed up implementation of the programs (AAFC, 2013). This created a situation where programs were uncoordinated, unstructured in terms of their development and implementation, and not consistent with the principles and objectives of existing government programs which affected the government's capacity to offer disaster support when needed (AAFC, 2013). The AgriRecovery program was therefore a framework to

help producers deal with the extraordinary costs that need to be incurred in the process of recovering from disasters. Specifically, AgriRecovery has four main objectives; "to provide a rapid financial response to assist with immediate recovery from a disaster situation; help producers quickly resume business operations after a disaster; enable short term actions to minimize or contain the impacts of a disaster on producers; assist producers to manage transition into new production where long-term restrictions are placed on a property due to a disease or pest situation" (AAFC, 2013). This was necessary to assist producers who might not have the capacity to recover even after receiving support from other programs. Under AgriRecovery, disasters ensuing from disease, pest and weather-related disasters such as flooding, drought, as well as disasters resulting from the contamination of the natural environment, are those considered when making decisions on who should receive support. However, cyclical events such as pricing cycles and events that are part of a long-term change such as market changes are not considered (AAFC, 2016b).

AgriRecovery is a cost shared between the federal and the provincial governments. The federal government provides 60% percent of the cost while the provincial government takes the remaining 40% (AAFC, 2016b). Producers who qualify to receive support through AgriRecovery receive up to 70% of their extraordinary cost (AAFC, 2016b). In an event of a disaster, an application for assessment is initiated by the provincial/territorial governments. This is followed by a joint assessment by the three levels of government to determine the impacts of the disaster, actions producers need to take to recover from the disaster, whether the producer has the capacity to undertake the necessary actions through the other business risk management programs, or if a further assistance is needed to facilitate the producer resumption to production within the shortest possible time (AAFC, 2016b). The information provided from the joint assessment is then used to make decisions on whether the AgriRecovery initiative should be implemented. The AgriRecovery initiative is a means to compliment the other programs in supporting producers address the risks to which they are exposed.

Although these programs help farmers to manage both small and large income shortfalls, as well as to recover quickly in an event of major disasters, an AAFC report on the evaluation of these programs indicated that not all performance targets have been achieved. For example, the AgriInsurance indicator of effectiveness of self-sustainability of 1.00 was not achieved (AAFC, 2013). A survey by Agricultural Producers Association of Saskatchewan to help understand farmers experience with the Growing Forward 2 programs and how the program helps farmers to manage business risk indicates that there is significant segment of farmers who withdraw from the programs, especially AgriStability (34%) and AgriInsurance (15%) (Howden, 2016). Moreover, the report shows that while only 30% of farmers consider AgriInsurance coverage as adequate, about 63% of respondents do not believe the AgriStability program will provide a benefit or future benefits to their operations (Howden, 2016). This suggests the need to better understand farmers concerns in managing risks they are exposed if the design of a risk mitigation strategy is to suit the needs of farmers especially with the preparation of new Agricultural framework by the Canadian Federation of Agriculture (CFA) to replace the Growing Forward 2 in 2018.

2.7. Theoretical framework

The sets of axioms proposed by Von Neumann and Morgenstern (1947) has been used to conduct economic research into risk attitude. These axioms have been used to show that the risk attitude of individuals can be inferred once the preference ordering and the distributional properties of the risk are known. One of the most common theoretical approaches that have been used to study the attitude of farmers under risk is the expected utility theory or model.

2.7.1. The Expected Utility Approach

With the expected utility approach, the decision maker chooses between risky prospects by comparing their expected utility values (Mongin, 1997). They are assumed to prefer activity that provides a “certain” return than that with a risky return. The individual is

assumed to have a utility function and tries to maximize his utility conditional on income constraint. Decision makers have different utility function based on their attitude towards risks. The wealth utility curve has been used to demonstrate the different risk preferences of individuals. The slope of the curve is measured by the marginal utility for every one-unit increase in wealth. The slope helps in understanding the risk behavior of a decision maker. Assuming farmers can make greater income only at the expense of greater risk, risk averse farmers face a concave utility function, while the risk neutral and the risk lover have a constant and convex utility function, respectively. A risk averse farmer's expected utility function can be illustrated by the figure below:

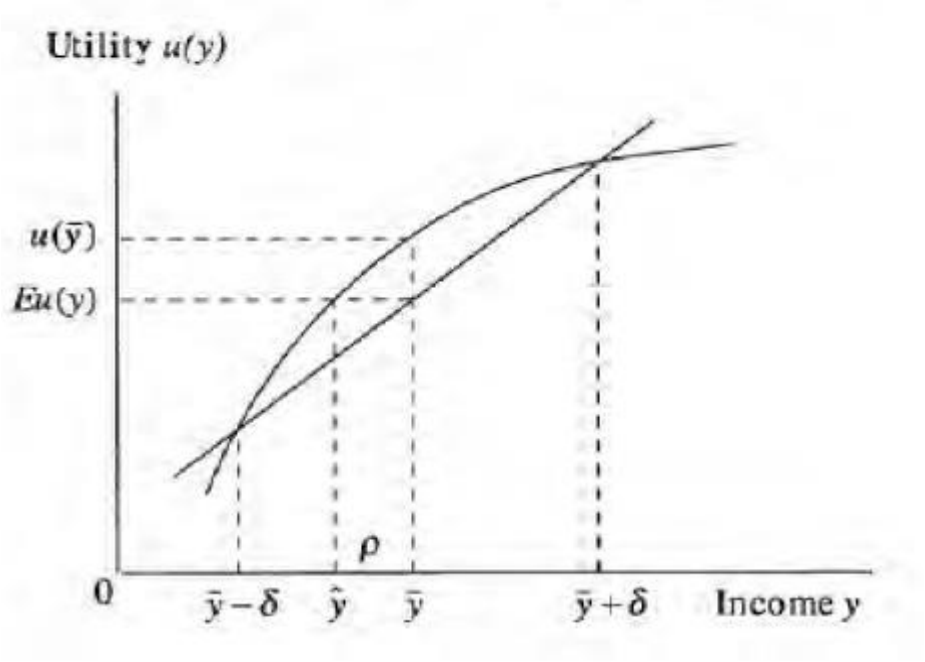

Figure 2.1: Utility function of a risk averse farmer (Source: Sadoulet & De Janvry, 1995 p.160)

Assuming a random income, the expected utility of the random income which can take two forms with equal probability can be written as $y = \begin{Bmatrix} \bar{Y} + \delta with propabilty \frac{1}{2} \\ \bar{Y} - \delta with probality \frac{1}{2} \end{Bmatrix}$ (2.1)

The expected utility function can therefore be given as

$E(u) = \frac{1}{2}\{U(\bar{y} + \delta) + U(\bar{y} - \delta)\}$. (2.2)

Given the concavity of the utility function of a risk averse producer, the expected utility *Eu(y)* is less than the utility of the certain income $\bar{y}$ [Thus $Eu(y) < u(\bar{y})$]. The loss of expected utility which is the cost of the risk is measured by the difference between the two. The cost can also be measured by the amount of the certain income the farmer is prepared to sacrifice to maintain the same position with respect to the risky income. The income $\hat{y}$ represents the certainty equivalent income which yields the same utility as the expected utility of Y. The risk premium which is the amount of average income the farmers is willing to sacrifice in exchange of random income for certain income. The risk premium or the cost of risk is the difference between $u(\hat{y})$ and $\bar{y}$. The cost of risk is determined by the shape of the utility function and the probability distribution of income. Because the risk averter has a diminishing marginal utility curve, he is willing to sacrifice the wealth when the loss is yet to occur to obtain a compensation should the risk occur.

As has been mentioned above, farmers as rational decision makers who seek to maximize utility subject to limited resources while at the same time trading-off with their goal of minimizing risk. Farmers seeking to reduce the cost of risk and uncertainty in production implement different risk management strategies by accepting the certain loss of small amount of wealth in preference to a chance of much larger loss should the risk occur or no loss if it doesn't occur. Thus farmers, will implement a strategy if they perceive the expected utility to be greater. Farmers will be willing to sacrifice some amount of average income in exchange for a sure income.

2.8. Conceptual Framework

The issue of risk management is conceptualized by Figure 2.1 below. Farmers engage in production with the hope of having positive net returns from their production activities. However, there are some unpredictable events which potentially could affect returns from the farm. Natural disasters and biophysical factors such as floods, weather, pest, diseases); market shocks (output and input price variations); the financial environment or factors (such as access to capital and fluctuations in interest rate) and institutional uncertainties (such as regulation and policy changes) are events over which the farmers have historically little or no control. These unpredictable events introduce different forms of risk which include production, market, financial and institutional risks into the farming business.

To ensure these events do not significantly affect the stability of farm income, farmers implement different kinds of strategies to manage the various risks they face in their farm business. However, the specific strategy implemented is influenced by the farm and farmer characteristics. Thus, the farm and farmer characteristics interact with the various sources of risk to determine the strategy a farmer may choose to adopt. Government and agencies also have risk management programs put in place to assist farmers in management of risk. Examples of such programs in Canada are the AgriInvest, AgriInsurance, AgriStability and the AgriRecovery programs introduced in 2009 as part of Growing Forward 2 initiatives. The farmers risk management strategies coupled with the support from government determines or influence the stability of farmers' income.

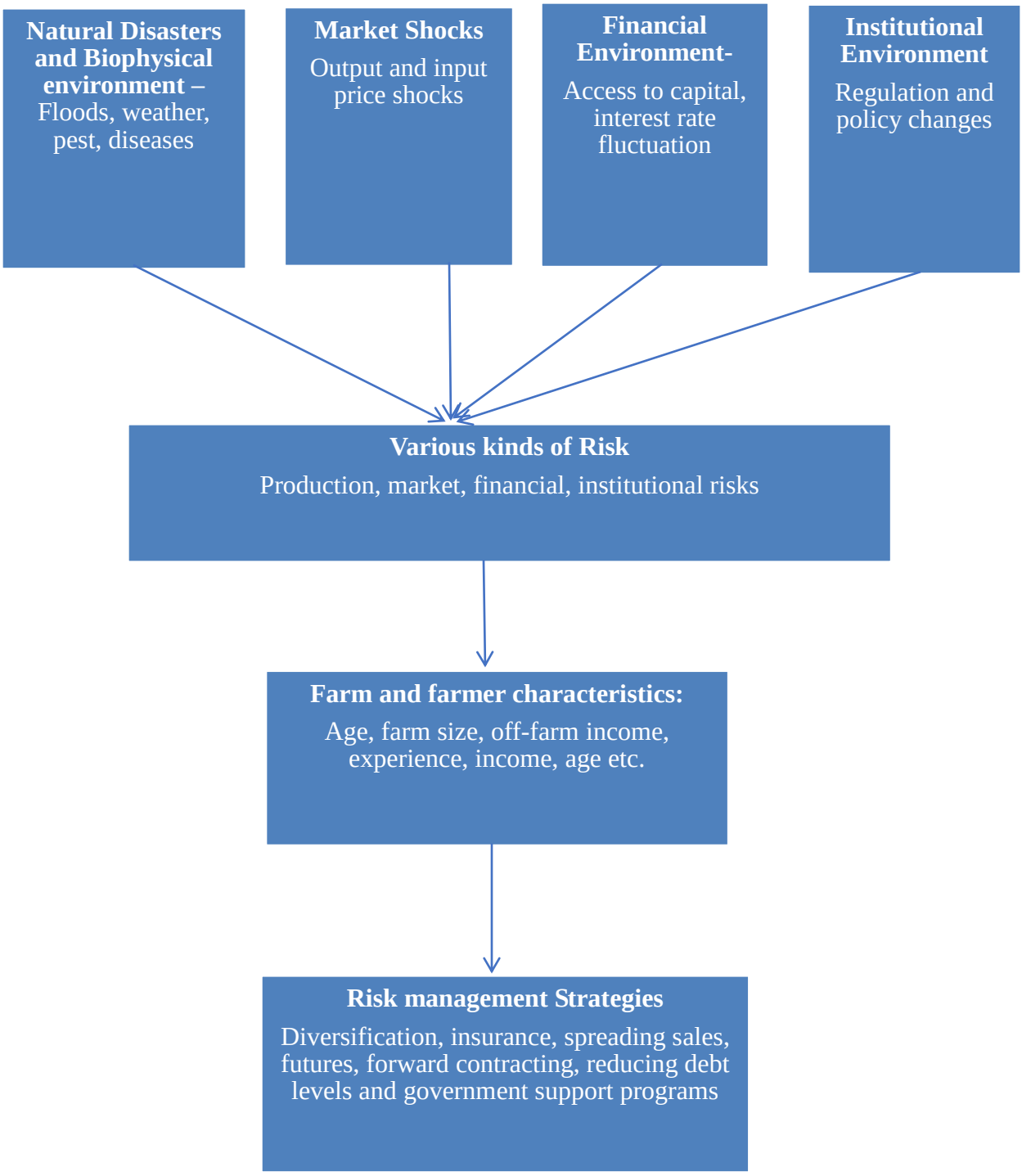

Figure 2.2: Conceptual Framework

CHAPTER 3

METHODOLOGY

3.1. Introduction

This chapter describes how data was collected to address the research question under examination. The design for this study is cross-sectional. Cross-sectional design is used to determine the prevalence of several cases in a population at a given point in time as well as identifying associations (Mann, 2003). The design helped in investigating the incidence of risk and risk management strategies among grain and oilseed farmers in Saskatchewan. It is evident from the review of literature that farmers have different perception of sources of risk and perceived relevance of the various risk management strategies also vary across farmers depending on the special circumstances of the farm and the farmer. As the literature reveals, the farm and farmer characteristics significantly influence the adoption of particular risk management strategies. Therefore, to have a better understanding of the perceived sources of risk and risk management practices of grain and oilseed farmers, a survey of Saskatchewan grain and oilseed was undertaken. The chapter describes the methodological and analytical procedures used for the study.

The survey was designed to examine issues such as farmers' perception of sources of risk and their most significant risk management strategies. Best-worst scaling (BWS) approach was adopted in designing the survey questionnaire where different scenarios of sources of production, price and financial risks and risk management strategies were presented in a stated preference experimental setting. The method is used to study the influence or importance of sets of incentives in a manner that permits the discrimination through trade-off of attributes. According to Auger et al. (2007), BWS could effectively overcome a variety of problems in the use of rating since it forces respondents to make a discriminating choice among the issues under consideration and therefore appropriate for studying preferences or relative importance of attributes to respondents. Lagerkvist (2013) compared BWS and direct ranking (DR) in investigating consumer preferences for

food labelling attribute and concluded that BWS improved individual choice predictions compared with DR, and generated a more consistent dominance ordering of attribute importance. The BWS approach has been used by Goodman et al. (2005) to determine the drinks and wine style preferences of consumers. The same approach was adopted in the study that examined market segments and identify different influences of consumer choice in wine markets (Goodman et al., 2005).

The chapter proceeds as follows; the best-worst approach and its possible advantages over the alternative methods are presented first followed by justification of the farm and farmer characteristics used for the study. Data collection procedures are presented next followed by analysis of the BWS choices of farmers on their major sources of risk and management strategies. The analytical technique of understanding how the farm and farmer characteristics influence their choice of a management strategy as well as the empirical model specification used for data analysis conclude the chapter.

3.2. Best-Worst Scaling Method

Best-worst scaling was used in this study to examine the perception of producers on the relative importance of the various sources of risks and risk management strategies by asking them to select the "best" and the "worst" from a series of scenarios presented to them. The best-worst method was developed by Louviere and Woodworth (1991) and first published in 1992 (Finn & Louviere, 1992). The best-worst approach assumes some underlying subjective dimension, such as "degree of importance" or "degree of interest" and the researcher measures the location of some set of objects along this dimension (Auger et al., 2004). The current study assumes the underlying dimension to be the "degree of importance" and the objects to be the various sources of risk and risk management strategies adopted by farmers to manage risks. As a stated preference based approach, it enables respondents to select the "best" and the "worst" attributes (sources of risk and risk management strategies in reference to this study) in a repeated number of choice sets. Respondents are given the opportunity to select the two items in a choice set that maximize the difference between them on an underlying scale of significance (Erdem

& Rigby, 2013). The best and worst choices in each scenario are counted, transformed into best worst score and the information from the score is used to determine the relative importance of each attribute in the choice sets based on the number of times it is selected as "best" or "worst". The best-worst scaling approach helps in ranking many items in regard to their importance to an individual (Erdem et al., 2012). According to Erdem & Rigby (2013), the approach also helps reduce the probable inconsistencies in responses associated with other methods such as rating or ranking, especially when long lists of items are rated or ranked, thereby improving on the implication for associated analysis and inferences.

Other approaches such as the Likert-type scale, the magnitude estimation and the ranking methods are used to study the importance of attributes to respondents or preferences of respondents. However, these methods, relatively, have weaknesses especially if one seeks to understanding how important an attribute is to respondents from a set of given attributes (Finn & Louviere, 1992; Goodman et al., 2005; Kaplan et al., 1993). For example, the Likert scale allows respondents to appraise attributes on a scale of preference, which according to Crask and Fox (1987), the ratings provided may be used differently across respondents. The authors indicate that the meaning respondents attach to categories will affects the perceived distance between categories. According to Goodman et al. (2005), the use of rating scales introduce difficulty in terms of identifying the most important attribute especially when one attribute does not dominate. This, according to the authors, may generate different conclusions more so when category ratings are presented as equal interval scales than they are as ordinal scales (Goodman et al., 2005). Moreover, rating scales do not provide enough insight in identifying the actual priorities of respondents because attributes are not measured relative to each other or respondents may like or dislike all attribute and may rate them as "important" or "not important" (Finn & Louviere, 1992).

According to Kaplan et al. (1993), magnitude estimation assigns a particular number to a case selected as standard by which other cases are rated in relation to the

standard case. For example, the authors noted that if the standard case is given a number 10, then all cases regarded as half as desirable to the standard case is assigned number 5 and those considered as twice as desirable to the standard will be given the number 20 (Kaplan et al., 1993). Standardization to a common measurement of ratings across respondents is performed which is then aggregated using geometric mean (Kaplan et al., 1993). Advocates of magnitude estimation believe the approach is meaningful because it has the attributes of a ratio scale. However, the approach has been criticized of lacking specific theory of measurement and only derives its reliability on face validity (Anderson, 2014). Kaplan et al. (1993) also point out that the meaning of scores from the magnitude estimation approach is problematic because values are not directly associated to any process of decision.

The ranking method presents to respondents a list of attributes and the task is to rank them according to specific properties. For example, asking respondents to rank their most important source of risk and risk management strategies in reference to this study. Although the task of ranking attributes is relatively easy to complete, it becomes more difficult for participants when the number of attributes increases (Cohen, 2009). Paired comparisons which require respondents to choose which is important from two items presented could be adopted to simplify the task of ranking, however, Cohen (2009) pointed out that this approach also becomes complicated as the number of pairs required to be judged rises rapidly as the number of items increases, especially when "n" items are presented. The authors suggested arranging the number of items into three or four subsets and asking respondents to rank in order of importance the items in each subset is one way of reducing the number of subsets. This too runs into difficulties because as the number of items in each subset increases, the number of subsets decrease. For instance, if 13 attributes are being compared and one uses subsets of four items in each subset, only 13 subsets will be needed if a balanced incomplete block design (BIBD) is applied (Cohen, 2009). However, one can choose the most preferred item ("best") and the least preferred item ("worst") instead of ranking four items in each choice set.

Goodman et al. (2005) point out that the best-worst approach possesses many advantages that helps to overcome the limitations of the other methods of measurements.

Several authors have adopted the best-worst scaling approach to study the preferences and perceptions of respondents. Erdem et al. (2012), used the approach to study stakeholders' perceptions of the share of the overall responsibility of each stage in the food supply chain has in ensuring that the meat people cook and eat at home is safe to consume. The meat supply chain included in the survey comprises ten stages; feed supplier, farmer, live animal transport, abattoir, meat transport, processor, wholesaler, retailer, and consumers. The survey respondents included consumers and farmers. In all, 267 respondents comprising 110 consumers and 157 farmers were interviewed. The authors indicate that the use of best-worst strategy allowed for direct assessment of perceptions of relative responsibility for food safety and helped in avoiding ambiguity and differences in interpretation which are endemic to approaches which record responses to stimuli on Likert or Visual Analogue scales (Erdem et al., 2012).

