# Identifying Barriers and Drivers of Early Soybean Adoption in Saskatchewan

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## Abstract

Key Words: Adoption, Extension, Soybeans, Saskatchewan

The introduction of earlier maturing soybean varieties into Western Canada has created an opportunity for Saskatchewan farmers to add a new crop into their rotations. However, farmers may be hesitant to adopt soybeans if they have less information or knowledge on growing soybeans than they do with other crops they are currently growing. Extension services can provide learning opportunities for farmers and reduce the uncertainty around growing soybeans. Collaborative extension services have been organized by the Saskatchewan Pulse Growers to facilitate adoption of soybeans in Saskatchewan. This thesis aims to assist extension service providers in the designing of future extension services by identifying factors that lead farmers to adopt, not-adopt, or dis-adopt soybeans, as well as identifying factors shared between these three adopter categories. With less than one percent of Saskatchewan cropland in soybeans, this research is studying the very early stages of adoption.

Interviews were conducted with 39 farmers throughout southern Saskatchewan in the summer of 2016. Of these farmers, 16 were currently growing soybeans, 10 had grown them in the past, and 13 had never grown soybeans. Through these interviews, economic factors, agronomic factors, and farm characteristics that influence the decision to adopt soybeans were identified. Social capital and absorptive capacity were studied to look at the function they serve in assisting farmers past barriers to adoption. The role and availability of extension services was also examined.

A probit model was developed to study the factors that influenced the decision to adopt soybeans. Results from the probit model show that absorptive capacity has a significant positive effect on the probability of adopting soybeans. Required gross return per acre is found to have a negative impact on the adoption decision.

An OLS model was run with years growing soybeans as the dependent variable to analyze the factors that led to farmers growing soybeans for a longer period. Results from the model show expected profitability of soybeans and participation in on-farm soybean trials have a significant positive effect on the number of years growing soybeans. Age had a quadratic impact

on years growing with the longest years growing at the age of 41. Social capital and absorptive capacity had a discernible impact.

Farmers reported they are satisfied with the amount of support and information available to them about growing soybeans, signalling extension services are functioning very well. Involvement in on-farm soybean trials had a significant positive effect on the number of years growing soybeans implying the importance for extension service providers to continue to create these opportunities for farmers. When asked to identify barriers to adoption, the need for higher soybean yields and earlier maturity dominated the response. Farmers in the sample also favoured further investments in breeding over agronomic research.

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# 1.0 Introduction

## 1.1 Background & Rationale

Innovation and technological improvements play a very important role in the advancement of the agricultural industry (Maertens & Barrett, 2012). Innovation can be thought of as a change in routine for farmers (Micheels & Nolan, 2016). A change in routine could be adopting a new technology, crop, or machinery, or it could be a change in production practices with existing technology (Micheels & Nolan, 2016). Farm-level innovation is important for Canadian farmers to increase their competitiveness not only with other local farmers, but also internationally (Micheels & Nolan, 2016). The Agri-Innovators Committee organized by Agriculture and Agri-Food Canada (AAFC), states that to reach the full growth potential of the agricultural industry, "we need to maximize innovation capacity across the entire value chain" (AAFC, 2015). The main long-term challenge that the committee identified to maximizing innovation was an underinvestment in research and development (AAFC, 2015).

Increasing investment into research and development to facilitate innovation will only increase innovation at the farm-level if information can be effectively communicated between extension agents, industry professionals, and farmers (Knickel et al. 2009). Knickel et al. (2009) state that often "there is a gap between the need for change and farmers' willingness to adjust, and the insufficient capacities of innovation agencies and advisory services to effectively support changes" (Knickel et al. 2009, pp. 134). Historically, adoption of innovations was thought of as a linear process where knowledge would flow down a formalized supply chain to the end user (Leeuwis & Aarts, 2011). In this linear model, research stopped too early in the diffusion process and farmers and extension agents were left without enough knowledge on the innovation (Roling, 1990). However, a much more efficient model is a continuous, dynamic innovation process that involves collaborative learning networks between researchers, extension agents, and farmers (Roling, 1990; Knickel et al. 2009). Therefore, technical and economic factors can not alone explain the innovation process; social, learning, and institutional aspects of the industry also need to be considered (Knickel et al. 2009).

With interest in soybeans continuing to spread west across the Canadian Prairies, there is an opportunity to study the barriers and drivers of adoption. Previous research has shown how a lack of accurate information can act as a barrier to adoption for a new crop (Marra, Pannell &

Abadi Ghadim, 2003; Abadi Ghadim, Pannell & Burton, 2005; Llewellyn, 2007). Information may be available to farmers; however, this information will need to be complete, unbiased, and relevant to growing soybeans in the province to be deemed accurate for Saskatchewan farmers. Extension services can act as a solution to this barrier by providing farmers with timely and accurate information. Extension services that involve two-way communication between extension agents and farmers are important during the adoption stages of an innovation to not only provide farmers with information but also identify the barriers they are facing (Birkhaeuser, Evernson & Feder, 1991). Collaborative extension services have been organized in the province with the goal of facilitating soybean adoption. This thesis aims to support the current work being done with extension services by providing an in-depth look at the barriers farmers are facing and identifying characteristics of different adopter categories. By identifying the current barriers to adoption, as well as looking at the role social and learning factors play in the adoption decision, would help to narrow the gap between research, innovation and final adoption at the farm-level.

### 1.1.1 Soybeans in Canada

Soybeans (*Glycine max*), are a member of the Fabaceae or legume family (USDA, 2015). Soybeans are a major world-wide commodity and there are many end uses for the crop. The whole soybean seed can be used in food markets for the creation of soy beverages, tofu, and miso (Soy Canada, 2015a). The oil can also be extracted from the seed and used as an edible food oil and for industrial purposes (Soy Canada, 2015a). Both the protein and the hulls of soybeans left over after the oil extraction can also be used for animal feed, human consumption and industrial purposes (Soy Canada, 2015a).

Soybeans have a large economic impact in Canada, contributing $5.6 billion to Canada's gross domestic product (Soy Canada, 2016). Soybeans are the third largest field crop in Canada generating $2.3 billion in farm cash receipts in 2015 (Statistics Canada CANSIM 002-0001, 2016). Production of soybeans has been steadily increasing at the national level reaching 5,467,100 seeded acres in the 2016 crop year (Statistics Canada CANSIM 001-0017, 2017). In Canada, Ontario was the province with the largest soybean production in 2016, at 2,710,000 seeded acres (Statistics Canada CANSIM 001-0017, 2017). Following Ontario, was Manitoba with 1,635,000 acres and then Quebec with 803,100 acres (Statistics Canada CANSIM 001-0017, 2017). Saskatchewan was fourth in the country for soybean acreage in 2016 planting

240,000 acres, and the Maritime provinces had the smallest acreage at 79,000 seeded acres. (Statistics Canada CANSIM 001-0017, 2017). Soybean acres were down 30,000 acres in Saskatchewan in 2016 mainly due to attractive lentil prices (Statistics Canada, 2016).

### 1.1.2 Opportunity in Western Canada

Soybeans have only recently become an option for Saskatchewan farmers with the introduction of earlier maturing soybean varieties. Acres were first reported in the province in 2013, as shown in Figure 1.1 (Soy Canada, 2015b). Manitoba farmers have been growing soybeans for a much longer time frame with seeded acres first being reported in 2001 (Soy Canada, 2015b). The increase of soybean acres in Western Canada is driving the increase in soybean acres nationally. Soybean acres increased 17.3% in Manitoba in 2016, and acres are predicted to increase again in 2017 in both Manitoba and Saskatchewan (Statistics Canada, 2016; Heppner, 2017).

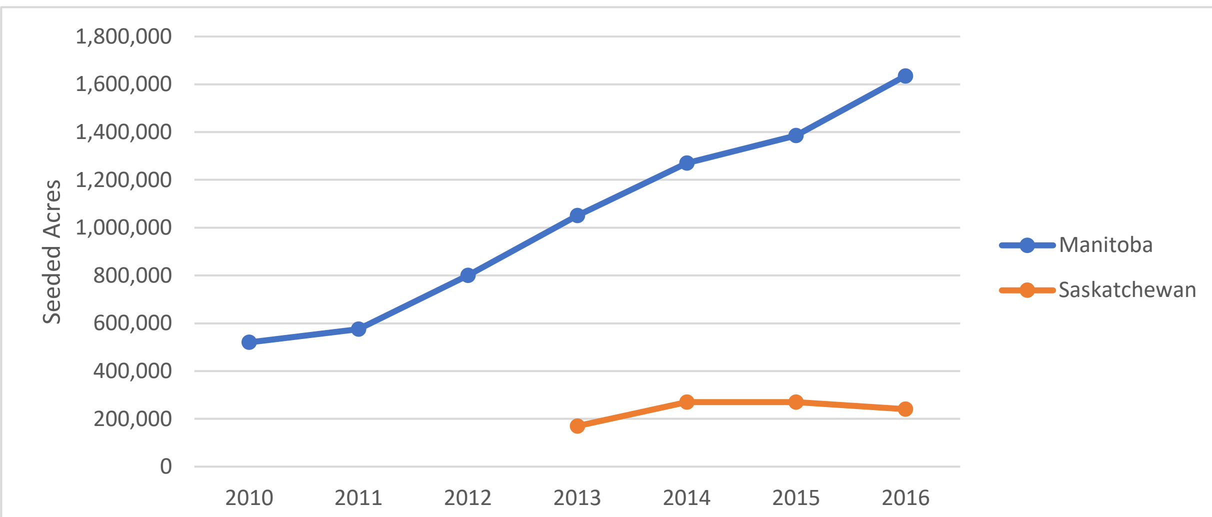


**Figure 1.1 Western Canadian Soybean Seeded Acres**

Source: (Statistics Canada CANSIM 001-0017, 2017)

Soybeans are a short-day warm season crop and they require enough heat to mature in time and reach their top yield potential (Saskatchewan Pulse Growers, 2015). Short-day refers to the photoperiod sensitivity of soybeans that they require shortened daylengths and longer nights to begin flowering (Kumudini & Tollenaar, 2000). When soybeans were first introduced to Canada, they had high heat unit requirements and were therefore almost exclusively grown in southern Ontario until the 1970's (Soy Canada, 2015b). In recent years, several seed companies and organizations have undertaken breeding programs to bring earlier maturing soybeans into the marketplace (Soy Canada, 2015b). These varieties have lower heat unit requirements and shorter photoperiod sensitivity to reach full maturity in Saskatchewan's shorter growing season. These earlier maturing varieties provide an opportunity for Western Canadian farmers to add another crop into their rotations. Currently, there are 24 early maturing soybean varieties available to Saskatchewan farmers for the 2017 crop year that are reported in the provincial seed guide (Saskatchewan Seed Growers Association, 2017). In 2017 alone, there are 24 new varieties being introduced in Manitoba and Saskatchewan (Minogue, 2016).

There are many factors making soybeans a good fit in Saskatchewan farmers' rotations. Climate change and changing weather patterns have led to increased precipitation and increased corn heat units being recorded. Corn heat units (CHUs) are used to measure the amount of "heat accumulated over the growing season specific to the physiological needs of a corn plant" (Fleury & Barker, 2015, pp. 1). Soybean maturity ratings also use CHUs as a measure of maturity (Fleury & Barker, 2015). The average CHU accumulations for Saskatchewan for 2010 and 2016 can be found in Appendix A. The maps show an increase in the average corn heat units for the province from 2084-2322 CHUs in 2010, to 2360-2570 CHUs in 2016 (AAFC, 2016). Higher average corn heat units are also seen in the far southeast corner of the province ranging from 2574-2788 CHUs which would make the number of varieties suitable for that region even higher (AAFC, 2016).

Besides corn heat units, the relative maturity system for soybeans is also important to determine varieties that would be suitable for Saskatchewan. The maturity group rating system was developed to give growers an idea on what varieties will reach maturity in time in their area (Fleury & Barker, 2015). In this system, varieties are classified into maturity groups from 000 in northern regions to IX in the southern United States (Fleury & Barker, 2015). These classifications are based on latitude ranges and photoperiod sensitivity, with each maturity region spanning one to two degrees of latitude or around 200 to 300 km from north to south (Fleury & Barker, 2015). The varieties that are most well-suited for production in Saskatchewan fall into the 000 and 00 categories (Fleury & Barker, 2015). Maturity rating is an important consideration for growers to make, as varieties grown north of their maturity area will increase the risk of lower yields and lower quality due to frost as the plant will not mature in time (Gabruch & Gietz, 2014).

Research into the genetics that influence early maturity and photosensitivity has been an important advancement in soybean research for the development of varieties suitable for Western Canada. Eight *Earliness* (*E*), loci have been identified in the soybean genome to affect flowering and maturity (Cober & Morrison, 2010). Cober & Morrison (2010) report these loci should be referred to as “photoperiod-sensitive loci” as “alleles at these loci control time to flowering and maturity through their response, or lack of response, to photoperiod” (Cober & Morrison, 2010, pp. 1005). Current research through the SoyaGen Genome Canada research project aims to improve yield potential and disease resistance of early maturing varieties through genotyping and building on the previous research done on identifying the *Earliness* loci (Genome Canada, 2015). Identification of these key DNA markers will greatly improve the soybean varieties that are bred for Canadian conditions (Genome Canada, 2015).

Increased precipitation is another factor making soybeans an attractive option for Saskatchewan farmers. In recent years, Saskatchewan has seen increasing levels of precipitation during the growing season, specifically in the south-east portion of the province as shown in Figure 1.2. This has created an opportunity for producers in these regions to add crops into their rotations with higher water requirements such as soybeans. Furthermore, soybeans give producers a legume crop to plant on wetter than average soils. Soybeans are better suited to excess moisture than competing legume crops such as peas or lentils, and therefore are being added in to the rotations of producers dealing with these growing conditions. Higher rainfall totals have led to water logged soils leading to an increase in fungal root pathogens and water molds such as *Pythium* and *Aphanomyces* root rots (Saskatchewan Pulse Growers, 2016). Certain seed treatments can provide control over the *Pythium* species, however there have been none developed for control of *Aphanomyces* (Saskatchewan Pulse Growers, 2016). Once these pathogen spores exist in the soil they can survive for many years, forcing farmers to stretch out the years between susceptible legume crops in their rotations up to six years (Saskatchewan Pulse Growers, 2016). Soybeans have been found to be resistant to *Aphanomyces*, giving farmers an option to keep a legume crop in their rotation if they need to reduce their acres of peas and lentils (Saskatchewan Pulse Growers, 2016).

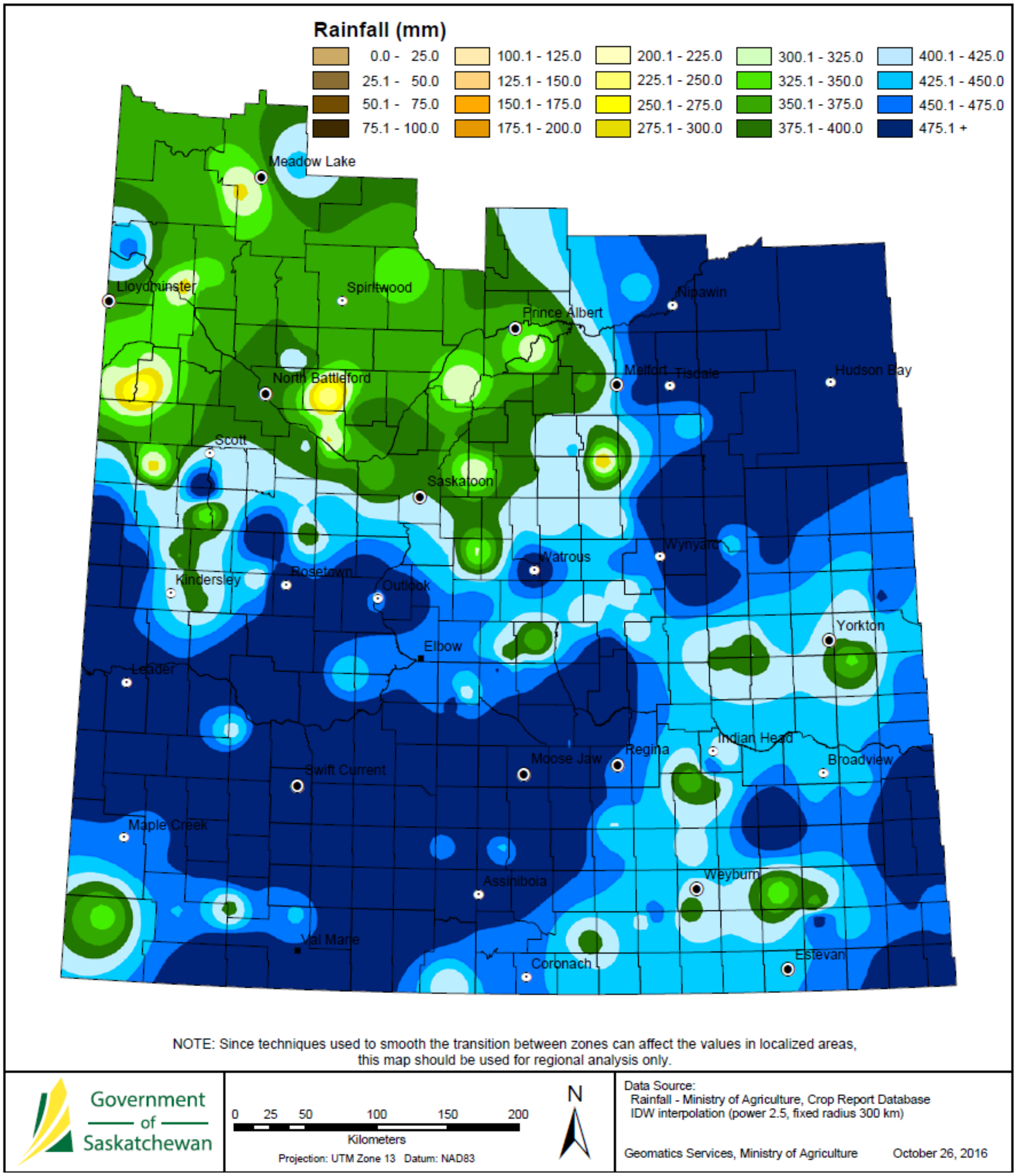


**Figure 1.2 Saskatchewan Accumulated Rainfall April 1, 2016- October 24, 2016**

Source: (Government of Saskatchewan, 2016b)

### 1.1.3 Soybean Extension Services

Farmers will only be willing to switch an existing crop in their rotation to soybeans if they are convinced that it will be a profitable addition to their crop rotation. A lack of accessible information will increase the uncertainty farmers have around soybeans, and therefore impede adoption (Marra, Pannell & Abadi Ghadim, 2003; Pannell et al. 2006). Furthermore, this information needs to be not only accessible, but also complete and come from a trustworthy source to farmers. Extension services are a way to create learning opportunities and provide resources to farmers to reduce a lack of information as a barrier to adoption. To help facilitate the adoption of soybeans in the province, the Saskatchewan Pulse Growers (SPG), organized a collaborative group called Soybean Cropportunity. This group aims to identify barriers to soybean adoption in the province and provide timely solutions and information to farmers.

The Soybean Cropportunity group was first organized by SPG in 2013, which was in the very early stages of soybean adoption in the province. The collaborative group has representation from all areas of the soybean industry. The group includes members from private seed and chemical companies, the Saskatchewan Ministry of Agriculture, Agriculture and Agri-Food Canada, SPG, Manitoba Pulse & Soybeans, Alberta Pulse Growers, Soy Canada, University of Saskatchewan weed scientists and plant breeders, public researchers, and farmers. The farmers who sit on this committee were selected as they were some of the first producers to grow soybeans in the province. The group meets annually to discuss current issues with soybean production and to identify research priorities. After the priorities are identified, tasks are divided up amongst group members to either help conduct future research or communicate information back to farmers. Furthermore, having representatives from outside of Saskatchewan is valuable to provide additional views on the adoption process in the province. Manitoba is much further ahead in the soybean adoption process; therefore, they have already dealt with many of the issues Saskatchewan is facing and can provide information on the steps they took. Alberta is at a similar stage of adoption as Saskatchewan, however they can still bring a different perspective to the issues being discussed.

## 1.2 Research Goal & Objectives

The goal of this thesis is to identify barriers and drivers to soybean adoption in Saskatchewan to assist in the designing of future extension services. This goal will be achieved by the following objectives:

Objective One: Identify economic and agronomic factors that are important in the adoption decision

Objective Two: Identify common characteristics between different adopter categories

Objective Three: Identify the role social capital and absorptive capacity play in the adoption decision

Objective Four: Identify current availability of extension services and information surrounding soybeans in the province

Identifying these factors and the issues producers are still facing, whether they are informational or technological, will assist the Soybean Cropportunity group and others in the industry, in designing future extension services and providing information to farmers.

## 1.3 Methodology Overview

To achieve the objectives outlined above, interviews were conducted with adopters, past-adopters, and non-adopters of soybeans throughout southern Saskatchewan. Studying past, present, and non-adopters of soybeans is an important contribution of this thesis to not only study factors that influence the adoption decision, but also the factors that influence farmers to continue growing soybeans. Identifying the factors that are important in both decisions will be useful for designing future extension services. For this research, adopters were defined as farmers who were currently growing soybeans, whereas past-adopters were farmers who had grown soybeans in the past but were not growing them currently. Past-adopters had not necessarily removed soybeans from their rotations for good, just for the current growing season. Non-adopters were farmers who had never grown soybeans.

The results from the interviews were analyzed using ANOVA analysis and t-tests to look at differences in characteristics between the three adopter categories. A probit model was developed to analyze the factors that influence farmers to adopt or not adopt soybeans. Analysis of the factors that influence farmers to grow soybeans for a longer period was also completed using an OLS model with years growing soybeans as the dependent variable.

## 1.4 Thesis Overview

Chapter Two will go over a review of the relevant literature for this thesis. It will start with a review of acreage response models and the factors that influence the acreage allocation decisions of farmers. As well, the idea of relative advantage will be reviewed around soybeans competing for a spot in a farmer's crop rotation. Next, adoption of innovations and how information can act as a barrier to adoption will be discussed. Previous studies of adoption of innovations in the agriculture sector will also be reviewed. The role of trials in the adoption decision for farmers will be outlined. Literature linking on-farm trials and networks will be discussed and lead into a review on social capital and the role it can play in the adoption process. Along with social capital, absorptive capacity will be examined and previous studies linking absorptive capacity to innovation.

Chapter Three describes the interview process and the sample of farmers who were interviewed. This chapter also provides a more in-depth description of the factors studied in the interviews and the measurement techniques used.

Chapter Four provides the descriptive statistics from the interviews and outlines differences found in the responses between the three adopter categories. The factors that farmers identify as the largest obstacles to growing soybeans in Saskatchewan will also be discussed.

Chapter Five presents the results from the data analysis done on the interview results. A probit model was run analyzing the factors that lead farmers to adopt or not-adopt soybeans. An ordinary least squares (OLS), model was also run looking at the effect factors have on the number of years growing soybeans.

Chapter Six provides a summary of the thesis and the main findings. Limitations of the thesis are also discussed, as well as future research that could be completed.

## 2.0 Literature Review

## 2.1 Introduction

The literature review covers the theory behind the factors and variables that influence a farmer's crop rotation decisions, as well as the decision to adopt a new crop. Literature on acreage response models is discussed to understand acreage allocation decisions. Theories of adoption and diffusion of an innovation, as well as relevant studies conducted in the agriculture sector will also be covered. Potential barriers to adoption will be discussed as well as solutions to these barriers. Previous studies on adoption of innovations in the agriculture industry provide the background theory for the variables and factors that will be studied around the adoption of soybeans in Saskatchewan.

This chapter is divided into four sections. The first section looks at acreage response models and the role expected profitability and risk play in the relative advantage of an innovation. The second section covers the main theories around adoption and diffusion. The third section goes over potential barriers to adoption including information. Previous studies in the agriculture sector are also discussed. The final section looks at factors that may assist farmers past barriers to adoption including social capital and absorptive capacity.

## 2.2 Searching for the Optimal Rotation- Acreage Response Models

Acreage response models are a useful tool for evaluating the effect of various economic factors on farmer's acreage allocation decisions in their crop rotations. The first studies on acreage response models focused on own price and prices of competing crops as the main drivers behind acreage allocation (Weersink, Cabas & Olale, 2010). Many of these first studies focused on evaluating the effect that agricultural support policies had on acreage allocation decisions (Weersink, Cabas & Olale, 2010; Lin & Dismukes, 2007; Chavas & Holt, 1990). However, recent studies also look at the role risk, yield potential, and changing climate patterns have on acreage allocation (Weersink, Cabas & Olale, 2010).

### 2.2.1 Importance of Net Returns

The profitability of each competing crop is a major driver behind acreage allocation decisions. Increases in the expected profitability of a crop is found to have a positive effect on acreage allocation decisions (Lin & Dismukes, 2007; Weersink, Cabas & Olale, 2010). Weersink, Cabas & Olale (2010) state that "the distribution of net returns to individual crops is the primary driver of area response function" (Weersink, Cabas & Olale, 2010, pp. 58). However, this net return will need to be split up into yield and price effects to fully understand the acreage decision (Weersink, Cabas & Olale, 2010). Many early acreage allocation models used crop prices alone as an explanatory profitability variable (Davison & Crowder, 1991). However, expected net return is often found to have more explanatory power than expected prices, as yield potential will also play an important role in acreage allocation decisions (Davison & Crowder, 1991). In their study, Davison & Crowder (1991) analyzed the acreage response for soybeans in the northeastern United States and the explanatory power of expected net return versus expected price. Their results showed that "expected net returns were as good or better than expected prices for estimating soybean acreage response" (Davison & Crowder, 1991, pp.33).

Weersink, Cabas & Olale (2010) further study the yield effect of expected net returns by looking at the impact of changes in climate on crop allocation decisions. Their results found that increases in the length of the growing season had a positive effect on yields of corn, soybeans, and winter wheat in Ontario. The authors also found that both expected price and yield were important factors that farmers considered in their acreage allocation decisions. The authors conclude that as changes in weather patterns continue to occur, "crop area allocation will thus be used by farmers as an adaptation strategy to changes in climate, even without changes in crop prices" (Weersink, Cabas & Olale, 2010, pp. 69).

### 2.2.2 Risk & Acreage Decisions

Risk is another important variable studied under acreage response models. Risk is involved in the acreage allocation decision when there is uncertainty around future yields or prices (Chavas & Holt, 1990; Liang et al. 2011). Previous studies have found risk to be a significant factor in acreage allocation decisions (Chavas & Holt, 1990; Lin & Dismukes, 2007). Chavas & Holt's (1990) study showed that price risk had a significant effect on corn and soybean acreage allocations in the United States. Lin & Dismukes (2007) work builds on this model using updated data. Liang et al. (2011) also use an acreage response model based on the work of Chavas & Holt (1990) to look at the supply response of major crops in the South Eastern United States. Their results show that improved genetics and crop varieties can lower yield risk and provide cost savings for farmers which will influence acre decisions. Also, the introduction of new markets for crops, such as ethanol for corn, can decrease market price risk which will also influence acreage decisions (Liang et al. 2011).

Chavas & Holt's (1990) findings do not support previous hypotheses that farmers exhibit constant absolute risk aversion (CARA), or constant relative risk aversion (CRRA). Their findings show that farmers exhibiting decreasing absolute risk aversion (DARA), will be associated with positive wealth effects. Lin & Dismukes (2007) come to the same conclusion in their study. In these cases, farmers may be more willing to take on more risk as their wealth increases which will influence acreage decisions (Goodwin & Mishra, 2005).

### 2.2.3Profitability, Risk & Relative Advantage

Acreage response models show the effect of expected profitability and risk on acreage allocation decisions, however these two factors will also play an important role in the decision to adopt a new crop. The decision to add soybeans into a crop rotation and continue to grow them will be influenced by the relative profitability of soybeans compared to other crops in the rotation. If a farmer is satisfied with the performance of the crops they are currently growing, they have less of an incentive to look at growing soybeans than a farmer who is looking to replace under performing crops in their rotation.