The best-worst approach was adopted by Loose & Lockshin (2013) to assess the importance of environmentally sustainable production techniques relative to other characteristics used by consumers to reduce risk during purchase, such as controlled quality standards and traceability across five countries. The study included attributes such as 'well-known brand', 'reputable wine region', 'promotional offer' and 'taste I like'. Seven wine attributes were used to generate seven Best Worst-choices sets with each having four items. The authors point to the usefulness of the best-worst scaling method for its capability of reducing measurement invariance problems, especially in a cross-national sample and for having a greater discriminatory property than rating scales because respondents are forced to trade off different alternatives which is necessary in understanding the real preferences of respondents.

Another example of a study that uses the Best-Worst method alongside latent class model is that of Loureiro & Arcos (2012) that measures the overall preferences of

management of the various forest management programs and the degree of preference heterogeneity across the sample for designing new forest policies in region of Galicia (NW of Spain). Seven management programs including forest biomass production, promoting forest quality certification (FSC and PEFC), payments for CO2 absorption, grants and subsidies to silviculture for fire prevention, planting fast-growing species that resist fire and can be cut relatively soon, encouraging landowners' associations and creating new forest cooperatives, encouraging innovation and scientific studies in forest issues were used as attributes to obtain seven combinations of three choice alternatives. The latent class model was used to understand the differences in preferences between the older and younger about their preferences towards forest management programs. The authors point out that the best-worst scaling method was very suitable method of elicitation preferences in the context of decision making under multiple conflicting criteria (Loureiro & Arcos, 2012). Sackett et al. (2013) also used the BWS method to elicit response on consumer's perception of "Sustainably produced" labels and their preferences for each of the individual sustainable farming practices.

The adoption of best-worst scaling (BWS) methods for the study was motivated by assessing the various limitations of the other methodologies as discussed in the literature above and the relative advantages of the BWS approach that overcomes the limitations of other methods of measurement approaches such as category rating scales or paired comparisons. Louviere et al. (2013), noted that the "worst" information collected in addition to the "best" enables participants' choices of the top and bottom objects in a set to be more reliable and valid than choices of middle objects. Cohen & Markowitz (2002) point out that the BWS method reduces bias in the rating scale, since there is only one option to choose something that is "most" or "least" important. Apart from participants finding the task of the Best-Worst method easy and quick to complete, they can gauge importance by multiple comparisons and can dislike something as well as like something (Goodman et al., 2005). Moreover, the authors noted that the approach allows for simplicity in analysis because it produces a coefficient in ratio level for each choice which allows for direct comparison (Goodman et al., 2005).

Sackett et al. (2013) also suggest that given the level of discrimination the Best-Worst method affords, the approach can address relative impacts on utility across attributes which customary discrete choice questions cannot and provide more information than single choice designs whilst simultaneously forcing respondents to consider the extremes of their utility space. Cohen and Orme (2004) further noted that people use better judgment when they only need to evaluate extreme preferences rather than preferences in levels.

In the design of Best-Worst choice sets, three choice-based measurement cases; case 1, case 2, and case 3 have been recognized in the literature. Case 1 requires respondents to choose the best and worst (on some subjective scale) from a set of objects; Case 2 asks participants to evaluate several profiles of objects described by combinations of attributes/features dictated by an underlying design; they "see" the profiles one at a time and choose the best and the worst feature/attribute levels within each presented profile and Case 3 requires individuals to choose the best and the worst designed profiles (choice alternatives) from various choice sets dictated by an underlying design (Louviere et al., 2013). The current study uses Case 1 because the researcher considers it to be more appropriate for the study. Case 1 BWS is considered more appropriate when the researcher is interested in the relative values associated with each of a list of objects (Flynn & Marley, 2014). Since the study is interested in capturing the perception of farmers concerning the relative importance of the various sources of risk and risk management strategies in their farming business, Case 1 was more suitable for the study. The main difference between Case 1 and the other cases is that study objects in Case 1 are simply presented as stand-alone measures and evaluated as such, while in other cases attributes are bundled into a product or service (Adamsen et al., 2013). Examples of Case 2 and 3 (for illustration) and Case 1 (used in this study) are presented in tables 3.1, 3.2 and 3.3.

Table 3.1: Example of Case 1 BWS Choice set

Most Important (Tick one)	**Of these sources of risks which will you consider as the most and least important to your farm operation**	**Least Important (Tick one)**
☐	Change in product prices	☐
☐	Change in world economic or political environment	☐
☐	Change in Government or producer policies	☐
☐	Change in input prices	☐

Table 3.2: An example of case 2 BWS (Adapted from Flynn, 2010)

BWS Case 2 **Please consider you are out shopping and want to buy apples. Tick which apple is most and least important to you.**
Apple 1
Organic
AU$8.99/kg
Packaged
B-grade
Best ☐
Worst ☐

Please consider you are out shopping and want to buy apples. Tick which apple is most and least important to you.
Apple 2
Conventional
AU$6.99/kg
Packaged
A-grade
Best ☐
Worst ☐

Table 3.3: An example of case BWS (Adapted from Flynn, 2010)

BWS Case 3 **Please consider you are out shopping and want to buy apples. Tick which apple is most and least important to you.**		
Apple 1	**Apple 2**	**Apple 3**
Organic	Conventional	Organic
AU$8.99/kg	AU$6.99/kg	AU$7.99/kg
Packaged	Packaged	Loose-weight
B-grade	A-grade	A-grade
Best ☐	**Best** ☐	**Best** ☐
Worst☐	**Worst**☐	**Worst**☐

In the design of Best/worst scaling survey, it is important to ensure that the choice sets include all items identified and possible comparisons appear in an equal number of times (Louviere & Woodworth, 1991). Vermunt & Magidson (2014) also suggested that the combinations of items should be designed very carefully towards the goal that each item is shown an equal number of times and each *pair* of items is shown an equal number of times. Balanced incomplete block design (BIBD) is normally used for case 1 best worst scaling, however BIBD does not exist for every combination. Therefore, the 2^K factorial design, which ensured that each attribute is orthogonal and appears an equal number of times (Coltman et al., 2011) was employed. The design was applied to sixteen sources of risk and sixteen risk management strategies identified based on literature. This yielded sixteen choice sets each for the "sources of risk" and "risk management strategies". The best worst part of the survey was designed such that there were four items (sources of risk and risk management strategies) in each choice set and across all choice sets, each source of risk or management strategy appeared four times and was paired once with each other. Table 3.4 presents the list of the sources of risk and risk management strategies used in designing the best-worst choice sets.

Table 3.4: List of sources of risks and risk management strategies

Sources of Risk	Risk Management Strategies
Change in product prices	Producing at low cost
Rainfall Variability	Keeping Financial reserve
Change in input prices	Implementing pests and diseases control programs
Diseases and pests	Reducing debt level
Accidents and health/disability	Buying crop insurance
Natural Disasters	Diversification
Unable to meet quality requirements	Getting market information
Change in world economic or political environment	Forward contracting
Unable to meet contract obligations	Spreading sales
Changes in interest rate	Use of future markets
Degree of debt to capital	Participating in government support programs
Change in Government or producer policies	Replacing labour with machinery
Availability of loan funds	Having seed reserves
Use of leverage	Off-farm income
Changes in Technology	Working off-farm
Cost of securing information	Having farm reservoir/irrigation

Questions on farm and farmer characteristics such as age, income, and experience were included in the survey. This is necessary to account or explain any differences observed in farmers' selection of their most important source of risk and risk management strategy. Locus of control questions which measure the belief that what happens depends on one's own ability or actions or is due to fate, luck or outside forces were also used to evaluate individual farmers' locus of control in relation to their perceived control of risks exposed to. The farm and farmer characteristics was used to explain any difference in the perception of control of risk (thus whether they feel they have control over risk or not).

3.3. Justification of Farm and Farmer Characteristics

Several studies have investigated how farm and farmer characteristics influences risk management strategy adoption by farmers. Participating in off –farm income generating activity could be a risk management strategy to manage variability in farm income. Farmers having income from other sources could potentially reduce the likelihood of relying on the other risk management strategies due to secured income (Hangara et al., 2011), however results from Aditto et al. (2012) shows conflicting results. The authors found that off-farm income has a positive association with production and marketing, diversification and financial risk strategies and they attributed this to the fact that farmers with off-farm income may adopt such strategies as a means of improving and sustaining farm income. Farm size was also found to have a negative relationship with the level of off farm income employment (Jetté-Nantel et al., 2011). The authors note that operating a smaller unincorporated farm increases the likelihood that the operator earns off-farm income compared to those operating larger farms (Jetté-Nantel et al., 2011). This is because larger farmers are likely to use hired labour on the farm to overcome farm labour constraint and therefore needs to be present to provide supervision (Alasia et al., 2007; Jetté-Nantel et al., 2011).

Aditto et al. (2012) found that female farmers in Thailand regard off farm income as more important strategy to manage risks compared to their male counterparts. This is

in contrast with a study in Canada that shows that female operators of smaller census-farms reporting domestic work and less than high school education have less than a 50 percent chance of being engaged in off-farm work (Alasia et al., 2007). The authors attribute this to additional household responsibilities that limit the amount of time available for off-farm employment or to gender discrimination by potential employers (Alasia et al., 2007). The authors also found farmers with higher education to be more inclined to use production and marketing management, diversification and off-farm income risk strategies. Farm experience was found to have a negative association with production and marketing management, diversification and financial management risk strategies; more experienced farmers are less likely to use these strategies compared to managers with less experience (Aditto et al., 2012).

Research has established a positive association between farm size and diversification. Larger farms have the greater probability to adopt a diversification strategy compared with farms of smaller size due to the limitations placed on farmers with smaller farm size to undertake crop diversification practices (Aditto et al., 2012). Unterschultz (2000) noted that non-farm income is an important risk response for smaller farms in Western Canada in managing market risk, however, this risk management strategy is less favoured by larger farms because larger farms require full time management and high capital requirements. With regards to household income, Aditto et al. (2012) found financial management strategies as more significant for farmers with higher household income and are less inclined to diversification strategy in comparison with farmers with low annual household income. Likewise, farmers who depend on external sources of income such as loans to finance their farm business consider productions and marketing strategies as well as off-farm income as more important risk management strategies.

Meuwissen et al. (1999) find that the perceived importance of insurance as a risk management strategy is positively related with legislation, production and financial risks but negatively associated with age.

The risk attitude of the farm managers influences the strategies they implement. Van-Winsen et al. (2014) noted that risk-averse farmers are more likely to use off-farm income whereas farmers willing to accept risk are more likely to use external strategies (such as contract) and diversification to manage risk. Thus, risk-averse farmers are likely to adopt *ex-post* strategies compared to risk seeking farmers who are inclined to adopt *ex ante* strategies. *Ex-ante* strategies are those adopted by farmers before production occur to reduce the impact of the predicted risk if they occur. Ex-post strategies on the other hand are used to alleviate the impact of risk after they have occurred. The authors attributed this to the greater need for risk seeking farmers to adopt appropriate strategies to guard against these risks. Farmers' decision to buy insurance significantly depends on the extent to which they can afford to pay for premium. Hangara et al. (2011) established that insurance is less used among cattle farmers in Namibia due to their inability to pay the premium. This indicates that farmers with small household income will be less likely to use insurance and may opt for other risk management strategies.

3.4. Data and data collection

As mentioned earlier, primary data were collected through an online survey of Saskatchewan grain and oilseed farmers. Ethics approval was sought and obtained from the University of Saskatchewan Behavioural Research Ethics Board before launching the survey questions. Insightrix, a market research company was employed to administer the survey to allow for a fair representation of study participants given the geographical coverage of the study and the firm having a producer database. A total sample size of 600 grain and oilseed farmers obtained from Insightrix producer database participated in the study. The survey was launched at the beginning of January 2017 and completed towards the end of February 2017. The researcher, together with the research committee met to review the entire questionnaire especially the sources of risk and risk management strategies to be used to generate the best-worst choices. Minor modifications were made based on the review before it was handed over to the research firm to be formatted into final online version to be administered to grain and oilseed farmers.

The survey instruments were mainly closed ended. Close or fixed questions allows for easy analysis and interpretation of responses since they fall into a limited set of categories (Fink and Kosecoff, 1998; cited in McLafferty, 2010 pg. 80). An online survey was thought of as the best approach in this study to ensure randomization of choice sets across respondents and to reduce the problem of missing values which present and advantage over other methods such as paper questionnaire (Cohen, 2009). Also, because the study seeks to understand the perception of grain and oilseed farmers on sources of risk and management strategies across Saskatchewan, the online survey is thought of as the best approach to ensure geographical representation given the wider use of internet and high growth of internet access in Canada. According to the Canadian Internet Registration Authority, about 87% of Canadian households are connected to the internet (CIRA, 2015). However, the rate of internet usage is lower for farm household. Statistics Canada reports the percentage of farms that were using the internet for farm business increased from 34.9% in 2006 to 55.6% in 2011 (Statistics Canada, 2011). Internet access reduces sample biases introduced by internet surveys. Geographical representativeness of the sample population was necessary to enhance the generalization of the study (Bluman, 1995). According to Cohen (2009), online surveys have advantage over paper questionnaires in terms of avoiding missing data points which arises when respondents fail to complete choice sets. Moreover, online surveys allow for randomizing choice sets which helps in eliminating pattern biases (Cohen, 2009).

The survey was categorized into six sections. The first section sought information on the farm operations of grain and oilseed farmers such as the type of crops grown in the past three years and how farm operation is financed. Also, information was sought on farmers' participation in risk management programs such as AgriStability, AgriInvest, AgriRecovery, AgriStability and the Global Ag Risk Solutions and the extent to which farmers are satisfied with their participation in these programs. The second section collected information on farmers' attitude towards risk using a scale where farmers select the extent to which they "agree" or "disagree" to statements presented. This was followed by locus of control questions which measured the locus of control of farmers as to their

control of risks they face. These questions were included to ascertain whether farmers consider their control of risk as dependent on their own abilities and efforts or determined by external forces to which they have less or no control. Examples of locus of control questions include: “I feel in control of the risks in my farm business due to my existing risk management strategies”; “whether or not I’m successful in managing or coping with risks depends mostly on my own ability”; “to a great extent, risk exposures in my farm business are determined by factors beyond my control”.

The next two sections presented different Best-Worst scenarios of sources of risk and risk management strategies and respondents were required to select their most and least important source of risk as well as their best and worst risk management strategy from each scenario. In all, 16 choice sets each containing four attributes, were created for both the sources of risk and risk management strategies. The final section contained information on the socio-demographic characteristics of farmers. Examples of questions included age of farmers, income, and experience in production, level of education, gross sales and asset to debt ratio. The information was needed to account or explain any differences observed in farmers’ selection of their most important source of risk and risk management strategy.

3.5. Data Analysis

Descriptive statistics in the form of histogram generated by excel analysis was used to provide information on the demographic characteristics of the respondents. In the analyses of the Best-Worst data, to ascertain farmers’ perception of their most important sources of risk and risk management strategies, the number of times a source of risk and a risk management strategy was selected as least important was subtracted from the number of times it was chosen as most important for all the sixteen sources of risk and risk management strategies. These calculations produce the individual level scale for each of the sources of risk and management strategies. The individual level scales for each of the sources and management strategies ranged from + 4 to – 4. This is because each of the sixteen sources of risk and risk management strategies appeared 4 times in all the Best-

Worst choice sets. Therefore, anything beyond this range would have constituted an error. As indicated by the range, the Best-Worst scores was either negative, zero or positive. Positive values meant that a particular source or management strategy was selected more often as best, zero meant they were selected with equal number of times as best and worst or was never selected as either best or worst and negative score indicate the source or strategy was chosen more frequently as worse.

According to Loose & Lockshin (2013) to estimate the best worst scores at the individual level, the number of times an item is selected as best or worst are added up across all choice sets and the difference between the "worst" and "bests" is taken. The difference between all bests and worst counts is divided by the number of respondents to give BWS at the aggregate level for each item (Loose & Lockshin, 2013). The resulting BWS can then be interpreted as the average of the number of times an item is selected as best or worst which gives an interval scale (Marley & Louviere, 2005). Thus, to estimate the relative importance of sources of risk and risk management strategies of grain and oilseed farmers at the aggregate level, the difference between all best and worst counts was divided by the number of respondents to give BWS at the aggregate level for each item.

The level importance of a source of risk and risk management strategy was then standardized to allow for easier interpretation and comparison between different groups of respondents. Loose & Lockshin (2013) notes that because the average BWS score take positive and negative values and sum to zero, it can therefore be difficult sometimes to interpret. The authors indicate that, in measuring the level of importance (as in the case of this study), a zero BWS score does not imply a negative attribute importance but just a low average. According to Goodman et al. (2005), standardization helps in comparing different group of respondents. Following Ochieng & Hobbs (2016), the best-worst scores were transformed into standard scores using the formula below:

$$Standard\ score = \frac{count(Best) - count(Worst)}{4n} \qquad (3.1)$$

where

Count (Best) = total number of times a source of risk or management strategy was most important;

Count (Worst) = total number of times a source of risk or management strategy was least important;

n = the number of survey respondents

4 = the frequency with which each source of risk and risk management strategy appears in the design.

Ochieng & Hobbs (2016), noted that, standard scores provide information on the ranking of the most to least source of risk and risk management strategies but provides little information on the relative importance of the sources of risk and risk management strategies. Therefore, ratio scores need to be generated to allow for comparison of the relative importance of attributes (sources of risks and risk management strategies). The standardization to generate ratio scores was done following procedures outlined by Loose & Lockshin (2013). The authors explain that standardization can be done by first transforming the BWS to a positive scale by estimating the square root of the best divided by the worst and then standardize the square-ratio to important weights. Loose & Lockshin (2013) noted that each square-value needs to be weighted or scaled by a factor so that the most important attribute (in this case sources of risk and risk management strategy) with the highest square root (B/W) takes the index or interval scale of 100 which is a given as

$$WF_{\text{important weight}} = \frac{100}{\sum_{1}^{n} sqrt(\frac{B}{W})} \quad (3.2)$$

The ratio will help in comparing the relative importance of the sources of risk and management strategies to farmers (Adamsen et al., 2013).

To determine heterogeneity among grain and oilseed farmers which according to literature is influenced by farm and farmer characteristics, the standard deviation of individual best-worst scores were estimated to understand whether farmers are homogenous with their choices or otherwise. Adamsen et al., (2013) emphasise that case1output does not reveal individual difference that may be present in the data. To further examine heterogeneity among choices of farmers, latent class cluster analysis was conducted. It assumes that unique segments in a data exist and there are respondents who have similar choices within segments but differ with their preferences across segments (Loose & Lockshin, 2013). It identifies segments within the population and uses co-variation among individual observed preference scores as a measure of utility to predict individuals' unique membership in a specific segment on a probability basis (Loose & Lockshin, 2013; Umberger et al., 2010). According to Ganesalingam et al. (2009) "the method assumes k latent groups or latent classes underlying the data set and that each case belongs to only one group and the number of classes and their sizes are not known a priori" (p. 2.). Umberger et al. (2010) also note that the method utilizes the preference scores of individuals as a measure of utility in predicting the unique membership in a particular latent class. The observed preference scores of individuals within a class are similar because they are presumed to come from same probability distribution, meaning unobserved utility is heterogeneous across classes but homogeneous within class (Umberger et al., 2010). In determining heterogeneity, the individual Best-Worst score for all the sources of risk and risk management strategies are used as dependent variable in the cluster analysis to understand how respondents are heterogeneous in their perception of most significant sources of risk and risk management strategies. The segments that emerge from the data were examined to determine the features of each of the segments. To understand the motivation behind the selection of a particular risk or risk management strategy as important the farm and farmer characteristics were included as covariates in the cluster analysis to help further predict the unique membership of respondents into the clusters identified. Regression analysis was also conducted to

establish a direct relationship between a source of risk and the risk management strategies farmers adopt to respond to such risk.

Based on the literature, the farm and farmer characteristics that were used to estimate the models include age, education, risk attitude, experience, farm size, off farm income, gender, type of farm, source of finance and household income.