For farmers to maintain soybeans in their rotation, the relative advantage of soybeans needs to be greater than other cropping alternatives. Rogers (1983) defines relative advantage as "the degree to which an innovation is perceived as better than the idea it supersedes" (Rogers, 1983, pp. 15). The relative advantage of an innovation is a driving factor behind the level of adoption for an innovation a farm will take over the long run (Pannell et al. 2006). Perceived relative advantage will be influenced by the short-term production costs, potential yield, and market price of the innovation (Abadi Ghadim, Pannell & Burton, 2005; Pannell et al. 2006). These factors will influence the expected profitability of the innovation. The profitability of the innovation going forward into the medium and long-term stages has also been found to be an important driver of adoption (Cary & Wilkinson, 1997). Furthermore, the innovation could provide other benefits to the farmers cropping system which will influence the relative advantage (Pannell et al. 2006). For example, soybeans are a legume crop and are therefore able to fix their own nitrogen. Adding legumes into a rotation can be beneficial to subsequent crops as there will be increased levels of nitrogen in the soil, which will increase the yield of the subsequent crop.

How the innovation will impact the overall riskiness of production is also a large factor behind the relative advantage of an innovation (Marra, Pannell & Abadi Ghadim, 2003; Abadi Ghadim, Pannell & Burton, 2005; Pannell et al. 2006). If farmers view soybeans as being more subject to price volatility, crop establishment failure, or yield losses, then they will view them as having a lower relative advantage compared to crops they have been currently growing in their rotations (Pannell et al. 2006). With the adoption of soybeans, the perceived amount of riskiness associated with adoption will change depending on each farmers' situation. Farmers who are planning on switching a high percentage of their acres to soybean production may have higher levels of risk than a farmer who is slowly adding acres into their rotation. As well, soybean adoption can be risk reducing when looked at from a crop diversification viewpoint. Increasing the number of crops in a rotation will spread out production risks for the farmer and decrease the overall riskiness of their operation. Furthermore, if a farmer already owns equipment needed for soybean production, such as a flex combine header and roller, then adding soybeans into their rotation will not require additional investments into equipment which lowers the financial risk of adopting soybeans.

When farmers are making acreage allocation decisions for crops they are currently growing, they will have experience and information available to more accurately predict the net return to those crops and decide on acreage levels. However, compared to the adoption of a new crop or innovation, information can often be incomplete. Farmers may not have access to accurate, complete information which can impede the adoption process. This highlights the important role for extension services in the adoption process.

## 2.3 Adoption and Diffusion

One of the most influential researchers to study adoption and diffusion of innovations was Everett M. Rogers. Rogers (1983) defined an innovation as "an idea, practice, or object that is perceived as new by an individual or another unit of adoption" (Rogers, 1983, pp. 11). This definition of innovation fits the introduction of soybeans into Western Canada, as the crop has been around for decades but is a new option for Saskatchewan farmers. Rogers (1983) defined diffusion as "the process by which an innovation is communicated through certain channels over time among the members of a social system" (Rogers, 1983, pp. 11). With an innovation, there will be a level of uncertainty around the diffusion process, therefore the communications taking place play an important role in the adoption process. If uncertainty is present, it suggests that there is a lack of predictability, structure, or information around the innovation (Rogers, 1983).

Jensen (1982), studied the diffusion process focusing on firms making adoption decisions under uncertainty. This research identified that firms may delay adopting an innovation if they are uncertain of its profitability. An option of delaying adoption is valuable for firms to gather information and learn about the innovation to revise their beliefs on profitability. This can be seen in the trialing stage of crop adoption where farmers try the crop on a small-scale basis first to determine if it will be a good fit for their operations.

Learning and trialing play an important role in the decision process to adopt an innovation. Rogers (1983) defined five stages for the innovation-decision process. The first stage, knowledge, is when an individual becomes aware of the innovation. Next is the persuasion stage where the individual forms their perceptions around the innovation. In the decision stage, the individual undergoes learning and trialing activities to determine whether to adopt the innovation or not. If the individual chooses to adopt the innovation they move into the implementation stage. Finally, the individual moves into the confirmation stage where the individual will continue to evaluate their decision to adopt the innovation and may choose to dis-adopt if a better alternative exists.

### 2.3.1 S-Shaped Adoption Curve

S-shaped adoption curves, shown in Figure 2.1, are commonly used in the literature to explain the rate of adoption for an innovation (Griliches 1957; Rogers, 1983; Jovanovic & Lach, 1989). S-shaped adoption curves display the cumulative percentage of individuals who adopt an innovation over time. As Rogers (1983) describes, the adoption curve will stay relatively flat at the beginning as only a few individuals will adopt the innovation. The curve will become steeper as more individuals adopt the innovation and then eventually level off again as fewer non-adopters remain.

Research by Jovanovic and Lach (1989) looks at the relationship between learning by doing and s-shaped adoption curves. Their research shows that “s-shaped diffusion arises naturally in an environment in which homogenous agents face the prospect of learning by doing” (Jovanovic & Lach, 1989, pp. 690). In this case, entrance or adoption costs will be lower for later adopters since they can learn from the information generated by early adopters. In this model, learning by doing and sharing of information among agents is key to advance the diffusion process.

Griliches (1957) study of adoption of hybrid corn showed that profitability was the main driver behind the diffusion process. Profitability influenced the speed that companies developed new hybrid varieties for adoption in certain geographical areas, as well as adoption of the hybrid varieties at the farm level. Geroski (2000) discussed that differing goals and abilities of firms can also be the main driver behind diffusion and timing of adoption for individual firms. In this case, individuals will have different characteristics that will influence their probability of adoption. Adoption of a new crop can also be thought of in this way, as not every new crop will fit into every farmer's rotation.

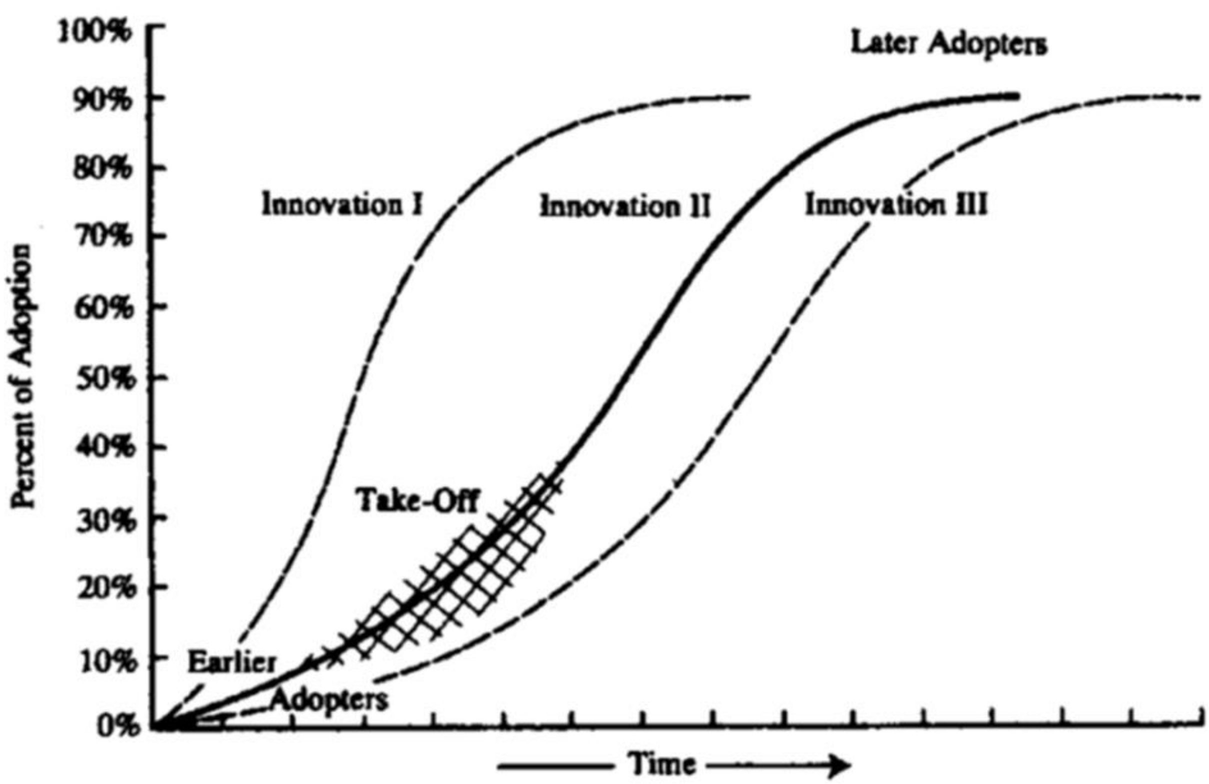


**Figure 2.1 S-Shaped Adoption Curve**

Source: (Rogers, 1983)

Rogers (1983) divides adopters into five categories, innovators, early adopters, early majority, late majority, and laggards. Innovators are a venturesome group, and they often have networks that stretch beyond their local area to connect them with other innovators. Early adopters also have networks; however, they will tend to be local networks (Rogers, 1983). These early adopters will be thought of as leaders in their area and be a useful connection for others moving through the adoption process. The next group is the early majority who will adopt an innovation slightly before an average adopter. The early majority are an important link in the adoption process between very early and late adopters. The late majority however, will adopt an innovation just after an average adopter. The late majority will often be skeptical of new innovations and require peer-pressure to adopt. The final group are the laggards who will be the last to adopt an innovation. This group is often isolated in terms of social networks and primarily have local connections.

## 2.4 Barriers to Adoption

### 2.4.1 Information as a Barrier to Adoption

There are many economic and non-economic factors that will influence the rate of adoption. Some of the economic risk variables that affect the adoption decision are how risky the farmer perceives the innovation to be or how much uncertainty they have regarding the innovation (Abadi Ghadim, Pannell & Burton, 2005). Learning is one of the key solutions to reducing risk and uncertainty in the adoption decision. Learning can allow the farmer to make better decisions about the technology and help them to implement the technology (Marra, Pannell & Abadi Ghadim, 2003). Another key element of risk and uncertainty that affects the adoption decision is the opinions that the farmer has on the economic returns from the technology in the current and future periods (Marra, Pannell & Abadi Ghadim, 2003). When a new technology or innovation becomes available to farmers, they will have their own individual perceptions of the costs and benefits associated with the new technology (Birkhaeuser, Evenson & Feder, 1991). These individual perceptions will often be incomplete, especially if the farmer has limited information available on the new technology (Birkhaeuser, Evenson & Feder, 1991). Birkhaeuser, Evenson & Feder (1991) states that since “farmers’ decisions are based on their perceptions, their resource allocation and technology choice will deviate from the social optimum if perceptions do not coincide with the correct attributes of the technology” (Birkhaeuser, Evenson & Feder, 1991, pp. 607).

One solution to information as a barrier to adoption is the role of extension services. Birkhaeuser, Evenson & Feder (1991) identify that extension services can be used to not only convey information from researchers or industry to farmers, but it also supports the flow of information from farmers back to researchers. Extension services will be most beneficial during the early stages of adoption when farmers are actively seeking information about the innovation. How large the payoff or benefit from extension services will be depends on the size of the gap between how productive farms are currently, and how productive they could be if the innovation is adopted (Birkhaeuser, Evenson & Feder, 1991).

### 2.4.2 Previous Studies on Adoption

One of the first studies on adoption focusing on economic variables, was Griliches (1957) study of the adoption of hybrid corn in the U.S. His research showed how economic variables could account for differences in the process of innovation, the adaption and distribution of an innovation, and the acceptance of an innovation. Several studies have been completed on how risk, uncertainty, and learning affect farmers' adoption decision (Feder, 1980; Shapiro, Borsen & Doster, 1992; Feder & Umali, 1993).

Feder (1980) uses a model of production under uncertainty to determine the effect of risk and risk aversion on the adoption decision. Feder asserts that the higher level of relative risk aversion a farmer has the lower the number of acres they will plant to the new crop. Credit constraints and total acreage will also influence the risk surrounding the innovation (Feder, 1980). Feder & Umali (1993) provide an overview of the previous research that had been conducted on adoption of agricultural innovations. The authors find that the effect of farm size, credit, tenure, and education often have a larger effect during the initial stages of adoption and then that effect fades over time. The authors conclude that more research is needed to study additional factors such as, "the type of technology and its interactions with related technologies, the structure of the market, and the nature and length of the policy interventions" (Feder & Umali, 1993, pp. 234). These factors can also play an important role in the adoption decision.

Shapiro, Borsen & Doster (1992) study the adoption of double-cropping soybeans and wheat in the United States. The authors find that risk perception is an important factor in the adoption decision; however, human capital factors are not found to have an influence on the decision. Farmer's who are adopting double-crop wheat and soybeans appear to do so as part as a risk diversification strategy.

Marra, Pannell & Abadi Ghadim (2003) look to identify the key aspects of risk, uncertainty, and learning that are crucial to the adoption decision. These aspects are usually blurred together or not given significant attention in the literature, therefore they look to separate the effects. The aspects of the adoption process they find as most important are farmers' perceptions about the riskiness of a technology, farmers' attitudes towards risk, the role of trialing and learning in adoption decisions, and the value of the option to delay adoption (Marra, Pannell & Abadi Ghadim, 2003). Abadi Ghadim, Pannell & Burton (2005) look specifically at how risk and uncertainty affect the adoption of a chickpeas in Western Australia. They identified risk aversion and relative riskiness of the innovation as the risk-related factors that had the largest impact on the adoption decision.

## 2.5 Moving Past Barriers to Adoption

### 2.5.1 The Role of On-Farm Trials

Research by Abadi Ghadim, Pannell & Burton (2005) found a positive association between participation in on-farm trials and the adoption of a new crop. Their research showed that trialing is an important step for farmers to learn about the crop and reduce any uncertainties they may have. Trying the crop on a small-scale allows the farmer to learn and improve their skills with growing the crop, which will allow the farmer to make better decisions when the crop is adopted on larger acres. Completing on-farm trials also allows the farmer to reduce uncertainties and improve decision making regarding the crop. From the trial, the farmer can revise the perception they had on the profitability or riskiness of the new crop and determine whether to increase acres or decrease.

Other studies have also studied the role of trialing in the adoption process. Fischer, Arnold & Gibbs (1996) look at the adoption of new wheat varieties in South Australia. They conclude that "the rate at which information becomes available is crucial to the speed of adoption, however it is the rate at which effective information grows which is relevant" (Fischer, Arnold & Gibbs, 1996, pp. 1079). They show that longer trialing periods will increase the amount of effective information available (Fischer, Arnold & Gibbs, 1996). Lindner and Gibbs (1990) use Bayesian learning to model farmer's beliefs about the mean and variance of different wheat variety yields and they concluded that due to bounded rationality, farmers' perceptions of possible yields will be highly influenced by recent experiences and growing conditions. Another conclusion the authors develop is when farmers have little information on a new variety they resort to knowledge they already have on similar varieties. Therefore, this knowledge may not accurately represent the new variety. Based on their research, completing on-farm trials over a longer period is the best solution to provide relevant information to farmers that they can relate to the other crops and varieties they are currently growing (Lindner & Gibbs, 1990).

### 2.5.2 On-Farm Trials & Networks

Participating in on-farm trials also allows farmers to create and build information networks which can assist them through the adoption process. Farmers could set up their own on-farm trials or be approached by a sales representative for a seed company to run a trial for them. Before moving into the trialing stage, any information the farmer has received about the innovation will have came from outside sources (Pannell et al. 2006). The social networks that a farmer has formed previously, therefore will have a large effect on the decision to begin trialing the innovation (Pannell et al. 2006).

Having direct contact with industry professionals and building a relationship with them through the trialing process, will allow the farmer to create a network they can turn to for information and support through the adoption process. Combining the role of extension services and informal networks has been shown to have a positive impact on the adoption of innovations and new management practices (Wossen et al. 2013). This form of extension can be thought of as social learning which involves both collective and communicative learning and can help generate new skills and knowledge (Muro & Jeffrey, 2008). With social learning, "it is thought that the generation of new knowledge, the acquisition of technical and social skills as well as the development of trust and relationships may form the basis for a common understanding of the system or problem at hand, agreement and collective action" (Muro & Jeffrey, 2008, pp. 330).

Social learning creates a new form of communication in extension models that goes beyond the traditional form of one-way knowledge transfer from extension agents to farmers (Dessie, Wurzinger & Hauser, 2012). Social learning allows for two-way communication between farmers and industry professionals. This is especially important for extension services around a new crop. Working with farmers through the trialing process allows industry professionals to see first hand the production barriers that farmers are still facing and to address these issues in the broader extension services they provide. This type of interaction between farmers and industry professionals requires trust between agents and helps to facilitate social capital in the industry.

### 2.5.3 Social Capital

Social capital can be defined as "the good will that is engendered by the fabric of social relations and that can be mobilized to facilitate action" (Adler & Kwon, 2002, pp. 17). Social capital enables individuals to come together to work towards a collective goal (Fairley-Gernot & Carberry, 2014). Social capital plays a role in the adoption process by creating networks and support systems to allow individuals to move past barriers to adoption. The Soybean Cropportunity group and other collaborative forms of extension services have social capital at their core. The Soybean Cropportunity group initiates the collaboration of multiple actors within the soybean industry to facilitate adoption amongst Saskatchewan farmers. Even though members of the group represent different and sometimes contradicting segments of the industry, working together can help to speed up the rate of adoption versus if each member was tackling this issue on their own.

This idea of collaborative action and social capital have been developed and built up over time in the agriculture industry in Saskatchewan. The Soybean Cropportunity group is not the first group of this kind to be created. Saskatchewan Pulse Growers have created similar groups for other crops moving through the adoption process. The role of social capital in larger organizations can be seen through the adoption process, but social capital could also play a role at the farm level in assisting producers past barriers to adoption.

James Coleman first introduced the idea of social capital to connect the views of sociologists and economists on the actions of individuals and the development of social organizations (Coleman, 1988). Coleman (1988) also linked social capital to information sharing, and how it can facilitate network development and support information sharing activities. Another one of the seminal publications to develop the theory of social capital was by Putnam, Leonardi & Nanetti (1993). In this work, the authors use social capital and involvement in civic engagements to explain why Northern Italy has been more prosperous than Southern Italy (Putnam, Leonardi & Nanetti, 1993). Northern Italy has a societal structure built on horizontal relationships, whereas Southern Italy uses hierarchical forms (Helliwell & Putnam, 1995). These horizontal relationships created more social capital in the Northern region, and therefore regional governments were more successful in the North (Helliwell & Putnam, 1995). Putnam's view of social capital highlights the importance of cooperation and coordination for the mutual benefits of all members of a group or association (Serageldin & Grootaert, 2000).

Social capital can be divided into two categories, cognitive and structural and is developed from the shared social norms of a society (Uphoff, 2000). Uphoff (2000) defined cognitive social capital as being derived "from mental processes and resulting in ideas reinforced by culture and ideology, specifically norms, values, attitudes, and beliefs that contribute cooperative behaviour and mutually beneficial collective action" (Uphoff, 2000, pp. 218). There are also structural forms of social capital which are defined as being "associated with various forms of social organization particularly roles, rules, precedents and procedures, as well as a wide variety of networks that contribute to cooperation and specifically to mutually beneficial collective action which is the stream of benefits that results from social capital" (Uphoff, 2000, pp. 218). Structural social capital focuses on the role both formal and informal networks play in the formation of social capital (Van Rijn, Bulte, Adekunle, 2012).

Putnam (2000) further divides structural social capital into bridging and bonding social capital. Bonding involves the horizontal ties between individuals who come from the same background or organization, whereas bridging refers to ties between members of different groups or organizations.

Ties between extension agents and farmers fall into the bridging structural social capital group, therefore this is where the Soybean Cropportunity group would fall. The Soybean Cropportunity group brings together individuals from all aspects of the agricultural industry. Social capital would be at the core of this group, and enables its members to work together to advance soybeans in the province. The social capital that exists in the agricultural industry in these larger organizations has been built up and developed overtime as previous adoption groups like the Soybean Cropportunity group have existed previously. Social capital can also play an important role at the farm-level and studies have looked at the relationship between social capital and adoption of innovations.

### 2.5.4 Previous Studies Linking Agriculture & Social Capital

Initially, social capital was mainly studied in the context of sustainable development (Serageldin & Grootaert, 2000). Therefore, many articles connecting social capital to agriculture focus on agricultural industries in developing countries. Measuring social capital can also be challenging as most of its components are intangible, and therefore are challenging to observe or measure (Gomez-Limon, Vera-Toscano & Garrido-Fernandez, 2014). However, surveys can be used to measure both structural and cognitive forms of social capital (Van Rijn, Bulte & Adekunle, 2012). Surveys measuring structural social capital often look at the networks or organizations that a person is a part of, whereas surveys measuring cognitive social capital look at the level of trust a person has or the norms related to cooperation that exist in a society (Van Rijn, Bulte &Adekunle, 2012).

Examples of articles that use survey data to measure social capital include Narayan & Pritchett (1997); Van Rijn, Bulte & Adekunle (2012); Gomez-Limon, Vera-Toscano & Garrido-Fernandez (2014); and Micheels & Nolan, (2016). Narayan & Pritchett (1997) use a survey in rural Tanzania to measure individuals' activity in associations and trust in different institutions and individuals. They find that social capital has a large influence on income in the village. The authors identify areas that social capital directly affects including: better publicly provided services, greater use of modern agricultural inputs, more community activity, and greater use of credit in agriculture (Narayan & Pritchett, 1997). Gomez-Limon, Vera-Toscano & Garrido-Fernandez (2014), look at measuring farmers' contribution to social capital in agricultural communities in Southern Spain using a survey of farmers in the region. They also look at the socioeconomic and demographic factors that affect the development of social capital. Their results show that farmers who are more actively involved in the agricultural sector are more likely to contribute to the development of social capital (Gomez-Limon, Vera-Toscano & Garrido-Fernandez, 2014). Van Rijn, Bulte & Adekunle, (2012) look at the role social capital plays in the adoption of agricultural innovations in different African countries. Their results show that structural social capital is positively associated with adoption of innovations, while the opposite is true for cognitive social capital. They explain this as "high levels of cognitive social capital might result in inward-looking modes of behaviour, or displace time and resources away from agricultural innovation" (Van Rijn, Bulte &Adekunle 2012, pg. 121). Micheels & Nolan (2016) look at the role that social capital, knowledge networks, and absorptive capacity play in the adoption of innovations on farms in Western Canada. Their results show that social capital and absorptive capacity have a larger effect than farm size on the number of innovations adopted by a farm (Micheels & Nolan, 2016).

### 2.5.5 Measurements of Social Capital

As previously mentioned, measuring social capital can be challenging as most of its components are intangible and hard to observe or measure (Gomez-Limon, Vera-Toscano & Garrido-Fernandez, 2014). However, previous research has shown that it is important to think of social capital as multi-dimensional versus a single entity (Grootaert et al. 2004). Groups, networks, norms, and trust are the factors frequently used to define social capital (Grootaert et al. 2004).

Molina-Morales and Martinez-Fernandez (2010) develop a likert scale for measuring social capital based on social interactions, trust, and shared vision. Social interactions help to build social capital as they are a way to share information and generate new knowledge. Social interactions are important between not only individuals from the same organization, but also important for ideas to be shared between individuals in different organizations. Molina-Morales & Martinez-Fernandez (2010) also find trust to be an important measure of social capital as it "acts a mechanism governing embedded relationships, thus facilitating innovation and learning" (Molina-Morales & Martinez-Fernandez, 2010, pp. 264). For information and knowledge sharing to occur between two individuals, there needs to be a level of trust between them. As well, shared vision is an important aspect of social capital as this enables knowledge and information to flow within networks as there is a common understanding between members. The authors also look at the role local institutions play in developing social capital. Local institutions can play an important role in linking external groups and networks to local groups and individuals. Links to external groups can be an important source of information for local groups and could potentially assist with adoption of an innovation (Molina-Morales & Martinez-Fernandez, 2010).

Looking at the Soybean Cropportunity group, social interaction between individuals in different organizations is key to gaining information on all aspects of the soybean industry and for sharing knowledge amongst all members. As well, the members of the groups need to be able to trust one another to share ideas and work together on extension and research projects. A shared vision is also important in the Soybean Cropportunity group, as all members are supporting one another to work towards a common goal of facilitating soybean adoption in the province. Local institutions are also important to the Soybean Cropportunity group as they serve as a link between farmers and larger organizations. This is useful to not only convey information to farmers, but also communicate the issues farmers are facing with soybeans to the group.

### 2.5.6 Absorptive Capacity

Absorptive capacity is another factor that could enable producers to move past barriers to adoption sooner. Absorptive capacity can be defined as "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends" (Cohen & Levinthal, 1990, pp. 128). Cohen & Levinthal (1990) show that for a firm to increase their innovation levels, they need to be able to evaluate and exploit external knowledge. As well, a firm's ability to evaluate knowledge will be a function of the related knowledge they have already gathered. Cohen & Levinthal's research measured absorptive capacity based on firm's R&D investments. They found that firms react to the characteristics of the learning environment they are in, and that absorptive capacity does play a role in the decision of firms when they are allocating resources for innovation.

Zhara & George (2002), look at absorptive capacity from a dynamic capability perspective relating to knowledge creation and how firms can use it to generate and sustain competitive advantages. The authors divide absorptive capacity into two forms, potential and realized. Potential absorptive capacity deals with the knowledge acquisition and assimilation stages, whereas realized absorptive capacity deals with knowledge transformation and exploitation stages (Zhara & George, 2002). Farmers who can more effectively and efficiently acquire, assimilate, transform, and exploit information may be able to move past barriers to adoption sooner than their peers.

### 2.5.7 Absorptive Capacity in Agriculture

Studies linking absorptive capacity to innovative performance tend to focus on high technology or manufacturing industries, however some studies have looked at the role absorptive capacity plays in innovation in agricultural sectors (Gellynck et al. 2015). Gellynck et al. (2015) look at the role absorptive capacity plays within the banana sector in Ecuador. The authors view absorptive capacity as a way "farmers can improve their technological innovation capabilities by recognizing, assimilating, and adapting valuable knowledge from a particular external source"

(Gellynck et al. 2015, pp. 95). Their results find a positive and strong relation between the absorptive capacity of the farmer and their innovation outcome.

Tepic et al. (2012) look at how farmers' networking behaviour and absorptive capacity is related to their level of innovativeness and profitability in the Dutch pork sector. They find that the networking frequency of farmers is positively correlated with the acquisition and assimilation aspects of absorptive capacity. The authors also find that assimilation capacity is the most important dimension of absorptive capacity for farmers. Their results imply that the most important factor to increase their level of innovativeness is for pig farmers to be able to recognize changes in technologies, regulations, market conditions, and consumer demands (Tepic et al. 2012).

Klerkx & Leeuwis (2008) look at the role innovation intermediaries play in the agriculture sector in the Netherlands following the privatization of many extension services. This privatization of extension services and support for innovation, requires famers to take on more initiative when they are seeking information on an innovation. Their research identifies a role for absorptive capacity, as a higher level of absorptive capacity will assist farmers when they are acquiring knowledge and then applying it to the innovation.

### 2.5.8 Measuring Absorptive Capacity

Zhara & George (2002) define absorptive capacity as "a set of organizational routines and processes by which firms acquire, assimilate, transform, and exploit knowledge to produce a dynamic organizational capability" ( Zhara & George, 2002, pp. 187). Measuring absorptive capacity is often focused around the actions that make up these four capabilities. Acquisition is defined as "a firm's capability to identify and acquire externally generated knowledge that is critical to its operations" (Zhara & George, 2002, pp. 189). The authors identify intensity, speed, and direction as three main factors that will influence a firm's success with knowledge acquisition. Assimilation refers to "the firm's routines and processes that allow it to analyze, process, interpret, and understand the information obtained from external sources" (Zhara & George, 2002, pp. 189). Understanding is a key component of the assimilation stage. Transformation is the ability of the firm to "develop and refine the routines that facilitate combining existing knowledge and the newly acquired and assimilated knowledge" (Zhara & George, 2002, pp. 190). To be successful at transformation, the firm will need to effectively internalize and convert the new information. Exploitation can be defined as "the routines that allow firms to refine, extend, and leverage existing competencies or to create new ones by incorporating acquired and transformed knowledge into its operations" (Zhara & George, 2002, pp. 190). Use and implementation are the key components identified by the authors for the exploitation stage.

Scales measuring capabilities are the most common tool used to measure absorptive capacity. Jansen, Van Den Bosch & Volberda (2005) look at the role organizational structure of a firm plays in the development of potential and realized absorptive capacity. To measure absorptive capacity, Jansen, Van Den Bosch & Volberda (2005) focus on three capabilities coordination, systems, and socialization. Coordination capabilities are important for building absorptive capacity as these skills can be used to include more employees in decision making and efficiently share knowledge amongst employees. System capabilities can be used to establish routines and specializations, however keeping employees focused on one area and stuck in a routine can have a negative effect on the development of absorptive capacity if it prevents knowledge sharing. Social capabilities are also important to consider as they are essential for building trust in the workplace which is also required for knowledge sharing. To measure the dimensions of potential and realized absorptive capacity, Jansen, Van Den Bosch & Volberda (2005) used a seven-point likert scale. The questions were divided between knowledge acquisition, assimilation, exploitation, and transformation.

Micheels & Nolan (2016) adjust the scale developed by Jansen, Van Den Bosch & Volberda (2005) for the questions to fit the Western Canadian agriculture industry. The authors show that linking the absorptive capacity scale to the decision to adopt an innovation at a farm level, shows the ability of the farm manager to: "1. become aware of an opportunity; 2. understand how the innovation could be applied on their farm; 3. transform knowledge into application of the innovation on the farm; and 4. exploit the innovation for increased efficiency" (Micheels & Nolan, 2016, pp. 129-130).

## 2.6 Chapter Summary

The net return of a crop and the yield and market price risk associated with that return have a significant effect on the acreage allocations of farmers. In these scenarios, farmers have more complete information from previous experiences or other information presented in the industry to make these acreage decisions. Expected profitability and risk also play a role in the decision to adopt a new crop or innovation, however complete information is not always present with a new crop. In this case, information is acting as a barrier to adoption. Trialing has been shown to be an important step in the adoption process to help farmers generate their own information on growing the new crop. Social capital and absorptive capacity have also both been found to influence adoption of innovations in previous literature.

Many studies have looked at the factors that influence farmers to adopt or not-adopt an innovation. The next chapter will outline the interview that was designed to identify the barriers that farmers are facing with soybean adoption in Saskatchewan.

# 3.0 Interview Methodology

## 3.1 Introduction

This chapter will outline the methodology behind the interviews of farmers in Saskatchewan aiming to identify the barriers and drivers of soybean adoption. Interviews were conducted with current adopters, past-adopters, and non-adopters for three weeks during July and August of 2016. Current adopters were defined as farmers who were currently growing soybeans in the 2016 crop year. Past adopters, were farmers who had grown soybeans in the past however, they did not have any soybeans planted for the 2016 crop year. The past-adopters had not necessarily completely dis-adopted soybeans, they had just chosen other crops to grow in their rotations currently. The non-adopter category were farmers who had never tried growing soybeans before. This chapter will also go over the specific variables and factors that were studied and the measurement techniques that were used, which were motivated by the literature review covered in the previous chapter.

The objectives of this research are to identify the economic and agronomic factors that are important in the decision to adopt soybeans. As well, this research aims to identify common characteristics between the different adopter categories. The final objectives look to identify the role of social capital and absorptive capacity in the adoption decision, as well as the availability of extension services and information surrounding soybeans in the province. To achieve these objectives, interviews were conducted with farmers throughout southern Saskatchewan. Past, present, and non-adopters of soybeans were all interviewed to study the factors that not only lead to a farmer trying soybeans, but eventually successfully working soybeans into their crop rotations.

## 3.2 Interview Strategy

The following section will describe in more detail the strategy used in the interviews conducted with Saskatchewan farmers. It will describe the sample of farmers that were interviewed, as well as the techniques used to identify and connect with farmers. Also, the geographical scope of the interviews will be discussed.

Face-to-face and telephone interviews were selected for this research to get a better understanding of the barriers farmers were still facing with soybean adoption in Saskatchewan. Face-to-face interviews were chosen over an online survey to increase the descriptive value of the data collected. As well, a higher level of effort is often exerted by face-to-face respondents (Heerwegh & Loosveldt, 2008). Face-to-face interviews give respondents a chance to describe their situations and opinions in their own words and allows them to emphasize the points they find most important (Kvale & Brinkmann, 2009). To increase the sample size, telephone interviews were also conducted. Combining different survey modes is a popular strategy to mitigate low survey responses (Heerwegh & Loosveldt, 2008). As farmers' schedules are very busy during the growing season, committing to a time to meet in person for an interview acted as a deterrent for some farmers to participate in the research. The option of completing the interview by phone was an attractive option for many farmers as they could fit it into their schedules when it was convenient for them without having to factor in travel-time for the interviewer. These calls were not random, names and phone numbers were obtained either through referrals or from previous contact.

Both face-to-face interviews and telephone interviews have benefits over web surveys. Completing the interviews in person or over the phone allowed for questions to be explained further if farmers had questions or were unsure how to answer. Whereas, with web surveys, questions and uncertainties that the respondent may have often lead to an increase in neutral or "don't know" answers or the questions will be left blank (Heerwegh & Loosveldt, 2008). Furthermore, conducting the interviews personally allowed farmers to expand on their thoughts and provide more details on their experiences with soybeans. This greatly increased the descriptive value of the data set.

With face-to-face and telephone interviews, social desirability bias needs to be considered. Fisher (1993) defines social desirability bias as a "systematic error in self-report measures resulting from the desire of respondents to avoid embarrassment and project a favourable image to others" (Fisher, 1993, pp. 303). Nederhof (1985) describes how social desirability can arise because of "self-deception" or "other-deception". Self-deception will occur when the respondent believes that a statement is true about themselves when it is false (Nederhof, 1985). Other-deception occurs when the respondent provides a false statement on purpose (Nederhof, 1985). Social desirability bias is most commonly a problem with sensitive topics. Krumpal (2011) refers to sensitivity as being related to behaviours that may be viewed as taboo, illegal or socially sanctioned as well as attitudes and opinions that may be unsocial. If farmers felt uncomfortable during any point of the interview, they were aware that they could refuse to answer a question or quit the interview. A copy of the interview consent form that was discussed with farmers prior to starting the interview can be found in Appendix B.

### 3.2.1 Timing of the Interviews

The timing of the interviews with Saskatchewan farmers is still within the very early stages of soybean adoption in the province. Saskatchewan farmers planted 240,000 acres of soybeans in 2016 which makes up less than one percent of Saskatchewan's 45.1 million cultivated acres (Government of Saskatchewan, 2015; CANSIM 001-0017, 2017). This early stage of adoption influenced the sampling technique. Since only a small percentage of famers have tried growing soybeans in the province, a more direct approach was needed to find these producers.

Conducting this research during the early stages of adoption in the province is important to identify the barriers to adoption that past and present adopters have faced to generate solutions before soybeans enter the "take-off" phase of the s-shaped adoption curve, and more farmers are interested in adding soybeans into their rotations. Identifying the barriers that the early adopters are facing will help extension and information providers to adequately address farmers' needs and assist in the designing of future extension services. Extension services have been found to be most beneficial during the early stages of adoption when farmers are actively seeking information about the innovation (Birkhaeuser, Evenson & Feder, 1991). Therefore, having well-functioning extension and information services is key to assisting farmers through the start of the adoption process and increases their chances of successfully working a new crop into their rotation.

Interviews were completed with farmers for three weeks in July and August of 2016. This timing was chosen for the interviews as farmers would be around their farms during the growing season, however it was not the harvest period yet so farmers would have time to complete the interview. Timing of interviews with farmers is important to consider as if it is too close to an extremely busy season like harvest, farmers have other jobs they could be doing that will be more directly beneficial to them than completing the interview (Kuehne, 2016).

### 3.2.2. Selecting the Geographical Area

South-eastern and east-central Saskatchewan were selected as the geographical areas of this research as this is where much of the soybean production occurs in the province (Arnason, 2015). Interest is continuing to spread west and north in the province, however soybeans are still thought of as more of a novelty in these areas (Arnason, 2015). Furthermore, farmers in the southern and eastern portions of the province would have the most experience with growing soybeans and therefore would be more able to discuss the barriers to adoption they faced. Focusing on this area was also important for identifying past-adopters as most of the early varieties introduced to the province would have only been suitable for production in this region.

To identify specific areas to focus on, Saskatchewan Pulse Growers provided a list of the amount of levy dollars collected from the sale of soybeans based on both towns and postal codes. This confirmed the south-east as an area of focus and shifted the focus towards central regions as Moose Jaw was the center with the highest amount of levy dollars collected. The map below illustrates the closest centre for interview respondents.

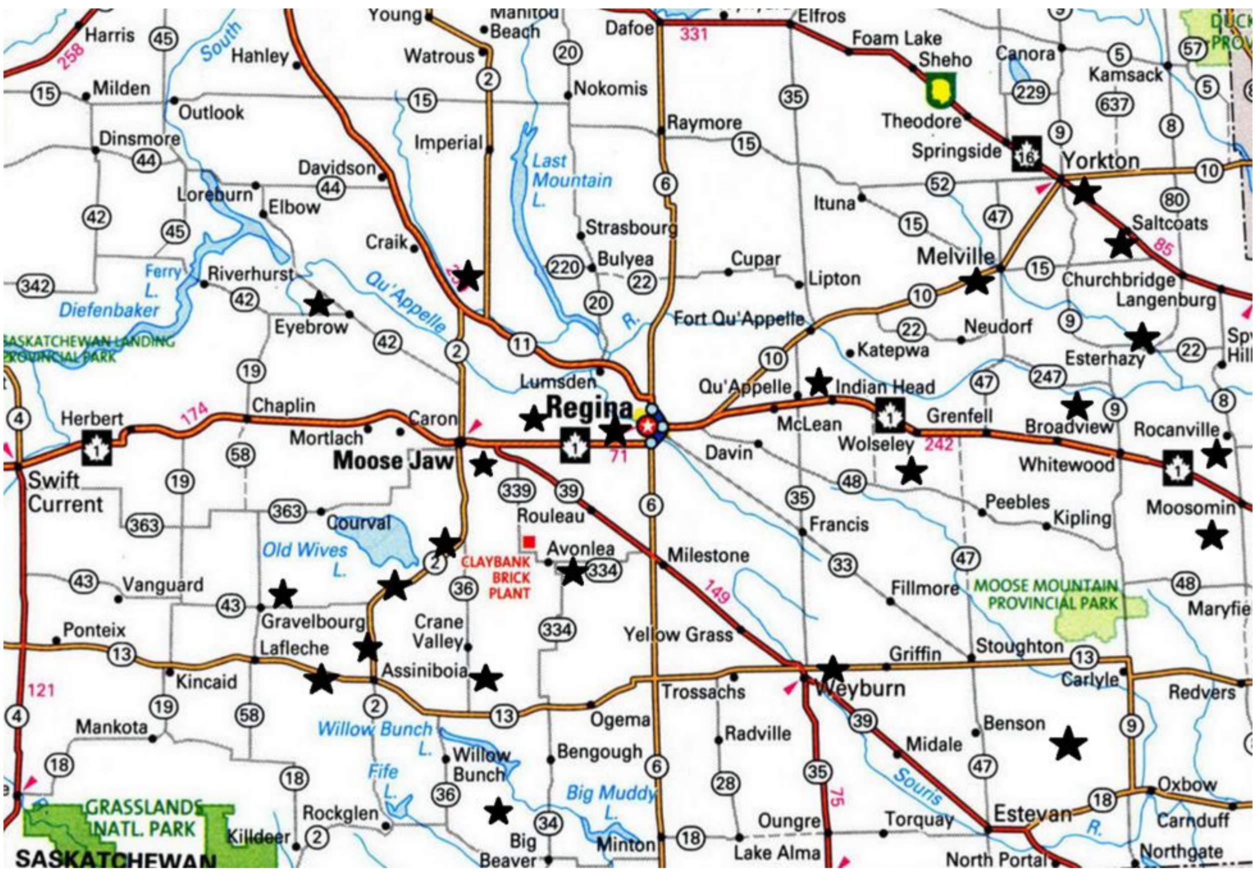


**Figure 3.1 Interview Respondent's Location**

Source: Author, map (US Atlas)

### 3.2.3 Defining the Sample: Past, Present & Non-Adopters

A total of 39 farmers were interviewed during the summer of 2016. Of these 39 farmers, 16 were currently growing soybeans, 10 had grown soybeans in the past, and 13 farmers had never grown soybeans.

The 16 adopters of soybeans had a range of experience with soybeans growing them from one to fifteen years. The average experience with growing soybeans was 4.8 years. The minimum number of soybean acres adopters had grown ranged from 2 to 640 acres, and the maximum acres ranged from 100 to 1920 acres. Smaller acres are often seen when farmers are first trying soybeans and potentially conducting a trial. Adopters who had been growing soybeans for over ten years, often started with very small acres as soybeans were still very novel in the province then. Nine out of the sixteen adopters planned to maintain soybean acres for next year, and the other seven adopters planned to increase their acres.

Past-adopters of soybeans had grown them for an average of 1.6 years before removing them from their rotations. The maximum number of years that a farmer had grown soybeans before choosing to not grow them in their rotations was three. The minimum acres that past-adopters had grown ranged from 20 to 160 acres, and the maximum ranged from 20 to 500 acres. Past-adopters are defined in this study as farmers who have grown soybeans in the past but are not currently this year. This does not mean that past-adopters will never grow soybeans again, just that these farmers have chosen other crops to grow that they feel will perform better or fit better in their current rotations.

### 3.2.4 Identifying Farmers

To identify farmers who may be interested in participating in the interviews, field days were attended in southern Saskatchewan. Both the Indian Head Agricultural Research Farm (IHARF), field day and the South-East Research Farm (SERF) field day were attended to network with farmers and get names of those who would be willing to participate in the research. From there, sales representatives and agricultural input retailers throughout southern Saskatchewan were contacted to identify other farmers who would be good to contact. Having a mutual connection with farmers was a key factor in gaining their trust to participate in the interview. Without knowing how their name and contact information was found, farmers would be hesitant to participate in the research. After each interview, farmers were asked if they knew of another farmer, not necessarily in their immediate area, who would be willing to be interviewed. This is referred to as a snowball or chain referral sampling technique that is often used in sociology research (Biernacki & Waldorf, 1981). This form of sampling creates a sample "through referrals made among people who share or know of others who possess some characteristics that are of research interest" (Biernacki & Waldorf, 1981, pg. 141). For this research, any farmer could be interviewed if they were actively farming and located within the geographical scope of the research.

Snowball sampling is a useful tool for finding smaller groups in a population, however sampling bias also needs to be considered. Since the sample will be influenced by respondents identifying other future respondents, the sample may not be representative of the entire population as it is not randomly selected (Magnani et al. 2005). Magnani et al. (2005) state that "in snowball sampling, the sample composition is heavily influenced by the choice of initial seeds, and the method, in practice, also tends to be biased towards favoring more cooperative as opposed to randomly chosen subjects and those that are part of larger personal networks" (Magnani et al. 2005, pp. 569). In this research, farmers who were identified and approached for an interview might have had larger networks and higher levels of social capital associated with these networks. Therefore, a bias towards farmers with higher levels of social capital also needs to be considered.

## 3.3 Interview Topics

The interview questionnaire was divided up into five categories looking at specific factors that may influence the decision to grow soybeans or not and lined up with the research objectives of this thesis. The first two sections focused on economic and agronomic considerations with growing soybeans. The third section included questions on basic farm characteristic. The fourth section looked to measure the level of social capital and absorptive capacity the farmer possessed, and the final section looked at the availability of extension services and information. A copy of the interview questionnaire can be found in Appendix C.

### 3.3.1 Economic Factors

Expected net return of a crop has been shown to be an important driver of both adoption and acreage allocation decisions (Abadi Ghadim, Pannell & Burton, 2005; Weersink, Cabas & Olale, 2010). For farmers to be interested in adopting a new crop, they must perceive the new technology to provide a greater return or be a better fit than the current technology in their rotations (Pannell et al. 2006). To determine how profitable farmers viewed soybeans compared to other crops in their rotation, farmers were asked to identify if they felt soybeans would provide an above average, average, or below average return on their farm. Asking questions around the required gross margins of the new crop and the gross margins of the competing crop is another strategy to understand how profitable the farmer views the new crop (Abadi Ghadim, Pannell & Burton, 2005). Soybeans are an oilseed; however, the crop is a member of the legume family. This means that soybeans could be replacing an oilseed, such as canola, in a farmer's rotation or a legume crop, such as peas or lentils. Farmers were asked what crop soybeans would be competing with for acres in their rotations. To evaluate the differences in gross return between the two crops, farmers were asked what the gross return of soybeans would need to be compared to canola or their main legume crop for farmers to chose soybeans. Farmers were also asked how many acres of soybeans they would grow at specific differences in gross return between competing crops to understand where the threshold is for soybeans to be an attractive option. The high seed costs associated with soybeans would also directly affect the profitability of the crop for farmers. Farmers were asked a likert scale question if they felt the cost of soybean seed was a deterrent for growing soybeans.

Risk and uncertainty also play an important role in crop adoption and acreage allocation decisions (Chavas & Holt, 1990; Marra, Pannell & Abadi Ghadim, 2003; Lin & Dismukes, 2007). Increasing uncertainties with an innovation will impede adoption. If farmers view soybeans to be more subject to price volatility, crop failure, or yield losses then they will view them as being riskier than other crops that they are currently growing in their rotations (Pannell et al. 2006). To evaluate farmer's risk perceptions surrounding soybeans, farmers were asked if they thought adding soybeans into their rotations would decrease, not change, or increase their overall risk. Another factor that could influence uncertainty with soybeans are the marketing opportunities available to farmers. Therefore, farmers were asked a likert scale question if they thought uncertainty of marketing opportunities were a deterrent for growing soybeans in Saskatchewan. Information was also collected on if farmers had been selling their soybeans to a local elevator, non-local elevator, or direct to a crush plant. A local elevator was defined as an elevator under one hour away from the producer's farm.

### 3.3.2 Agronomic Factors

Agronomic factors will also play an important role in the decision to grow soybeans. Yield potential for a new crop compared to competing ones is important in the adoption decision (Pannell et al. 2006). Maturity ratings also play an important role in the adoption decision, as farmers need to select varieties that will mature in time for their production region. Understanding maturity ratings and selecting suitable varieties as well as having reasonable yield expectations, will increase farmer's chances of success with trying soybeans (CPS, 2017). Dis-satisfaction with yield potential or the maturity ratings of current varieties could lead farmers to remove soybeans from their rotations. To look at if these were motivating factors behind dis-adopting soybeans, past and present adopters were asked on a likert scale how satisfied they were with these factors. All three adopter groups were asked how important yield potential and maturity ratings would be to them when they are looking at potential varieties to grow. As well, the importance of disease resistance was also looked at when selecting a variety as some disease pressure is beginning to show up in soybean crops in the province (Clezy, 2016). Likert questions to understand the importance of these characteristics when choosing a variety can show researchers which characteristics are most important to farmers, and if they require more information to understand the importance of these factors when choosing a variety.

Besides yield potential, a new crop could provide other advantages over cropping alternatives that would increase the new crops relative advantage to farmers (Pannell et al. 2006). One benefit of soybeans is they can be used as a weed management tool in a rotation to help clean up fields as glyphosate resistant varieties allow for the control of a broad-spectrum of weeds (Reddy, 2001). Soybeans can tolerate a higher rate of glyphosate than other glyphosate resistant crops such as canola, therefore they may provide better control of weeds than other glyphosate resistant crop options (Government of Saskatchewan, 2017). Farmers were asked a likert scale question to see if they thought soybeans could be used in their rotations as a weed management strategy. The effectiveness of using soybeans as a weed management tool would not be a useful solution for farmers who had a problem with glyphosate resistant weeds. Therefore, farmers were asked a likert scale question if glyphosate resistant weeds were a problem on their farms. As well, farmers were asked if the introduction of the new Roundup Ready Xtend® soybeans which have resistance to both glyphosate and dicamba would be a better fit for their farm. This would be relevant information for seed companies and other groups providing information in the industry to understand how farmers are feeling about the release of these new varieties.

The perceived ability farmers viewed themselves to have with growing soybeans was also looked at. A higher perceived ability with growing soybeans would increase the farmer's confidence and the chances that they will try the crop (Läpple & Kelley, 2010). Farmers were asked likert scale questions if they felt confident in their ability to grow soybeans and if they would consider themselves to have strong agronomic knowledge. Farmers were also asked if they had completed any courses in agronomy. Next, farmers were asked to describe a recent agronomic problem they encountered and how they dealt with it to illustrate how confident they were in their agronomic capabilities. As well, yields from the previous growing season for their three largest crops in terms of seeded acres were also collected to act as a check for the level of agronomic knowledge the farmer perceived themselves to have.

The factors that influence farmers to "brown-bag" soybeans were also looked at during the interview. Brown-bagging refers to farmers saving their harvested soybean seed from the previous year and planting it the following spring[1]. Since the patent on the first-generation Roundup Ready soybean trait expired, it is now possible for farmers to save their soybean seed and replant it the next year (Hefty, 2011). Even though farmers are saving in seed costs, these varieties typically do not perform as well as the new second-generation trait varieties and farmers also do not have support throughout the growing season from seed companies (Hefty, 2011). The amount of brown-bag seed that is planted every year in the province is currently unknown. Therefore, looking at how prevalent brown-bagging was within the sample was of interest to the Saskatchewan Pulse Growers and the Soybean Cropportunity group. Farmers who were planting brown-bagged varieties were asked several likert scale questions if they thought growing brown-bagged varieties was common in their area, if they felt the yields were competitive with non-brown-bag varieties, and if no support from a sales rep was a deterrent for growing brown-bagged varieties. Farmers who were not currently growing brown-bagged varieties were asked if they would ever consider it and why they had chosen not to so far. The answers from these

[1] Social desirability bias needs to be considered with the questions around brown-bagging soybeans as some farmers may have chosen to not admit to brown-bagging to appear more socially desirable. Even though brown-bagging is not illegal, it is a practice that is looked down on by industry professionals.

questions would help SPG and others in the industry by identifying the main factors that lead farmers to brown-bag and how farmers feel about the practice.

### 3.3.3 Farm Characteristics

Demographic or farm characteristic variables are important to the adoption decision as they may influence the goals of the farmer or have an influence on their ability to adopt the innovation (Pannell et al. 2006). One of the objectives for this research was to identify common characteristics between the three adopter categories to understand the similarities and differences between the groups. Structural farm variables were looked at such as farm size, number of employees, human capital, percentage of income from farming, and future plans for the farming operation. Size is an important variable to look at, as different innovations will be appealing to certain sized operations. If the innovation requires little change in current technologies or practices to adopt, then adoption should not be inhibited by farm size (Fernandez-Cornejo, Daberkow & McBride, 2001). However, if significant amounts of financial or human capital are required to adopt the innovation than larger farms would be more likely to adopt (Fernandez-Cornejo, Daberkow & McBride, 2001). The effect of the number of full-time employees will also depend on the characteristics of the innovation. If the adoption process is intensive, then having more labour available will aid in adoption (Daberkow & McBride, 2003). However, if the innovation is labour saving, then it would be more attractive to farmers who have less full-time employees (Feder, Just & Zilberman, 1985).

Human capital can be assessed through the education and experience of the farmer (Micheels & Nolan, 2016). Higher levels of education and experience are found to increase the probability of adopting new technologies (Daberkow & McBride, 2003). Age on the other hand, is found to decrease the probability of adoption (Daberkow & McBride, 2003). Younger farmers often have more education and are more willing to try new innovations than older farmers (Daberkow & McBride, 2003). Stage of farming career can also influence the decision to adopt innovations (Micheels & Nolan, 2016). Farmers who are near retirement are less likely to want to change their farming practices and adopt new innovations (Micheels & Nolan, 2016). Farmers were asked in the interview if they were planning on increasing, maintaining, or decreasing the size of their operations to measure the stage they were at. As well, farmers were also asked if they had a succession plan in place, as having a successor present increases the likelihood of adoption (Micheels & Nolan, 2016).

Many studies also find access to capital or additional funds an important factor in the adoption decision (Feder, Just & Zilberman, 1985). The percentage of on-farm and off-farm income each farmer has can also influence the adoption decision depending on the characteristics of the innovation (Fernandez-Cornejo et al, 2007). If an innovation is “managerial saving” it will be more attractive to farmers who are also working off-farm and therefore, have less time to put into their farming operation (Fernandez-Cornejo et al, 2007). On the other hand, if the innovation is “managerially intensive” farmers who work off-farm will be more reluctant to adopt the technology as they will not have the time to do it (Fernandez-Cornejo et al, 2007).

### 3.3.4 Social Capital & Absorptive Capacity

Both social capital and absorptive capacity have been found to have a positive impact on the adoption of innovations (Tepic et al. 2012; Van Rijn, Bulte & Adekunle, 2012; Micheels & Nolan, 2016). Another objective of this research was to look at if social capital and absorptive capacity played a role in moving farmers past barriers to adoption sooner. This would imply that farmers who had adopted soybeans would have a higher level of social capital and absorptive capacity. To measure each farmer’s perceived level of social capital and absorptive capacity, farmers were asked a series of five-point likert item questions and the values from these questions were summed together to give an overall score for social capital and absorptive capacity (Spector 1992; Gliem & Gliem, 2003). A higher summed value would represent more agreeance with the activities and capabilities that underlie social capital and absorptive capacity (Gliem & Gliem. 2003). Cronbach’s alpha was used as a measure of internal consistency reliability for the likert items that made up the scores for social capital and absorptive capacity (Cronbach, 1951; Santos, 1999). The social capital alpha was found to be 0.8022, and the absorptive capacity alpha was found to be 0.8649. Both scores are above the acceptable threshold for alpha scores of 0.70 (Gliem & Gliem, 2003). The results of the likert item analysis can be found in Appendix D.

The likert scale used for the social capital section was initially developed by Molina-Morales & Martinez-Fernandez (2010). The questions were divided into four categories: social interaction, trust, shared vision, and local involvement (Molina-Morales & Martinez-Fernandez, 2010; Micheels & Nolan, 2016). Using these categories, accounts for both cognitive and structural forms of social capital (Micheels & Nolan, 2016). Higher levels of social interaction would lead to more opportunities for networking which would increase the information available to farmers. Social interaction was measured by asking farmers how often they discussed agricultural farming practices with their neighbours. Questions also looked at if farmers tried to seek information and answers locally; and if their neighbours would frequently ask them questions regarding farming practices. Farmers were then asked if they felt they had informal social networks they could rely on for information and if these networks had increased the level of innovation on their farms.

Trust is an important component to social capital as there needs to be trust between actors to work together towards a common goal and for information sharing to occur. Farmers' trust in their knowledge providers is important for both learning and information sharing to occur surrounding innovations (Gellynck et al. 2015). Trust was measured by asking farmers if they would trust the recommendations and advice given to them by their neighbours, by a sales rep they deal with frequently, and by a sales rep they have never dealt with before.

Shared vision facilitates the development of social capital as it enables knowledge sharing and makes it easier for individuals to work together. Shared vision was measured by asking if common backgrounds and similar management styles between neighbours made it easier to interact and discuss ideas. As well, farmers were asked if they felt farmers in their area cared about the success of their neighbours and if they would be willing to help their neighbours out in times of need.