3.6. Model Specification

Following Vermunt & Magidson (2002), a multinomial logit model was selected in estimating the latent class cluster model. The model is given below:

$$f(\mathrm{y_i}|z_i,\theta) = \sum_{k=1}^{k} \pi_{\mathrm{k|z_i}} \prod_{j=1}^{J} f_k(y_{ij}|z_i, \theta_{jk}) \qquad (3.3)$$

The authors explain that $\mathrm{y_i}$ denotes an object's scores on a set of observed variables (in this case, the individual best worst scores for all the sources of risk and risk management strategies used as indicators or dependent variables in the cluster analysis), z_i represents object i's covariates, K is the number of clusters,$\pi_{\mathrm{k|z_i}}$ indicate the prior probability of belonging to latent class or cluster K given covariates z_i, J denotes the total number of indicators and θ is the model parameters.

The covariates included in the model were off-farm income, farm size, household income, farmer's experience, source of finance, nature of farm (whether the farm is only grain, oilseed or mixed), internal locus of control, external locus of control, the risk averseness of farmers, risk loving nature of farmers, education, age and gender.

CHAPTER 4

RESULTS AND DISCUSSION OF THE SASKATCHEWAN GRAIN AND OILSEED PRODUCERS SURVEY

4.1. Introduction

This chapter provides results on the Saskatchewan grain and oilseed producers survey conducted by Insightrix in February 2017. The role of risk in agriculture cannot be overlooked if farm entrepreneurs are to produce optimally and maintain a stable farm income. This reality necessitates the need to find proper strategies to manage risks in production agriculture. However, strategies designed to help farmers manage risk must be considered useful and efficient from the perspective of farmers and therefore, calls for understanding how relevant a strategy is to the farmer. Martin (1996), raises concerns of the fact that research effort to model risk fall short of the "importance producers attached to the risk strategies being modelled and that increases the risk of standardised modelling formulation in producing inappropriate results". The authors suggested the need to understand the risks, characteristics, conditions, nature and type of farming under study to better equip themselves in their attempt to model risk management strategies that seek to reduce risks and uncertainty associated with the agriculture enterprise (Martin, 1996). This thesis identifies the perceived risks faced by grain and oilseed producers in Saskatchewan and the risk management strategies considered important by these producers in managing risks. Also, how the kind of risk and the farm and farmer characteristics influence the strategies they adopt was also investigated.

Data was gathered through survey to answer these questions. Surveys are most appropriate if one wants to understand the opinion, experiences and behaviour of people (Driscoll, 2011). Survey was chosen because the thesis wanted to understand the perception of grain and oilseed producers with regards to their most important sources of risk and risk management strategies. Moreover, it was the best approach to reach a greater number of producers as possible.

Most of survey respondents were members of an online producer panel owned by Insightrix (79% of participants). However, some participants were also reached through phone (14.5%) and panel discussions (6.5%). Two screening questions were used to ensure participant is a grain or oilseed producer and play a major role in making decisions concerning farm operations. Participants were assigned unique identification codes to prevent identification of respondents and ensure anonymity and duplication of responses. Following these response validity checks, the responses retained constituted the data set.

The remainder of the chapter is organized as follows: the socio-economic characteristics of respondents are presented first. This is followed by descriptive statistics on the type of crop grown in the past three years, their participation in the federal and provincial business risk management strategies in Canada (AgriInvest, AgriInsurance, AgriStability and AgriRecovery) and their perception of how satisfactorily these strategies have helped them manage production, marketing and financial risks. The third section describes results from the BWS analysis on the relative importance of the sources of risk and risk management strategies which is followed by results on the latent class cluster analysis. Results on the regression analysis are presented in the last section of the chapter.

4.2. Socio-Economic Characteristics of Saskatchewan Grain and Oilseed Producers

The survey process provided a total sample size of 600, however, not all participants responded to some of the relevant questions. The average age of survey respondents was 53 which is almost the same as the average age of Saskatchewan farm operators reported by Statistics Canada (55) in the 2016 census of agriculture (StatisticsCanada, 2016). The minimum age was 19 and maximum was 91. Most of the participants were male (77.2%) and females constituted about 22.8% of survey respondents. Statistics Canada reported that males constituted 75.1% and females are about 24.9% of total farm operators in Saskatchewan in the 2016 census of agriculture.

In relation to education, 39.8% had high school, vocational or technical education, 23.7% had college education, 28.2% had university education and about 7.7% had graduate level education. Only 0.7% of grain and oilseed producers had no formal education. The educational attainments of grain and oilseed producers is higher compared to that at the national level reported by Statistics Canada. The National household survey in 2011 reported that 78.3% of farm operators had completed at least a secondary education and as much as 21.7% had no certificate, diploma or degree compared with just 0.7% who had no education among respondents in this study.

With respect to experience, majority of the sampled population (29%) had worked as grain or oilseed farmer well over 40 years. Moreover, while 26% has from 31-40 years of experience, 15.3% falls within 21-30 years of experience and 16% of them has from 11-20 years of experience working as grain or oilseed producers. Only 13.7% has less than ten years of experience. The survey also revealed that majority of respondents had gross sales less than $250,000 (47.4%). About 18.3% reported gross sales from $250,000-$499,000, 8.6% had sales from $500,000-$749,000, 7.2% fell within the $750,000-$999,000 gross sales category and the rest of the respondents (18.5%) had 1 million and above in gross sales. Tables 4.1 a and b displays the socio-economic characteristics of sampled survey respondents

Table 4.1a: Socio-Economic Characteristics of Respondents

Socio-economic characteristics of respondents	N	Min	Max	Mean/percentage	Std. deviation	Comparative Census statistics
Age	577	19	91	53.1	14.1	55^{+}
Gender	**600**					
Male	463			77.2		75.1^{+}
Female	137			22.8		24.9^{+}
Education	**600**					
No education	4			0.7		21.7*
High school/vocational/technical	239			39.8		
College	142			23.7		78.3*
University	169			28.2		
Graduate School	46			7.7		
Experience	**600**					
Less than 10 years	82			13.7		
11-20 years	96			16.0		
21-30 years	92			15.3		
31-40 years	156			26.0		
Over 40 years	174			29.0		
Gross sales	**513**					
Less than $250k	243			47.4		
250k-$499k	94			18.3		
$500k-$749k	44			8.6		
$750k-$999	37			7.2		
$1000k and above	95			18.5		

Table 4.1b: Socio-Economic Characteristics of Respondents

Debt/asset ratio	**461**	
0%	101	21.9
0.01%-24.99%	276	59.9
25.00%-49.99%	64	13.9
Greater than 50%	20	4.3
Household income	**490**	
Less than $50sk	111	22.7
$50k-$99k	193	39.4
$100k-$150k	104	2 1.2
Greater than $150k	82	16.7

The survey asked respondents to indicate their debt to asset ratio with the purpose of finding out whether producers rely on internal or external sources of financing in running their farm operations. The results reveal that 59.9% had their debt from 0.01%-24.99%, 13.9% reported debt from 25.00%-49.99%, 4.3% reported debt to their asset of over 50% and 21.9% of producers reported no debt. With regards to respondent's annual household income, 22.7% had annual income less than $50,000, 39.4% was within $50,000-$99,000 annual household income category, 21.2% reported annual household income from $100,000-$150,000 and the remaining 16.7% had annual income of over $150,000.

Respondents were moreover asked to indicate the type of crop they have grown within the past three years. In all, 81.4% of producers indicated they have grown both grains and oilseeds in their farm while 14.6 reported they have cultivated only grains in their farm out of a total number of 590 producers who responded to that question. Only 4.1% reported of growing only oilseeds within the period. Figure 4.1 shows how the type of crop grown have varied over the years.

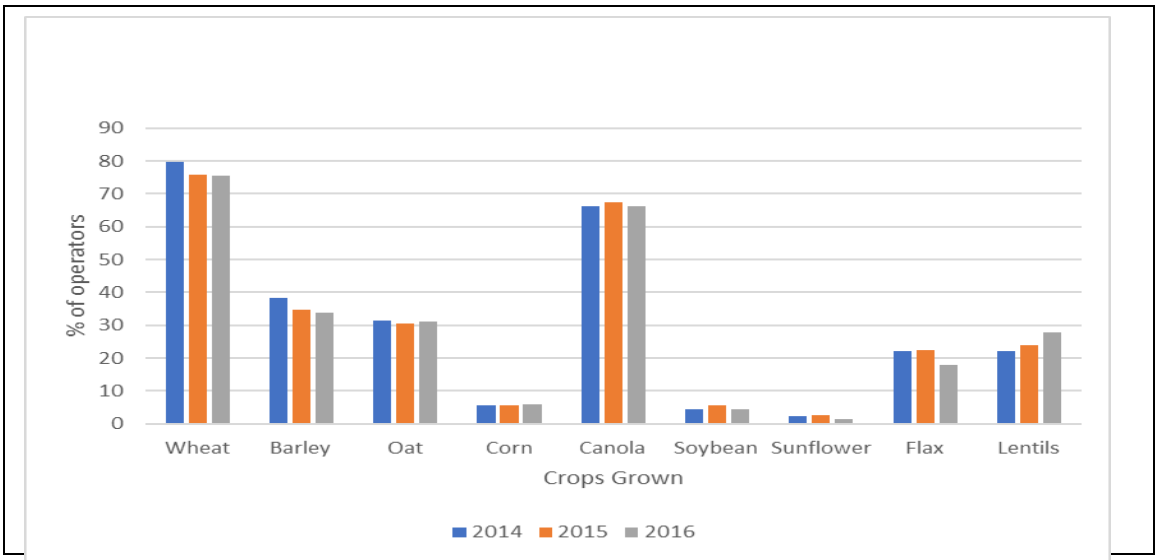

Figure 4.1: Distribution of farm operators by type of crop grown (2014-2016)

The survey results did not reveal significant changes in the number of farm operators growing each crop within the three-year period. Only wheat and barley witnessed a marginal decrease in the percentage of producers growing these crops between 2014 and 2015. Also, the number of canola operators also saw a marginal increase between 2014 and 2015 but again decreases slightly in 2016. Farm operators growing lentils has increased between the period.

The survey also sought information from respondents if they receive income from any other source apart from income from the farm. The results revealed that 48.8% of grain and oilseed farmers receive off-farm income and males rather than females are more likely to receive such income. This means that most of the operators were engaged full time on the farm. This is consistent with the 2016 Census of Agriculture report that most farm operators continued to work more than 40 hours a week on the farm (Statistics Canada, 2016). Alasia et.al (2007) also noted that female operators of smaller census-farms in Canada reporting domestic work have less than 50 percent chance of being engaged in off-farm work and the authors attribute this to additional household responsibilities that limit the amount of time available for off-farm employment. Figure 4.2 shows the distribution of off-farm income in percentage by gender of respondents

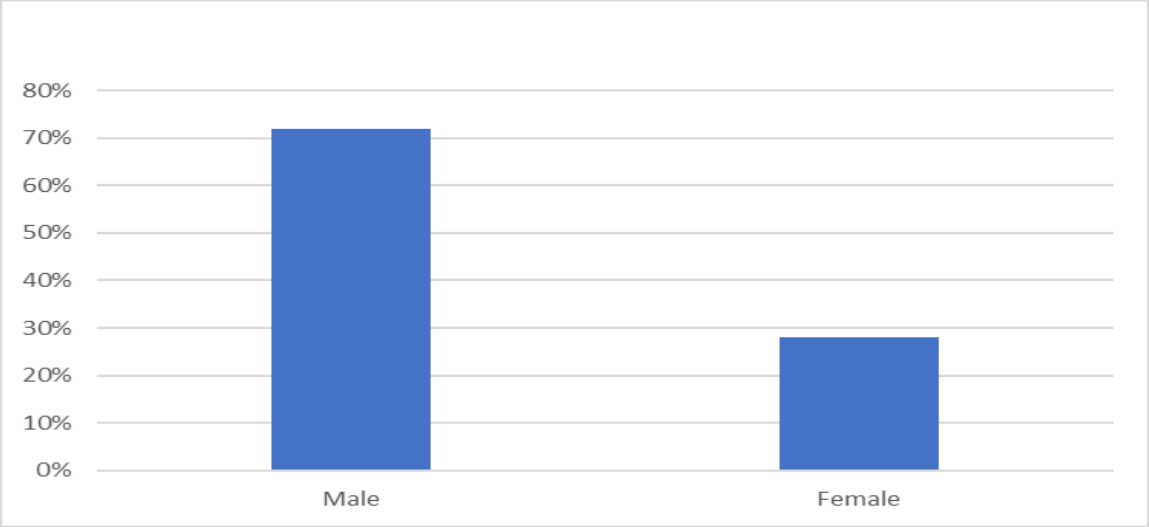

Figure 4.2: Distribution of off-farm income by gender

4.3. Participation in Federal and Provincial Risk Management Strategies

Questions on producers' participation in Federal and Provincial risk management strategies were included in the survey to ascertain the extent to which grain and oilseed producers in the province participate in these risk management strategies (AgriInsurance, AgriInvest, AgriStability and AgriRecovery). This was necessary to provide understanding as to how farmers perceive the importance of these business risk management strategies meeting the risk management needs of producers. It was also important to provide information to Federal and Provincial Governments on the rate of participation by these farm operators to ensure optimal design of future strategies that meet the specific needs of farmers. The results show that while 68.8% of respondents indicated they participate in AgriInvest, only 27.8% participate in AgriInsurance. Moreover, AgriStability recorded a participation rate of 52.7% and about 18.3% of grain and oilseed farmers indicated they do not participate in any of the government risk management programs.

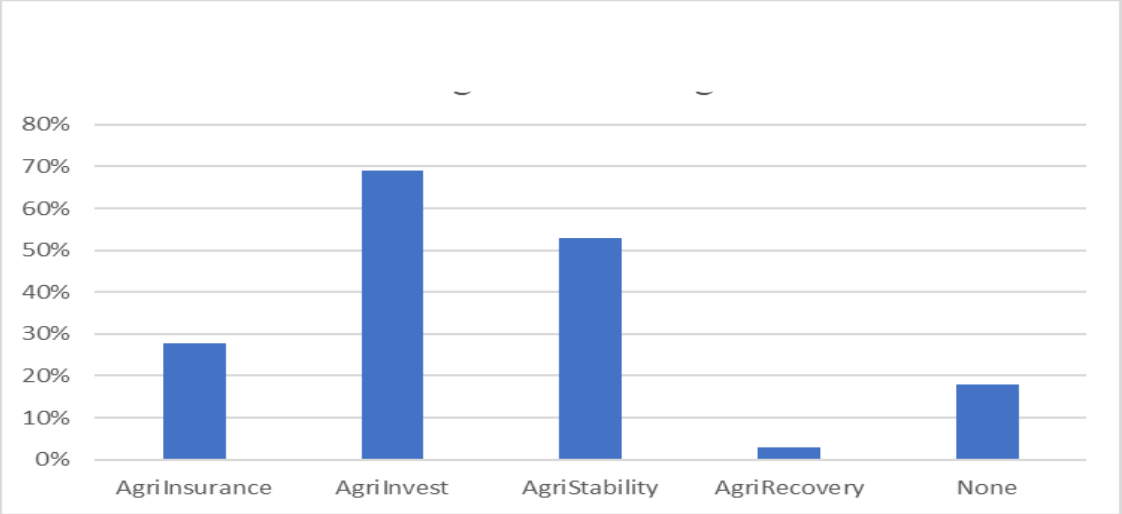

Figure 4.3: Participation in Federal and Provincial Business Risk Management Strategies

It is important to mention that, the survey response on producers' participation in AgriInsurance do not reflect the provincial statistics. The 2016-2017 annual report of Saskatchewan crop insurance corporation reported about 79.4% insurance coverage of all seeded acres and about 19,953 customers (SCIC, 2016). The low participation rate in AgriInsurance in this survey may be due to the inability of some farmers to make the connection that AgriInsurance is the same as crop insurance. Saskatchewan Crop Insurance Corporation that administers the AgriInsurance program uses crop insurance to mean the same thing as AgriInsurance hence, farmers may be more familiar with crop insurance.

4.4. The Federal and Provincial Business Risk Management Strategies helping farmers to cope with Risk

Following to the participation question, respondents who indicated they participate in the government risk management strategies were further asked to indicate the extent to which participation in these programs helped in managing risks related to production, marketing, and financial risks.

On coping with production risk, the majority of respondents who participate in AgriInsurance strongly agree with the statement that the strategy has helped them cope with production risk. Seventy eight percent responded agree as against only 6% who disagreed to the question. Sixty percent of grain and oilseed producers also agree that AgriInvest has helped them cope with their production risk with only 14% disagreeing with that. In addition, 39.6% agree with the statement that AgriStability has been important in dealing with production risk as against 31.3% who disagree (disagree = 17.1% and strongly disagree = 14.2%). Respondents were fairly divided on the issue of AgriStability helping them to address their production risk. Lastly, respondents were almost unanimous in their response as to how AgriRecovery has helped them manage production risk. Eighty five percent in total agreed to that question (Strongly agree = 40% and agree = 45%) as against only 5% of participants in the program who disagreed.

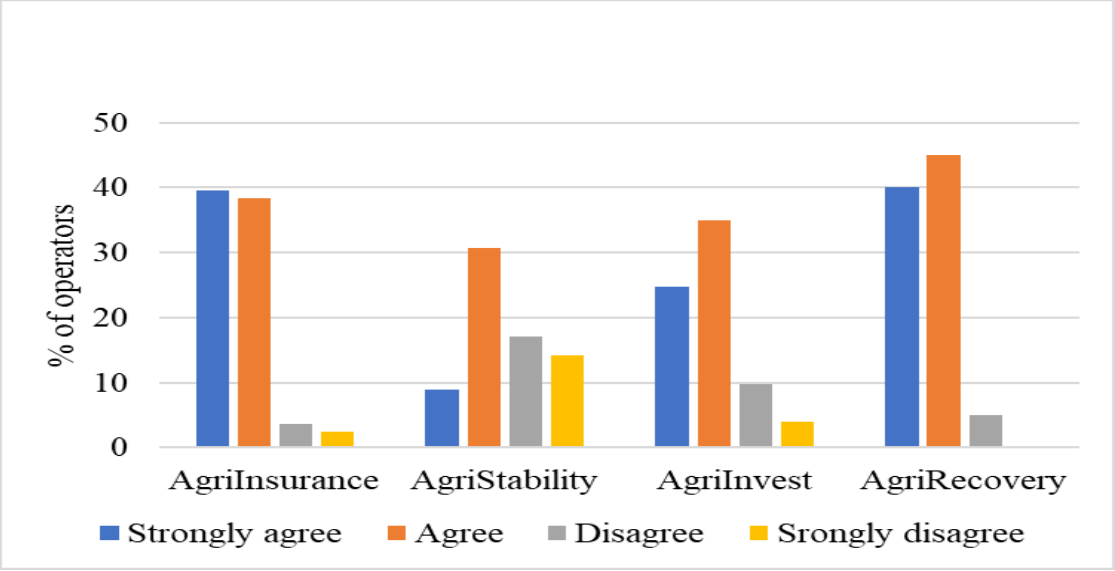

Figure 4.4: Efficiency of managing production risk with government risk management strategies

With regards to coping with marketing risk, while 44.9% of respondents agree with the question that AgriInsurance is important in coping with such risk, 24.6% also disagreed with the same question. On AgriStability helping to cope with marketing risk, a total of 26.6% of respondents agree (strongly agree = 7% and agree = 19.6%) to that. However, majority of grain and oilseed producers disagree with the significance of AgriStability to manage market risk. About 34.8% disagree that the strategy is important in managing marketing. Forty percent of respondents agree that AgriInvest is important in managing marketing risk as against 22.8% who disagree. A majority of participants in AgriRecovery consider the strategy as important to manage market risk. A total of 55% percent agrees (strongly agree = 35% and agree = 20%) compared to only 10% percent of producers who disagree that AgriRecovery is important in coping with marketing risk.

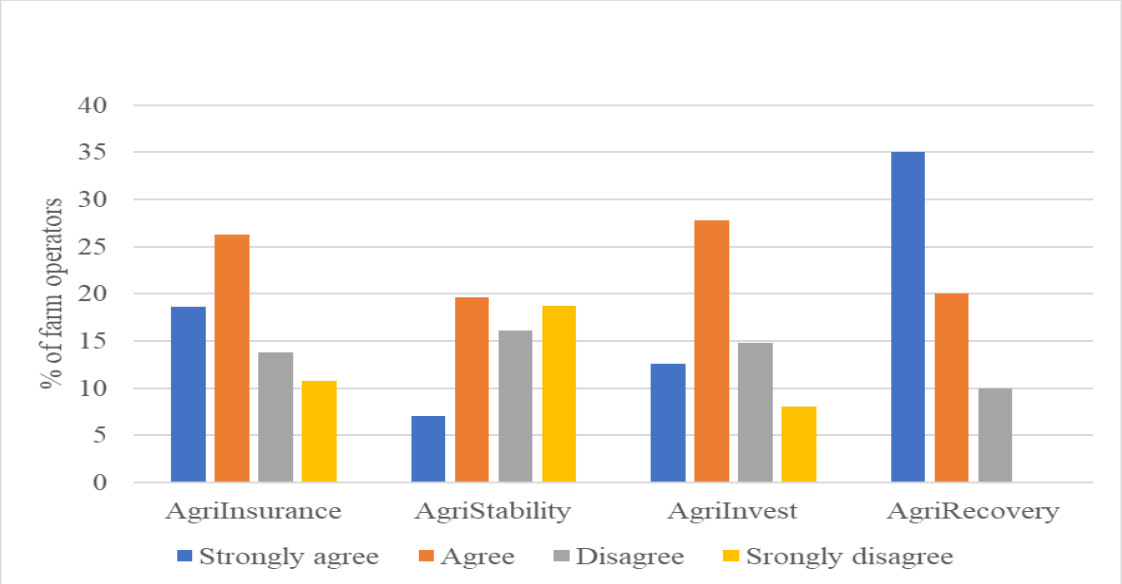

Figure 4.5: Efficiency of managing marketing risks with government risk management strategies

Likewise, the survey asked grain and oilseed producers who participate in the government risk management strategies to also indicate the extent to which the strategies have helped them cope with their financial risk. Seventy-six percentage agree that

AgriInsurance is important in helping them cope with financial risk. Only 8% disagree that the strategy is significant in coping with financial risk. On AgriStability, a total of 43.4% agree that it is important in coping with financial risk compared with 31% of grain and oilseed producer who disagree that AgriStability has helped them cope with their financial risk. A majority of respondents moreover agree that AgriInvest is important in coping with financial risk. A total of 65% of respondents agree with the importance of the strategy in dealing with financial risk as against only 11.1% who disagree. Forty five percent of producers also agree with the significance of AgriRecovery helping to address financial risk. Only 5% of them disagree with the importance of the strategy in helping them cope with their financial risk.

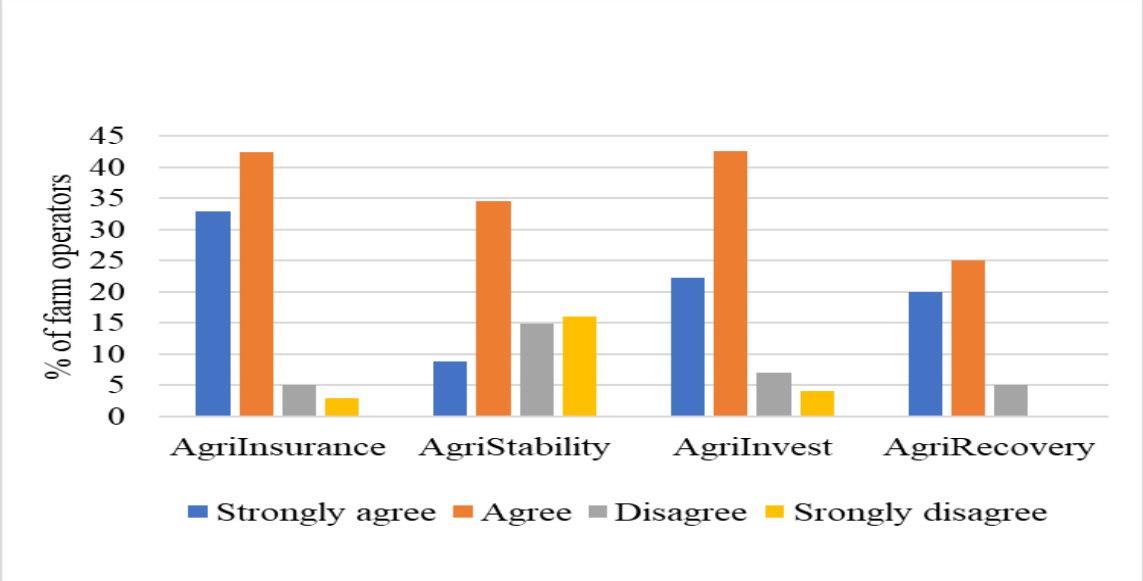

Figure 4.6: Efficiency of managing financial risk with government risk management strategies

4.5. Best-Worst Scaling Analysis of most important sources of risk to Grain and Oilseed farmers in Saskatchewan.

This section presents results and analysis on the relative importance of the various sources of risk grain and oilseed producers encounter in their farm operations. As noted earlier, risks faced by farmers are not uniform but differ depending on several factors

such as weather conditions, experience of the farmer and even the institutional environment. This makes the need to understand specifically the most important sources of risk to these group of farmers necessary.

Best-worst standard scores were estimated following the approach outlined in the methodology section. The process generated individual level scales or scores for each of the sources of risk which allowed for simple comparison across the entire sample**.** The scale for each source of risk was estimated by adding the best-worst scores of each individual respondent for each of the source of risk used in this study. An initial result was estimated using the summary statistics of the standard best-worst scores that was needed to generate ranking for the sources of risk. The difference between the total best and total worst scores (aggregate BWS in Table 4.2) was used to determine the maximum difference between the individual scales of the sources of risk. The ranking and importance of each of the sources of risk and risk management strategy is presented in Table 4.2.

Table 4.2: Summary Statistics of Best-Worst Scaling, Relative Importance and Heterogeneity

Table 4.2: Summary Statistics of Best-Worst Scaling, Relative Importance and Heterogeneity

Sources of Risk	(1) Total Best	(2) Total Worst	(3) Aggregate B-W score	(4) B-W Score (standard score)	(5) Ranking based on standard score	(6) Mean of Individual B-W score	(7) Stdev of individual B-W score	(8) Stdev/ mean	(9) Sqrt B-W	(10) Standardized Sqrt interval Scale (relative importance)	(11) Ranking based on stand. scale
Change in product prices	1379	135	1244	0.518	1	2.073	1.528	0.74	3.20	100	1
Rainfall Variability	1151	210	941	0.392	2	1.568	1.962	1.25	2.34	73.1	2
Change in input prices	1047	265	782	0.326	3	1.303	1.475	1.13	1.99	62.2	3
Diseases and pests	754	254	500	0.208	4	0.833	1.651	1.98	1.72	53.8	4
Accidents and health/disability	731	467	264	0.110	5	0.440	2.112	4.80	1.25	39.1	5
Natural Disasters	746	522	224	0.093	6	0.373	2.037	5.46	1.20	37.4	6
Unable to meet quality requirements	738	516	222	0.093	7	0.370	1.637	4.42	1.20	37.4	6
Change in world economic or political environment	607	721	-114	-0.048	8	-0.190	2.009	-10.57	0.92	28.8	8
Unable to meet contract obligations	381	512	-131	-0.055	9	-0.218	1.621	-7.44	0.86	26.9	9
Changes in interest rate	371	572	-201	-0.084	10	-0.335	1.727	-5.16	0.81	25.3	12
Degree of debt to capital	456	680	-224	-0.093	11	-0.373	1.887	-5.06	0.82	25.6	10
Change in Government or producer policies	482	723	-241	-0.100	12	-0.402	1.894	-4.71	0.82	25.6	10
Availability of loan funds	377	744	-367	-0.153	13	-0.612	1.851	-3.02	0.71	22.2	13
Use of leverage	170	910	-740	-0.308	14	-1.233	1.492	-1.21	0.43	13.4	14
Changes in Technology	138	976	-838	-0.349	15	-1.397	1.522	-1.09	0.38	11.9	15
Cost of securing information	72	1393	-1321	-0.550	16	-2.202	1.379	-0.63	0.23	7.2	16

Table 4.2 reveals that marketing and more especially production risks are the most important perceived sources of risks to grain and oilseed producers in Saskatchewan as the top seven most important risks come from these sources. The standard scores for each source of risk reveals that *variations in product prices* with aggregate and standard BW score of 1244 and 0.518 respectively and *rainfall variability* with aggregate score of 941 and standard score of 0.392 are considered the first and second most important sources of risk to grain and oilseed producers. *Changes in input price* and *pests and diseases* were the third (selected 782 times with standard score of 0.326) and fourth (selected 500 times with standard score of 0.208) most important risk faced by producers. *Accidents and health/disability* selected 264 times with a standard score of 0.110 was the fifth most important source of risk while *natural disaster* was considered by producers as the sixth most important sources of risk (selected 224 times with standard score of 0.093). *Unable to meet quality requirement* was the 7th most important sources of risk to grain and oilseed producers.

The results reveal production and marketing risks to be most important sources of risk to producers. This suggest that farmers are more concerned with risks that can affect farm revenue. For example, significant yield losses due to weather factors and lower prices negatively affect the quantity of output that can be sold, or the revenue generated from sale of output. Most of the risks considered to be of lesser importance are those from financial and institutional sources. These risks recorded negative aggregate BW scores meaning, they recorded more "least counts" than "most counts" in the entire sample. For example, out of the sixteen sources of risk presented, *cost of securing information* was ranked as the least important source of risk with aggregate BW and standard score of -1321 and -0.550 respectively. This is followed in order of least important by *changes in technology* (BW score of -838 and standard score of -0.349), *use of leverage, availability of loan funds, changes in government or producer policies, degree of debt to capital, changes in interest, unable to meet contract obligations* and *changes in world economic or political environment.*

As mentioned in the methodology chapter, the ranking based on the standard score only provides information on a basic ranking of the sources of risk but there is little information on the relative importance of these risks; that is how important they are relative to each other.

To understand the relative importance, a probability ratio or interval scale was estimated from the BW scores. Column 10 of Table 4.2 shows the probability ratio or interval scale computed from the BW scores. As noted earlier, square root of the best divided by the worst of all risks presented was scaled by a factor such that the most important risk [(the one with the highest Sqrt (B/W)] takes the index or interval scale of 100 and all other risks was compared relative to the high-ranking interval. A change in product prices had the interval scale of 100 because it is the risk with the highest-ranking interval. The standardized square root interval scale did not reveal much change in relation to the ranking of the most important risk sources. The top five risks were the same as the ranking based on the standard score. *Changes in product prices* was still ranked the most important risk followed *by rainfall variability, change in input prices, pests and diseases* and *accidents and health/disability* in order of most importance. *Natural disasters* and *unable to meet quality requirement* ranked 6^{th} and 7^{th} most important risks based on the standard scores, however they shared the 6^{th} most important sources of risk according to the ranking based on the standardized square root interval scale. On the other hand, *cost of securing information* was still ranked as the least important risk followed by *changes in technology, use of leverage, availability of loan funds, changes in interest rate, change in government or producer policies* and *degree of debt to capital, unable to meet quality requirement* and *change in world economic or political environment.*

Ranking based on the standardized square root interval scale means that, compared to *changes in product prices* considered by producers as the most important, *rainfall variability* and *change in input prices* are 0.73 and 0.62 times respectively as important as changes in product prices. Moreover, *pests and diseases* is 0.54 times as important *whiles accidents and health/disability* is 0.39 times as important to change in

product prices. *Natural disasters* and *unable to meet quality requirement* are both 0.37 times as important to change in product prices. The results also reveal a large interval between the most important risk (ranked 1st) and the other risk sources considered important to producers. This points to relative importance of the most important risk (changes in product process) to the other risks. The second through to the fourth risks were significantly important though with a varying degree judging from the fact that they are more than 0.50 time as important to the most important risk. Risk five and six show similar relative importance compared to the most important risk.

The results on the best worst scaling for the most important risk sources affecting the operations of grain and oilseed farmers show that farmers consider marketing and production risks as their most important sources of risk. Specifically, changes in product prices and risks that could induce variability in yields such as rainfall variability, pest and diseases, natural disasters as well as other risks such as accidents and health/disability, change input prices and unable to meet quality requirement were risks considered more important to Saskatchewan grain and oilseed producers. However, cost of securing information, changes in technology, use of leverage, availability of loan funds were some of the least sources of risk to producers in their farm operations. The result is consistent with findings of other researchers. Harwood et al. (1999), Knutson et al. (1998) and Kimura et al. (2010), all found variation in output price as well as yield variability to be significant risks faced by wheat and corn farmers in the United States, Australia, Italy, Estonia and Germany. Moreover, rainfall variability, pest and diseases, cost of operating input and personal risks such as injuries and accidents have been found to be important risks expressed by farmers in Alabama, Florida, and Australia (Nguyen et al., 2005; Boggess et al., 1985)

4.6. Best-Worst Scaling Analysis of Most Important Risk Management Strategies to Grain and Oilseed Farmers in Saskatchewan.

I utilized the same methodological approach outlined in section 4.5 to understand the risk management strategies considered important by producers in managing the various risks encountered in their farm business. The literature reveals producers have used different

risk strategies to manage risks based on factors such as the structural characteristics of the farm or the risk attitude of the farmers (Ahsan & Roth, 2010; Hall et al., 2003). More so, advances in the risk management strategies available to the farmer have resulted in the use of different strategies to manage risks. These factors necessitated the need to understand the risk management strategies grain and oilseed farmers consider important in managing risk. This section provides results on the relative importance of the risk management strategies considered important by survey respondents.

Individual-level scores (aggregate best and worst scores) for each of the risk management strategies were generated. As mentioned in section 4.5, the individual-level scales were estimated by adding the best-worst scores of each individual respondent for each of the risk management strategies. Following the individual-level scores, standard scores for each of the risk management strategies were generated by taking the difference between the aggregate best and worst and dividing by the number of times each risk strategy appeared in the best-worst choice multiplied by the total number of respondents. The standard score was needed in ranking the risk management strategies to help understand which tools producers consider most important. Table 4.3 presents results on the ranking of the most important risk management strategies by Saskatchewan grain and oilseed farmers

Table 4.3: Summary Statistics of Best-Worst Scaling, Relative Importance and Heterogeneity

Risk Management Strategies	(1) Total Best	(2) Total Worst	(3) Aggregate B-W score	(4) B/W Score (standard score)	(5) Ranking based on standard score	(6) Mean of Individual B-W score	(7) Stdev of individual B-W score	(8) Stdev/ Mean	(9) Sqrt B-W	(10) Standardized Sqrt interval Scale (relative importance)	(11) Ranking based on stand. scale
Producing at low cost	1315	169	1146	0.478	1	1.910	1.672	0.88	2.79	100	1
Keeping financial reserve	1099	184	915	0.381	2	1.525	1.606	1.05	2.44	87.5	2
Implementing pest and diseases control programs	894	278	616	0.257	3	1.027	1.742	1.70	1.79	64.2	3
Reducing debt level	925	373	552	0.230	4	0.920	1.966	2.14	1.57	56.3	4
Buying crop insurance	827	353	474	0.198	5	0.790	2.072	2.62	1.53	54.8	5
Diversification	647	406	241	0.100	6	0.402	1.796	4.47	1.26	45.2	6
Getting market information	637	513	124	0.052	7	0.207	1.800	8.70	1.11	39.8	7
Forward contracting	566	554	12	0.005	8	0.020	1.820	91	1.01	36.2	8
Spreading sales	497	528	-31	-0.012	9	-0.052	1.622	-31.2	0.97	34.8	9
Use of future markets	447	510	-63	-0.026	10	-0.105	1.608	-15.3	0.94	33.7	10
Participating in government support programs	468	537	-69	-0.029	11	-0.122	1.753	-14.4	0.93	33.3	11
Replacing labour with machinery	306	653	-347	-0.145	12	-0.578	1.658	-2.87	0.68	24.4	12
Having seed reserves	322	814	-492	-0.205	13	-0.820	1.868	-2.28	0.63	22.6	13
Off-farm investment	212	1011	-799	-0.333	14	-1.332	1.635	-1.23	0.46	16.5	15
Working off-farm	308	1182	-874	-0.364	15	-1.457	2.223	-1.53	0.51	18.3	14
Having farm reservoir/irrigation	130	1535	-1405	-0.585	16	-2.342	1.762	-0.75	0.29	10.4	16

Based on the standard score ranking, the data shows that producers consider *producing at a lower cost* (selected 1146 times with standard score of 0.478) and *keeping financial reserve* (aggregate and standard score of 915 and 0.381 respectively) as their most important and second most important risk management strategy. Financial risk mostly arises from farmers relying on external sources of financing such as borrowing. Keeping financial reserve means that farmers do not need to depend on such external sources to finance farm operations. This may explain why the financial risks sources had low ratings as indicated in the previous section. *Implementing pest and diseases control programs* selected 616 times with a standard score of 0.257 was the third most important risk management strategy while *reducing debt level* (aggregate score of 552 and standard score 0.230) was the 4th most important risk management strategy to grain and oilseed producers in Saskatchewan. The importance of reducing debt level as risk management strategy may partially explains why producers do not consider *use of leverage* as a major risk. Leverage as an investment strategy increases the debt stock of producers, therefore, the desire to reduce debt means that leverage as a financing strategy will be less preferred by producers. In addition, *buying crop insurance* was the 5th most important risk management strategy (selected 474 time with standard score of 0.198) followed in order of most important by *diversification* (aggregate and standard score of 241 and 0.100), *getting market information* (selected 124 times with standard score of 0.052) and *forward contracting* (selected 12 times with standard score of 0.005).

On the other hand, the standard score ranking also revealed that producers consider having *farm reservoir/irrigation* as the least important risk management strategy followed by *working off-farm*. Moreover, *off farm investment* and *having seed reserve* was ranked the 3rd and 4th least important risk management strategy. In addition, *replacing labour with machinery, participation in government support programs, use of future markets* and *spreading sales* were also considered least important to producers. Producers ranking of *buying crop insurance* as one of the most important risk management strategies, support the believe that some producers may not have been able

to make the connection that AgriInsurance and Crop Insurance are the same hence the low response in participation in AgriInsurance which is government insurance program to support farmers.

I estimated a standardized square root interval scale from the best-worst scores to allow for comparison of the relative importance of the risk management strategies used in the thesis. The standardized square root interval scale is shown in column 10 of Table 4.3**.** The results show no changes in the ranking of the most important risk management strategies from that of the standard scores. *Producing at low cost* was still ranked the most important risk management strategy followed by *keeping financial reserve, implementing pests and diseases control programs, reducing debt level, buying crop insurance, diversification, getting market information* and *forward contracting* in order of most important. Similar results were witnessed with regards to the least ranked risk management strategies except a swap in the position between *off-farm investment* and *working off-farm* which were 3rd and 2nd least important strategies respectively based on the standard score ranking but was 2nd and 3rd least important strategies based on standardized square root interval scale ranking. The results also indicate a huge drop between the 2nd and 3rd most important strategies emphasising the relative importance of the top two risk management strategies to producers in managing risk judging by the uniformity among producers as to their importance.

Summarizing, the results indicate that grain and oilseed producers consider *producing at low cost, keeping financial reserve, pests and diseases control programs, reducing debt level, buying crop insurance, diversification getting market information* and *forward contracting* as the most important risk management strategies to manage risk. However, strategies such as *working off-farm, off-farm investment, participating in government support programs, having farm reservoir, replacing labour with machinery* were regarded least important to producers in managing risk in their farm operations. Nguyen et al. (2005) found diversification of crops and having equity and farm management deposit as important risk management strategies to farmers in the Upper Eyre Peninsula of South Australia and Southwest Queensland. Moreover, while

prevention of pests and diseases incursions and use of market information were found to be important risk management strategies by farmers in New Zealand (Melyukhina, 2011a). Bard et al. (2003) also found production contracts, crop insurance as among the tools used by value-enhanced grain producers in Illinois to manage risk.

The BWS provides results on the aggregate ranking of sources of risk and risk management strategies considered important by respondents but does not reveal heterogeneity among respondents. Heterogeneity in producers' responses was further examined and the next section presents analysis on that.