Local involvement was the final measurement used for social capital. Involvement in different organizations would increase networking and information sharing opportunities for farmers. Farmers were asked to state the local agricultural groups they were involved with and local non-agricultural groups. Farmers were also asked about their volunteering activities within their communities.

The absorptive capacity scale was initially developed by Jansen, Van Den Bosch & Volberda, (2005). The questions are divided between potential and realized absorptive capacity, and focus on the organizational capabilities or routines and processes, that a farm would use in their networks with external knowledge (Van Rijn, Bulte & Adekunle, 2012; Micheels & Nolan, 2016). Potential absorptive capacity questions focused on knowledge acquisition and assimilation capabilities of the farm. Farms who can more efficiently acquire and assimilate knowledge may be able to move past barriers to adoption faster. Potential absorptive capacity was measured by asking questions around frequency of interactions with industry professionals and how often farmers are looking for new ideas to increase the efficiency of their operations. Farmers were also asked if they thought they could quickly recognize changes and opportunities within the industry and if developing relationships with industry professionals was an important activity for their farm.

The second set of absorptive capacity questions aimed to measure the realized absorptive capacity of the farmer. These questions were based around knowledge transformation and exploitation capabilities of the farmer. Being able to evaluate knowledge and transform it to fit the specific needs of their farms would assist farmers through the adoption process. Farmers were asked how frequently they talk with industry professionals on how changes in the market could affect their farm business and if they record and store the knowledge they acquire. Farmers were also asked about how frequently they discuss new opportunities or changes to production practices on their farm and if employees will share their previous knowledge and experiences. Questions were also asked on evaluating the usefulness of new knowledge and if a lot of time is spent on knowledge transformation activities. As well, farmers were asked if they would be willing to conduct their own on-farm trials to understand how to adapt an innovation.

### 3.3.5 Extension Services & Availability of Information

A lack of complete and unbiased information can act as a barrier to adoption and extension services can be a solution to this barrier (Birkhaeuser, Evenson & Feder, 1991). The final objective of this thesis is to evaluate if farmers are satisfied with the extension services and information being provided around soybeans in Saskatchewan, or if a lack of information and support could be impeding adoption.

Previous research has shown the important role that both public and private extension plays throughout the adoption process of a new crop (Marsh, Pannell & Lindner, 2004). Farmers were asked likert scale questions on if they thought they relied frequently on both private and public and extension services. Farmers were also asked where the first place they turn to is when they are faced with an agronomic problem. These questions are important to establish where farmers are relying on for most of their information to then understand if they are satisfied with these sources. It also illustrates what the most relied on channels are for knowledge transfer which will help industry professionals in providing future extension services.

Past and present adopters were both asked likert questions on if they felt they had enough support available to them when they were growing soybeans and if they felt there was enough information available on growing soybeans in Saskatchewan. These questions would help to identify if a lack of information could be acting as a barrier to adoption. Past and present adopters were also asked if they had participated in an on-farm soybean trial before and if they valued the opportunity to participate in these trials. On-farm trials have been shown to have a positive effect on adoption of a new crop and is an important stage in the adoption process (Abadi Ghadim, Pannell & Burton, 2005; Pannell et al. 2006).

Farmers were also asked what they thought the role of the Saskatchewan Pulse Growers (SPG), should be moving forward with soybeans in the province. Since soybeans are still in the early adoption stage in the province, what the future structure of soybean research and extension could be has not been established. Currently, SPG focuses on solely on agronomic research for soybeans. However, there could be an opportunity for SPG to become involved with soybean breeding in the future. Therefore, it was important to hear what farmers thought the role of SPG should be in the future.

## 3.4 Chapter Summary

Based on the potential barriers to adoption identified in the literature review and factors that could assist farmers past barriers to adoption, an interview was developed and conducted with farmers in southern Saskatchewan. Through the interviews conducted with farmers, a wide range of questions were asked to fully understand all the factors that could influence the decision to grow or not grow soybeans and to meet the objectives of this research. Studying a wide range of factors allows for a more complete picture of the barriers still facing soybean adoption in the province. The next chapter will discuss the results from the interviews and illustrate what barriers to adoption exist.

# 4.0 Interview Results

## 4.1 Introduction

This chapter will highlight the most important results that were found from the interviews and give an overview of the characteristics of the three categories of soybean adopters. Figure 4.1 illustrates what farmers themselves thought the biggest obstacle to growing soybeans in Saskatchewan was. The results from this question give a good overview of the current barriers soybean adoption in Saskatchewan is still facing.

The main obstacles that were mentioned were the need for earlier maturing varieties and varieties that have a higher yield potential. As one farmer stated, “the heat units and growing season that current varieties need will not work in our area to reach full yield potential, we need new varieties developed” (Interview 14). Another factor mentioned directly related to yield potential and maturity, was Saskatchewan’s climate. As one farmer said “the biggest challenge is our weather or climate, we need varieties that are suited to our area and that are more drought tolerant. There’s also the risk of late spring or early fall frost that will smoke any current variety, at least you know lentils can handle some frost stress” (Interview 20).

The lack of profitability in soybeans was also mentioned, “profitability just is not there yet for our area, yields are not there that would make it worth while. There is too much risk involved to put the cash out on soybeans when peas and lentils are cheaper to grow and they have been proven to perform” (Interview 26). Another factor mentioned was producers’ attitudes towards soybeans. One farmer said, “the biggest issue is producers who are not willing to try something new. Also, producers need to be doing their homework, if they just jump into it they will have trouble” (Interview 11). Another farmer mentioned that producers need to be viewing soybeans differently, “producers do not seem to be differentiating between gross and net income, there is a perception out there that there is no money in soybeans from people who are looking at it from only a gross return perspective. By adding soybeans into their rotation, they’ve stopped applying nitrogen, people need to think about the long-term rotational benefits and calculate a net return. Farmers also need to think about that for the long-term picture, instead of always short-term. The first-year growing soybeans can be rough, but once the issues are worked out it can be profitable; the problem is that most people would quit after one bad year” (Interview 12).

Seed costs were another obstacle mentioned, "high seed costs are the biggest obstacle, the returns are not always that strong and you will be losing money if you have to spend that much at the start" (Interview 10). Harvest-ability concerns were another obstacle for some producers, "plants need to be taller or have a higher pod set, we're just afraid we would lose too many when we went to combine them" (Interview 3). Marketing options were also seen as an obstacle in certain regions, "There is not enough people with knowledge about marketing in this area and the distances to haul are long" (Interview 1).

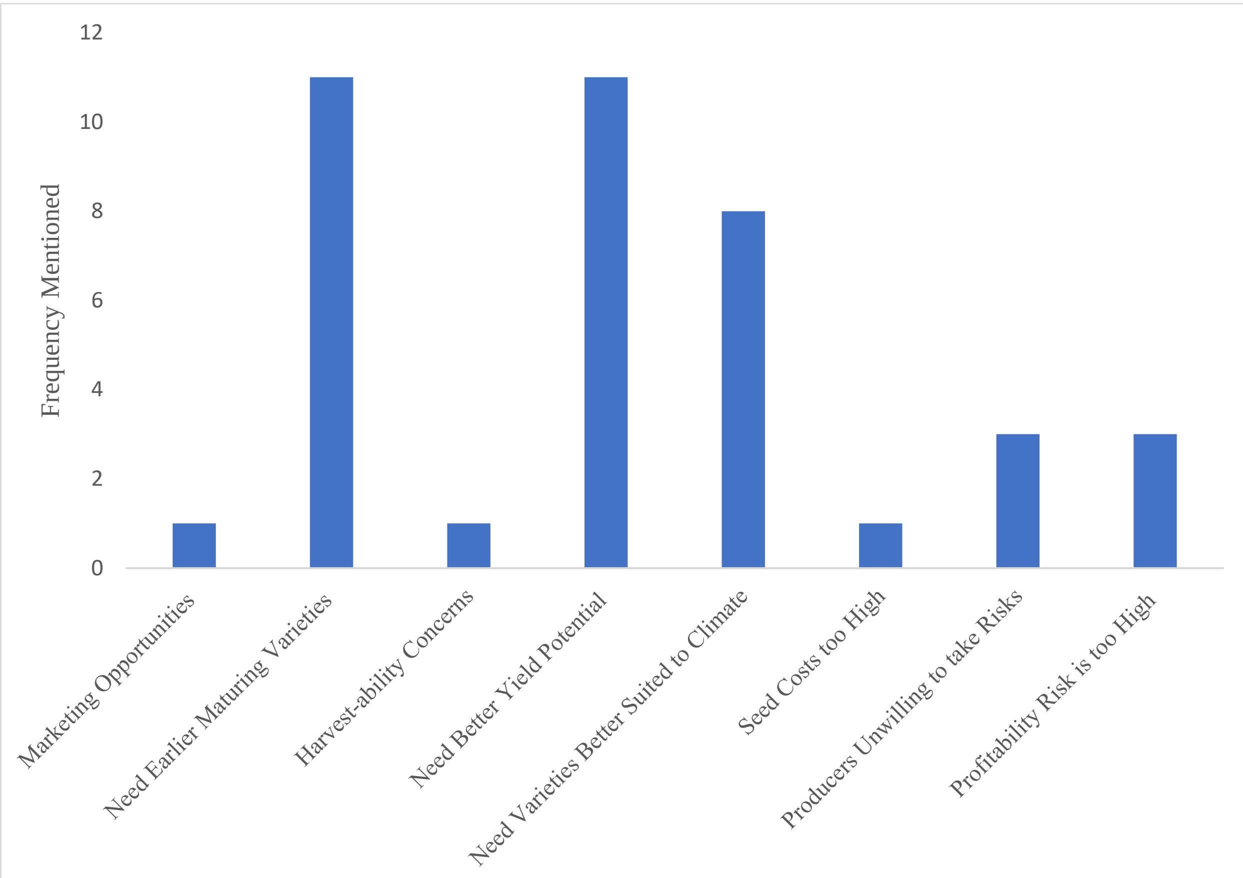


**Figure 4.1 Biggest Obstacle to Growing Soybeans in Saskatchewan**

Source: Author

Even with the obstacles that producers identified, there is still a lot of interest and optimism around soybeans as shown in Figure 4.2. Both past-adopters and non-adopters were asked if they would consider adding soybeans into their rotation again or for the first time. This question was asked on a likert scale, 1 being strongly disagree 10 being strongly agree[2]. From the results, most past and non-adopters agree or strongly agree that they would consider growing soybeans in the future. For most past-adopters, their interest in growing soybeans again may signal that they have not worked soybeans out of their rotations for good. These farmers likely had competing crops in their rotations which were more attractive to them for this growing season and selected those crops over soybeans. Non-adopters also show an interest in considering soybeans as a potential rotational crop in the future.

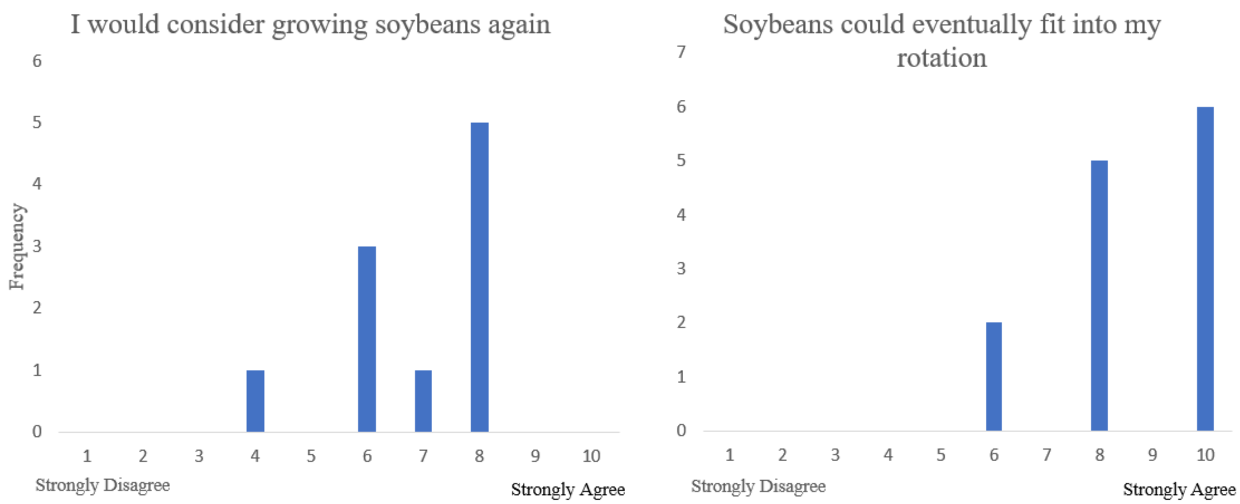


**Figure 4.2 Interest in Growing Soybeans in the Future**

Source: Author

## 4.2 Economic Factors

The perceptions farmers have with expected profitability and riskiness of soybeans are shown in Table 4.1. First, farmers were asked about the expected profitability of soybeans compared to other crops they were growing, and if they thought soybeans would provide an above-average, average, or below-average return. Adopters were the only category of farmers who thought soybeans would provide an above average return. Most past-adopters believed that soybeans would provide a below average return, whereas non-adopters were more equally split between below average and average return. Next, farmers were asked if they thought adding soybeans into their rotations would increase, not change, or decrease their overall production risk. The

[2] The original likert scale was developed with values from 1 to 5, however some respondents answered with half numbers, therefore all values were multiplied by two. This transformed the answers into whole numbers, however it also creates a bias as not all farmers were aware that they could pick half numbers and chose only whole.

majority of adopters felt adopting soybeans did not affect their overall production risk, however most past-adopters and non-adopters felt it would increase their overall production risk. At least one respondent from every group thought that soybeans would decrease their overall production risk. These farmers were looking at soybeans from beyond a gross return perspective, and could recognize how soybeans could lower their risk from a crop rotation diversification perspective.

**Table 4.1 Expected Profitability & Risk Perceptions**

| | **Past-Adopters (10)** | **Adopters (16)** | **Non-Adopters (13)** |
|---|---|---|---|
| What do you think the gross return of soybeans is or would be compared to other crops in your rotation? | Below: 80%<br>Average: 20% | Below: 25%<br>Average: 38%<br>Above: 38% | Below: 46%<br>Average: 54% |
| How does/would adding soybeans into your rotation affect your overall risk? | Increase: 70%<br>No Change: 20%<br>Decrease: 10% | Increase: 19%<br>No Change: 56%<br>Decrease: 25% | Increase: 46%<br>No Change: 31%<br>Decrease: 23% |

Source: Author

Farmers were then asked which crop(s) soybeans would be compared to in their rotation. Pulses and oilseeds were the most common answers as shown in Table 4.2; however, some farmers were looking to switch out cereal acres for soybeans. The next two questions looked at the gross return of soybeans versus canola and peas. Farmers were asked what the gross return of soybeans would need to be compared to canola and peas for them to grow soybeans. Adopters and past-adopters of soybeans were willing to consider growing soybeans if the gross return of soybeans was less than the gross return of canola. At least some respondents in all three groups were willing to consider growing soybeans if the gross return was less than the gross return of peas.

**Table 4.2 Comparison of Soybeans to Pulse & Oilseed Crops**

| | **Past- Adopters (10)** | **Adopters (16)** | **Non-Adopters (13)** |
|---|---|---|---|
| What crop are soybeans compared to in your rotation? | Pulse: 50 %<br>Oilseed: 10%<br>Cereal: 20%<br>Pulse & Oilseed: 10%<br>Cereal & Pulse: 10% | Pulse: 44%<br>Oilseed: 38%<br>Cereal: 6%<br>Pulse & Oilseed: 13% | Pulse: 69%<br>Oilseed: 31% |
| Where does the gross return of soybeans need to be compared to canola? | -$100/ac: 10%<br>-$25/ac: 10%<br>Same:20%<br>+$50/ac: 40%<br>Wouldn't Switch Canola Acres: 20% | -$50/ac: 13%<br>Same: 44%<br>+50/ac: 25%<br>Not Growing Canola: 13%<br>Wouldn't Switch Canola Acres: 6% | Same: 54%<br>+$50/ac: 15%<br>+$100/ac: 8%<br>Wouldn't Switch Canola Acres: 23% |
| Where does the gross return of soybeans need to be compared to peas? | -$25/ac: 10%<br>Same: 30%<br>+$50/ac: 10%<br>+$75/ac: 10%<br>+$100/ac: 10%<br>Not Growing Pulses: 10%<br>Wouldn't Switch Acres: 20% | -$75/ac: 6%<br>-$50/ac: 13%<br>Same: 31%<br>+$50/ac: 19%<br>Not Growing Pulses: 31% | -$40/ac: 8%<br>Same: 62%<br>+$50/ac: 8%<br>+$100/ac: 8%<br>Not Growing Pulses: 15% |

Source: Author

Farmers were then asked specifically what the gross return per acre of soybeans would need to be to add or keep soybeans in their rotation. However, not all producers were able to answer this question as they felt they did not have enough experience or could not think of a number at the time of the interview. 35 producers could answer the question. Adopters had the lowest gross return per acre required to keep soybeans in their rotation as reported in Table 4.3. To calculate the approximate yield required to achieve the average level of gross return, an estimated market price of $9.35/bushel was used. This price was reported in the 2016 Provincial Crop Planning Guide by the Saskatchewan Ministry of Agriculture (Government of Saskatchewan, 2016a).

**Table 4.3 Required Gross Return per Acre**

| | **Past- Adopters (9)** | **Adopters (15)** | **Non-Adopters (11)** |
|---|---|---|---|
| Gross Return/Acre | Average: $338.89 | Average: $329.33 | Average: $430 |
| | Yield Required at $9.35/bu: 36 bu/acre | Yield Required at $9.35/bu: 35/acre | Yield Required at $9.35/bu: 46 bu/acre |
| | Minimum: $250 | Minimum: $200 | Minimum: $250 |
| | Maximum: $400 | Maximum: $600 | Maximum: $500 |

Source: Author; Government of Saskatchewan, 2016a.

The next questions looked at factors that may deter farmers from growing soybeans. Producers were asked if they thought the cost of soybean seed was a large deterrent for growing soybeans. The average cost of soybean seed is $89.60 per acre which is significantly higher than the next most expensive crops, corn at $78.30 per acre and canola at $59.45 per acre (Government of Saskatchewan, 2016a). Adopters had the highest number of farmers strongly agree that the cost of soybean seed is a deterrent for growing soybeans. Whereas, the distribution for past-adopters and non-adopters was more equal.

Producers were also asked if they thought that uncertainty of marketing opportunities was a large deterrent for growing soybeans. Most adopters and past-adopters answered closely to strongly disagree, however the distribution for non-adopters was more equal. Since soybeans are a major world-wide commodity, the size of the soybean market is not a concern for Saskatchewan farmers (Boersch, 2014). Saskatchewan farmers appear to be satisfied with the amount of marketing opportunities available to them and it is not a deterrent for growing soybeans. The results from both the seed and marketing deterrent questions are shown in Figure 4.3.

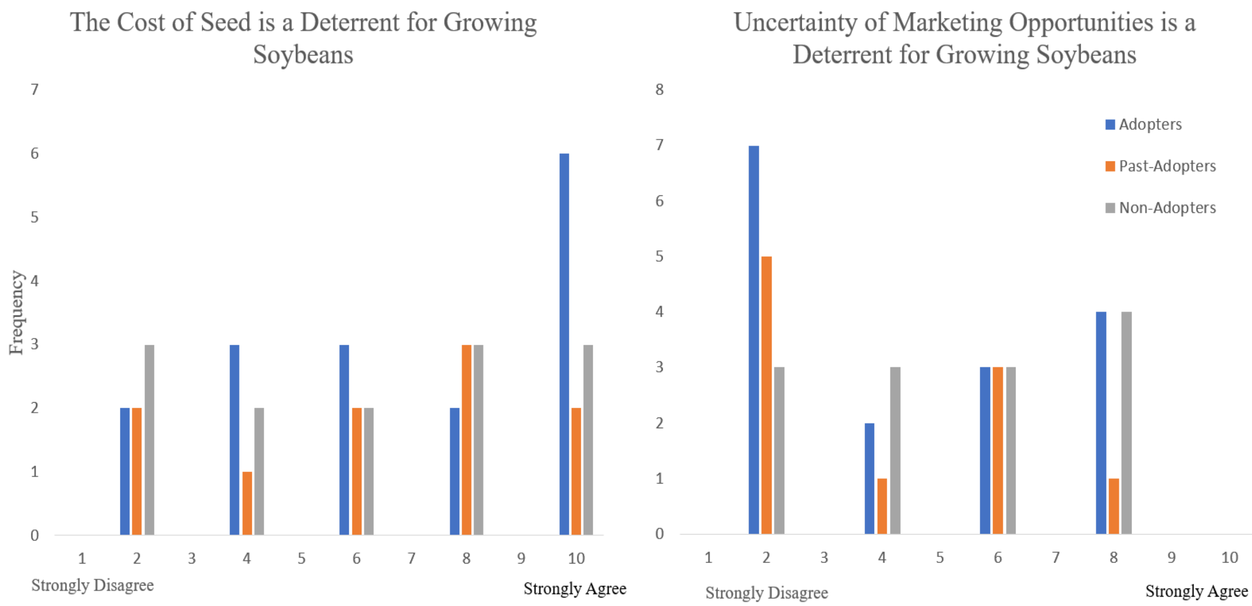


**Figure 4.3 Potential Deterrents for Growing Soybeans**

Source: Author

### 4.2.1 Farm Performance vs RM Average

Farmers' different perceptions on what the gross return of soybeans needed to be to add or keep soybeans in their rotation, would be directly influenced by the performance of the other crops they are currently growing. If farmers' other rotational crops are performing quite well, then soybeans need to meet or exceed this level to be attractive to farmers. The decision to adopt soybeans could also be influenced by how the farmer is performing compared to others in their area. To study this, average yield for each farmer's three largest crops, in terms of seeded acres, from the previous growing season were collected. These yields were then compared to the average yields in that farmer's Rural Municipality (RM), from the previous growing season provided by the Ministry of Agriculture in the Provincial Crop Planning Guide (Government of Saskatchewan, 2016a). No RM average yields are available for soybeans, so the average yields in the Provincial Crop Planning Guide provided by the Ministry of Agriculture were used. As well, one farmer was growing triticale, but there was no data on triticale from either source so it was not included. Average prices were also collected from the Provincial Crop Planning Guide, and then the gross return for the crop was calculated. Prices from the Crop Planning Guide are based on "harvest time future prices and contract prices obtained as of December 2015"

(Government of Saskatchewan, 2016a, pp. 3). These numbers were then compared to the RM average for each area, and the difference in the return the farmer was making on each crop compared to the average in their area was calculated and reported in Table 4.4. Looking at the average difference in return, adopters had the lowest average return over their RM average. Past-Adopters had the highest average return over their RM average. Adopters were also the only group to have respondents performing below their RM average.

**Table 4.4 Return Over RM Average- Based on Provincial Crop Planning Guide**

| | **Past-Adopters** | **Adopters** | **Non-Adopters** |
|---|---|---|---|
| Average | $106.03 | $81.82 | $87.44 |
| Minimum | $37.76 | -$61.64 | $13.29 |
| Maximum | $191.13 | $283.72 | $192.96 |
| Standard Deviation | 55.68 | 92.77 | 54.32 |

Source: Author

These results show that the past-adopters are doing well compared to the other farmers in their area. If these farmers are having success with the other crops they are growing in their rotations, they would have less incentive to look for new crops to add into their rotations such as soybeans (Levinthal & March,1993). In comparison, adopters of soybeans are performing overall at the lowest level compared to their RM average and therefore are likely looking to replace under-performing crops in their rotations. In their case, soybeans would have a higher relative advantage potentially over other crops they are growing if soybeans are a better fit and can provide a higher return. However, these return estimates only consider agronomic measures reported by farmers in terms of average yield. To fully compare the performance between the three groups actual prices received by farmers for their crops would need to be accounted for. In this case, adopters may have lower average yields than the other two groups but they may be better at marketing and may receive higher average prices than the other groups which would adjust their gross return per acre.

The return each farmer is seeing over their RM average can be divided into three groups, low, mid, and high. Low contains values from $-64.64 to $56.10, mid contains values from $56.10 to $159.07, and the high return groups contains values from $159.07 to $298.36. Looking at the distribution of farmers over these ranges and split between groups in Figure 4.3, shows that adopters had the highest frequency of respondents performing at the low return level. Non-adopters had the highest frequency of respondents performing at the mid return level, and adopters and past-adopters were tied for the highest frequency at the high return level.

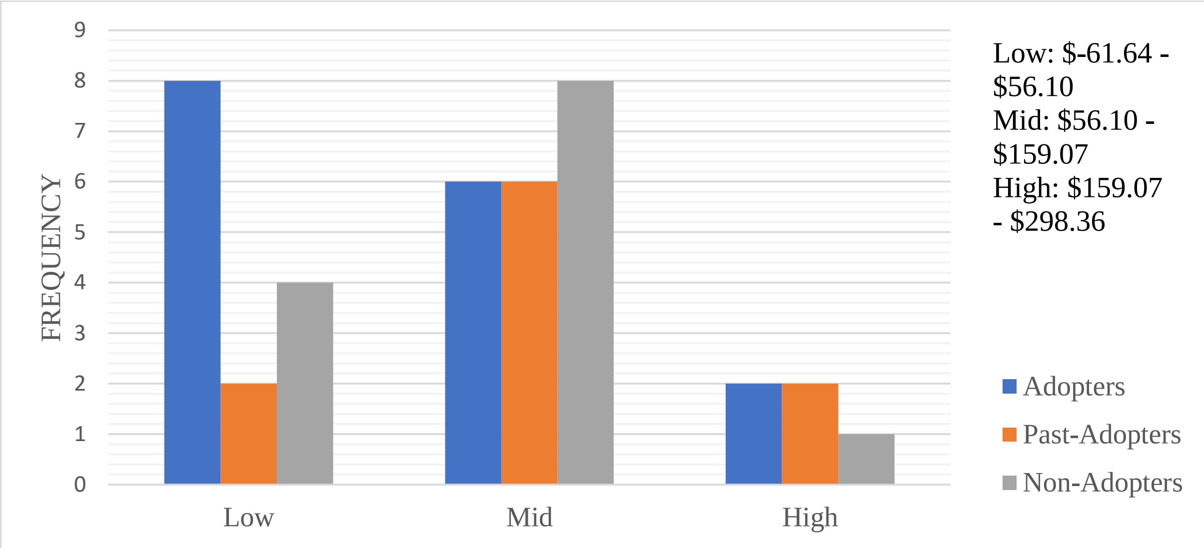


**Figure 4.4 Return Over RM Average Distribution**

Source: Author

## 4.3 Agronomic Factors

The main agronomic characteristics studied were yield potential, maturity rating, and disease resistance of varieties. Adopters and past-adopters were asked on a likert scale if they were satisfied with the potential of the soybean varieties they had been growing in these areas. Results from these questions are shown in Figure 4.4.  One past-adopter was not able to answer the questions as he felt it had been too long since he last grew soybeans and would not be able to accurately answer the questions. As well, one adopter did not answer the question about disease resistance as he had not experienced any disease in his soybeans and felt he could not provide an accurate answer.

Most adopters agreed that they were satisfied with the yield potential of current varieties, however most past-adopters answered closer to strongly disagree. Most adopters either agreed or strongly agreed that they were satisfied with the maturity ratings of current varieties. For past-adopters, the results were more equally spread. Regarding satisfaction with disease resistance, agree and strongly agree were tied for the top response from adopters. Strongly agree was the most common answer from past-adopters.