4.7. Examining Heterogeneity of the Best-Worst Choices

Adamsen et al. (2013) emphasise that, case 1 output of BWS does not reveal individual difference or probable heterogeneity that may be present in the data. The best-worst results are helpful in determining sources of risk and risk management strategies that are important to producers. Therefore, to understand whether there was uniformity in the best-worst choice of respondents or whether producers were heterogeneous in their choices, I estimated the standard deviation of the individual best worst scores. According to Mueller & Rungie (2009), the standard deviation of the individual B–W score over all respondents measures the variations in the importance of the attribute over the sample. The authors indicate that the greater the standard deviation the more respondents differ and the smaller the standard deviation the more agreement there is between respondents; zero standard deviation reveals all respondents agree on the importance of the attribute (Mueller & Rungie, 2009). Column 7 of Tables 4.2 and 4.3 show the standard deviation of individual best worst scores for the sources of risk and risk management strategies. It must be mentioned that standard deviations above one provides hints of heterogeneity in the responses of producers (Mueller & Rungie, 2009). A closer look at the tables reveal the presence of heterogeneity of producers in their selection of most important sources of risk and risk management strategies since the standard deviation of the individual best-worst scores are all above one.

Although the individual standard deviations give hints of differences in the selection of responses, however, it does not reveal the extent of heterogeneity of

responses. Therefore, to determine the extent of heterogeneity of responses, I estimated the ratio of individual standard deviation and individual mean. Column 8 of Tables 4.2 and 4.3 display the ratio for all the sources of risk and risk management strategies. While greater absolute ratios indicate greater heterogeneity in responses, ratios that are zero or close to zero suggest absolute agreement or greater uniformity in the extent to which producers considers a particular risk or risk management strategy as important or not.

On the sources of risk, the results reveal that there is relatively higher agreement on the relative importance of risks such as *changes in product prices, changes in input prices, use of leverage, rainfall variability*, *changes in technology* and *cost of securing information*. That is producers mostly agree on the importance or unimportance of these risk sources to their farm operations. Other risks such as *changes in world economic or political environment, natural disasters, changes in government or producer policies, degree of debt to capital, changes in interest rate, accidents and health/disability* among others show respondents' disagreement and heterogeneity concerning the relative importance to their farm business These risks have standard deviation over mean ratio far above one.

With regards to the risk management strategies, producers seem to differ on their agreement on the relative importance or unimportance of these strategies. Apart from *producing at low cost, off farm investment, keeping financial reserve and having farm reservoir/irrigation* where producers seem to show relatively higher agreement on their relative importance, there is disagreement and heterogeneity on the relative importance with regards to the other risk management strategies. For example, risk management strategies such as *spreading sales, forward contracting, use of future markets, participating in government support programs, getting market information* among others all have standard deviation over mean ratio well above one. Respondents ranked *forward contracting* among the most important risk management strategies but the Stdev/mean ratio (91) shows a greater heterogeneity in the agreement of producers. Mueller & Rungie (2009) noted that specific attention needs to be paid to such risk that show a high amount

of heterogeneity and reasonable importance as only a subset of producers considers it to be important but not all respondents.

In initiated policies to support farmers in managing risk, policy makers should target risk management strategies where there is higher agreement among producers with regards to their relative importance in coping with risk. This is because, such risk strategies are more likely to have higher adoption rate because most producers agree to its importance in managing risk they face. In this case, strategies that help producers to lower their production cost or enhance their financial reserves should be aimed. Following the heterogeneity among producers revealed by the standard deviation over mean ratio, I performed a latent class cluster analysis to form segments of grain and oilseed producers.

4.8. Latent Class Cluster Analysis of Most Important Sources of Risk

Umberger et al., (2010), noted that latent class cluster estimates the probability of class membership using model parameters and observed individual measures. This allows for predicting and describing differences in preferences not directly observable (Meghani et al., 2009). Coltman et al. (2011) also explained that the approach allows for estimating a maximum likelihood based model that accounts simultaneously for similarities and differences between attributes. The authors continued that the approach at the same enables subtype of related cases to be classified based on unobserved heterogeneity, estimating the posterior probability of an attribute falling into a class and including exogenous variables (covariates) to enable simultaneous segment classification and description (Coltman et al., 2011).

Latent class cluster methods were used in the thesis to classify producers based on how they rate the importance of each of the sources of risk and risk management strategies to their farm operations and how the structural characteristics of the farm and farmers influence such perception. Several latent class models were estimated and based on the information criteria, two distinct classes were identified. According to Fraley & Raftery (1998), the most popular set of model selection tools in LC cluster analysis are information criteria such as Akaike, Bayesian, and consistent Akaike information criteria,

or AIC, BIC, and CAIC (Fraley & Raftery, 1998). The AIC was used as the criteria in the selection of the best model because the AIC or BIC is able to address the drawbacks in either underfitting or overfitting a model because they take into account parsimony by adjusting the log likelihood goodness-of-fit values to account for the number of parameters in the model (Snipes & Taylor, 2014). As a criterion for model selection, the lower the value of the AIC or BIC the better the model fit (Fabozzi et al., 2014). Coltman et al. (2011) also suggests the need to examine the classification statistics to ensure that the model has an acceptable and comparatively low ratio of classification errors. Table 4.4 shows statistics on the measures of goodness of fit and other classification statistics.

Table 4.4: Measures of model fit and parsimony by segments

	Number of clusters			
	1	2	3	4
Log Likelihood	-10,629	-10,416	-10,294	-10,205
BIC	22,725	23,155	23,659	24,104
AIC	21,748	**21,609**	21614	21,644
AIC3	21,993	21,997	22,127	22,261
CAIC	22,970	235,43	24,172	24,721
Npar	245	388	513	617
Classification error	0.000	0.020	0.028	0.024

It is evident from table 4.4 that the AIC statistics increases beyond the second cluster which signifies the idleness of the model. As Snipes & Taylor (2014) notes, the number of parameters is necessary to satisfy the criteria of parsimony. The two-cluster solution has the smaller number of parameters compared to the three and four cluster solutions. Moreover, the classification statistics also shows the two-cluster model has a lower classification error compared to the three and four cluster models. The criteria of parsimony, classification error and the AIC statistics influenced the selection of two

cluster model as the optimal model for classifying producers based on their perception of the importance of the various sources of risk to their business performance.

The mean best-worst scores and characteristics of the latent class cluster presented in Tables 4.5a and 4.5b reveal the relative importance of the sources of risks across segments. The mean best-worst scores are based on the cluster level conditional probabilities for each source of risk and provides an indication of importance of the sources of risk to producers. As the tables reveal, producers were mostly similar across clusters on their perception of the relative importance of the sources of risk to their operations with some variations. For example, change in product prices and rainfall variability were among the top three important risk sources for both clusters which reinforces the importance of these risks sources as revealed by the aggregate sample rating in Table 4.2

Some covariates were also found to be significant in predicting the unique membership in a specific latent class. In all, thirteen covariates were included in the grain and oilseed producer survey. These comprises off-farm income, sales used as a measure of farm size, gender, experience, age, type of farm, internal locus, external locus, risk tolerance, education, household income and debt/capital ratio used to measure producers' source of finance.

Table 4.5a: Mean B-W for each source of risk by Latent Class Cluster

Class Size	**Cluster 1**	**Cluster 2**	
	64%	**36%**	
Sources of Risk	**MEAN B-W**	**MEAN B-W**	**Wald Statistics**
Change in product prices	1.88	2.33	6.72***
Change in world economic or political environment	-0.48	0.45	21.53***
Change in Government or producer policies	-0.52	-0.06	2.93*
Change in input prices	1.39	1.01	10.94***
Unable to meet quality requirements	0.03	1.07	49.05***
Changes in interest rate	0.32	-1.50	115.29***
Availability of loan funds	0.26	-2.05	191.42***
Use of leverage	-0.94	-1.75	18.45***
Degree of debt to capital	0.35	-1.87	169.57***
Rainfall Variability	1.15	2.50	42.84***
Diseases and pests	0.30	1.47	53.78***
Changes in Technology	-1.41	-1.21	0.00
Natural Disasters	-0.27	1.62	117.05***
Accidents and health/disability	0.08	0.87	11.65***
Unable to meet contract obligations	-0.09	-0.39	3.65*
Cost of securing information	-2.05	-2.49	6.240**

*p<0.1, **p<0.05, ***p<0.01

Table 4.5b: Characteristics of Latent Class Clusters

Size	Cluster 1 64% **Most important sources of risk**	**Mean**	Cluster 2 36% **Most important sources of risk**	**Mean**
Most	Change in product prices	1.88	Rainfall Variability	2.50
2nd	Change in input prices	1.39	Change in product prices	2.33
3rd	Rainfall Variability	1.15	Natural Disasters	1.62
4th	Degree of debt to capital	0.35	Diseases and pests	1.47
5th	Changes in interest rate	0.32	Unable to meet quality requirements	1.07
6th	Diseases and pests	0.30	Change in input prices	1.01
7th			Accidents and health/disability	0.87

Cluster one had the largest class with 64% of producers falling within that class and the remaining 36% were in cluster 2. Producers in cluster one consider risks emanating from both production, marketing and finances as important to their farm operation. Variation in product prices, variations in input prices and rainfall variability are the top three most important risks to farmers in this cluster. However, financial risks such as degree of debt to capital and changes in interest rate were also important to producers in this cluster though they were not important at the aggregate level ranking presented in Table 4.2. Higher price volatility means higher costs of managing risks (Tothova, 2011) and rainfall variability could potentially cause output fluctuation which may consequently threatens

the stability of farm income. It is therefore not surprising farmers consider these risks as most important to their business.

Unlike producers in cluster one, those in cluster two consider only risk from production and the market as most important to their farm business. None of the financial risks was seen as important by producers in this cluster. Producers consider rainfall variability and variation in product prices as their top two most important risks followed by natural disaster, pests and diseases, unable to meet quality requirement, variations in input prices and accidents and health/disability. As much as there could be a general fall in prices for grains and oilseed due to the market forces, these sectors have grading systems used to assess quality of crops. The Canadian Grain Commission for example has a comprehensive grading factors such as artificial stain, blackpoint, darkened kernels, fertilizer pellets among others used to assess the quality of producers' grains which determines the price to be paid to producers. Producers in this cluster are probably those who are unable to meet the grain quality requirements and therefore not able to attract the higher premium offered to quality grain. Producers in cluster two consider pests and diseases as more important compared to those in cluster one. This may help explain why inability to meet quality requirement is considered important since pests and diseases could affect the quality of grains or oilseed produced.

Policies that seek to help grain and oilseed producers to cope with risk should target these risks considered important by producers across segments. Policies that help producers to cope with changes in product prices, variations in input prices, rainfall variability, natural disasters, control pests and diseases and improve upon the quality of crops produced will be beneficial to the farm business of grain and oilseed farmers.

4.9. Significant Covariates

Five out of the thirteen covariates included in the latent class cluster analysis were found to be statistically significant. The variables related to off-farm income, debt to asset ratio, age, external locus and household income were all statistically significant covariates in the latent class cluster analysis. Other covariates such as sales, gender, experience, type

of farm, internal locus, risk averse, risk lover and education were not statistically significant. Table 4.6 shows the significant covariates and the discussion of those variables follows.

Table 4.6: Significant Covariates

Covariates	**Wald**	**p-value**	
Off-farm income	4.39	0.036	**
Sales	0.16	0.69	Ns
Gender	0.21	0.65	Ns
Experience	0.25	0.62	Ns
Debt/asset ratio	16.35	0.001	***
Age	17.17	0.001	***
Type of farm	0.65	0.72	Ns
Internal Locus	0.92	0.34	Ns
External Locus	3.86	0.05	*
Risk Averse	0.08	0.77	Ns
Risk Seeking	2.63	0.10	Ns
Education	1.98	0.16	Ns
Household income	7.57	0.006	***

*p<0.1, **p<0.05, p<0.01

4.9.1. Off-farm income

Off-farm income was collected as a categorical variable in the survey. Producers were to answer “Yes” or “No” to a question that asked whether they earn income from any other source apart from income from their farm. The variable was statistically significant at the 5% level as shown in Table 4.6. Producers who do not earn off-farm income are more likely to fall in cluster one as shown by the conditional probabilities. Those who do not earn income from other sources apart from income from their farm are 61% more likely

to belong to cluster one. Thus, producers without off-farm income are more likely to consider risks in cluster one as most important to their business than risks in cluster two.

4.9.2. Debt to asset ratio

Debt to asset ratio was used to measure the debt/capital of grain and oilseed producers. A higher ratio signifies reliance on external financing and lower ratio means that farm operations are financed internally. The variable was included in the survey as categorical with four levels; 1 (0% debt/asset ratio), 2 (0.01% to 24.99% debt/asset ratio), 3 (25.00% to 49.99% debt/asset ratio) and 4 (Greater than 50% debt/asset ratio). The variable was significant at the 1% level of significance. Producers who have zero debt to asset ratio are likely to be in cluster two while farmers in the remaining categories likely falls in cluster one. As the debt to asset ratio increases from the second category through to the fourth category, the probability of farmers falling into cluster one increases. The results clearly show that farmers who rely solely on internal financing of their operations consider risks in cluster two as important to their business. Interestingly, this group of farmers did not consider any of the financial risks as important to the farm business. However, producers more likely to be in cluster one with varying degree of debt, indicated financial risk such as changes in interest rate and degree of debt to capital as important to their farm business. These are probably producers who depend on external sources of financing such as borrowing and therefore will be more concerned with increase in interest rate which likely affect the percentage of revenues that have to go to service debt. Addito et al. (2012) found that farmers who have loans are likely to pay more attention to the changes to their farm financial situation, such as interest rates and level of debt. This is consistent with findings from this thesis that found farmers with some level of debt consider risks such as changes in interest rate and degree of debt to capital as important.

Table 4.7: Probabilities of Significant Covariates by Class Cluster

Covariates	Cluster 1 Probability	Cluster 2 Probability
Off-farm income		
No	0.61	0.39
Debt/asset ratio		
0%	0.36	0.64
0.01% to 24.99%	0.67	0.33
25.00% to 49.99%	0.80	0.19
Greater than 50%	0.95	0.05
Age		
Below 45 years	0.92	0.08
45-54 years	0.70	0.30
55-64 years	0.56	0.44
65 and above	0.41	0.59
External locus		
Disagree	0.55	0.45
Agree	0.60	0.40
Strongly agree	0.79	0.21
Household income		
Less than $ 49.999k	0.75	0.25
$50-$99k	0.64	0.36
$100-$150k	0.62	0.38
Greater than $150K	0.53	0.47

4.9.3. Age

Age was collected initially as continuous variable but was recoded as categorical to preserve degrees of freedom in the latent class cluster analysis. The variable was in four

categorical levels; 1 representing farmers below 45 years, 2 (45-54 years), 3 representing producers within the age group 55-64 years and 4 represent those who are above 64 years. Age was statistically significant at the 5% level. Farmers under the age of 65 are likely to be in cluster one with different probabilities (90%, 70, 56% respectively). That is, they are more likely to consider changes in product prices, rainfall variability, change in interest rate among other as important risk sources. It can be observed that as age increases, the probability of farmers belonging to cluster one decreases.

Farmers older than 64 are 59% more likely to be in cluster two. This means that farmers who are more than 64 years are not likely to consider financial risks as more important to the farm business and they are also farmers who are more likely unable to meet quality requirement. This is surprising because such group of farmers "all things being equal" would be thought of as producers with much experience in handling grains or oilseed and therefore should not have problems with meeting quality requirements. However, considering the non-significance of experience in the cluster analysis means that farmers' years of experience do not determine the type of risk he may consider important.

4.9.4. External Locus of control of risk

Two locus of control variables; external and internal locus were used in the latent class cluster analysis. These variables were created from six locus of control questions included in the survey. Three of the questions (a, b and f) measured producers' internal locus of control while the remaining three questions (c, d and e) measured their external locus of control of risks. All six questions were measured in a form of Likert scale with 1 representing strongly disagree, 2 indicating disagree, 3 (neutral), 4 representing agree and 5 indicating strongly agree to each of the locus of control questions. Following Ochieng & Hobbs (2016), I transformed the internal and external loci questions into a single variable by estimating the average. Thus, the three internal loci were summed up and divided by 3 to give a single variable [(a + b + f/)3]. The calculation was done for the external control question to also yield a single variable [(c + d + e/)3]. As noted by

Ochieng & Hobbs (2016), estimating the average which produces a categorical variable is effective compared to other approaches such as factor analysis which yields continuous variable. The authors suggest that, taking into account degrees of freedom in the cluster analysis, categorical variables are more effective rather than continuous variables, as they take fewer degrees of freedom (Ochieng & Hobbs, 2016). The internal locus of control was not statistically significant however, the external loci was significant at the 10% level.

The results reveal that producers with external loci; that is those who agree with the fact that risks in their business are due to external forces to which they have less, or no control are likely to be in cluster one. Producers who strongly agree that risks are due to external forces beyond their control have 60% probability of being in cluster one compared with 79% of those who strongly agree. A closer examination of the risks in cluster one shows that most of the risks are those to which farmers has less control over and may explain why greater percentage of producers who agree are found in this cluster. For example, changes in product and input price, rainfall variability and changes in interest rate are all risk outside the producers control**.**

4.9.5. Household income

Household income included as categorical variable with four categories; 1(Less than $ 49.999k), 2 ($50-$99k), 3 ($100-$150k) and 4 (greater than $150K) was statistically significant at the 1% level. The results reveal that producers in all household income categories are likely to belong to cluster one compared to cluster two. However, it can be observed that as household income increases, the probability of belonging to cluster one decreases and that of cluster two increases. As household income increases, the capacity of producers to finance their farm operation internally improves and may not necessarily need to resort to external financing such as borrowing. Thus, they may therefore not consider some risks in cluster one such as changes in interest rate and degree of debt to capital as threat to their farm business anymore. The next section presents cluster analysis results on the producers' perception on most important risk management strategies.

4.10. Latent Class Cluster Analysis of Most Important Risk Management Strategies

I performed latent class cluster analysis on the most important risk management strategies to enable classification of producers based on how they rate the importance of each of the risk management strategies to their farm operations and how the structural characteristics of the farm and farmers used as covariates in the latent class cluster analysis help predicts individuals' unique membership in a specific class or segment. Similar to the cluster analysis on the sources of risk, several latent class models were estimated and based on the information criteria, three distinct classes were identified. The AIC was used to select the optimal model. Table 4.8 shows statistics on the measures of goodness of fit and other classification statistics:

Table 4.8: Measures of model fit and parsimony by segments

	Number of clusters			
	1	2	3	4
Log Likelihood	-10,906	-10,698	-10,542	-10,451
BIC	23,267	23,551	24,001	24,560
AIC	22,298	22,116	**22,060**	22,132
AIC3	22,541	22,476	22,547	22,746
CAIC	23,510	23911	24,488	25,194
Npar	243	360	487	614
Classification error	0.000	0.027	0.024	0.026

A close observation of Table 4.8 reveals that beyond cluster 3, the AIC increases indicating 3-cluster model as the best model. Also, the classification error decreases from cluster 2 to 3 but begins to increase again beyond cluster 3. Compared to cluster 4, cluster three has fewer parameters satisfying the criteria of parsimony. So, based on the AIC statistics, classification statistics and parsimony, three cluster-model were selected as the

model with the best fit. Tables 4.9a and 4.9b present the mean best-worst scores and characteristics of the latent class cluster

Table 4.9a: Mean B-W for each risk management strategy by Latent Class Cluster

Class Size	**Cluster 1**	**Cluster 2**	**Cluster 3**	
	58.2%	**33.4%**	**8.4%**	
Risk Management Strategies	**MEAN B-W**	**MEAN B-W**	**MEAN B-W**	**Wald Statistics**
Getting market information	0.30	0.37	0.10	1.62
Spreading sales	0.23	-0.14	0.09	4.34
Diversification	0.40	0.28	0.30	1.20
Producing at low cost	1.93	1.61	1.83	2.22
Forward contracting	0.50	-0.31	-0.58	21.63***
Use of future markets	0.20	-0.40	-0.22	16.35***
Off-farm investment	-2.01	-0.59	0.57	101.47***
Reducing debt level	1.18	0.73	-0.34	6.85**
Keeping financial reserve	1.74	1.20	1.15	6.82**
Buying crop insurance	1.15	0.08	1.47	22.42***
Replacing labour with machinery	-0.47	-0.81	-1.26	2.61
Having seed reserves	-1.25	-0.19	-1.47	25.31***
Implementing pest and diseases control programs	1.45	0.32	1.10	24.78***
Having farm reservoir/irrigation	-3.34	-0.70	-3.03	252.02***
Participating in government support programs	0.19	-0.39	-0.66	10.72***
Working off-farm	-2.21	-1.04	0.96	32.21***

*p<0.1, **p<0.05, ***p<0.01

Table 4.9b: Characteristics of Latent Class Clusters

Size	Cluster 1 58.2%		Cluster 2 33.4%		Cluster 3 8.4%	
	Most important Strategies	**Mean**	**Most important strategies**	**Mean**	**Most important strategies**	**Mean**
Most	Producing at low cost	1.93	Producing at low cost	1.61	Producing at low cost	1.83
2nd	Keeping financial reserve	1.74	Keeping financial reserve	1.20	Buying crop insurance	1.47
3rd	Implementing pest and diseases control program	1.45	Reducing debt level	0.73	Keeping financial reserve	1.15
4th	Reducing debt level	1.18	Getting market information	0.37	Implementing pest and diseases control program	1.10
5th	Buying crop insurance	1.15	Implementing pest and diseases control program	0.32	Working off-farm	0.96
6th	Forward contracting	0.50			Off-farm investment	0.57
7th	Diversification	0.40			Diversification	0.30

Cluster one represents the dominant cluster with 58.2% of producers falling into that cluster. This is followed by cluster two with 33.4% and the remaining 8.4% of producers were in cluster three. Producers in cluster one and two consider combination of production, marketing and financial risk management strategies important in managing risks they face in their farm business. Unlike producers in cluster one and two, those in cluster three consider only production and financial risk management strategies important in managing risks. Producers in cluster one considers producing at low cost, keeping financial reserve, and implementing pest and diseases control program as their top three most important risk management strategy. This is followed by reducing their debt level and buying crop insurance. Forward contracting was also considered important by this cluster of farmers. Similar to the perception of producers in cluster one, those in cluster

two rank producing at low cost and keeping financial reserve as their top two most important risk management strategy followed by reducing debt level, getting market information and implementing pest and diseases control program. Only farmers in cluster one and two considered reducing debt level as important risk management strategy to their operations. Statistics Canada 2011 farm financial survey reveal that, current liabilities of grain and oilseed farms in Saskatchewan rose from 69,512 in 2010 to 70,698 in 2011 while long time liabilities also increased from 183,832 to 212,820 within the same period (Statistics Canada, 2013). Moreover, interest expenses also rose from 12,034 to 12,203 between 2010 and 2011. Producers in cluster 1 and 2 are perhaps farmers who rely on external financing to support operations and therefore maybe more concern with increasing debt.