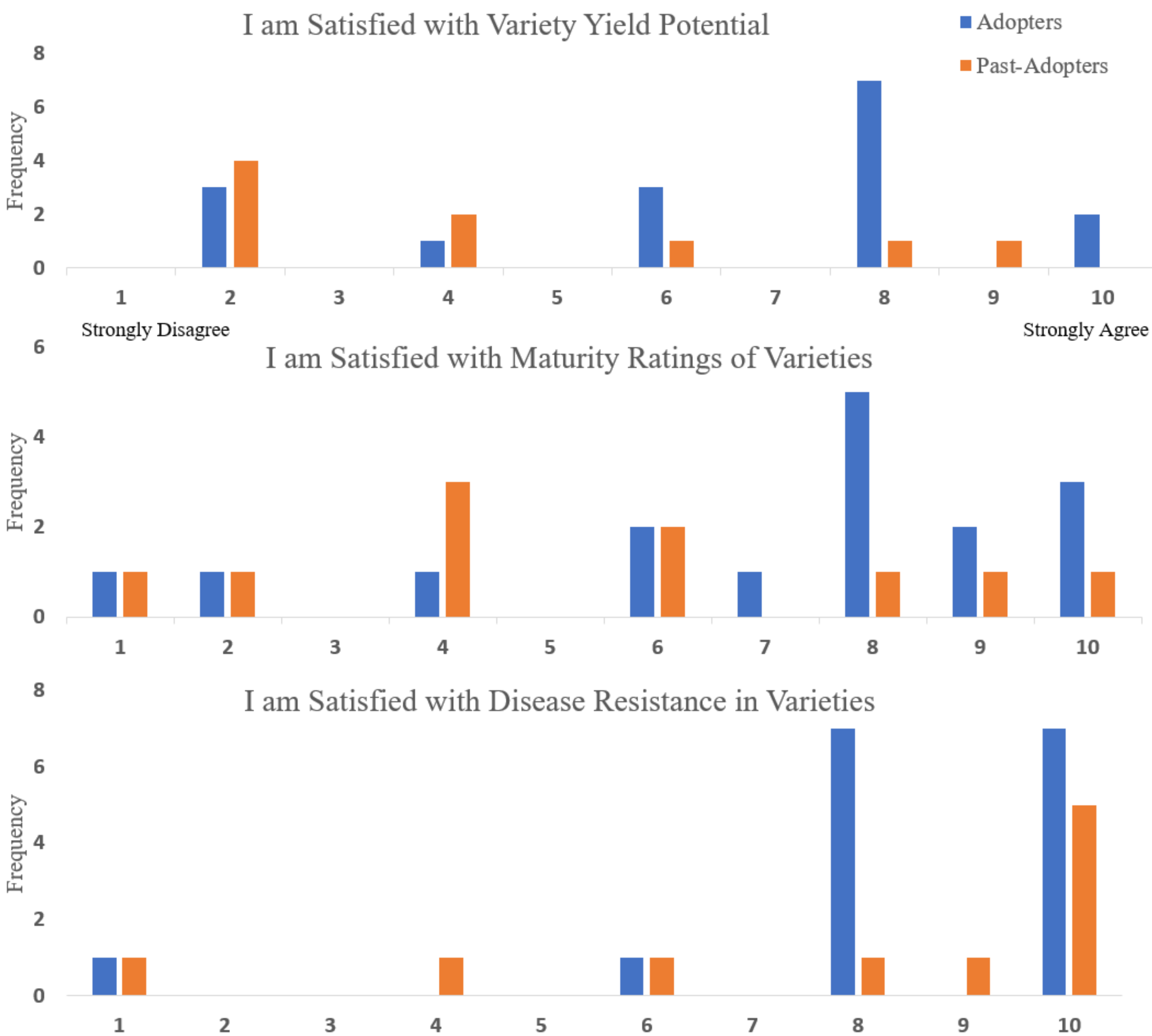


**Figure 4.5 Satisfaction with Yield Potential, Maturity Rating & Disease Resistance**

Source: Author

Farmers were also asked how they viewed yield potential, maturity rating, and disease resistance in terms of agronomic importance when they were selecting a variety. This question was asked to all three groups of respondents. Strongly agree was the most popular answer for all three groups when asked if they thought yield potential was the most important agronomic consideration when choosing a variety. However, adopters had the largest range of answers. Majority of adopters agreed that maturity rating was an important characteristic to consider, however not all felt that it was the most important. Past-adopters for the majority were neutral on this statement and most non-adopters also agreed. Most adopters and past-adopters disagreed or were neutral whether disease resistance was an important characteristic to consider when selecting a variety. Non-adopters had a higher percentage of respondents agree that disease resistance is an important characteristic to consider when choosing a variety. These results are shown in Figure 4.5.

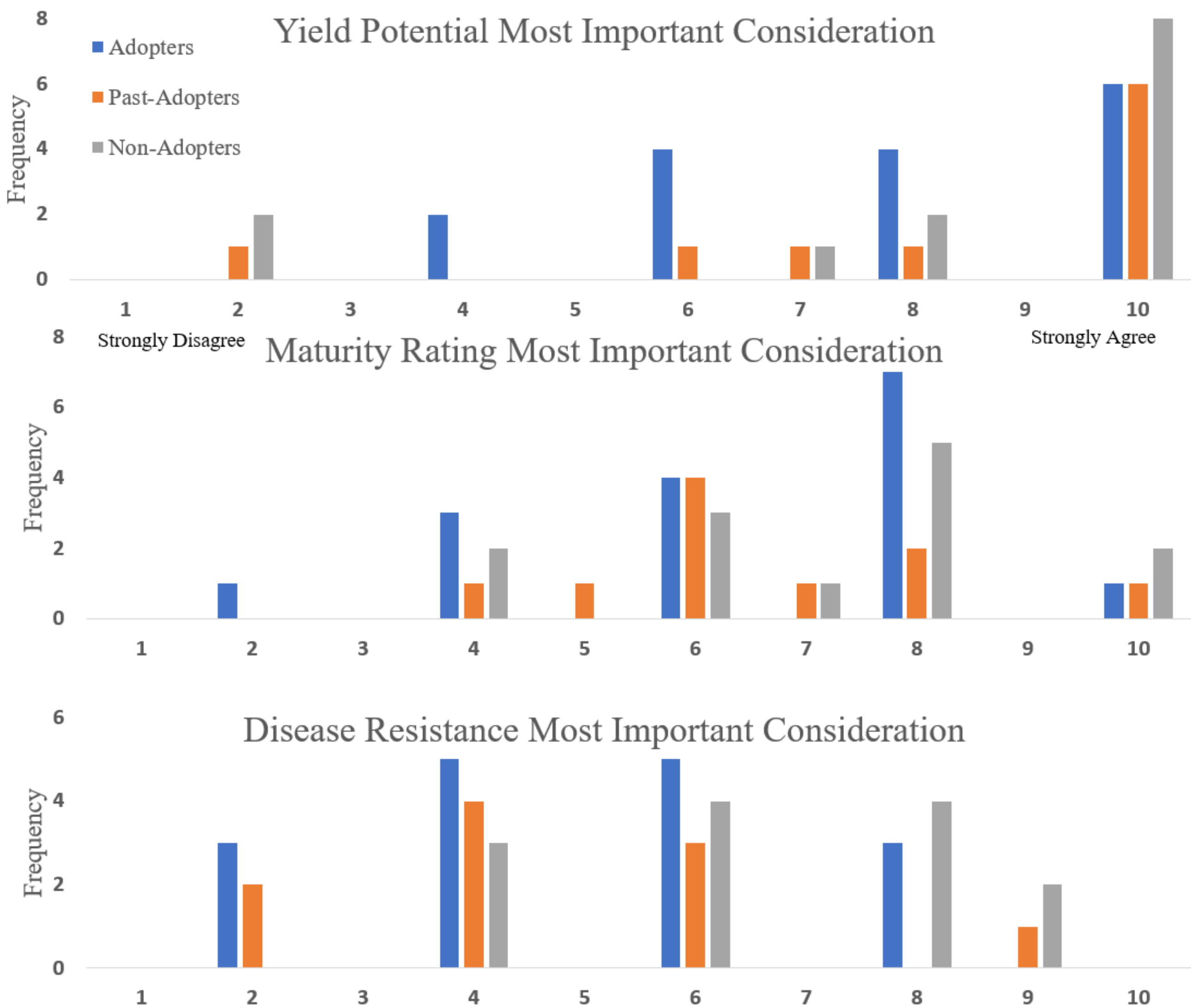


**Figure 4.6 Importance of Agronomic Factors when Selecting Varieties**

Source: Author

Farmers were then asked questions regarding how soybeans could fit into their rotations on their farms and some general questions about their level of agronomic knowledge. First farmers were asked if they thought soybeans could be used as a weed management tool in their rotations to help clean up fields. Most farmers in all three categories agreed or strongly agreed with this statement. Farmers were also asked if glyphosate resistant weeds were a problem on their farm and if the new Roundup Ready 2 Dicamba resistant soybean varieties would make growing soybeans a better fit for their farm. Most farmers interviewed answered closely to strongly disagree that glyphosate resistant weeds were a problem on their farms.

For the 2017 growing season, soybean growers will have the option of Roundup Ready 2 Xtend® soybean varieties that have resistance to glyphosate and dicamba (Monsanto, 2016). This gives farmers more choice when it comes to weed control in soybeans. Majority of adopters and non-adopters agreed that the new Roundup Ready 2 Dicamba resistant soybean varieties would be a better fit for their farms. Looking at the past-adopters, disagree was the top response. Some farmers had concerns over adding another resistance group into the crop and what that would mean for resistant weeds in the future.

Farmers were also asked if they felt confident in their ability to grow soybeans. Most adopters and past-adopters agreed or strongly agreed that they felt confident in their abilities to successfully grow soybeans. The non-adopters had more respondents who were neutral when answering the question. However, non-adopters still felt confident in their ability to grow soybeans indicating that this crop is not agronomically challenging for producers to adopt and perception of ability is not a barrier to adoption. Figure 4.6 illustrates the results of the rotation and confidence questions.

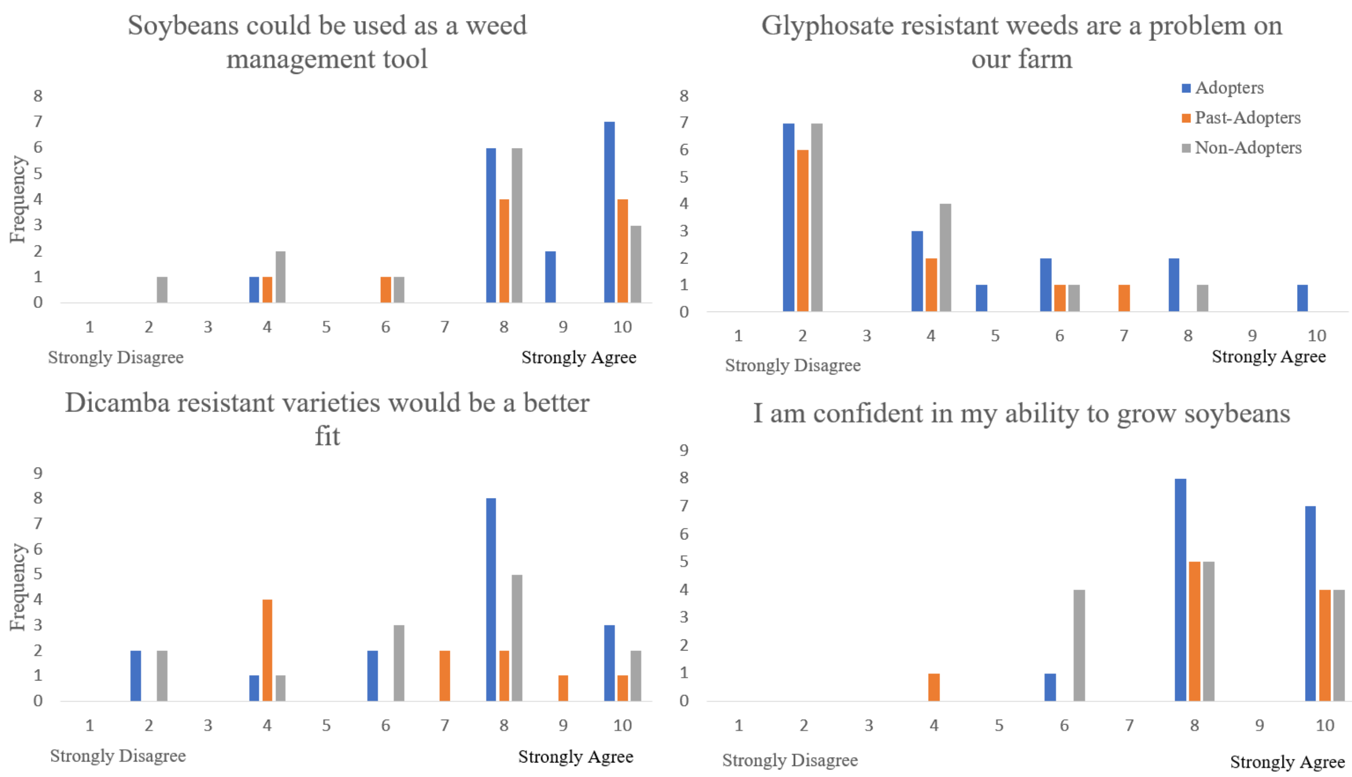


**Figure 4.7 Agronomic Confidence & Considerations**

Source: Author

### 4.3.1 Brown-Bagging Soybeans

Of the 39 farmers interviewed, only three were currently growing brown-bagged varieties, and one had done it when they ran out of seed, although it was not something they intended on doing. When asked if they would consider growing a brown-bagged variety in the future, thirteen of the remaining 35 farmers said they would. When asked, what factor would lead to them making this decision, all thirteen answered seed costs. The other 22 farmers gave several reasons for why they would not consider growing a brown-bagged variety and are reported in Figure 4.7. The main reason was farmers wanted to have the best genetics available to them for lower heat units and better yield potential. Some farmers also mentioned being believers in certified seed and several were also either seed growers or sold soybean seed. Another factor was the convenience of buying new seed and having it treated and inoculated at the retail before it was delivered.

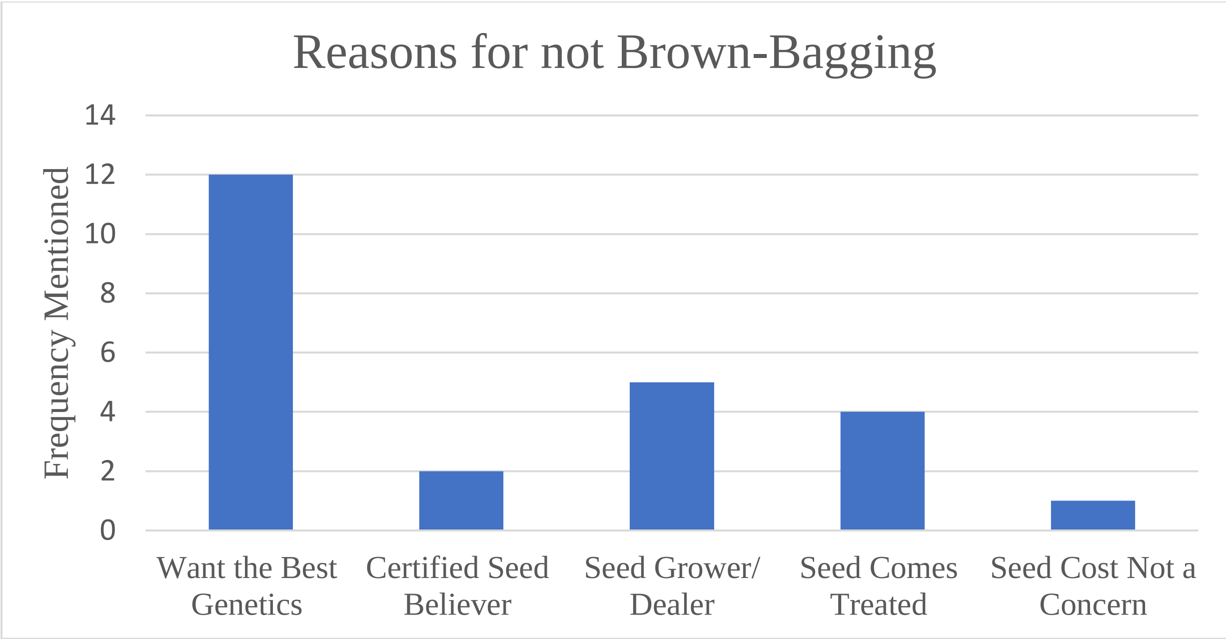


**Figure 4.8 Reasons for not Brown-Bagging**

Source: Author

The four farmers who had grown or were currently growing brown-bagged varieties were asked three additional likert questions, 1 being strongly disagree and 10 being strongly agree. The questions were:

1. Growing brown-bagged varieties is common in this area
2. The yields of brown-bagged varieties are competitive with non-brown-bagged varieties
3. Not having support from a sales rep through the growing season is a deterrent from growing brown-bagged varieties.

Their answers are shown in Table 4.5

**Table 4.5 Brown-Bagging Likert Scale Responses**

| | Producer 1 | Producer 2 | Producer 3 | Producer 4 |
|---|---|---|---|---|
| Growing brown-bagged varieties is common in this area | 8 | 10 | 2 | 8 |
| Yields of brown-bagged varieties are competitive | 10 | 10 | 8 | 8 |
| Not having support from a sales rep is a deterrent for growing brown-bagged varieties | 2 | 2 | 4 | 2 |

Source: Author

## 4.4 Farm Characteristics

Farmers were also asked basic farm and farmer characteristic questions which are reported in Table 4.6. All farmers could answer all questions, except for one adopter who did not want to reveal how much income from farming made up his total income.

Adopters were the group that had the smallest average farm size at 4,706.25 acres. Past-adopters had the largest average farm size at 7,390 acres. Non-adopters had the lowest average full-time employees with 2.5, and adopters and past-adopters had the same average at 3.4.

Adopters were the category that had the highest average for years of farming experience, and they also had the highest average age. For education, post-secondary had the highest percentage of respondents in all three categories. This included university or technical school training.

For plans for the farming operation going forward, the response to maintain or increase acres was split equally between adopters and non-adopters, however 70% of past-adopters were looking to increase acres. Past-adopters also had the highest percentage of farmers who had a succession plan set up.

Looking at percent of total income from farming, adopters had the lowest percentage at 77%. Adopters also had the highest average for number of crops in their rotation. Most respondents in all three categories, were currently growing other legumes or they had tried them in the past.

**Table 4.6 Farm Characteristics**

| | **Past-Adopters (10)** | **Adopters (16)** | **Non-Adopters (13)** |
|---|---|---|---|
| Farm Size (Acres) | Mean: 7,390 | Mean: 4,706 | Mean: 5,392 |
| Number of full-time employees | Mean: 3.4 | Mean: 3.4 | Mean: 2.5 |
| Age | Mean: 48.6 | Mean: 48.9 | Mean: 37.8 |
| Farming Experience | Mean: 28.4 | Mean: 29.4 | Mean: 18.5 |
| Education | High School: 10%<br>Some Post Secondary: 30%<br>Post Secondary: 60% | High School: 38%<br>Some Post Secondary: 25%<br>Post Secondary: 44%<br>MSc. Degree: 6% | High School: 31%<br>Post Secondary: 69% |
| Plans for Farming Operation | Maintain: 30%<br>Increase: 70% | Maintain acres: 56%<br>Increase: 44% | Maintain: 54%<br>Increase: 46% |
| Do you have a succession plan? | No: 40%<br>Yes:60% | No: 63%<br>Yes: 38% | No: 46%<br>Yes: 54% |
| % Total Income Made Farming | Mean: 100% | Mean: 77% | Mean: 83% |
| Number of Crops in Rotation | Mean: 4.5 | Mean: 4.8 | Mean: 3.7 |
| Currently Growing or have Previously Grown Other Legumes | Yes: 90%<br>No: 10% | Yes: 88%<br>No: 12% | Yes: 92%<br>No: 8% |

Source: Author

## 4.5 Social Capital & Absorptive Capacity

Farmers were asked twelve scale questions during the interview that aimed to measure the level of social capital that each farmer possessed. Strongly agreeing with the statements would represent a higher level of social capital. Farmer's answers were summed together to calculate their social capital score. A score of 120 was the highest that a farmer could obtain. Past-adopters had the highest average score at 94.2 with adopters a close second at 93.69 as shown in Table 4.7. The average score for non-adopters was also close, at 92.92. No significance difference was found between the average scores of the three adopter categories, which leads to the conclusion that there is likely a high level of social capital amongst farmers and in the agricultural sector in Saskatchewan in general[3]. This can be seen in the collaborative groups and initiatives that are created throughout the industry.

**Table 4.7 Social Capital Averages**

| | **Past-Adopters (10)** | **Adopters (16)** | **Non-Adopters (13)** |
|---|---|---|---|
| Average | 94.2 | 93.69 | 92.92 |
| Minimum | 80 | 66 | 73 |
| Maximum | 116 | 120 | 108 |

Source: Author

Farmers were asked about their involvement with local agricultural groups, other local groups and boards, and their volunteering activities within their community. Looking at local group involvement can be used to further measure social capital. Adopters had the highest percentage of farmers involved with local agriculture groups, local boards, and volunteering within their communities. The percentages of involvement are shown in Table 4.8.

[3] ANOVA Analysis was calculated on the Social Capital variable, and the null hypothesis of equal means was not rejected.

**Table 4.8 Farmer Involvement**

| | Past-Adopters (10) | Adopters (16) | Non-Adopters (13) |
|---|---|---|---|
| Local Agriculture Groups | Yes: 60% | Yes: 63% | Yes: 46% |
| Local Boards | Yes: 80% | Yes: 81% | Yes: 54% |
| Volunteering | Yes: 80% | Yes: 94% | Yes: 77% |

Source: Author

To measure absorptive capacity, farmers were asked 16 scale questions that aimed to measure the level of absorptive capacity each farmer possessed. Again, farmer's answers were summed together with the highest score a farmer could achieve being 160. Average scores are reported in Table 4.9. Past-adopters again have the highest average absorptive capacity score at 137.7, adopters are second with 127.38, and non-adopters had the lowest with 124.46. However, no significant difference was found between the average scores of the three adopter categories.[4] Past-adopters were also found to have the highest average when the score was split between potential and realized absorptive capacity. The highest potential absorptive capacity score that could be obtained was 50, and the highest realized absorptive capacity score that could be obtained was 110. No significant difference was found between the means of the three groups for potential absorptive capacity, however a significant difference was found between the means of the three groups for realized absorptive capacity.

**Table 4.9 Absorptive Capacity Averages**

| | Past-Adopters (10) | Adopters (16) | Non-Adopters (13) |
|---|---|---|---|
| Combined Average | 137.7 | 127.38 | 124.46 |
| Potential AC Average | 44.3 | 41.81 | 40.85 |
| Realized AC Average | 93.4 | 85.56 | 83.62 |

Source: Author

Looking at previous literature, one would expect adopters of soybeans to have the highest level of absorptive capacity. However, the past-adopter group have also moved through the

[4] ANOVA analysis was calculated on the full absorptive capacity variable, potential absorptive capacity, and realized absorptive capacity. The null hypothesis of equal means was only rejected for realized absorptive capacity.

adoption process and therefore a higher level of absorptive capacity may have helped them through the process previously. Furthermore, past-adopters having a significantly higher level of realized absorptive capacity would assist them in evaluating soybeans once they had tried growing the crop. The past-adopters decided that other crops would be a better fit in their rotations, however they are willing to try soybeans again in the future when it is a better fit for their farm.

## 4.6 Extension Services & Availability of Information

The first two questions in this section asked farmers if they would agree with the statement that they frequently rely on public extension services and if they frequently rely on private extension services. Non-adopters had the highest percentage of respondents who agreed that they frequently relied on public extension services as shown in Figure 4.8. However, adopters had the highest percentage of respondents who agreed that they frequently rely on private extension services.

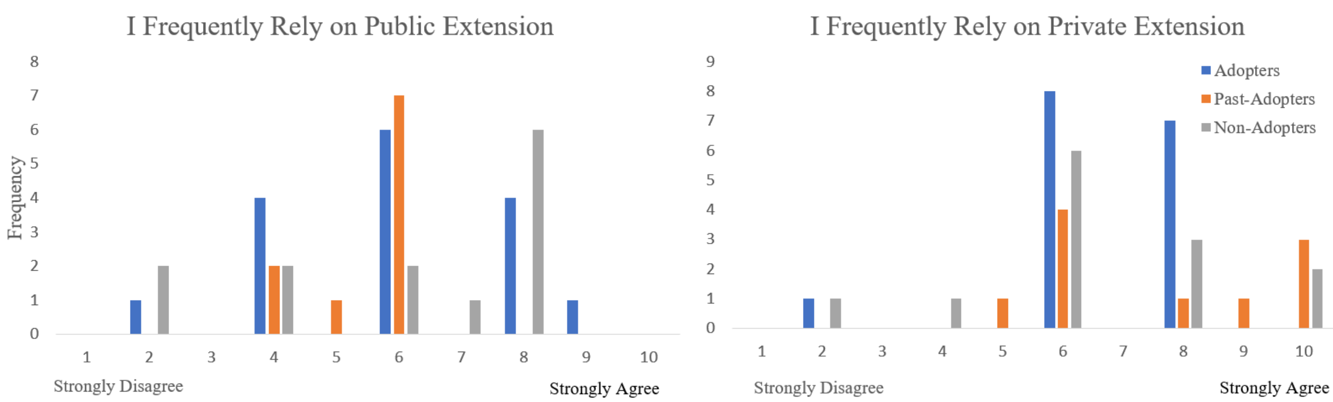


**Figure 4.9 Frequency of Relying on Public & Private Extension Services**

Source: Author

Farmers were then asked where the first place they turn was when they were encountered with an agronomic problem. Agronomist was the most popular choice across all three categories as reported in 4.10. This would be a local agronomist either working at their local crop input retail or independently in their area. This result shows that it is important for both larger public and private groups to provide support and resources to local retails as this is often the first-place farmers turn for information.

**Table 4.10 Most Relied on Information Sources**

| Past-Adopter (10) | Adopter (16) | Non-Adopter (13) |
|---|---|---|
| Agronomist: 50% | Agronomist: 44% | Agronomist: 54% |
| Sales Rep: 20% | Sales Rep: 13% | Sales Rep: 8% |
| Internet: 10% | Internet: 25% | Internet: 15% |
| Neighbour: 20% | Neighbour: 19% | Neighbour: 15% |
| | | Family: 15% |

Source: Author

Adopters and past-adopters of soybeans were asked questions on whether they felt there was enough easily accessible information available on growing soybeans, and whether they felt that farmers had enough support available to them throughout the production process. One adopter felt he was not able to answer the questions as it was his first-time growing soybeans, and one past-adopter felt it had been too long since he had tried growing soybeans to answer the question accurately. Therefore, the sample size for this question is 15 and 9. Most adopters and past-adopters agreed or strongly agreed that there is enough easily accessible information on growing soybeans. Agree and strongly agree were also the two most popular answers when farmers were asked if they have enough support available to them throughout the production process. The results are shown in Figure 4.9.