Producers in cluster 3 also ranked producing at low cost, buying crop insurance, keeping financial reserve, and implementing pest and diseases control programs as the top four most important risk management strategy. Moreover, off-farm work and investment were also considered important by this group of grain and oilseed producers. Although off-farm work and investment were not considered important at the aggregate level, famers in cluster three rank these strategies as important to risk management in their operations. Interestingly, they are the only group of famers who do not consider reducing debt level as important risk management strategy (mean best-worst score of -0.34). This may be due to the fact that, the off-farm income earn by these farmers through off-farm work and investment helps them to finance farm operations internally without resorting to external borrowing and therefore have little concern with increasing debt. It is observed from Table 4.9b that producing at low cost and keeping financial reserve are both one of the top three most important risk management risk strategies for all three clusters. These two risk management strategies were the two most important strategies based on the aggregate level ranking provided in Table 4.3.

In summary, results from both the aggregate level ranking and the cluster analysis on the risk management strategies considered important by grain and oilseed producers in Saskatchewan reveal that farmers consider strategies such as producing at

low cost, keeping financial reserve, implementing pest and diseases control programs among others as important. Therefore, service providers and policy makers should consider these in initiating policies and programs that meet the optimal needs of producers.

4.11. Significant Covariates

All thirteen covariates used for the cluster analysis on the most important sources of risk were included in estimating the cluster model for the most important risk management strategies. This help to predict the unique membership of producers based on the perception of most important risk management strategies. Seven of the covariates including off-farm income, sales, experience, debt to asset ratio, risk averse and education were all statistically significant. The significant covariates are presented in Table 4.10.

Table 4.10: Significant Covariates

Covariates	**Wald**	**p-value**	
Off-farm income	8.34	0.015	**
Sales	7.50	0.024	**
Gender	1.60	0.45	Ns
Experience	10.98	0.004	***
Debt/asset ratio	5.02	0.081	*
Age	1.36	0.51	Ns
Type of farm	3.47	0.48	Ns
Internal Locus	0.78	0.68	Ns
External Locus	4.21	0.12	Ns
Risk Averse	5.01	0.082	*
Risk Seeking	0.06	0.97	Ns
Education	7.42	0.025	**
Household income	1.39	0.5	Ns

*p<0.1, **p<0.05, ***p<0.01

4.11.1. Off-farm Income

Off-farm income was significant at the 5% level. Producers who do not earn off-farm income are likely to be in cluster 1 with 68% probability of being in that cluster. Moreover, the probability of farmers who earn off-farm income falling into cluster 3; where off farm investment and work were considered important is higher than those who do not earn off-farm income. The result is consistent with findings by Hangara et al. (2011), who reported that because off-farm income could be a risk management strategy to manage variability in farm income, producers earning income off-farm could potentially reduce the probability of relying on other risk management strategies.

4.11.2. Sales

Sales was used to measure farm size and was included as a categorical variable with five levels. The variable was found to be significant at the 5% level. It can be observed that, there is almost an equal split of probability of producers with sales revenue less than $250,000 falling into either cluster one or two (45% for cluster 1 and 42% for cluster 2). Beyond that, the probability of producers falling into cluster one increases as shown by the conditional probabilities in Table 4.11. Thus, producers are likely to consider strategies such as buying crop insurance, diversification, forward contracting important. The result is consistent with findings of other studies. Shucksmith & Smith (1991) report that diversification activities are concentrated in larger farms. Aditto et al. (2012), also found diversification to be positively related to farm size. The authors noted that due to the limitations placed on farmers with smaller farm size to undertake crop diversification practices, larger farms have the greater probability to adopt a diversification strategy. Results from this study also show that farmers are likely to consider diversification important risk management strategy as farm size increases.

Cluster one producers with larger farm size did not consider strategies such as off-farm investment or work important. As noted by Unterschultz (2000), non-farm income is less favoured by larger farms because larger farms require full time management and high capital requirement and may partially explain why farmers in cluster one did not considered these strategies important. Research has also shown that there is a significant

positive relationship between farm enterprise diversification and having crop insurance (Mishra et al., 2004). Interestingly farmers in cluster one who considered diversification as important risk management strategy also indicated buying crop insurance as also important. As farm size increases, farmers are expose to several risks and may therefore, find it prudent to purchase crop insurance to protect his/her crops should anything happens.

Table 4.11: Probabilities of Significant Covariates by Class Cluster

Covariates	Cluster 1 Probability	Cluster 2 Probability	Cluster 3 Probability
Off-farm income			
No	0.68	0.29	0.03
Sales			
less than $250k	0.45	0.42	0.13
$250K to $499K	0.64	0.25	0.11
$500K to $749K	0.79	0.21	0.00
$750K to $999K	0.70	0.27	0.03
$1000 and above	0.70	0.30	0.00
Experience			
Less than 10 years	0.06	0.82	0.12
11-20 years	0.50	0.43	0.07
21-30 years	0.62	0.32	0.06
31-40 years	0.66	0.25	0.09
Over 40 years	0.71	0.20	0.09
Debt/asset ratio			
0%	0.54	0.31	0.15
0.01% to 24.99%	0.58	0.34	0.08
25.00% to 49.99%	0.64	0.33	0.04
Greater than 50%	0.60	0.40	0.00
Risk averse			
Disagree	0.38	0.02	0.60
Agree	0.59	0.33	0.08
Strongly agree	0.63	0.28	0.08
Education			
Otherwise	0.67	0.29	0.04
college and above	0.52	0.37	0.11

4.11.3. Experience

Experience was collected as a categorical variable with five levels in the producer survey. Category 1 represented farmers with less than 10 years of experience as grain or oilseed producer, 2 represented those with 11-20 years of experience, 3 for those with 21-30 years of experience, 4 represented 31-40 years of experience and the last category 5 were those with over 40 years of experience. The variable was significant at the 1% significance level. The results reveal that producers with less than 10 years of experience are likely to belong to cluster two with 82% probability of belonging to that class. This means that, they are more likely to consider risks management strategies in cluster two as most important in managing risks in their production activities. As producers' years of experience increases, the probability of belong to cluster two decreases in favour of cluster one. Thus, as the years of experience as a grain or oilseed producer increases, a farmer's likelihood of belonging to cluster one also increases as shown by the conditional probabilities. According to Pope & Prescott (1980), farmer experience exhibits a positive effect on diversification and that less experienced farmers are less diversified. Results from table 4.11 reveal that farmers with less than 10 years of experience compared with other groups do not consider diversification as important. Experienced farmers may have considerable knowledge about the market and might have established strong relationships and trust with buyers and therefore likely to consider forward contracting as important strategy in reducing risk. Compared with experienced producers, less experience farmers may have less market experience and therefore will consider getting market information important strategy as revealed by the results. Producers likely to be in cluster two who are mostly farmers with less than 10 years of experience were the only cluster of farmers likely to consider getting market information important.

4.11.4. Debt to Asset Ratio

The variable was used to measure whether financing of farm operations comes from internal or external sources. The higher the ratio, the more a farmer rely on external source of financing farm operations. Debt/asset ratio was included in the survey as a

categorical variable and was significant at the 10% significance level. The result shows that producers with varying debt to asset ratio are likely to be in either cluster one or two though with different probabilities. They are more likely to be in cluster one than two. Also, the probabilities of being in these two clusters increase as debt of producers increases. As the debt level of producers increases, it can be observed that the probability of belonging to cluster 3 where producers do not consider reducing debt level as important risk management strategy decreases becoming zero for producers whose debt/asset ratio is greater than 50%. This means that as debt levels increase, farmers become more concern about the sustenance of their farm business and may therefore consider measures that help reduce debt levels important as shown by the selection of this strategy by producers in cluster 1 and 2 as important.

4.11.5. Risk Aversion

Five questions were included in the survey to measure the risk attitude of farmers. The questions were priori categorized to measure whether farmers are risk averse or risk lovers and were measured in a Likert scale form with 1 indicating strongly disagree and 5 representing strongly agree. Two of the questions ("a" and "e") measured the risk averseness of the producer while the remaining three ("b", "c", and "d") measured the risk loving nature of producers. As was done with the locus of control questions, I transformed the risk attitude questions by estimating the average to yield a single variable for risk averseness [(a + e)/2] and risk loving [(b + c + d)/3]. While "risk loving" was not significant, risk averse was significant at the 10% level. Producers who agreed that they are risk averse were more likely to be found in cluster one. The relatively risk averseness nature of producers in cluster one may explain why risk management strategies such as buying crop insurance, forward contracting, diversification and reducing debt levels are considered important by producers in this cluster. Sulewski & Kłoczko-Gajewska (2014) found that Polish farmers who use or plan to implement activities as insuring crops, maintaining financial reserves and avoiding taking credit have higher than average level of risk aversion

4.11.6. Education

The variable was also included as a categorical variable with five levels but was re-categorized into two; 1 indicating farmers with less than college education and two for those with education from college and above. Education was significant at the 5% percent level. Table 4.11 shows that there is not much difference in the risk management strategies preferred by farmers with different educational background. In general, both farmers with less than college education and those with education from college and above are all likely to belong to cluster one however with varying probabilities. Producers with less than college education had 67% probability of being in cluster one compared with 52% of those college and above education. Producers with college and above education are more likely to consider important risk management strategies in cluster two and three compared to those with less than college education. Alasia et al. (2007) found farmers with higher education to be more inclined to use off-farm income risk strategies. Farmers with more than college education in this study are likely to consider off-farm work and investment important compared to those with less than college education.

To better understand how respondents are distributed within cluster based on farm and farmers characteristics, I estimated the distribution of farmers within cluster. Table 4.12 shows the probabilities of the significant covariates within class cluster;

Table 4.12: Probabilities of Significant Covariates within Class Cluster

Covariates	Cluster 1 Probability	Cluster 2 Probability	Cluster 3 Probability
Off-farm income			
No	0.62	0.45	0.18
Sales			
less than $250k	0.35	0.57	0.73
$250K to $499K	0.20	0.13	0.24
$500K to $749K	0.12	0.05	0.00
$750K to $999K	0.10	0.06	0.03
$1000 and above	0.24	0.18	0.00
Experience			
Less than 10 years	0.01	0.27	0.15
11-20 years	0.13	0.19	0.12
21-30 years	0.18	0.16	0.12
31-40 years	0.29	0.19	0.27
Over 40 years	0.39	0.19	0.33
Debt/asset ratio			
0%	0.19	0.19	0.36
0.01% to 24.99%	0.61	0.62	0.57
25.00% to 49.99%	0.16	0.14	0.06
Greater than 50%	0.05	0.05	0.00
Risk averse			
Disagree	0.01	0.00	0.09
Neutral	0.18	0.25	0.18
Agree	0.81	0.75	0.73
Education			
Otherwise	0.47	0.35	0.19
college and above	0.53	0.65	0.81

It is evident from table 4.12 that farmers in cluster one are those who do not earn off-farm income (62% of them are less likely to earn off-farm income), have different sales revenue, over 40 years of experience (39%). Majority of them also have debt to asset ratio between 0.01% to 24.99% and are likely to be risk averse and have education above college. Unlike farmers in cluster one, those in cluster two are likely to have sales revenue less than $250, 000 (57%) and less than ten years' experience. However, they are similar in their debt to asset ratio, risk attitude and level of education. Farmers in cluster three are more likely to earn off farm income (only 18% are less likely to receive off farm income). Interestingly, they are the only group of farmers who consider off-farm work and investment as important risk management strategies. They are similar to farmers in cluster two and one in terms of their sales revenue and years of experience respectively. Moreover, they do not differ from farmers in both one and two in relation to their debt to asset ratio, risk attitude and education.

4.12. Regression Analysis

To help establish a direct relationship between the sources of risk and the risk management strategies (that is how the sources of risk considered important by farmers predicts the kind of strategy farmers use), a regression analysis was conducted. To explore the effects of different model specifications, an OLS regression was initially estimated, however due to some limitations of the OLS regression model, an ordered probit model was also estimated.

4.12.1. OLS Analysis

The OLS was estimated to determine the influence of a source of risk on the risk management strategies employ by farmers to manage it. The model was estimated using the best-worst scores for the sources of risk and risk management strategies generated from the best-worst analysis with the risk management strategies as dependent variables and the sources of risks as the independent variables. However, only those sources of risk and risk management strategies revealed by the best-worst analysis as important to

producers were considered in the regression analysis. Moreover, socio-demographic characteristics of producers were included to control for the effect of sales, gender, experience, age, education, and household income. Different models were estimated for each of the dependent variables. Tables 4.13 a and b present results on the OLS analysis.

Table 4.13a: Results on OLS model

Variables	Getting market information			Producing at low cost			Keeping Financial Reserve			Pest and diseases Control programs		
	Coefficient	SE	PV	coefficient	SE	PV	Coefficient	SE	PV	coefficient	SE	PV
Variations in product price	.085	.058	.14	.152 ***	.053	.00	.060	.053	.25			
Variations in input prices	-.068	.059	.25	.257 ***	.056	.00	.070	.056	.20			
Rainfall variability				.063	.042	.14	.097 **	.042	.02	.064	.039	.10
Pests and diseases				.097 **	.048	.04	.046	.047	.33	.440 ***	.044	.00
Accident and health				.067 *	.037	.07	.138 ***	.036	.00	.023	.034	.50
Natural disaster				.069	.042	.10	.030	.041	.46			
Unable to meet quality requirement	.111 **	.052	.03	-.024	.048	.63	-.062	.047	.19	.065	.045	.15
Degree of debt to capital												
Change in interest rate												
Use of leverage												
Sales	.113 **	.053	.03				.044	.048	.36	.098 **	.047	.04
Gender	.443 **	.213	.04				-.130	.197	.51	-.184	.188	.33
Experience				-.072	.088	.41	-.126	.090	.16	.074	.088	.40
Age				.016 *	.008	.07	.019 **	.009	.03	.011	.008	.19
Education	-.122	.169	.47	-.081	.154	.60	.045	.151	.77			
Household income	-.076	.303	.36	.078	.075	.30	-.029	.074	.69	-.050	.072	.49

*p<0.1, **p<0.05, ***p<0.01

The OLS results suggest that farmers who *unable to meet quality requirement* is important risk to them consider *seeking market information* important risk management strategy. Moreover, increase in sales and being a male producer positively influence consideration of *seeking market information* important risk management strategy. Surprisingly, variation in output and input prices were not significant. Marketing information on especially output prices would enable farmers to have greater strengths in negotiating and even make production decision. Therefore, producers with greater concern with output price variation would have been expected to consider seeking market information important to reduce concern over uncertainty of price variation. *Producing at low cost* is important risk strategy for producers who consider *variation in output and input prices*, *pests and diseases* and *accident and health* important sources of risk. Increase in age also positively influence perception of *producing at low cost* as important strategy. While *keeping financial reserve* is more likely to be considered most important strategy by farmers who consider *rainfall variability* and *accident and health* important risks, *implementing pest and diseases control program* is significant risk strategy to producers who *pests and diseases* is important risk. Moreover, increase in sales and age positively influence consideration of *implementing pests and diseases control programs* and *keeping financial reserve* respectively as important strategies.

Table 4.13b: Results on OLS model

Variables	Reducing Debt Level			Buying Crop insurance			Diversification			Forward contracting			Gov't Support program		
	COEFF	SE	PV	COEFF	SE	PV	COEFF	SE	PV	COEFF	SE	PV	COEFF	SE	PV
Variations in product prices	-.053	.059	.37				.105 *	.059	.07	-.026	.056	.64			
Variations in input prices							-.158 **	.060	.01	-.097 *	.058	.09			
Rainfall variability										-.081 *	.042	.06			
Pests and diseases	-.055	.053	.30	.051	.060	.40	-.060	.051	.24	-.121 **	.049	.01			
Accident and health										-.089 **	.039	.02			
Natural disaster				-.016	.051	.75							.053	.041	.19
Unable to meet Quality requirement	-.110 *	.055	.05				.097 *	.053	.07				-.043	.050	.39
Degree of debt to capital															
Change in interest rate	.284 ***	.052	.00												
Use of leverage	-.137 **	.058	.02												
Sales	.059	.055	.28				-.037	.054	.50	.306 ***	.052	.00			
Gender	.443 **	.218	.04	.187	.251	.46				.405 *	.206	.05	.351 *	.208	.09
Experience				-.105	.114	.34	.117	.102	.25	.052	.097	.59			
Age	-.008	.006	.22	.019 *	.011	.08	-.010	.010	.32	-.012	.009	.21	.009	.006	.15
Education	-.298 *	.172	.08	.217	.198	.27									
Household income				.099	.095	.30	.052	.084	.54				.103	.081	.20

*p<0.1, **p<0.05, ***p<0.01

While positive association was found between *changes in interest rate* and *reducing debt level* as a risk management strategy, there was a negative relationship between the strategy and *unable to meet quality requirement* and *use of leverage*. Crop insurance has often been used as a strategy to safeguard investment of producers in case of uncertainties such as inadequate rainfall, pests and diseases etc which affects crop yield. Therefore, one would have expected that, *buying crop insurance* should be considered important risk management strategy to farmers who consider *rainfall variability* and *pests and diseases* important risks. However, these risks were not found to be significant. Though *diversification* is important strategy to farmers who consider *variation in output prices* and *unable to meet quality requirement* as important risks, it is less important to producers who consider *variation in input prices* important risk. *Variation in input prices*, *rainfall variability*, *pests and diseases* and *accident and health* were all found to have a negative association with forward contracting. This is also an unexpected result because forward contracting has been used as a strategy to hedge against risk such as variation in prices and would have expected producers who consider variation in output prices important risk to consider *forward contracting* important risk management strategy. However, variation in output prices was not found to be significantly related to *forward contracting*. With the exception of gender, none of the variables were found to have a significant relationship with government support programs. This is again surprising result because these program, for example, the AgriStability and AgriInsurance programs are meant to support farmers to manage risks emanating from pest and diseases, weather factors, low prices, high input prices etc. Therefore, one would have expected farmers who consider these sources of risk important, to consider participating in these government support program important risk management strategy.