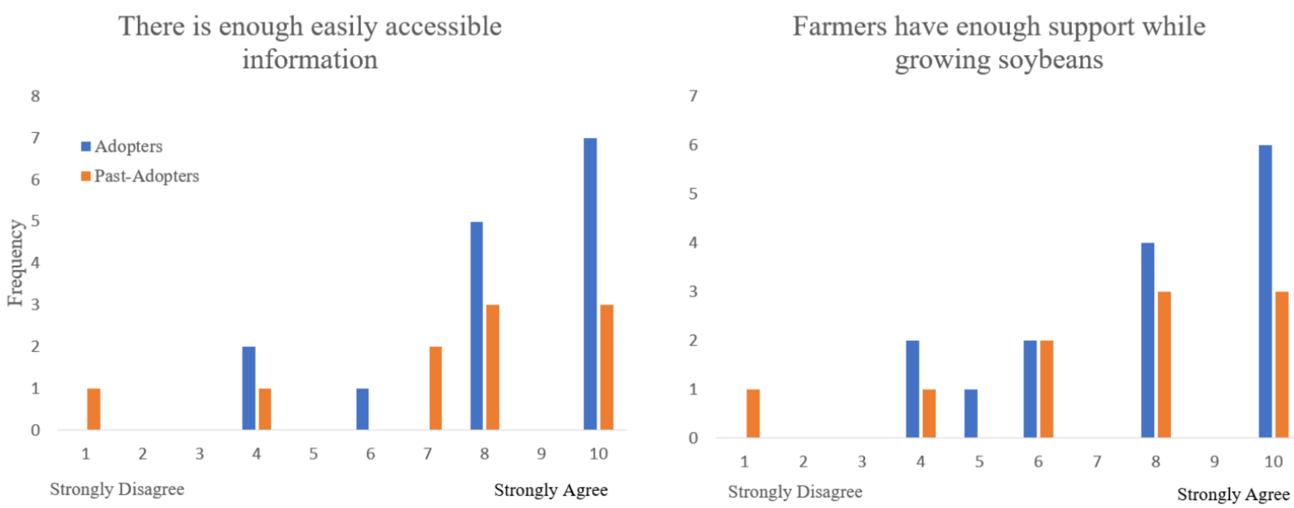


**Figure 4.10 Availability of Information & Support**

Source: Author

Both adopters and past-adopters were asked if they had ever participated in an on-farm soybean trial before. Five out of sixteen adopters had participated in a trial that was set up by a seed company. Two adopters had been running their own trials that they had set up themselves. The other nine adopters had never participated in a trial. Five out of ten past-adopters had participated in an on-farm trial with a seed company before. One past-adopter had also set up his own trials in the past. The other four past-adopters had never completed a trial. Setting up on-farm trials not through a seed company is also a valuable learning tool as it allows farmers to experiment with different ideas and techniques to determine the best production system for their farm.

Farmers were also asked about what they thought the Saskatchewan Pulse Grower's (SPG), role should be in the adoption process of soybeans in the province. They were asked if they thought SPG should invest in soybean breeding, or should SPG focus solely on agronomy research. Majority of farmers either agreed or strongly agreed that SPG should look at investing in soybean breeding, as shown in Figure 4.10. Therefore, most farmers answered closely to strongly disagree or disagree for the statement that SPG should focus only on soybean agronomy research.

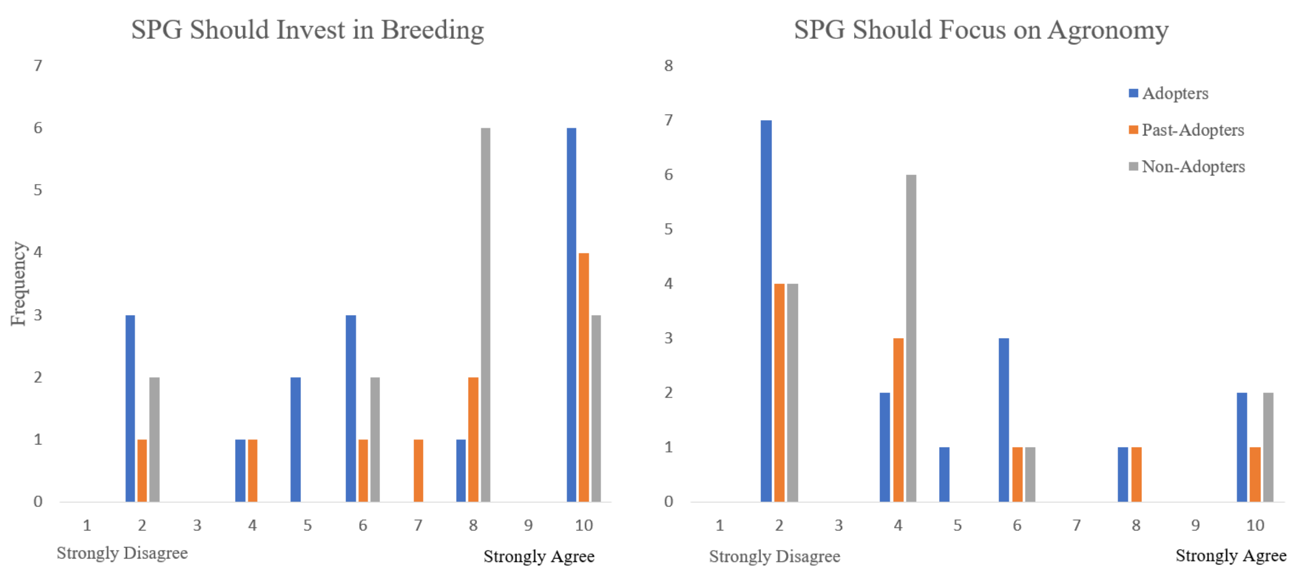


**Figure 4.11 Role of SPG**

Source: Author

## 4.7 Chapter Summary

The results from the farmer interviews provide valuable insights into the barriers to adoption farmers are still facing when it comes to soybeans in Saskatchewan. It also gives insight into the factors that lead adopters to become past-adopters and choose to not keep soybeans in their rotation for the current period. Farmers currently growing soybeans have a more positive outlook for the expected profitability of the crop. They also require a lower gross return per acre to keep soybeans in their rotations. Some farmers in all three groups could see soybeans lowering their production risk through a crop diversification strategy in their rotations.

For agronomic characteristics, yield potential and maturity rating were the two most frequently mentioned obstacles that farmers identified for growing soybeans in Saskatchewan. Adopters were the group most satisfied with the yield potential and maturity ratings of current varieties, which is likely because they have the most experience with the newest varieties on the market. Yield potential is still the most important characteristic when it comes to selecting a variety to grow. Non-adopters also felt that disease resistance was an important characteristic to look at when selecting a variety. Since soybeans have seen relatively low diseases pressure so far this is not a characteristic that past or current adopters are focusing on. However, this low level of disease pressure could change as soybean acres continue to increase across the province.

Adopters were the groups with the smallest average farm size and past-adopters were the largest. Adopters and past-adopters were tied for the average number of full-time employees at 3.4. Adopters were also the oldest group and had the most farming experience, non-adopters on the other hand were the youngest with the least experience. Post-secondary was the most common education level for all three groups. Adopters also had the lowest percentage of their income come from farming activities.

Past-adopters had the highest average scores for both social capital and absorptive capacity. Furthermore, no significant differences were found between the three adopter categories with these factors except for realized absorptive capacity. However, the snowball sampling method used could be creating a bias in the sample towards farmers who would have higher social capital and absorptive capacity scores as these farmers would have larger networks and connections which allowed them to be discovered to participate in this research.

The results from the questions around extension services, show that the extension system around soybeans is functioning well. Farmers are satisfied to very satisfied with the amount of information and support available to them. Furthermore, farmers are looking for the Saskatchewan Pulse Growers to invest in soybean breeding in the province. Farmers identified the need for higher yielding and earlier maturing varieties as the biggest obstacles to soybean adoption, therefore, they are looking for support from SPG to invest in breeding and help to generate new varieties that will meet their demands.

The next chapter will analyze the results from the farmer interviews to determine the factors that influence farmers to adopt or not-adopt soybeans. As well, the factors that influence farmers to adopt and continue growing soybeans will be analyzed.

# 5.0 Data Analysis

## 5.1 Introduction

This chapter will go through the results from the analysis conducted on the interview data. To begin, ANOVA analysis and t-tests were conducted on different variables for comparison of means between the three adopter categories. Next, a probit model was run with the decision to adopt or not adopt soybeans as the dependent variable. Required gross return and absorptive capacity were found to have a statistically significant effect on the probability of adopting soybeans. Finally, an OLS model was run to analyze the factors that influenced farmers to grow soybeans for a longer period. Expected profitability and participating in a trial had a significant positive effect on the number of years growing soybeans.

## 5.2 ANOVA Analysis

To begin, ANOVA analysis was conducted on descriptive variables to look at if the means were equal across the three adopter categories. Of these variables, the null hypothesis of equal means was rejected for required gross return per acre, age and realized absorptive capacity as shown in Table 5.1. T-tests were then conducted between the means of each adopter group. Looking at required gross return per acre and age, the null hypothesis of equal means was rejected at a 5% level for adopters versus non-adopters and past-adopters versus non-adopters. The null hypothesis of equal means was not rejected between adopters and past-adopters. For realized absorptive capacity, the null hypothesis of equal means was rejected at a 5% level for past-adopters versus adopters and past-adopters versus non-adopters. The null hypothesis of equal means was not rejected between adopters and non-adopters. The results from both the ANOVA and t-tests can be found in Appendix E.

**Table 11 Results from ANOVA Analysis**

| Variable | Significance | Adopters vs Past-Adopters | Adopters vs Non-Adopters | Past-Adopters vs Non-Adopters |
|---|---|---|---|---|
| Required Gross Return/Acre** | Yes ($p$-value=0.013184) | Fail to Reject | Reject** | Reject** |
| Age** | Yes ($p$-value =0.035412) | Fail to Reject | Reject** | Reject** |
| Acres | No ($p$-value = 0.369861) | | | |
| Full-Time Employees | No ($p$-value= 0.78649923) | | | |
| Social Capital | No ($p$-value =0.970702) | | | |
| Absorptive Capacity | No ($p$-value= 0.108767) | | | |
| Potential Absorptive Capacity | No ($p$-value =0.243208) | | | |
| Realized Absorptive Capacity* | Yes ($p$-value= 0.103398) | Reject** | Fail to Reject | Reject** |

**Significant at the 5% Level; *Significant at the 10% Level

Source: Author

## 5.3 Additional Analysis: Return over RM Average

Further analysis was conducted to look at the relationship between different farm characteristics and the performance of those farmers compared to others in their RM. Figure 5.1 shows the relationship between farm size and return over the RM average. Most of the farmers performing at a mid or high-return level are found to have a larger farm size. Adopters are the exception to this at the high-return level, as these farmers have significantly smaller average acres than the past or non-adopters at this level.

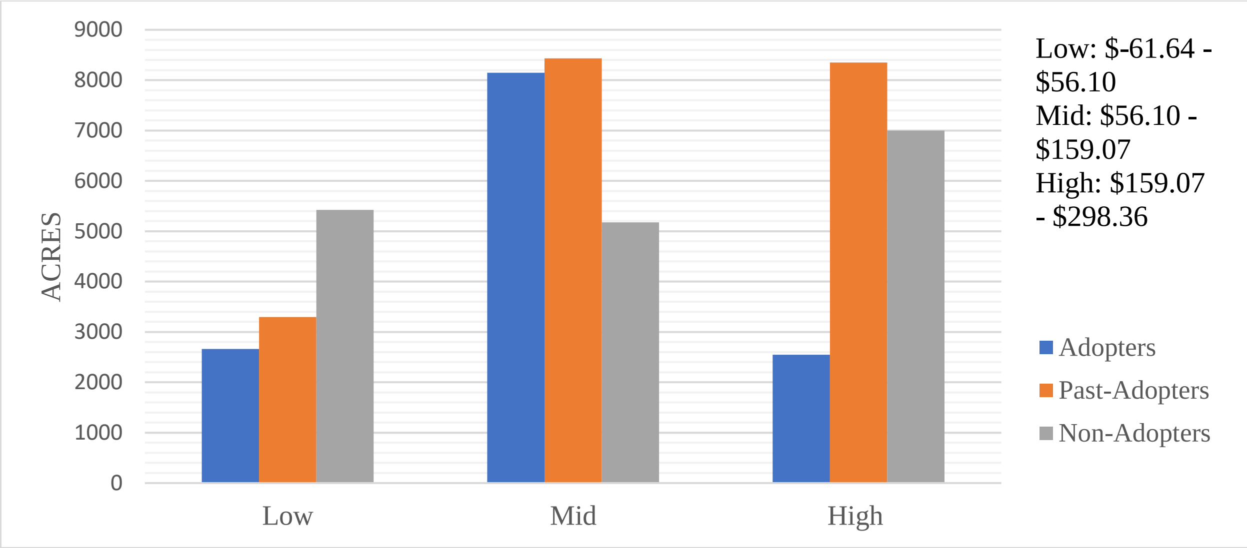


**Figure 5.1 Acres vs Return Over RM Average**

Source: Author

Looking at average absorptive capacity scores distributed across return over RM average in Figure 5.2, shows that past-adopters have the highest absorptive capacity score across all three return levels. This result would be expected since past-adopters were found to have the overall highest absorptive capacity average.

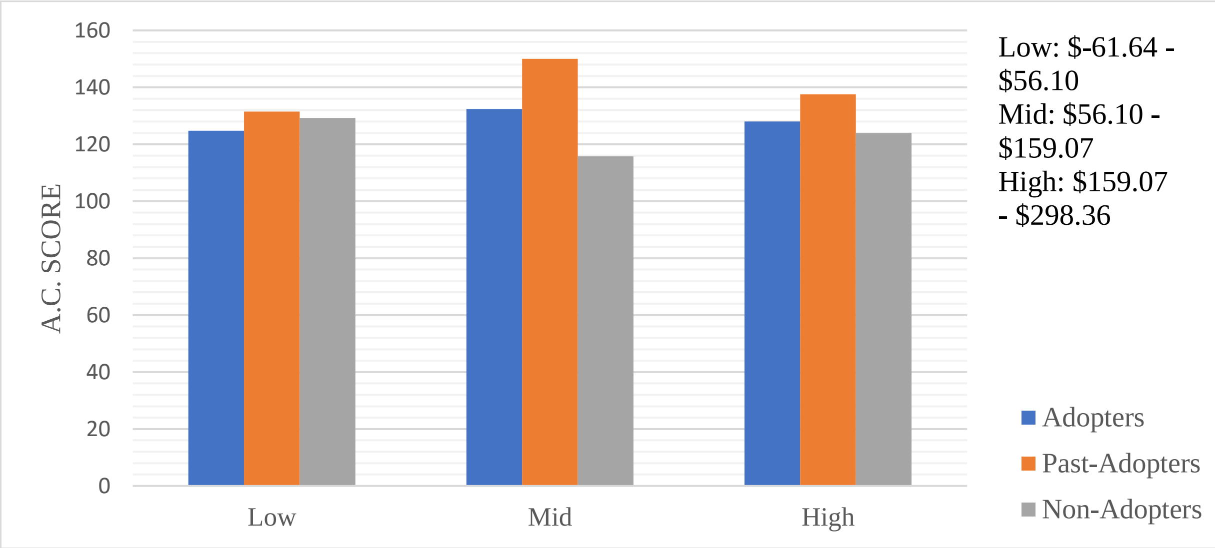


**Figure 5.2 Absorptive Capacity Score vs Return Over RM Average**

Source: Author

Figure 5.3 shows the relationship between age and return over RM average. Adopters are the oldest category in both the low and mid return group, followed by past-adopters and then non-adopters. However, looking at the high-return category, past-adopters have the highest average age of any other return group. In comparison, the adopters and non-adopters have their respondents with the lowest average age found in the high return group.

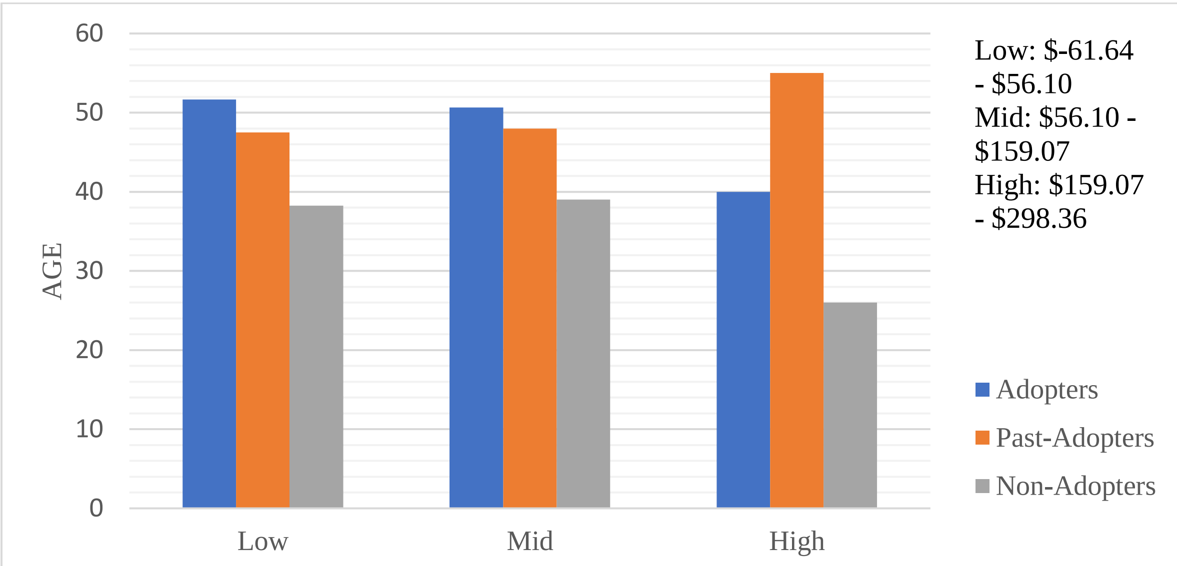


**Figure 5.3 Age vs Return Over RM Average**

Source: Author

Farmers who are performing at a mid or high return level over their RM average, are found to also have a higher average number of full-time employees as shown in Figure 5.4. This is consistent across all three adopter categories, except for adopters in the high-return level.

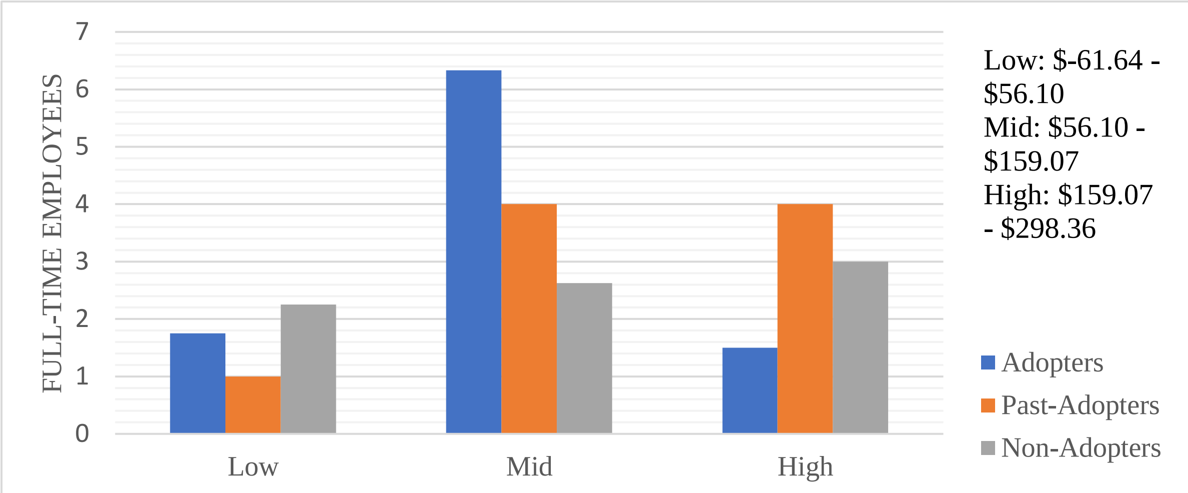


**Figure 5.4 Full-Time Employees vs Return Over RM Average**

Source: Author

Figure 5.5 shows the relationship between the number of crops a farmer has in their rotation and the level of return over RM average. Farmers from all three adopter categories in the mid-return group are found to have the highest average number of crops in their rotation. The high return group has the lowest number of crops for both adopters and non-adopters. These farmers would appear to have three to four crops that they are having success with and therefore, they may have less of an incentive to add new crops into their rotations (Levinthal & March, 1993).

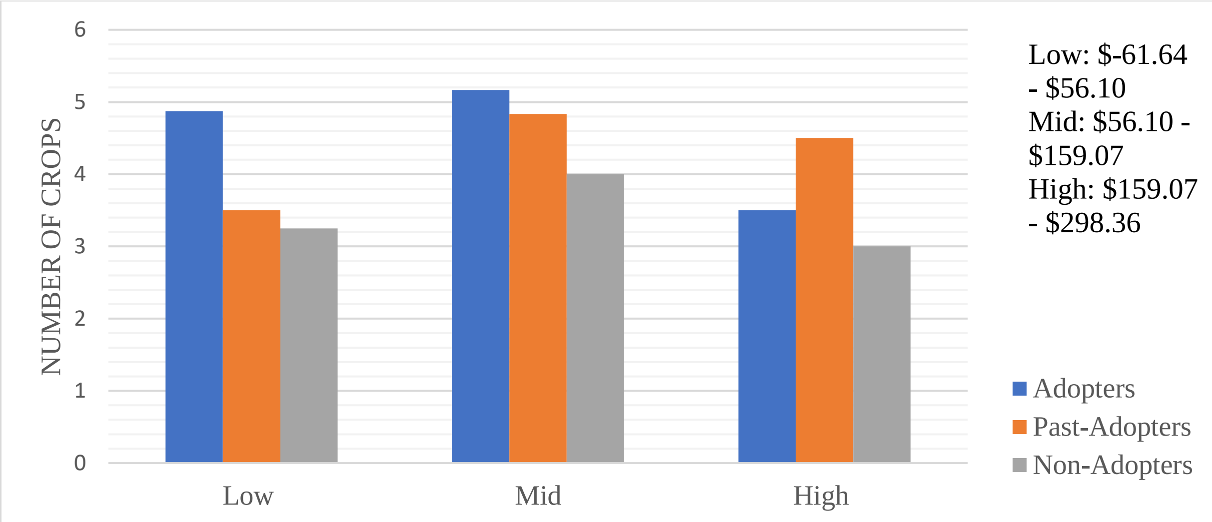


**Figure 5.5 Number of Crops in Rotation vs Return Over RM Average**

Source: Author

## 5.4 Probit Model

To analyze the effects that different economic factors and farm characteristics had on the decision to adopt or not adopt soybeans, a probit model was run with a binary dependent variable. For dichotomous adoption decisions, logit or probit models can be used. Adopters and past-adopters were labelled with a one since they have adopted soybeans either currently or in the past. Non-adopters were labelled with a zero.

The model was as follows:

$$Y = \beta 0 + \beta 1\ Req.\ Gross + \beta 2\ ExpectedProfit\ \beta 3\ FTEAc. + \beta 4\ Age + \beta 5\ Age^2 + \beta 6\ AC$$

### 5.4.1 Model Variables

The model variables were chosen based on a review of the literature and specific variables whose affect we wanted to study further. Table 5.2 gives an overview of the variables included.

**Table 5.12 Probit Model Variables**[5]

| Variable | Mean | Standard Deviation | Description | Predicted Sign |
|---|---|---|---|---|
| GrossReturn | 365.36 | 90.69 | The required gross return/ acre required for farmers to keep or add soybeans in to their rotation. | (-) |
| ExpectedProfit | 0.69 | 0.73 | Variable representing if farmers thought soybeans would provide an below average return (1), average return (2), above average return (3). | (+) |
| FTEAc | 0.00070 | 0.00077 | The number of full-time employees per acre the farmer has. | (+) |
| Age | 45.10 | 12.77 | Age of the farmer. | (-) |
| $Age^2$ | 2193.05 | 1105.92 | Age of the farmer squared. | (uncertain) |
| Absorptive Capacity | 129.05 | 15.56 | Summed score of the farmer from absorptive capacity likert questions. | (+) |

Source: Author

[5] Other model specifications were run which included different variables such as involvement in soybean trials, social capital, potential absorptive capacity, and realized absorptive capacity. Models including social capital and potential and realized absorptive capacity were found to have lower pseudo $R^2$ values and lower predictive power. The trial variable was found to be a perfect predictor and was dropped from the model. The results of these other specifications can be found in Appendix F.

Looking at required gross return per acre is a way to measure how competitive soybeans need to be compared to other crops a farmer already has in their rotation. Producers who have profit as the main motivator behind their adoption decision will only adopt the new crop if they perceive it to have a higher return than the current crop (Zentner et al. 2002). As the required gross return per acre increases, it is predicted that adoption of soybeans will decrease as it is competing with other crops that may be out performing soybeans from a gross revenue perspective. For the farmers who were not able to come up with a value for required gross return per acre, the average for their group of adopters was used.

Profitability of an innovation both currently and in the future, plays an important role in the adoption decision (Cary, Webb & Barr, 2001). Previous research has shown, that farmers are less likely to adopt an innovation if they view profitability to be low or fall in five to ten years (Cary, Webb & Barr, 2001). Therefore, the more profitable farmers except soybeans to be, the more likely they are to adopt.

The variable full-time employees per acre represents labour availability. The effect of labour availability will change depending on the characteristics of the innovation. If the adoption process is very labour intensive, then having more full-time employees per acre farmed, will be beneficial to the adoption process (Daberkow & McBride, 2003). However, if the innovation is labour saving then it will be attractive to farmers who have less full-time employees available per acre (Feder, Just & Zilberman, 1985). Increasing full-time employees is predicted to have a positive effect on the decision to adopt soybeans, as having more labour available to help experiment with a new crop will make it easier for farmers to work the crop into their rotation.

Age is hypothesized to have a negative effect on adoption rates. Older farmers who are moving closer to retirement will be less willing to innovate and make changes to their farming practices than farmers who are just starting out or in the middle of their careers (Daberkow & McBride, 2003). As well, younger farmers are often thought of as more innovative and more willing to try new innovations and ideas (Daberkow & McBride, 2003). Age is also predicted to have a quadratic effect on the adoption decision.

Absorptive capacity is predicted to have a positive effect on the decision to adopt soybeans. Previous studies have found absorptive capacity to have a positive impact on the adoption of innovation (Gellynck et al. 2015; Micheels & Nolan, 2016). Farmers who can more efficiently and effectively acquire, assimilate, transform, and exploit knowledge could move past barriers to adoption sooner which will have a positive impact on adoption rates.

### 5.4.2 Model Results

The results from the probit model are shown in Table 5.3.

**Table 5.13 Probit Model Results**

| | |
|---|---|
| Number of Observations | 39 |
| LR Chi2 (6) | 42.07 |
| Prob > Chi2 | 0.0000 |
| Pseudo $R^2$ | 0.8474 |

| | *Coef.* | *Std. Err.* | *z* | *p-value* |
|---|---|---|---|---|
| GrossReturn* | -.074 | .039 | -1.91 | 0.056 |
| ExpectedProfit | 2.224 | 1.592 | 1.40 | 0.163 |
| FTEAc | 14875.84 | 9170.742 | 1.62 | 0.105 |
| Age | .812 | .593 | 1.37 | 0.171 |
| Age2 | -.006 | .006 | -1.01 | 0.311 |
| AC* | .309 | .181 | 1.71 | 0.087 |
| cons | -39.815 | 22.315 | -1.78 | 0.074 |

*Significant at the 10% level

Note: 5 Failures and 16 successes completely determined

Source: Author

Two variables were found to be significant, required gross return per acre and absorptive capacity at a ten percent significance level. Absorptive capacity is found to have a positive effect on the probability of adoption which matches prior expectations. For a one-unit increase in the summated score for absorptive capacity, the predicted probability of adoption increases by 0.309. Required gross return per acre is found to have a negative effect on the probability of adoption which matches up with prior expectations. As the required gross return per acre increases by a dollar, the predicted probability of adoption decreases by 0.074.

The model also states that 5 failures and 16 successes have been completely determined. Since there are no missing standard errors in the output from Stata, a continuous variable or a combination of continuous variables has been found to be a great predictor of the dependent variable (Stata, 2017).

### 5.4.3 Model Predictive Power

Since adjusted $R^2$ is not a reliable measure of overall fit for probit regressions, a measure based on the percentage of observations explained correctly is used instead (Strudenmund, 2011). Overall, the model explained 96.15% of the adopters and past-adopters correctly and 92.31% of the non-adopters correctly. This gave an overall predictive power for the model of 94.87% as shown in Table 5.4.