As indicated earlier, there were limitations to some of the OLS models estimated as some of the dependent variables were not normal as required in running an OLS model. Specifically, *producing at low cost*, *reducing debt level*, *keeping financial reserve*, *buying crop insurance* and *implementing pests and diseases control programs* were not

normally distributed even after transformation. Hence, an ordered probit model was also estimated

4.12.2. Ordered Probit Analysis

The ordered probit model was used to examine the influence of a particular source of risk on the adoption of a risk management strategy. The best worst scores generated from the best-worst analysis on the risk management strategies were used as the dependent variables and those on the sources of risk as independent variables. The ordered probit model was appropriate because of the ordered nature of the dependent variables(Abdel-Aty, 2003). The scores generated from the best-worst analysis was ordered ranging from +4 to -4 depending on the number of times a particular risk strategy was selected as most or least important. The socio-demographic characteristics were again used as controlled variables in estimating the model. Only those sources of risk and risk management strategies considered important by producers from the best-worst analysis were included in estimating the model. The ordered probit model results are provided in Appendix 2.

The chapter has looked at the analysis and discussion of data obtained from the grain and oilseed producers survey. The descriptive statistics suggest that male more than female producers earn income from other sources apart from their farm income. Also, whereas more than half of respondents indicated their participation in AgriInvest and AgriStability, the participation rate in AgriInsurance and AgriRecovery is quite low among these producers. The best-worst scaling analysis also suggests that while producers consider risk emanating from production and the market as most important risk sources, risk management strategies such as producing at lower cost, keeping financial reserve, implementing pests and diseases control, reducing debt level and buying crop insurance are considered important in managing these risks. On the other hand, the latent class cluster analysis reveals two unique clusters of producers based on their most important sources of risk and three unique clusters depending upon producers' perception of important risk management strategies. Also, the regression analysis show that

producers use different risk management strategies depending upon the kind of risk they consider most important to their farm operations.

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1. Introduction

The principal objective of this thesis was to understand the perception of actual risk and risk management practices among grain and oilseed producers in Saskatchewan. Farm managers operate in a riskier and uncertain environment which affects their production, investment, and management decisions. For example, the market for agricultural inputs and outputs have direct effect on farm income. While higher input cost increases the cost of production, lower output prices increases the financial risk of producers. Moreover, the variety of risks related to weather, pests and diseases or personal circumstances influence production in ways that are outside the control of the farmer. Such uncertainties increase the risk environment within which farmers produce. Although farmers across the world face risks, what risk is considered important by a farmer or group of farmers differ depending on the structural characteristic of the farm, farmer and other climatic conditions beyond farmers control. Moreover, the risk management strategies employed by producers to cope with risk also differ. The study therefore was undertaken to:

a. Identify the perceived sources of risks faced by oilseed and grain farmers in Saskatchewan

b. Identify and rank the risk management strategies farmers perceived to be important in managing risk

c. Analyse how personal and structural characteristics of farmers and farms influence perception of risk and risk management strategies considered important by farmers

To explore these issues, an online survey of grain and oilseed producers was used to collect data to examine the issues. Best-worst scaling and latent class cluster were the tools used in analysing the data. The chapter describes the major findings and policy

implications of the study and concludes with comments on limitations of the study and further research suggestions.

5.2. Findings and Policy Implications

The thesis found that, almost forty nine percent of producers earn off-farm income. This suggests that almost half of grain and oilseed producers work on the farm full time as more than 50% indicated they do not earn income from any other sources apart from income from the farm. Male farmers were more likely to receive income from other sources compared to female producers. While over 70% of male producers indicated they earn off-farm income, only about 27% of female producers responded they earn off-farm income. The result is consistent with Statistics Canada report that most farm operators continue to work full time according to the 2016 Census of Agriculture (Statistics Canada, 2016).

On producers' participation in Federal and Provincial business risk management strategies, the thesis reveals that over fifty percent of respondents participate in AgriInvest and AgriStability however, the stated participation in AgriInsurance and AgriRecovery is quite low. There are also significant number of grain and oilseed producers who do not participate in any of these programs. However, producers who participate in these programs mostly agree that, the strategies have helped them cope with risk emanating especially from production and financial sources. While this sample of producers in Saskatchewan initially stated that they did not use AgriInsurance at the same rate as the extent that is reported by SCIC, the results show that these farmers do rate crop insurance as one of the most important risk management strategies. This give credence to my earlier suggestion that some farmers may not realize that crop insurance is the means by which the AgriInsurance policy is delivered, which also suggests that more could be done to make farmers aware of this. Moreover, policy makers need to have greater engagement with farmers to educate them on the greater benefits these business risk management strategies provide for farmers to help enhance participation.

With regards to sources of risks and risk management strategies perceived as important by grain and oilseed producers, the best-worst scaling results suggest that *variation in output prices, rainfall variability, variation in input prices, pests and diseases, accidents and health/disability, natural disasters, and inability of producers to meet quality requirements* were among the risks considered significant by producers. Results on the aggregate sample implies that farmers are view production and marketing risks as more important to their farm business. Farm managers are concerned with stability of farm revenue and the results on farmers ranking of their perceived sources of risk confirm this. This is because farmers seem to be more concerned with events that have direct impact on farm revenue. For example, lower prices and not being able to meet quality requirements could affects prices and negatively affect farm revenue. Moreover, inadequate rainfall, natural disasters pest and diseases are all events that can reduce yield and the quantity of output farmers can sell. In relation to the risk management strategies, the results suggest *producing at low cost, keeping financial reserve, implementing pests and diseases control programs, reducing debt levels, buying crop insurance, diversification, getting market information and forward contracting* as among the risk management strategies perceived important by grain and oilseed producers. Although price risk was ranked as the greatest risk to respondents, tools such as spreading sales was ranked relatively low. Considering the ranking of price risk as important, spreading sales, a simple tool in reducing price risk would have been expected to be ranked high. Spreading sales throughout the year ensure that producers receive average price for the year. The results provide useful insight to policy makers, government agencies and extension agents as to what risks and risk management strategies are considered significant to the farm business of these group of farmers. This information should provide useful guidance to policy makers and agricultural agencies in designing programs and offering farm advice aimed at helping farmers to manage risk in their farm business. Strategies designed to assist farmers in coping with risk should be considered useful and efficient from the perspective of producers. For example, strategies and practices that help farmers to strategically cut down input cost such as reducing herbicide application,

reducing seed cost by buying from few dealers to generate more volume to qualify for discounts would be beneficial. In addition, providing market information such as grain quality requirements for the crop season would also help farmers to receive premiums for quality grain production especially producers who ranked seeking market information important risk management strategy. Policy makers should work and develop methods to improve the efficacy and utilization of tools such as *spreading sales* which is perceived by respondents as relatively not important although price risk is perceived as important to producers.

The best-worst analysis also showed heterogeneity in producers' selection of the most important sources of risk and risk management strategies. That is, the results suggested non-homogeneity with regards to the choices of produces. To further explore the unique segments that exist in the data, I perform a latent class cluster analysis on the most important sources of risk and risk management strategies. The cluster analysis on the most important sources of risk suggested two unique classification of grain and oilseed producers based on their perception of risks. Producers in cluster one (with 64% probability of belonging to that cluster) appeared to consider risks emanating from production, marketing, and finances as important to their farm operation. Producers in cluster two seemed concerned more with risks originating from production and the market as most important to their farm business. The heterogeneity in responses mean that policy makers promoting a one size fit all risk management tool may not necessary work. A more targeted approach would yield more appropriate results. For instance, financial risks such as changes in interest rate and degree of debt to capital were ranked relatively low for the aggregate sample, these risks are quite significant to farmers in cluster one. This has implication for policy makers to promote strategies that help to reduce farm debt. For example, strategies such as consolidating purchases of seed and other farm inputs will help to benefit from discounts. Off-farm income activities can be encouraged. Engaging in off-farm income activities can not only enhance the capacity of producers to repay debt (Briggeman, 2011) but also strengthen the ability of farm operators to internally financed farm operations and reduce that amount of farm revenue

that goes into debt servicing. The cluster analysis on the most important risk management strategies also revealed three distinct clusters. The probability of producers falling into cluster one was 58.2%. These were producers who consider combination of production, marketing, and financial risk management strategies important in managing risk. Producers in cluster two (with 33.4% probability of being in that cluster) were similar to those in cluster one in their perception of most important risk management strategies. However, there were variations in the probabilities and ranking of the strategies between these two clusters of farmers. Also, strategies such as buying crop insurance, forward contracting, and diversification were perceived as more important by farmers in cluster one than those in cluster two. Producers in cluster three were farmers who considered only production and financial risk management strategies important in managing risks. This has interesting implications for buyers and policy makers. Buyers can use forward contracting to establish long term relationship with farmers, especially those in cluster one. Crop Insurance is a government tool used as a means of stabilizing farm revenue by reducing the financial impact from yield losses due to unfavourable weather conditions. However, producers in cluster two do not perceive this strategy as important even though results from the aggregate sample and the cluster analysis both reveal that weather risk such as rainfall variability and natural disasters were perceived important. This suggest the need for policy makers to do more engagement and education on the importance of having crop insurance to ensure greater utilization of such an important strategy.

The cluster analysis revealed some similarities among farmers in both clusters in relation to their most important sources of risk and risk management strategies. For example, risks such as variation in output prices, rainfall variability, pests and diseases, and changes in input prices were selected by both cluster of farmers as important. In addition, risk management strategies such as producing at low cost, keeping financial reserve, implementing pests and diseases control programs were selected by producers in all three clusters as important. This implies that for such risks, strategies can be designed or promoted that target all farmers. However, strategies that narrowly target farmers in

cluster 1in dealing with changes in interest rate, reducing their debt level and cluster two to cope with natural disasters, meeting quality requirements will also be necessary.

As noted in chapter 3, I included covariates in the cluster analysis to help categorize producers into unique clusters based on the heterogeneity revealed by the best-worst scaling analysis. With regards to producers' perception of risks, variables such as off-farm income, debt to asset ratio, age of a producer, perception of external locus of control and producer household income were found to significantly help understand the classification of producers into the clusters. On their perception of most important risk management strategies, off-farm income, sales revenue, experience of a producer, debt to asset ratio, perception of risk averseness and the level of education of a producer were the variables found to be significant in understanding which of the three unique segments a producer is likely to belong. Understanding of how these characteristics influence the likelihood of ranking a particular risk management strategy or considering a particular risk important will help in identifying which producer needs what risk management strategy. In addition, policy makers and extension officers can raise awareness of farmers on some tools that should have more use but are less likely to be adopted by farmers in managing risk. For example, respondents rated marketing risks as important, however, tools such as spreading sales and forward contracting that could be more useful in managing such risks were rated less important by respondents. Spreading sales throughout the years guarantees that the producer's average price will be close to the season average price because it averages out the within year variability (Patrick, 1998). Forward contracting can be done for both input and output to avoid the risk of price increase and unavailability of inputs (Patrick, 1998) or significant drop in prices which affects farm income stability. Providing market information for producers in cluster two, who mostly have of experience and smaller farm size will be beneficial since they are the only cluster of farmers who perceive seeking market information as significant management tool. Others service providers can also use this information to identify clients for their services. For example, insurance companies could target producers in

clusters one and three who considered buying crop insurance as important risk management strategies.

In general, the purpose of the thesis is to elicit responses from grain and oilseed farmers in relation to how they identify and manage risk in agriculture. The best-worst scaling results have provided useful information concerning the various sources of risk and risk management strategies producers perceive to be important to their farm business. This understanding should guide the development of new policy tools and farm management strategies that suit the specific needs of these group of producers with the hope of encouraging the adoption of risk management tools by producers. Moreover, for some risk management tools perceived by producers to be ineffective or not important, as revealed by the best worst scaling result, new methods may be developed to help improve their utilization and efficacy. More importantly, the information provided by this study should serve as a useful guide in the preparation of the new Agricultural framework by the Canadian Federation of Agriculture (CFA) to replace the Growing Forward 2 in 2018 to ensure that strategies will be considered useful to grain and oilseed producers in Saskatchewan and the country at large.

5.3. Limitations and Further Research

One of the major limitations to this study was time and resources which limited the sample population to only grain and oilseed farmers in Saskatchewan. Since Alberta and Manitoba are major producers of grains and oilseeds in Canada, inclusion of producers in these provinces will have provided a broader understanding of the perception of these group of farmers concerning their sources of risk and the risk management strategies adopted in managing these risks. However, this would not have a significant impact on the study since Saskatchewan is a leading producer of these crops especially wheat and canola.

Another limitation has to do with the use of online and internet-based survey. Online based survey was thought of as the best means of reaching producers since contact

details of respondents was not known. The use of the internet to administer the questionnaire could have potentially created the possibility of not reaching some producers especially those with no or poor internet connection. The 2016 census of Agriculture reports about 61.3% of farms used internet for farm business out of which 51.2% have access to high speed (Statistics Canada, 2016). This is a significant improvement in internet access among farm population in Saskatchewan and therefore, this limitation should be of little concern.

The literature on best-worst scaling indicates that when the number of choice sets to be performed by respondents are too many, sensory fatigue could become a problem. However, this was mitigated by reducing the number of tasks to be performed. Furthermore, respondents completed all the BWS tasks, so I presume that these tasks were not overly burdensome.

Since Alberta and Manitoba are also major producers of grains and oilseed, especially wheat and canola, future research should seek to expand the sample size to include farmers from these provinces and farmers producing other commodities. This will help provide a broader perspective on the perception of grain and oilseed producers and others in relation to their most important risk and risk management strategies. Such studies will also provide the opportunity to compare if there are significant differences in the perception of risk and risk management strategies among farmers in these provinces. For example, the government of Alberta has in place the agriculture drought and excess moisture risk management plan aimed at helping farmers to reduce production risks caused by drought and excess moisture. Such programs all other things being equal would affect the risk perception of farmers. Most studies that have looked at risk management in agriculture have adopted the traditional scaling approaches such as the Likert scale type in understanding farmers' perception of risk and risk management strategies. Future studies can use the best-worst which as mentioned in the methodology chapter, is able to overcome the limitations of these traditional approaches.

5.4. Conclusions

The thesis has identified several risks and risk management strategies considered important by grain and oilseed farmers in Saskatchewan. Moreover, other risks and risk management strategies considered least important by these group of farmers were also outlined. The results from the study suggest that marketing and production risks were more important to producers in their farm business. In relation to their important risk management strategies, production and financial risk management strategies were perceived most important, however financial risk management strategy such as forward contracting was also ranked important by farmers. The results also suggest the existence of unique clusters of producers based on their perception of sources of risk and risk management strategies. This suggests that encouraging adoption of a universal risk management strategies will be less effective since producers have different perception of risk management strategies that are more important to them. The information should guide policies makers and service providers in designing strategies that suit the specific needs of farmers.

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7. APPENDICES

Appendix 1: Saskatchewan Grain and Oilseed Producer Survey

We would want you to help us better understand your sources of risks and risk management strategies by answering the following questions to the best of your knowledge.

Researcher: Eric Micheels, Department of Agriculture and Resource Economics, University of Saskatchewan, Saskatoon, SK
Phone: 306-966-8411 Email: eric.micheels@usask.ca

Purpose of research: This study is to understand the sources of risk of farmers and the strategies adopted to manage these risks and the challenges farmers are saddle with. Your responses are therefore needed about some questions on your sources of risk and your risk management strategies. The information collected will be used to develop a Master's Thesis in the Department of Agriculture and Resource Economics at the University of Saskatchewan.

The survey is expected to take not more than 30 minutes of your time.

Participation and Right to Withdraw:
Your participation in the research is completely voluntary and that you may choose not to participate or stop participating in the study at any time, for any reason, if you so decide. Your decision to stop participating, or to refuse to answer particular questions, will not affect your relationship with the researcher, University of Saskatchewan or any other group associated with this study.

Potential Benefits: Your participation in the study will help provide an updated information on sources of risk, sources of information and risk management strategies of farmers. This will help inform farm advisors and provide the needed information to guide policy directions.

Potential Risks: No known risks to participating in this survey

Storage of Data: The information provided in the survey will be securely stored by the Information Technology Division at the University of Saskatchewan. The data will be destroyed, after at least 5 years, when it is no longer required.

Confidentiality: Data will be combined and aggregated to protect individual respondents and conclusions will be published in both print and electronic format. These data will be used to develop a Master's Thesis and may also be used for conference presentations, or publication in academic journals. Anonymity of participants will be ensured in any manner of presenting the data.

Question about the research

Any questions concerning the research or your role as participant in the study should be directed to the researcher using the numbers or emails provided above.

This study has received ethical approval from the University of Saskatchewan Research Ethics Board. Any questions regarding your rights as a participant may be addressed to that committee through the Research Ethics Office ethics.office@usask.ca (306) 966-2975.

Consent to Participate: *I have read and understood the description provided above and consent to participate in the study. I understand that by completion of this survey, I give permission for the researcher to use the data gathered in the manner described*

☐ I Accept

☐ I decline

Qualifies

A. Do you produce grains or oilseed crops?

[IF YES CONTINUE]

[IF NO, THANKS AND TERMINATE]

B. Do you have any role in taking decisions in your farm operation?

[IF YES CONTINUE]

[IF NO, THANK AND TERMINATE]

SURVEY

1. Your farm is a ..... (Check one box only)

☐ Sole proprietorship

☐ Family owned corporation

☐ Partnership

☐ Corporation with outside investors

2. Over the past 3 years, what specific crops/animals have been produced in your farm? (**Check all that apply)**

Crops	**2014**	**2015**	**2016**
Wheat	☐	☐	☐
Barley	☐	☐	☐
Oat	☐	☐	☐
Corn	☐	☐	☐
Canola	☐	☐	☐
Soybean	☐	☐	☐
Sunflower	☐	☐	☐
Flax	☐	☐	☐
Lentils	☐	☐	☐
Chickpeas	☐	☐	☐
Hogs	☐	☐	☐
Dairy	☐	☐	☐
Beef	☐	☐	☐
Poultry	☐	☐	☐
Other (please specify)			

Federal and provincial governments work together to provide programs designed to support farmers cope with risk in their operations (Example: AgriInsurance, AgriStability, AgriInvest, AgriRecovery). We will like to seek your opinion on these programs.

3. Indicate which of the following government support programs do you participate in

Program	**Check all that apply**
AgriInsurance	☐
AgriInvest	☐
AgriStability	☐
AgriRecovery	☐

4. If you checked any of the programs in question 8, on a scale of 1-5 indicate your agreement or disagreement as to how participation in the program(s) has helped your farm business to cope with the following risks?

1 2 3 4 5

Strongly Agree Agree Neutral Disagree strongly Disagree

A.

Program	**Production Risk**				
	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
AgriInsurance	○	○	○	○	○
AgriStability	○	○	○	○	○
AgriInvest	○	○	○	○	○
AgriRecovery	○	○	○	○	○

B.

Program	**Marketing Risk**				
	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
AgriInsurance	○	○	○	○	○
AgriStability	○	○	○	○	○
AgriInvest	○	○	○	○	○
AgriRecovery	○	○	○	○	○

C.

Program	**Financial Risk**				
	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
AgriInsurance	○	○	○	○	○
AgriStability	○	○	○	○	○
AgriInvest	○	○	○	○	○
AgriRecovery	○	○	○	○	○

5. Indicate from below which of the following insurance programs you are enrolled in?

Program	**Check all that apply**
Fire insurance	☐
Liability/property insurance	☐
Life insurance	☐

Global Ag Risk Solutions (GARS) is a new private multi-peril insurance product that insures or covers farmers' seeds, fertilizer and chemical costs as well as a specific amount of revenue per acre.

6. Have you heard of the Global Ag Risk Solutions?

☐ Yes ☐ No

7. If you answered Yes to question 11, are you enrolled in Global Ag Risk Solutions?

☐ Yes ☐ No

[IF YES CONTINUE TO 13 OTHERWISWE SKIP TO QUESTION 14]

8. How would you rate your level of satisfaction with the Global Ag Risk Solutions

Very satisfied	Satisfied	Neither	Dissatisfied	Very dissatisfied
◯	◯	◯	◯	◯

9. Apart from income from your farm, do you earn income from any other source?

☐ Yes

☐ No

Risk Attitude

10. On a scale of 1-4 indicate the extent to which you agree or disagree with the following statements

1	2	3	4	5
Strongly Agree	Agree	Neutral	Disagree	strongly Disagree

a. I prefer to know with certainty the financial returns of my farm business in my production activities.