**Table 5.14 Model Predictive Power**

| | **1's Observed** | **0's Observed** | |
|---|---|---|---|
| 1's Predicted | 25 | 1 | 26 |
| 0's Predicted | 1 | 12 | 13 |
| | 26 | 13 | 39 |
| **Accuracy** | 0.9615 | 0.9231 | **0.9487** |

Source: Author

## 5.5 OLS Model

The probit model studied the factors that influenced farmers to adopt or not adopt soybeans. However, identifying the factors that affect a farmer's decision to grow soybeans for a longer period would also be useful for the provision of future extension services. To do this, an OLS model was run with the number of years growing soybeans as the dependent variable. Looking at the number of years experience between past-adopters and adopters in Figure 5.6, shows that past-adopters often have as much or more experience than some current adopters. However, past-adopters have made the decision to not keep soybeans in their crop rotation in the current growing season. Some past-adopters are willing to try soybeans again in the future, and if they were to adopt soybeans again their previous experience with the crop would be valuable.

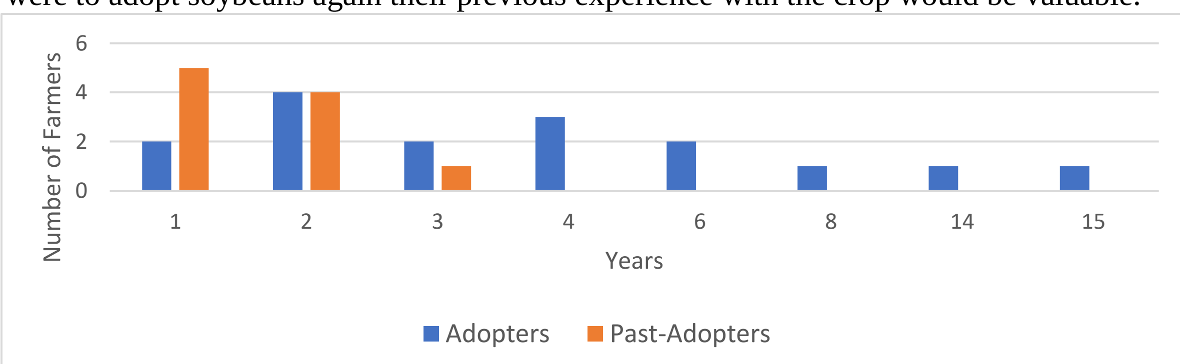


**Figure 5.6 Years Growing Soybeans**

Source: Author

The OLS model was as follows:

$$Years\ Growing = \beta_0 + \beta_1\, ExpectedProfit + \beta_2\, FTEAc. + \beta_3\, Age + \beta_4\, Age^2 + \beta_5 Trial. + \beta_6\, SC + \beta_7\, AC$$

### 5.5.1 Model Variables

Table 5.5 gives a description of the variables included in the model[6].

[6] Other model specifications were ran including variables for gross return required per acre and marketing choice, however the model fit was worse with these variables included. A model was also ran using the same variables as the probit model, however this model fit was also worse than the model that is reported. The other model specifications can be found in Appendix F.

**Table 5.15 OLS Model Variables**

| Variable | Mean | Standard Deviation | Description | Expected Sign |
|---|---|---|---|---|
| Expected Profit | 0.69 | 0.73 | Variable representing if farmers thought soybeans would provide an below average return (1), average return (2), above average return (3). | (+) |
| FTEAc | 0.00070 | 0.00077 | The number of full-time employees per acre the farmer has. | (+) |
| Age | 45.10 | 12.77 | Age of the farmer. | (-) |
| $Age^2$ | 2193.05 | 1105.92 | Age of the farmer squared | (uncertain) |
| Trial | 0.38 | 0.49 | 1 if the farmer has completed a soybean trial, 0 if not. | (+) |
| Social Capital | 95.69 | 12.56 | Summed score of the farmer from social capital likert questions. | (uncertain) |
| Absorptive Capacity | 129.05 | 15.56 | Summed score of the farmer from absorptive capacity likert questions. | (+) |

Source: Author

Expected profit is perceived to have a positive effect again, the same as in the probit model. The more profitable farmers view soybeans, the more likely they are to grow them for a longer period. Also, having more experience growing soybeans would allow farmers to adjust their practices with the crop to further their profitability potential.

The number of full-time employees per acre is also predicted to have a positive effect the same as in the probit model before. Having more labour available per acre, holding all other factors constant, would make it easier for the farmer to successfully work soybeans into their rotation. Farms with more labour available would also have more help to experiment with different production practices which would improve their skill with growing the crop and could influence them to grow soybeans for a longer period. Age is again predicted to have a negative effect following the results found in previous literature.

Social capital and absorptive capacity were two factors hypothesized to help farmers move past barriers to adoption sooner. Previous studies have shown that social capital and absorptive capacity have a positive effect on adoption of innovations. Van Rijn, Bulte & Adekunle (2012) find that structural social capital has a positive influence on the adoption of innovations in African countries. Micheels & Nolan (2016), find that social capital and absorptive capacity play an important role in the number of innovations adopted by a farm. Moving past barriers to adoption sooner would allow farmers to develop a successful system to work soybeans into their rotation and would encourage them to grow the crop for a longer number of years. The effect of social capital in this study is uncertain as many of the questions around social capital focus on involvement with local groups and different agricultural groups. Farmers who are very involved with lots of different organizations may have less time to spend on farming innovation activities and therefore could find it harder to successfully work soybeans into their rotations (Adler & Kwon, 2002).

Farmers participating in on-farm trials has also been shown to increase adoption rates. Trialing allows farmers to learn hands-on about the innovation and reduces uncertainties they may have had regarding the innovation (Abadi Ghadim, Pannell & Burton, 2005). Trialing also gives farmers an opportunity to improve their skills with growing the crop before moving into adoption with larger acres (Abadi Ghadim, Pannell & Burton, 2005). Therefore, involvement in on-farm soybean trials is predicted to have a positive effect on the number of years growing soybeans.

### 5.5.2 Model Results

The results from the OLS model are shown in Table 5.6.

**Table 5.16 OLS Model Results**

| | |
|---|---|
| Number of Observations | 39 |
| Prob> F | 0.0017 |
| R-Squared | 0.4982 |
| Adjusted R-Squared | 0.3849 |
| Standard Error | 2.6967 |

| | *Coefficient* | *Robust Standard Error* | *tStat* | *P-Value* |
|---|---|---|---|---|
| Intercept | -13.597 | 6.107 | -2.23 | 0.033 |
| ExpectedProfit* | 1.246 | .708 | 1.76 | 0.088 |
| FTEAc | 1208.352 | 1313.003 | 0.920 | 0.365 |
| Age*** | .680 | .235 | 2.89 | 0.007 |
| Age2*** | -.008 | .003 | -2.81 | 0.009 |
| Trial*** | 3.069 | .817 | 3.75 | 0.001 |
| SC | -.006 | .045 | -0.13 | 0.890 |
| AC | -.002 | .022 | -0.10 | 0.921 |

*Significant at the 10% Level; ***Significant at the 1% Level

Source: Author

Expected profit, age, $age^2$ and trial were all found to be statistically significant. Expected profit has a positive effect as anticipated and is statistically significant at a ten percent level. As a farmer views soybeans as being as profitable as or more profitable than other crops they are currently growing, years growing soybeans will increase by 1.246.

Age was found to be significant and have a quadratic impact on years growing soybeans. The effect of age is shown to decrease overtime. The longest period growing soybeans occurred with an age of 41 as shown by Figure 5.7 The positive effect of age shows that it is the older farmers who are more likely to adopt soybeans and work them into their rotations over time.

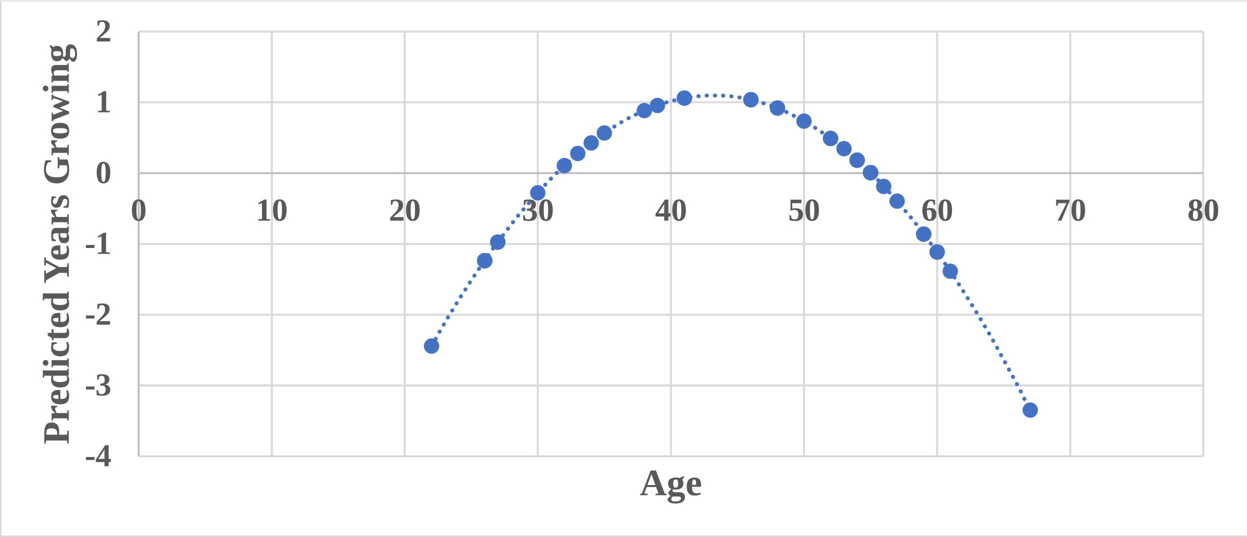


**Figure 5.7 Quadratic Impact of Age**

Source: Author

The variable trial is also found to be significant at the one percent level. For every additional year participating in a soybean trial, years growing soybeans increases by 3.069. The positive effect matches up with other results found in the literature. Trialing allows farmers to experiment with the crop on a small-scale basis and determine if and how the crop may fit into their farm. Taking the time to take part in a trial can reduce uncertainties around the crop and help farmers improve their skills with growing soybeans which would increase their chances of success and allow them to grow the crop for a longer period (Abadi Ghadim, Pannell & Burton, 2005).

### 5.5.3 Testing for Multicollinearity & Heteroskedasticity

The model was checked for multicollinearity and heteroskedasticity. Variance Inflation Factors (VIF) were looked at for multicollinearity and the only variables shown to be correlated are age and age$^2$ which was expected. The rest of the VIF values are less than 10 which signals no multicollinearity is present.

**Table 5.17 Variance Inflation Factors**

| Variable | VIF | 1/VIF |
|---|---|---|
| Age | 77.77 | 0.0129 |
| Age2 | 77.04 | 0.0130 |
| SC | 1.55 | 0.6457 |
| AC | 1.39 | 0.7213 |
| Trial | 1.21 | 0.8272 |
| FTEAc | 1.15 | 0.8718 |
| Expected Profit | 1.05 | 0.8718 |
| Mean VIF | 23.02 | |

Source: Author

The Breusch-Pagan test was conducted to check the model for heteroskedasticity, and the results show heteroskedasticity is present in the model. When the assumption of homogeneous variances is violated, the OLS method will still calculate unbiased and consistent estimates, however these estimates will not be the best linear unbiased estimates (Zaiontz, 2017). This is because the estimates will not necessarily have the smallest variances and the standard errors will be biased and inconsistent (Zaiontz, 2017). Robust standard errors are used as a solution to the heteroskedasticity and reported in the model results. The results of the test can be found in Appendix E.

## 5.6 Chapter Summary

ANOVA analysis was conducted on several factor variables and the null hypothesis of equal means was rejected for required gross return per acre, age, and realized absorptive capacity. T-tests were then conducted between each of the three adopter categories and the null hypothesis of equal means was rejected for adopters versus non-adopters and past-adopters versus non-adopters for gross return per acre and age. The null hypothesis of equal means was rejected for past-adopters versus adopters and past-adopters versus non-adopters for realized absorptive capacity.

A probit model was run with a dependent variable labelled 1 if farmers had adopted soybeans either currently or in the past, and 0 if they had never grown soybeans. Required gross return and absorptive capacity were found to be significant at a ten percent level.[7] The higher the gross return farmers required for soybeans, the less likely they were to adopt the crop. Higher absorptive capacity scores increased the probability of adopting soybeans.

An OLS model was also run using years growing soybeans as the dependent variable. Results from the model show expected profitability of soybeans and participation in on-farm soybean trials have a significant positive effect on the number of years growing soybeans. Age had a quadratic impact on adoption with highest adoption at the age of 41. Full-time employees per acre, social capital and absorptive capacity were found to not have a significant impact.

[7] Omitted variable bias needs to be considered for both models as data was not collected for the gross return or profitability of the next competing crop with soybeans. Profitability of the next best alternative would influence the adoption decision and the decision to continue growing soybeans. As well, there was no data collected on the amount and size of machinery each farmer had available in their operation. Full-time employees per acre was used as a measurement of the shadow value of time; however, availability of machinery is not accounted for.

# 6.0 Conclusion

## 6.1 Introduction

This chapter will provide a summary and concluding comments on the results of the research. The main findings will also be linked to the research objectives of the thesis. Finally, limitations to this research will be discussed and the opportunity for further study.

## 6.2 Thesis Summary

The goal of this research was to examine soybean adoption in Saskatchewan by identifying barriers and drivers of adoption. This goal would be accomplished by achieving four objectives. The first objective was to identify economic and agronomic factors that were important in the adoption decision. The second objective was to identify common characteristics between adopter categories. The third objective was to identify if social capital and absorptive capacity played a role in the adoption decision, and the final objective was to identify the current availability of extension services and information pertaining to soybeans in the province. The results of this research would be useful to those in the industry who are providing extension services around soybeans.

The results from the interviews with farmers in southern Saskatchewan provide valuable insight into the issues and concerns farmers have with growing soybeans in the province. For economic factors, required gross return per acre and expected profitability of soybeans play an important role in the decision to adopt soybeans and continue to grow them. The required gross return and expected profitability of soybeans would be directly influenced by the performance of other crops in the farmer's rotation and the relative advantage soybeans would have compared to these crops. Past-adopters were found to have the highest return over their RM averages, and therefore have likely worked soybeans out of their rotations as they have other crops that are performing better for them. Whereas current adopters of soybeans had the lowest return over their RM average, and are likely looking for new crops that may be more successful in their rotations. For current adopters, the relative advantage of soybeans compared to other crops they are growing could be quite high.

Agronomically, yield potential and maturity ratings are still the two main limiting factors farmers identified with soybean production in the province. Adopters who had more experience with current varieties were more satisfied with the yield potential and maturity ratings available in the market. Past-adopters were less satisfied; however, these perceptions could be coming from varieties that are several years old since past-adopters last grew soybeans. Yield potential and maturity ratings were found to be more important characteristics than disease resistance for all three adopter categories when they were looking at varieties to potentially grow.

For farm characteristics, age was found to have a quadratic impact on the decision to continue growing soybeans. At first, age had a positive impact on the number of years growing soybeans with the predicted longest years occurring at an age of 41. After that point, the impact of age is negative on the decision to continue growing soybeans. Age was also the only characteristic where the equality of means was rejected between the three adopter categories. Equality of means was rejected between adopters and non-adopters, and past-adopters and non-adopters.

Absorptive capacity was found to have a positive significant effect on the probability of adopting soybeans. However, social capital and absorptive capacity were not found to have a significant effect on the decision to continue growing soybeans in this sample. Furthermore, realized absorptive capacity was found to be statistically significant in the ANOVA analysis. The null hypothesis of equal means was rejected between past-adopters and adopters and between past-adopters and non-adopters. A higher level of realized absorptive capacity would assist the past-adopters as they were trying soybeans in their rotations and evaluating the fit for their operations. These farmers decided that other crops would be a better fit for their farms this growing season.

The ability to separate the factors between past, present, and non-adopters was crucial to the findings of this thesis. Separating these three adopter categories, highlighted the innovativeness of the past-adopter category. Even though these farmers are not currently growing soybeans, they had often tried them before some of the current adopters and were involved with the very early stages of adoption in the province. These farmers are willing to innovate and try new crops, however they also run very successful operations and can evaluate quickly whether a new crop is a good fit for their rotations right now or not. These farmers are also willing to add soybeans back into their rotations in the future when it makes sense for their operations.

Regarding extension services, farmers appear to be satisfied with the level of support and amount of information available to them on growing soybeans. This would imply that the current extension system around soybeans is functioning very well. Furthermore, the significant positive impact on participating in on-farm trials on the number of years growing soybeans is an important result. On-farm trials provide farmers with a valuable opportunity to work through the uncertainties they have with the crop and learn about it on a small-scale basis first. From an extension perspective, it is crucial to continue to offer farmers the opportunity to do these trials to further advance adoption in the province. The data from these trials are also very valuable to the industry, therefore increasing the number of sites and data collected would also be beneficial.

To help connect farmers who are wanting to a do a trial with industry representatives, a research network could be established like the "On-Farm Network" established by the Manitoba Pulse & Soybean Growers (Manitoba Pulse & Soybean Growers, 2017). Manitoba Pulse & Soybean Growers provides an opportunity for farmers who are interested in participating in a soybean trial to apply for one on their website (Manitoba Pulse & Soybean Growers, 2017). The different protocols for each trial are explained, so if farmers had a specific issue they wanted to learn more about, they could select the trial that most closely matched what they are wanting to learn about (Manitoba Pulse & Soybean Growers, 2017). Farmers are also given the option to submit an idea for a protocol that is not currently being offered (Manitoba Pulse & Soybean Growers, 2017). Saskatchewan Pulse Growers could look at setting up a similar system to connect interested, motivated farmers with industry professionals. Saskatchewan farmers are looking for SPG to become more involved with the adoption process of soybeans and specifically investing in soybean breeding projects. Creating a research network like the one established in Manitoba, would be a way for SPG to signal to farmers their increased involvement with soybeans in the province.

## 6.3 Study Limitations & Further Research

The main limitation with this research was the small sample size of 39 farmers. The length of the interview and the time-frame to complete them before harvest resulted in a smaller sample size. Some farmers were deterred from taking the interview based on its length. A smaller sample size limited the probit regression to fewer variables and ruled out the option of running a multinomial probit regression with adopt, dis-adopt, and not-adopt as the dependent variable. The nonsignificant results for social capital and absorptive capacity in the OLS model may also be influenced by the small sample size. Furthermore, more significant ANOVA results between adopter categories may have been found with a larger sample. Omitted variable bias needs to be considered in the results of both regressions. For example, data was not collected on the market prices for the next best alternative crop that soybeans would be competing with. The profitability of the crop farmers would be comparing soybeans to would also influence the decision to adopt soybeans and continuing to grow them. Omitted variables also needs to be considered as a cause of heteroskedasticity in the probit model. The hetprob command was ran in Stata to test for heteroskedasticity and the null hypothesis of homoscedasticity was rejected at a ten percent level. An additional variable Yield, which calculated the difference in averages between farmer's yields and the averages for their RM, was added as a potential variable that may be correlated with the variance. The results from the hetprob model are reported in Appendix E.

Selection bias also needs to be considered with this research as the farmers who were willing to participate in the interviews may have more connections within the industry as they were identified either at field days or through industry professionals. Having more connections with industry professionals and other farmers would lead to higher social capital and absorptive capacity which would influence the scores for these factors across all three groups to be very close.

However, there were benefits from conducting the interviews personally. Personal interviews had a higher response rate, as the farmers who had put their names forward at the field days were quite interested in the research. As well, having shared connections from throughout the industry was a way to gain farmers' trust and made them more willing to participate. The interview format also allowed for better communication and a more complete and descriptive outlook on how these farmers viewed soybean adoption in Saskatchewan. Having a direct conversation and building trust in the process, led to more open answers and further discussion instead of just simply providing a numerical answer.

Further research looking at the role of SPG moving forward through soybean adoption in the province would be useful. Farmers have identified a need for SPG to invest in soybean breeding, therefore looking at how soybean breeding funding could be structured in the province would be beneficial. Furthermore, if soybean acres hit significant levels in the province, looking at the opportunity to create a separate soybean producer group would be a valuable option to explore.

There is also an opportunity for further research into the role that social capital plays in producer led organizations. The social capital that exists within these groups has been built up over time with the collaborative extension and research groups that have been created. However, collaborative groups are not always developed when a new crop is moving through the adoption process. Therefore, looking at the role of social capital in these organizations and whether this is a factor that leads to faster adoption for new crops would be very important information for the structure of extension and research surrounding new crops in the future.

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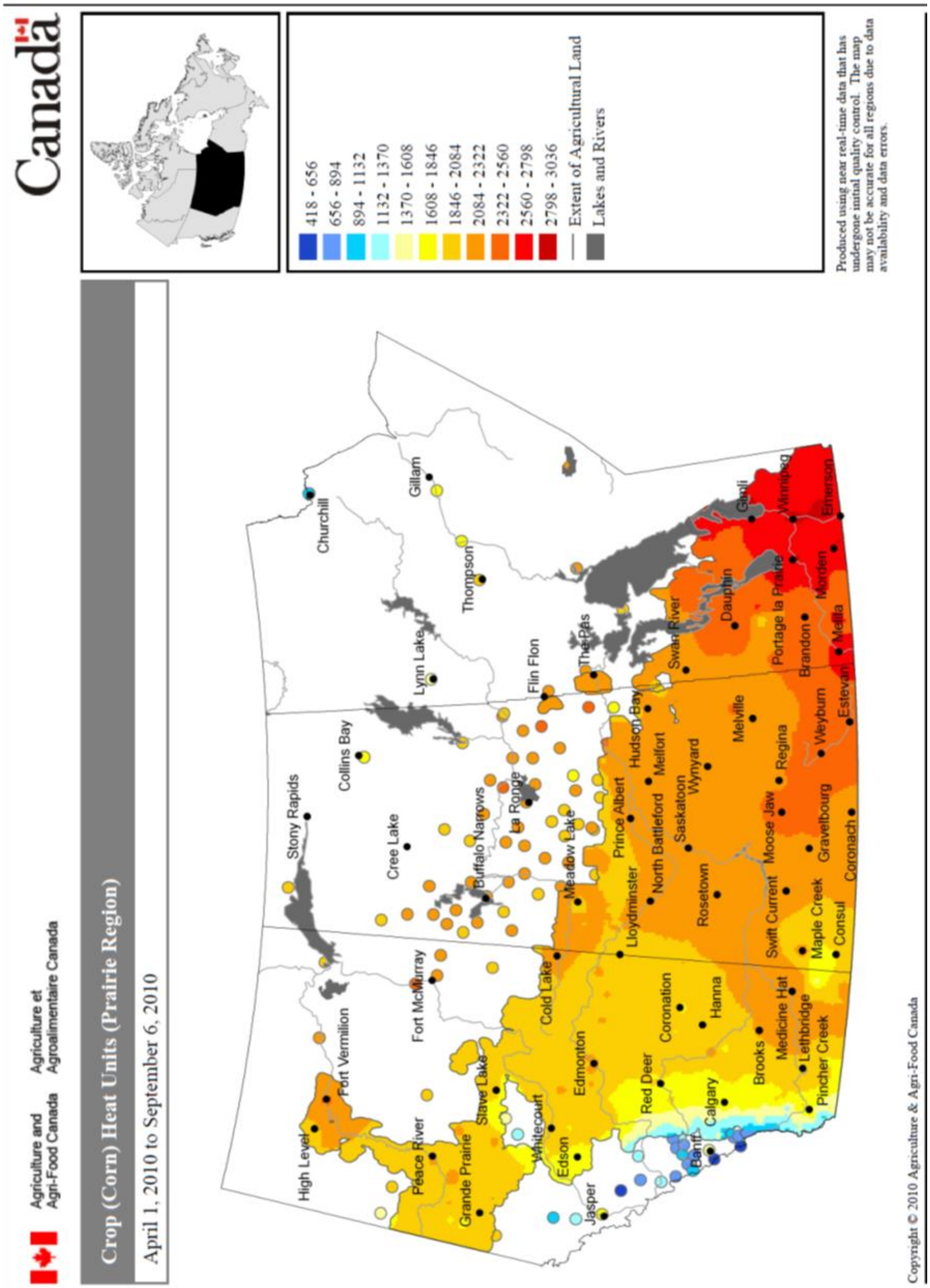
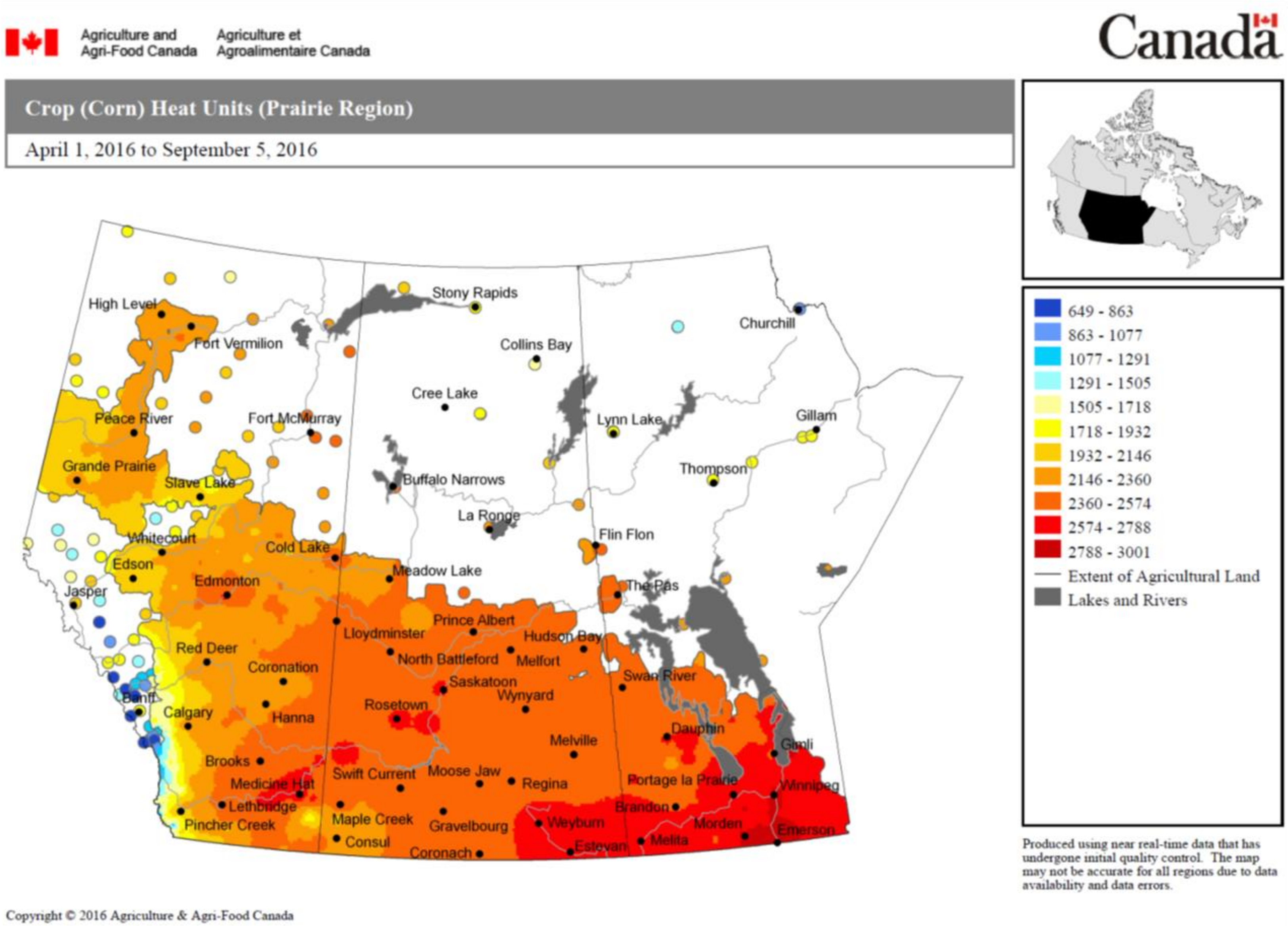
# Appendix A: Saskatchewan Corn Heat Units (CHU's) 2010 & 2016





Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Canada
Crop (Corn) Heat Units (Prairie Region)
April 1, 2016 to September 5, 2016
649 - 863
863 - 1077
1077 - 1291
1291 - 1505
1505 - 1718
1718 - 1932
1932 - 2146
2146 - 2360
2360 - 2574
2574 - 2788
2788 - 3001
Extent of Agricultural Land
Lakes and Rivers
Produced using near real-time data that has undergone initial quality control. The map may not be accurate for all regions due to data availability and data errors.
High Level
Fort Vermilion
Peace River
Fort McMurray
Grande Prairie
Slave Lake
Whitecourt
Edson
Jasper
Cold Lake
Edmonton
Red Deer
Coronation
Banff
Calgary
Hanna
Brooks
Medicine Hat
Lethbridge
Pincher Creek
Stony Rapids
Collins Bay
Cree Lake
Buffalo Narrows
La Ronge
Meadow Lake
Prince Albert
Lloydminster
North Battleford
Hudson Bay
Melfort
Saskatoon
Wynyard
Rosetown
Melville
Swift Current
Moose Jaw
Regina
Maple Creek
Consul
Gravelbourg
Coronach
Weyburn
Estevan
Churchill
Lynn Lake
Gillam
Thompson
Flin Flon
The Pas
Swan River
Dauphin
Gimli
Portage la Prairie
Winnipeg
Brandon
Morden
Melita
Emerson
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## Appendix B: Interview Consent Form

**Interview Information Form**

You are invited to participate in a study: ***Facilitating Soybean Adoption in Saskatchewan***

**Researcher:** Kelsey Richardson MSc. Candidate, Agricultural Economics, University of Saskatchewan

(306)380-9375 (cell); kjr996@mail.usask.ca

**Purpose:**

The purpose of this research is to assist the Saskatchewan Pulse Growers, governments, and other organisations in designing extension services to better meet the information needs of farmers. This research will help identify the characteristics and factors that lead farmers to adopt, not adopt, or dis-adopt soybeans. Identifying these factors, and the issues producers are still facing, whether they are informal or technological, will help improve soybean adoption in Saskatchewan. As well, understanding common characteristics and factors shared between different adopter categories will allow more tailored extension services to be designed.