1	2	3	4	5
◯	◯	◯	◯	◯

b. In my production, I am always willing to take risk in order to realize higher average price and returns

1	2	3	4	5
◯	◯	◯	◯	◯

c. I have no problem making risky decisions if the perceived benefit is high

1	2	3	4	5
◯	◯	◯	◯	◯

d. I like taking risk in marketing my produce in order to realize greater average returns

1	2	3	4	5
◯	◯	◯	◯	◯

e. Playing it safe is better in making production, marketing or financial decisions

1	2	3	4	5
◯	◯	◯	◯	◯

Control of Risk

11. On a scale of 1-4 indicate the extent to which you agree or disagree with the following statements

1	2	3	4	5
Strongly Agree	Agree	Neutral	Disagree	strongly Disagree

a. I feel in control of the risks in my farm business due to my existing risk management strategies?

1	2	3	4	5
◯	◯	◯	◯	◯

b. Whether or not I'm successful in managing or coping with risks depends mostly on my own ability

1	2	3	4	5
◯	◯	◯	◯	◯

c. To a great extent, risk exposures in my farm business are determined by factors beyond my control?

1	2	3	4	5
◯	◯	◯	◯	◯

d. Whether or not I am Success in my farm business is mostly a matter of luck

1	2	3	4	5
◯	◯	◯	◯	◯

e. It is not advisable to plan too far ahead by enhancing my current risk management strategies because incidences of risk in my farm are such that they cannot be fully prevented

1	2	3	4	5
◯	◯	◯	◯	◯

f. To a great extent, incidences of risks in my farm business are determined by the risk management practices I have in existence

1	2	3	4	5
◯	◯	◯	◯	◯

Sources of Risk

12. We will like to understand what you perceive to be the most significant risk management strategy to your farm enterprise. For each of the following 16 choice sets, tick (click) the ONE source of risk you consider MOST important and the ONE considered LEAST important to your farm business

Most Important (Tick one)	**Of these sources of risks which will you consider as the most and least important to your farm operation**	**Least Important (Tick one)**
☐	Change in product prices	☐
☐	Change in world economic or political environment	☐
☐	Change in Government or producer policies	☐
☐	Change in input prices	☐

For the 2nd choice sets, tick the ONE source of risk you consider MOST important and the ONE considered LEAST important to your farm business.

Most Important (Tick one)	**Of these sources of risks which will you consider as the most and least important to your farm operation**	**Least Important (Tick one)**
☐	Unable to meet quality requirements	☐
☐	Changes in interest rate	☐
☐	Availability of loan funds	☐
☐	Use of leverage	☐

For the 3rd choice sets, tick the ONE source of risk you consider MOST important and the ONE considered LEAST important to your farm business.

Most Important (Tick one)	**Of these sources of risks which will you consider as the most and least important to your farm operation**	**Least Important (Tick one)**
☐	Degree of debt to capital	☐
☐	Rainfall variability	☐
☐	Diseases and pest	☐
☐	Changes in Technology	☐

For the 4th choice sets, tick the ONE source of risk you consider MOST important and the ONE considered LEAST important to your farm business.

Most Important (Tick one)	**Of these sources of risks which will you consider as the most and least important to your farm operation**	**Least Important (Tick one)**
☐	Natural disaster	☐
☐	Accidents and disability	☐
☐	Unable to meet contract obligations	☐
☐	Cost of securing information	☐

For the 5th choice sets, tick the ONE source of risk you consider MOST important and the ONE considered LEAST important to your farm business.

Most Important (Tick one)	**Of these sources of risks which will you consider as the most and least important to your farm operation**	**Least Important (Tick one)**
☐	Changes in product price	☐
☐	Unable to meet quality requirement	☐
☐	Degree of debt to capital	☐
☐	Natural disaster	☐

For the 6th choice sets, tick the ONE source of risk you consider MOST important and the ONE considered LEAST important to your farm business.

Most Important (Tick one)	**Of these sources of risks which will you consider as the most and least important to your farm operation**	**Least Important (Tick one)**
☐	Changes in world economic or political environment	☐
☐	Changes in interest rate	☐
☐	Rainfall variability	☐
☐	Accident and disability	☐

For the 7th choice sets, tick the ONE source of risk you consider MOST important and the ONE considered LEAST important to your farm business.

Most Important (Tick one)	**Of these sources of risks which will you consider as the most and least important to your farm operation**	**Least Important (Tick one)**
☐	Changes in government or producer policies	☐
☐	Availability of loan funds	☐
☐	Pest and diseases	☐
☐	Unable to meet contract obligations	☐

For the 8th choice sets, tick the ONE source of risk you consider MOST important and the ONE considered LEAST important to your farm business.

Most Important (Tick one)	**Of these sources of risks which will you consider as the most and least important to your farm operation**	**Least Important (Tick one)**
☐	Change in input prices	☐
☐	Use of leverage	☐
☐	Changes in technology	☐
☐	Cost of securing information	☐

For the 9th choice sets, tick the ONE source of risk you consider MOST important and the ONE considered LEAST important to your farm business

Most Important (Tick one)	**Of these sources of risks which will you consider as the most and least important to your farm operation**	**Least Important (Tick one)**
☐	Change in product prices	☐
☐	Change in interest rate	☐
☐	Cost of securing information	☐
☐	Pests and diseases	☐

For the 10th choice sets, tick the ONE source of risk you consider MOST important and the ONE considered LEAST important to your farm business

Most Important (Tick one)	**Of these sources of risks which will you consider as the most and least important to your farm operation**	**Least Important (Tick one)**
☐	Change in government and producer policies	☐
☐	Use of leverage	☐
☐	Degree of debt to capital	☐
☐	Accidents and disability	☐

For the 11th choice sets, tick the ONE source of risk you consider MOST important and the ONE considered LEAST important to your farm business

Most Important (Tick one)	**Of these sources of risks which will you consider as the most and least important to your farm operation**	**Least Important (Tick one)**
☐	Change in input prices	☐
☐	Availability of loan funds	☐
☐	Rainfall variability	☐
☐	Natural disasters	☐

For the 12th choice sets, tick the ONE source of risk you consider MOST important and the ONE considered LEAST important to your farm business

Most Important (Tick one)	**Of these sources of risks which will you consider as the most and least important to your farm operation**	**Least Important (Tick one)**
☐	Change in world economic and political environment	☐
☐	Unable to meet quality requirement	☐
☐	Changes in technology	☐
☐	Unable to meet contract obligations	☐

For the 13th choice sets, tick the ONE source of risk you consider MOST important and the ONE considered LEAST important to your farm business

Most Important (Tick one)	**Of these sources of risks which will you consider as the most and least important to your farm operation**	**Least Important (Tick one)**
☐	Change in product prices	☐
☐	Unable to meet contract obligations	☐
☐	Rainfall variability	☐
☐	Use of leverage	☐

For the 14th choice sets, tick the ONE source of risk you consider MOST important and the ONE considered LEAST important to your farm business

Most Important (Tick one)	**Of these sources of risks which will you consider as the most and least important to your farm operation**	**Least Important (Tick one)**
☐	Change in government and producer policies	☐
☐	Change in interest rate	☐
☐	Change in technology	☐
☐	Natural disasters	☐

For the 15th choice sets, tick the ONE source of risk you consider MOST important and the ONE considered LEAST important to your farm business

Most Important (Tick one)	**Of these sources of risks which will you consider as the most and least important to your farm operation**	**Least Important (Tick one)**
☐	Change in input prices	☐
☐	Unable to meet quality requirements	☐
☐	Pests and diseases	☐
☐	Accidents and disability	☐

For the 16th choice sets, tick the ONE source of risk you consider MOST important and the ONE considered LEAST important to your farm business

Most Important (Tick one)	**Of these sources of risks which will you consider as the most and least important to your farm operation**	**Least Important (Tick one)**
☐	Change in world economic and political environment	☐
☐	Availability of loan funds	☐
☐	Degree of debt to capital	☐
☐	Cost of securing information	☐

Risk Management Strategies

13. We will like to understand what you perceive to be the most significant risk management strategy to your farm enterprise. For each of the following choice sets, tick (click) the ONE risk management strategy you consider MOST important and the ONE considered LEAST important to manage risk in your farm business

Most Important (Tick one)	**Of these risk management strategies, which will you consider as the most and least important to manage risk in your farm operation**	**Least Important (Tick one)**
☐	Getting market information	☐
☐	Spreading sales	☐
☐	Diversification	☐
☐	Producing at low cost	☐

For the 2nd choice sets, tick the ONE strategy you consider MOST important and the ONE considered LEAST important to manage risk in your farm business

Most Important (Tick one)	**Of these risk management strategies, which will you consider as the most and least important to manage risk in your farm operation**	**Least Important (Tick one)**
☐	Forward contracting	☐
☐	Use of future markets	☐
☐	Off-farm investment	☐
☐	Reducing debt level	☐

For the 3rd choice sets, tick the ONE strategy you consider MOST important and the ONE considered LEAST important to manage risk in your farm business

Most Important (Tick one)	**Of these risk management strategies, which will you consider as the most and least important to manage risk in your farm operation**	**Least Important (Tick one)**
☐	Keeping financial reserve/working capital	☐
☐	Buying crop insurance	☐
☐	Replacing labour with machinery	☐
☐	Having seed reserve	☐

For the 4th choice sets, tick the ONE strategy you consider MOST important and the ONE considered LEAST important to manage risk in your farm business

Most Important (Tick one)	**Of these risk management strategies, which will you consider as the most and least important to manage risk in your farm operation**	**Least Important (Tick one)**
☐	Implementing pest and diseases control programs	☐
☐	Having farm reservoir/irrigation	☐
☐	Participating in government support programs	☐
☐	Working off-farm	☐

For the 5th choice sets, tick the ONE strategy you consider MOST important and the ONE considered LEAST important to manage risk in your farm business

Most Important (Tick one)	**Of these risk management strategies, which will you consider as the most and least important to manage risk in your farm operation**	**Least Important (Tick one)**
☐	Getting market information	☐
☐	Forward contracting	☐
☐	Keeping financial reserve/working capital	☐
☐	Implementing pests and diseases control programs	☐

For the 6th choice sets, tick the ONE strategy you consider MOST important and the ONE considered LEAST important to manage risk in your farm business

Most Important (Tick one)	**Of these risk management strategies, which will you consider as the most and least important to manage risk in your farm operation**	**Least Important (Tick one)**
☐	Spreading sales	☐
☐	Use of future markets	☐
☐	Buying crop insurance	☐
☐	Having farm reservoir/irrigation	☐

For the 7th choice sets, tick the ONE strategy you consider MOST important and the ONE considered LEAST important to manage risk in your farm business

Most Important (Tick one)	**Of these risk management strategies, which will you consider as the most and least important to manage risk in your farm operation**	**Least Important (Tick one)**
☐	Diversification	☐
☐	Off-farm investment	☐
☐	Replacing labour with machinery	☐
☐	Participating in government support programs	☐

For the 8th choice sets, tick the ONE strategy you consider MOST important and the ONE considered LEAST important to manage risk in your farm business

Most Important (Tick one)	**Of these risk management strategies, which will you consider as the most and least important to manage risk in your farm operation**	**Least Important (Tick one)**
☐	Producing at low cost	☐
☐	Reducing debt level	☐
☐	Having seed reserve	☐
☐	Working off-farm	☐

For the 9th choice sets, tick the ONE strategy you consider MOST important and the ONE considered LEAST important to manage risk in your farm business

Most Important (Tick one)	**Of these risk management strategies, which will you consider as the most and least important to manage risk in your farm operation**	**Least Important (Tick one)**
☐	Getting market information	☐
☐	Use of future markets	☐
☐	Working off-farm	☐
☐	Replacing labour with machinery	☐

For the 10th choice sets, tick the ONE strategy you consider MOST important and the ONE considered LEAST important to manage risk in your farm business

Most Important (Tick one)	**Of these risk management strategies, which will you consider as the most and least important to manage risk in your farm operation**	**Least Important (Tick one)**
☐	Diversification	☐
☐	Reducing debt level	☐
☐	Keeping financial reserve/working capital	☐
☐	Having farm reservoir/irrigation	☐

For the 11th choice sets, tick the ONE strategy you consider MOST important and the ONE considered LEAST important to manage risk in your farm business

Most Important (Tick one)	**Of these risk management strategies, which will you consider as the most and least important to manage risk in your farm operation**	**Least Important (Tick one)**
☐	Buying crop insurance	☐
☐	Implementing pests and diseases control programs	☐
☐	Producing at low cost	☐
☐	Off-farm investment	☐

For the 12th choice sets, tick the ONE strategy you consider MOST important and the ONE considered LEAST important to manage risk in your farm business

Most Important (Tick one)	**Of these risk management strategies, which will you consider as the most and least important to manage risk in your farm operation**	**Least Important (Tick one)**
☐	Forward contracting	☐
☐	Participating in government support programs	☐
☐	Spreading sales	☐
☐	Keeping seed reserve	☐

For the 13th choice sets, tick the ONE strategy you consider MOST important and the ONE considered LEAST important to manage risk in your farm business

Most Important (Tick one)	**Of these risk management strategies, which will you consider as the most and least important to manage risk in your farm operation**	**Least Important (Tick one)**
☐	Reducing debt level	☐
☐	Buying crop insurance	☐
☐	Participating in government support programs	☐
☐	Getting market information	☐

For the 14th choice sets, tick the ONE strategy you consider MOST important and the ONE considered LEAST important to manage risk in your farm business

Most Important (Tick one)	**Of these risk management strategies, which will you consider as the most and least important to manage risk in your farm operation**	**Least Important (Tick one)**
☐	Having seed reserve	☐
☐	Diversification	☐
☐	Implementing pests and diseases control program	☐
☐	Use of future markets	☐

For the 15th choice sets, tick the ONE strategy you consider MOST important and the ONE considered LEAST important to manage risk in your farm business

Most Important (Tick one)	**Of these risk management strategies, which will you consider as the most and least important to manage risk in your farm operation**	**Least Important (Tick one)**
☐	Forward contracting	☐
☐	Producing at low cost	☐
☐	Having farm reservoir/irrigation	☐
☐	Replacing labour with machinery	☐

For the 16th choice sets, tick the ONE strategy you consider MOST important and the ONE considered LEAST important to manage risk in your farm business

Most Important (Tick one)	**Of these risk management strategies, which will you consider as the most and least important to manage risk in your farm operation**	**Least Important (Tick one)**
☐	Working off-farm	☐
☐	Keeping financial reserve/working capital	☐
☐	Off-farm investment	☐
☐	Spreading sales	☐

We would like to know you and your farm business operations. The following questions are designed to tell us a little about you and your farm operations

14. Please indicate your gender

☐ Female

15. Which year you were born?

16. What is the highest level of Education you have completed?

☐ High school

☐ College education

☐ University education

☐ Graduate School

☐ Never attended school

☐ Other please specify

17. How many years have you been working as a farmer?

☐ Less than 10 years

☐ 11-20 years

☐ 21-30 years

☐ 31-40 years

☐ Over 40 years

18. Which of the following best describe your gross sales from your farm business in the past year?

Less than $100K	$100K to $249K	$250K to $499K	$500K to $749K	$750K to $1,000K	$1,000K to $1,500K	Greater than $1,500K	Don't Know/Refused
◯	◯	◯	◯	◯	◯	◯	◯

19. Currently, what is your debt to asset ratio? $(\frac{Total\ Debt}{Total\ Assets})*100$

0%	0.01% to 9.99%	10.00% to 24.99%	25.00% to 49.99%	Greater than 50%	Don't Know/Refused
◯	◯	◯	◯	◯	◯

20. Which of the following best describe your annual household income?

☐ Less than $ 49.999k

☐ $50-$99k

☐ $100-$150k

☐ Greater than $150k

Appendix 2: Ordered Probit Model

Tables A2.1 a and b show results of the ordered probit model

Table A2.1a: Ordered Probit model with Significant Variables

Variables	Getting market information			Producing at low cost			Keeping Financial reserve			Pest and diseases Control programs		
	coefficient	SE	PV	coefficient	SE	PV	coefficient	SE	PV	coefficient	SE	PV
Variations in product prices	.048	.033	.15	.095**	.035	.01						
Variations in input prices	-.041	.034	.22	.160***	.035	.00	.036	.034	.30			
Rainfall variability							.042	.027	.12			
Pests and diseases				.072**	.030	.02				.288***	.030	.00
Accident and health				.031	.023	.18	.078***	.024	.00			
Natural disaster												
Unable to meet quality Requirement	.062**	.030	.04				-.070**	.031	.03	.041	.028	.15
Degree of debt to capital							-.025	.029	.38			
Change in interest rate				-.029	.029	.31	-.073**	.031	.02			
Use of leverage							-.091**	.034	.01			
Sales	.062**	.030	.04				.024	.031	.42	.083**	.030	.01
Gender	.273**	.122	.03	-.124	.125	.32						
Experience							-.083	.057	.14			
Age				.009 **	.003	.01	.010	.006	.07	.011	.003	.00
Education												
Household income	-.053	.048	.27	.041	.048	.40						

*p<0.1, **p<0.05, ***p<0.00

The results suggest farmers who have concerns with their inability to meet quality requirements are more likely to consider *getting market information* important risk management strategy. Also increase in sales increase the probability of considering this strategy important and a male farmer is more likely to use the strategy. Moreover, *producing at low cost, keeping financial reserve* and *implementing pests and diseases control programs* are likely to be considered important risk strategies by farmers who believe *variation in output and input prices, pests and diseases, accident and health* are important sources of risk. However, *keeping financial reserve* is less likely to be used as a strategy when it comes to managing *use of leverage, inability to meet quality requirement* and *variation in interest rate*.

Table A2.1b. Ordered Probit Model with Significant Variables

Variables	Reducing Debt Level			Buying Crop insurance			Diversification			Forward contracting			Gov't Support programs		
	COEFF	SE	PV	COEFF	SE	PV	COEFF	SE	PV	COEFF	SE	PV	COEFF	SE	PV
Variations in product prices							.060*	.034	.08	-.021	.033	.53			
Variations in input prices	-.017	.030	.58				-.089**	.035	.01	-.042	.035	.23			
Rainfall variability										-.050**	.025	.04	-.015	.026	.56
Pests and diseases				.026	.030	.38	-.035	.029	.24	-.079**	.029	.01			
Accident and health	.040*	.021	.05							-.045*	.023	.05			
Natural disaster				-.006	.025	.81							.037	.025	.14
Unable to meet Quality requirement							.055*	.030	.07	.044	.030	.14			
Degree of debt to capital	.185***	.026	.00												
Change in interest rate	.096***	.028	.00												
Use of leverage	-.066**	.030	.03												
Sales							-.022	.031	.48	.181***	.031	.00			
Gender	.212*	.109	.05							.237*	.120	.05	.219	.122	.07
Experience	.060	.051	.24				.069	.058	.23						
Age	-.007	.005	.14	.007*	.003	.05	-.005	.006	.33	-.004	.003	.20	.005	.003	.18
Education	-.148	.090	.10	.113	.010	.24									
Household income				.045	.047	.34	.031	.048	.52				.055	.047	.24

*p<0.1, **p<0.05, ***p<0.001

Reducing debt level was more likely to be considered important risk management strategy for farmers who find *accident and health*, *degree of debt to capital* and *changes in interest rate* most important sources of risks to their farm business. Nevertheless, they are less likely to use *reducing debt level* to manage risk related to the *use of leverage*. Similar to the results from the OLS analysis, none of the sources of risks included in the model were found to have significant association with *buying crop insurance* as a management strategy with age as exception which has a positive association with the strategy. While *diversification* is less likely to be used to manage risk related to *variation in input prices*, it is more likely to be considered important in managing risks associated with *variation in output prices* and *inability to meet quality requirement*. Unexpectedly, *forward contracting* was found to have no significant association with *variation in output and input prices*, but the strategy is less likely to be used to manage risk related to *rainfall variability*, *pests and diseases* and *accident and health*. Results on *participating in government support program*s was similar to that on *buying crop insurance* as the variables were not significant.