This research project is co-ordinated by the Department of Agricultural and Resource Economics (Dr. Richard Gray), University of Saskatchewan. The results of this research will constitute part of Ms. Richardson's thesis requirements for a MSc degree in Agricultural Economics. This research is funded by the SoyaGen -Genome Canada Project.

**Procedure:** I would like to receive your responses to some questions about the factors that influence your decision to adopt or not adopt soybeans, and the history of soybean production on your farm. I will ask you about economic factors, risk, and agronomic considerations. I'll ask about basic characteristics of your farm such as number of acres, number of employees etc. Because we are interested in extension, I'll ask questions about your regular contacts, your networks, where you obtain new cropping information, and how you adapt this new knowledge to fit your farm. At the end I'll ask if you have any ideas to improve extension services.

Your participation in this study is appreciated and completely voluntary. It is expected that the interview should last between 30 and 60 minutes. You may withdraw at any time during this process should you feel uncomfortable or at risk. All interviews will be digitally recorded but you have the right to shut off the recorder at any time if you choose. You should also feel free to decline to answer any particular question(s). Should you choose to withdraw from the study no data pertaining to your participation will be retained.

**Confidentiality:** Individual interview results will be seen only by Dr. Gray and Ms. Richardson The interviews will be digitally recorded to insure accuracy of transcription of your responses and will analyzed by Ms. Richardson.

The original audio recording of the interview and the data from your responses will be securely stored by Dr. Richard Gray at the Department of Agricultural and Resource Economics for a period of five years. The data will be stored by respondent number and kept separate from the list of participant names.

**Reporting:** The research findings and conclusions will be published in a variety of formats, both print and electronic. These materials may be further used for purposes of conference presentations, or publications in academic journals, books or popular press. In these publications, the data will be reported in a manner that protects confidentiality and the anonymity of the participants. If you are interested in receiving an electronic copy of these reports, please contact Ms. Richardson at the number or email provided above.

**Right to Withdraw:** You may withdraw from the study for any reason, at any time, without penalty of any sort.

**Consent to Participate:** Your willingness to participate in this survey implies your consent. A copy of this information form will be left with you for your records. If you have any questions concerning the study, please feel free to contact Ms. Richardson at the number or email provided above.

## Appendix C: Interview Questionnaire

**Survey Contact**

Name:

Farm Name:

Land Location:

RM:

**Section 1: Introduction- In this section we would like to learn about your previous history growing soybeans.**

1. Which description best describes the current situation on your farm with respect to soybeans:

- I am currently growing soybeans
- I have never grown soybeans
- I have grown soybeans in the past, but am not currently

If you are growing soybeans:

- How long have you been growing soybeans?
  ___________Years
- How many acres do you have planted this year?
  ___________Acres
- How many acres have you planted in previous years?
  ______________________________________________Acres
- How many acres of your land are suitable for soybean production?
  ___________Acres
- What are your intentions for soybean acres next year?
  i. More acres
  ii. The same acres
  iii. Less Acres
  iv. I don't intend on planting soybeans next year
- Have you ever planted a brown-bagged variety?
  i. Yes
  ii. No

If you have not grown soybeans:

- How many acres of your land are suitable for soybean production?
  ___________Acres
- What is the main reason why you are not interested in growing soybeans at this time? Explain.

- Soybeans could eventually fit into my rotation

1 2 3 4 5
Strongly Disagree Strongly Agree

If you have grown soybeans in the past:

- How many years previous had you grown soybeans?
  ____________ Years
- How many acres have you planted in previous years?
  ____________ Acres
- How many acres of your land are suitable for soybean production?
  ____________ Acres
- Have you ever planted a brown-bagged variety?
  - Yes
  - No
- I would consider adding soybeans back into my rotation

1 2 3 4 5
Strongly Disagree Strongly Agree

**Section 2: Economic Factors- In this section we are trying to determine how economic factors influence the decision to adopt or not adopt soybeans.**

2. Compared to other crops you grow, soybeans provide an:
   - Above average return
   - Average return
   - Below average return
3. Does adding soybeans into your rotation:
   - Decrease risk
   - Not affect risk
   - Increase risk

   Explain.

4. What is your expected gross return per acre to add or keep soybeans in your rotation? (Can use Saskatchewan Crop Planning Guide if not sure of a number)
   ____________________$/Acre
5. When you're thinking about growing soybeans or adding them into your rotation, what crop do you compare them to?
   - Pulse
   - Oilseed
   - Other
6. What would the gross return per acre of soybeans have to be compared to canola in order for you to grow soybeans?
   _________________________$/Acre

7. What would the gross return per acre of soybeans have to be compared to peas in order for you to grow soybeans?
   _________________________$/Acre

8. If soybeans had a gross return of $100/acre less than canola, how many acres of soybeans would you grow?
   ________________________Acres
   - Repeat for $50 less _______Acres
   - $50 more ___________Acres
   - $100 more __________Acres

9. If soybeans had a gross return of $100/acre less than peas, how many acres of soybeans would you grow?
   ________________________Acres
   - Repeat for $50 less _______Acres
   - $50 more ___________Acres
   - $100 more __________Acres

10. If soybeans turned out to be profitable for your farm in the long-run, how many acres would be planted to soybeans?
    ___________________Acres

11. The cost of soybean seed is a large deterrent for growing soybeans.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | | | Strongly Agree |

12. Uncertainty of marketing opportunities is a large deterrent for growing soybeans.

1 2 3 4 5

Strongly Disagree Strongly Agree

13. Our soybean production has been sold to:
    - Local elevator (< 1 hr drive)
    - Non-local elevator
    - Direct to crush plant
    - Other- please specify

14. We use forward contracting options to market our soybeans.
    - Yes
    - No

**Brown-bagged seed questions:**

15. Would you consider growing a brown-bagged variety? What factors would lead you to making this decision?

16. Growing brown bagged seed varieties is very common in this area.

1 2 3 4 5

Strongly Disagree Strongly Agree

17. The yields of brown-bagged varieties are competitive with non-brown-bagged varieties.

1 2 3 4 5

Strongly Disagree Strongly Agree

18. Not having support from a sales rep through the growing season is a deterrent from growing brown-bagged varieties.

1 2 3 4 5

Strongly Disagree Strongly Agree

**Section 3: Non-Economic Factors- In this section we are trying to determine how agronomic factors affect the decision to adopt or not adopt soybeans.**

19. I am satisfied with the yield potential of current varieties on the market.

1 2 3 4 5

Strongly Disagree Strongly Agree

20. Yield potential is the most important agronomic consideration when choosing a soybean variety.

1 2 3 4 5

Strongly Disagree Strongly Agree

21. The soybean yield I would expect if I was to grow soybeans, or the yield I am expecting this year is:

_______________ Bu/ac

22. I am satisfied with the current maturity ratings of available varieties.

1 2 3 4 5

Strongly Disagree Strongly Agree

23. Maturity rating is the most important agronomic consideration when choosing a soybean variety.

1 2 3 4 5

Strongly Disagree Strongly Agree

24. I am satisfied with the current level and package of disease resistance available in varieties.

1 2 3 4 5

Strongly Disagree Strongly Agree

25. Disease resistance is the most important agronomic consideration when choosing a soybean variety.

1 2 3 4 5

Strongly Disagree Strongly Agree

26. Soybeans are used, or could be used, as a weed management tool in our rotation to clean up fields.

1 2 3 4 5
Strongly Disagree Strongly Agree

27. Glyphosate resistant weeds are a problem on our farm.

1 2 3 4 5
Strongly Disagree Strongly Agree

28. The new Roundup Ready 2 Dicamba resistant soybean varieties make growing soybeans a better fit on our farm.

1 2 3 4 5
Strongly Disagree Strongly Agree

29. Have you completed any courses in agronomy? Explain.
    - o Yes (please specify)
        - i.
    - o No

30. I feel confident in my abilities to successfully grow soybeans.

1 2 3 4 5
Strongly Disagree Strongly Agree

31. I frequently (1-2/ week) consult an agronomist to assist with agronomic decisions.

1 2 3 4 5
Strongly Disagree Strongly Agree

32. I consider myself to have strong agronomic knowledge.

1 2 3 4 5
Strongly Disagree Strongly Agree

33. Can you tell me about a recent agronomic problem you encountered and how you solved it?

34. What were your average yields last year for your 3 largest crops in respect to seeded acres?
    - Crop: ______________________________ Yield: ______________________ (bu/ac)
    - Crop: ______________________________ Yield: ______________________ (bu/ac)
    - Crop: ______________________________ Yield: ______________________ (bu/ac)

**Section 4: Farmer/Farm Characteristics**

35. How many acres do you farm?
    ______________ Acres
36. How many employees/operators do you have on your farm?
    ______________ Employees
    - What are their relation to you?
        i.
        ii.
        iii.
37. How many of these employees are involved with decision making activities on your farm?
    ______________ Employees
38. How old are you?
    ______________ Years Old
39. How many years of farming experience do you have?
    ________________ Years
40. What are your plans for your farming operation in the next five years?
    - Decrease acres
    - Maintain acres
    - Increase acres
41. Do you have a succession plan or someone available to take over your operation? Explain.
42. How many years of farming experience do your employees have? (both full time and part time)
    -
    -
43. Do you hire additional help for seeding and/or harvest? If so how many?
    ________________ People
44. What percentage of your total income is made farming?
    ________________ %
45. What level of education have you completed?
    - Some high school
    - Completed high school
    - Some technical school
    - Some university

- Completed technical school
- Completed university
- Completed MSc.
- Completed PhD.

46. What level of education have your employees completed? (Same options as question 36)
    -
    -
    -
47. We make the majority of the decisions on our farm as a group.

    1 2 3 4 5
    Strongly Disagree Strongly Agree

48. I have previously grown or am currently growing pulses.
    - Yes
    - No
49. I own or have access to a flex or draper header.
    - Yes
    - No
50. I own or have access to a roller.
    - Yes
    - No
51. How many crops are currently in your rotation?
    ____________ Crops

**Section 5: Social Capital- In this section, we are trying to measure your involvement in networks and groups that have collaboration at their core. Involvement in collaborative groups and the formal or informal networks they can create, can assist farmers in moving past barriers to adoption. By determining the importance of these networks and groups in the adoption process, future extension services can be designed with collaboration as a key aspect. Questions in this section will be focused on four areas: social interaction, trust, shared vision, and local involvement.**

**Social Interaction**

52. I discuss current agricultural issues and farming practices with my neighbours several times a week.

    1 2 3 4 5
    Strongly Disagree Strongly Agree

53. Do you usually crop check alone or with other neighbours/employees?

54. I meet often socially with friends, relatives, or colleagues (once/week).

1 2 3 4 5
Strongly Disagree Strongly Agree

55. I will ask my neighbours production questions and seek information locally (from sales reps, retails, agronomists, and field days).

1 2 3 4 5
Strongly Disagree Strongly Agree

56. I have an informal network of sales representatives and/or agronomists who I rely on for information (1-2/ week).

1 2 3 4 5
Strongly Disagree Strongly Agree

57. My neighbours frequently ask me questions regarding farming practices.

1 2 3 4 5
Strongly Disagree Strongly Agree

58. Creating informal networks has increased the level of innovation on our farm.

1 2 3 4 5
Strongly Disagree Strongly Agree

**Trust**

59. I trust the recommendations and advice given to me by my neighbours.

1 2 3 4 5
Strongly Disagree Strongly Agree

60. I trust the recommendations and advice given to me by sales representatives or professional agronomists I frequently deal with.

1 2 3 4 5
Strongly Disagree Strongly Agree

61. I would trust the recommendation made by a sales rep or agronomist who I had not dealt with before.

1 2 3 4 5
Strongly Disagree Strongly Agree

**Shared Vision**

62. Common backgrounds and similar farm management strategies allow me to interact and discuss new ideas with my neighbours.

1 2 3 4 5
Strongly Disagree Strongly Agree

63. Farmers in this area care about the success and well-being of their neighbours.

1 2 3 4 5
Strongly Disagree Strongly Agree

64. I am willing to lend a helping hand to my neighbours in times of need.

1 2 3 4 5
Strongly Disagree Strongly Agree

**Local Involvement**

65. I am a member or involved with a local agricultural group(s). (Current or past)
    - Yes (please list)
        i.
        ii.
        iii.
    - No
66. I am a member of a local board(s) in our community (ex. CO-OP, Recreational Associations, School, RM etc.) (Current or past)
    - Yes (please list)
        i.
        ii.
        iii.
    - No
67. I volunteer when needed in the community (ex. Coaching, school programs, 4-H, community fundraisers etc.) (Current or past)
    - Yes (please list)

i.
ii.
iii.

- No

**Section 6: Absorptive Capacity- In this section we are trying to measure the level of absorptive capacity your farm has built up over time. Absorptive capacity refers to how your farm acquires, assimilates, transforms, and exploits external knowledge to be beneficial and fit your specific on-farm situation. Potential absorptive capacity measures acquiring and assimilating practices, and realized absorptive capacity measures transforming and exploiting activities.**

**Potential Absorptive Capacity**

68. Employees on our farm have frequent interactions with industry professionals to acquire new knowledge.

1 2 3 4 5
Strongly Disagree Strongly Agree

69. We collect information from industry members through informal means (trade shows, tours, meetings, lunches etc.)

1 2 3 4 5
Strongly Disagree Strongly Agree

70. We are constantly looking at ways to increase the efficiency of our operation.

1 2 3 4 5
Strongly Disagree Strongly Agree

71. Establishing relationships with industry partners who can provide us with knowledge and information about innovations is an important activity for our farm.

1 2 3 4 5
Strongly Disagree Strongly Agree

72. We quickly recognize changes and opportunities within the industry.

1 2 3 4 5
Strongly Disagree Strongly Agree

73. We can quickly analyze and interpret changing market demands.

1 2 3 4 5
Strongly Disagree Strongly Agree

**Realized Absorptive Capacity**

74. We record and store newly acquired knowledge so we have it for future reference.

1 2 3 4 5
Strongly Disagree Strongly Agree

75. Our farm regularly discusses new opportunities for production or changes to our production practices that could increase our profitability or efficiency.

1 2 3 4 5
Strongly Disagree Strongly Agree

76. We frequently talk with a marketing advisor on how specific changes in the market could affect our farm business.

1 2 3 4 5
Strongly Disagree Strongly Agree

77. Employees frequently share previous knowledge and experiences when we are seeking information.

1 2 3 4 5
Strongly Disagree Strongly Agree

78. We can very quickly determine how useful new knowledge will be on our farm.

1 2 3 4 5
Strongly Disagree Strongly Agree

79. We spend a lot of time adapting external acquired information to fit our on farm situation.

1 2 3 4 5
Strongly Disagree Strongly Agree

80. We are confident in how activities on our farm should be performed

1 2 3 4 5
Strongly Disagree Strongly Agree

81. Roles and responsibilities are clearly defined on our farm.

1 2 3 4 5
Strongly Disagree Strongly Agree

82. The use of adapted acquired external information often leads to increased profitability for our farm.

1 2 3 4 5
Strongly Disagree Strongly Agree

83. We are constantly looking at how to better exploit knowledge to fit our on farm situation.

1 2 3 4 5
Strongly Disagree Strongly Agree

84. We will conduct our own on-farm trials to understand how to adapt innovations to fit our situation.

1 2 3 4 5
Strongly Disagree Strongly Agree

**Section 7: Extension Services- In this section we are trying to determine which forms of extension services are most frequently used by farmers and which ones are the most helpful. As well, we are trying to determine if enough easily accessible information on growing soybeans is available to farmers.**

85. I frequently rely on public extension services.

1 2 3 4 5
Strongly Disagree Strongly Agree

86. I frequently rely on private extension services.

1 2 3 4 5
Strongly Disagree Strongly Agree

87. When encountered with an agronomic problem the first place I turn is:
    - Internet
    - Print resources
    - Sales representative
    - Agronomist
    - Neighbour
    - Other (please specify)
88. I feel there is enough information available on growing soybeans that is easily accessible.

1 2 3 4 5
Strongly Disagree Strongly Agree

89. I feel that farmers have enough support available to them throughout the production process.

1 2 3 4 5
Strongly Disagree Strongly Agree

90. I value field days (public and private) and the ability to see varieties growing first hand near my area.

1 2 3 4 5
Strongly Disagree Strongly Agree

91. I have participated in an on-farm soybean trial.
    - Yes (for how many years)
      ____________ Years
    - No
92. I appreciate and value the opportunity to do on-farm trials.

1 2 3 4 5
Strongly Disagree Strongly Agree

93. Saskatchewan Pulse Growers should invest in soybean breeding

1 2 3 4 5
Strongly Disagree Strongly Agree

94. Saskatchewan Pulse Growers should focus solely on soybean agronomy research

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | | | Strongly Agree |

**Conclusion**

95. What do you think the major obstacle to growing soybeans in Saskatchewan is? Explain.

# Appendix D: Likert Item Analysis

**Social Capital Likert Item Analysis**

| Social Capital (Alpha = 0.8022) | Mean | Standard Deviation | Item-test Correlation |
|---|---|---|---|
| I discuss current issues & farming practices with neighbours several times a week | 7.46 | 2.14 | 0.6440 |
| I meet often socially with friends, relatives, or colleagues | 7.99 | 2.01 | 0.4238 |
| I will ask my neighbours production questions and seek information locally | 8.49 | 1.80 | 0.6192 |
| I have an informal network of sales reps and/or agronomists who I rely on for information | 8.28 | 1.96 | 0.4844 |
| My neighbours frequently ask me questions regarding farming practices | 7.44 | 2.31 | 0.5615 |
| Creating informal networks has increased the level of innovation on our farm | 7.97 | 2.01 | 0.5147 |
| I trust the recommendations and advice given to me by my neighbours | 6.87 | 1.95 | 0.6647 |
| I trust the recommendations and advice given to me by professionals I frequently deal with | 8.54 | 1.31 | 0.4602 |
| I would trust the recommendations and advice given to me by a professional I had not dealt with before | 5.77 | 1.65 | 0.4836 |
| Common backgrounds & similar farm management styles allow for interaction and discussion with my neighbours | 8.21 | 1.71 | 0.5733 |
| Farmers in this area care about the success and well being of their neighbours | 7.38 | 1.89 | 0.6472 |
| I am willing to lend a helping hand to my neighbours in times of need | 9.21 | 1.26 | 0.6572 |

## Absorptive Capacity Likert Item Analysis

| Absorptive Capacity (Alpha = 0.8737) | Mean | Standard Deviation | Item-test Correlation |
|---|---|---|---|
| Employees have frequent interactions with industry professionals to acquire new knowledge | 7.79 | 2.25 | 0.6511 |
| We collect information from industry members through informal means | 8.05 | 1.73 | 0.4872 |
| We are constantly looking at ways to increase the efficiency of our operation | 9.46 | 1.10 | 0.7036 |
| Establishing relationships with industry partners is an important activity for our farm | 8.69 | 1.47 | 0.3724 |
| We quickly recognize changes and opportunities within the industry | 8.12 | 1.36 | 0.5836 |
| We record and store newly acquired knowledge for future reference | 7.23 | 2.16 | 0.6004 |
| We regularly discuss new opportunities for production or changes to production practice that could increase profitability of efficiency | 8.67 | 1.46 | 0.7890 |
| We frequently talk with a marketing advisor on how changes in the market could affect our farm business | 6.18 | 2.92 | 0.2352 |
| Employees share previous knowledge & experiences when we are seeking information | 7.28 | 2.88 | 0.5126 |
| We can very quickly determine how useful new knowledge will be on our farm | 7.64 | 1.46 | 0.7133 |
| We spend a lot of time adapting external information to fit our farm | 7.44 | 1.65 | 0.5682 |
| We are confident in how activities should be performed on our farm | 8.69 | 1.22 | 0.5477 |
| Roles & Responsibilities are clearly defined on our farm | 8.21 | 1.59 | 0.3547 |

## Absorptive Capacity Likert Analysis Cont.

| | | | |
|---|---|---|---|
| The use of adapted external information often leads to increased profitability | 7.87 | 1.79 | 0.6996 |
| We are constantly looking at how to better exploit knowledge to fit our farm | 8.82 | 1.27 | 0.6809 |
| We will conduct our own on-farm trials to understand how to adapt innovations to fit our situation | 8.90 | 1.50 | 0.6983 |

## Appendix E: Data Analysis

**ANOVA Results Required Gross Return per Acre**

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| Adopters | 15 | 4940 | 329.3333 | 10095.95 |
| Past-Adopters | 9 | 3050 | 338.8889 | 2986.111 |
| Non-Adopters | 11 | 4730 | 430 | 6525 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 71606.35 | 2 | 35803.17 | 4.970889 | 0.013184 | 3.294537 |
| Within Groups | 230482.2 | 32 | 7202.569 | | | |
| | | | | | | |
| Total | 302088.6 | 34 | | | | |

Source: Author's Calculations

**t-Test Adopters vs Past-Adopters**

| | *Adopters* | *Past-Adopters* |
|---|---|---|
| Mean | 329.3333 | 338.8888889 |
| Variance | 10095.95 | 2986.111111 |
| Observations | 15 | 9 |
| Hypothesized Mean Difference | 0 | |
| df | 22 | |
| t Stat | -0.30144 | |
| P(T<=t) one-tail | 0.382954 | |
| t Critical one-tail | 1.717144 | |
| P(T<=t) two-tail | 0.765908 | |
| t Critical two-tail | 2.073873 | |

Source: Author's Calculations

**t-Test Adopters vs Non-Adopters**

| | *Adopters* | *Non-Adopters* |
|---|---|---|
| Mean | 329.3333 | 430 |
| Variance | 10095.95 | 6525 |
| Observations | 15 | 11 |
| Hypothesized Mean Difference | 0 | |
| df | 24 | |
| t Stat | -2.82896 | |
| P(T<=t) one-tail | 0.004641 | |
| t Critical one-tail | 1.710882 | |
| P(T<=t) two-tail | 0.009282 | |
| t Critical two-tail | 2.063899 | |

Source: Author's Calculations

**t-Test Past-Adopters vs Non-Adopters**

| | *Past-Adopters* | *Non-Adopters* |
|---|---|---|
| Mean | 338.8889 | 430 |
| Variance | 2986.111 | 6525 |
| Observations | 9 | 11 |
| Hypothesized Mean Difference | 0 | |
| df | 17 | |
| t Stat | -2.99576 | |
| P(T<=t) one-tail | 0.004064 | |
| t Critical one-tail | 1.739607 | |
| P(T<=t) two-tail | 0.008128 | |
| t Critical two-tail | 2.109816 | |

Source: Author's Calculations

**ANOVA Results Age**

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| Adopters | 16 | 782 | 48.875 | 114.1167 |
| Past -Adopters | 10 | 486 | 48.6 | 148.7111 |
| Non-Adopters | 13 | 491 | 37.76923 | 174.5256 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 1049.132 | 2 | 524.566 | 3.67082 | 0.035412 | 3.259446 |
| Within Groups | 5144.458 | 36 | 142.9016 | | | |
| | | | | | | |
| Total | 6193.59 | 38 | | | | |

Source: Author’s Calculations

**t-Test Adopters vs Past-Adopters**

| | *Adopters* | *Past - Adopters* |
|---|---|---|
| Mean | 48.875 | 48.6 |
| Variance | 114.1167 | 148.7111 |
| Observations | 16 | 10 |
| Hypothesized Mean Difference | 0 | |
| df | 17 | |
| t Stat | 0.058626 | |
| P(T<=t) one-tail | 0.476967 | |
| t Critical one-tail | 1.739607 | |
| P(T<=t) two-tail | 0.953934 | |
| t Critical two-tail | 2.109816 | |

Source: Author’s Calculations

**t-Test Adopters vs Non-Adopters**

| | *Adopters* | *Non-Adopters* |
|---|---|---|
| Mean | 48.875 | 37.76923 |
| Variance | 114.1167 | 174.5256 |
| Observations | 16 | 13 |
| Hypothesized Mean Difference | 0 | |
| df | 23 | |
| t Stat | 2.449431 | |
| P(T<=t) one-tail | 0.011172 | |
| t Critical one-tail | 1.713872 | |
| P(T<=t) two-tail | 0.022344 | |
| t Critical two-tail | 2.068658 | |

Source: Author's Calculations

**t-Test Past-Adopters vs Non-Adopters**

| | *Past - Adopters* | *Non-Adopters* |
|---|---|---|
| Mean | 48.6 | 37.76923 |
| Variance | 148.7111 | 174.5256 |
| Observations | 10 | 13 |
| Hypothesized Mean Difference | 0 | |
| df | 20 | |
| t Stat | 2.036083 | |
| P(T<=t) one-tail | 0.027602 | |
| t Critical one-tail | 1.724718 | |
| P(T<=t) two-tail | 0.055204 | |
| t Critical two-tail | 2.085963 | |

Source: Author's Calculations

**ANOVA Results Realized Absorptive Capacity**

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| Adopters | 16 | 1369 | 85.5625 | 114.6625 |
| Past-Adopters | 10 | 934 | 93.4 | 90.04444 |
| Non-Adopters | 13 | 1087 | 83.61538 | 155.9231 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 591.3548 | 2 | 295.6774 | 2.418401 | 0.103398 | 3.259446 |
| Within Groups | 4401.414 | 36 | 122.2615 | | | |
| | | | | | | |
| Total | 4992.769 | 38 | | | | |

Source: Author's Calculations

**t-Test Adopters vs Past-Adopters**

| | *Adopters* | *Past-Adopters* |
|---|---|---|
| Mean | 85.5625 | 93.4 |
| Variance | 114.6625 | 90.04444 |
| Observations | 16 | 10 |
| Hypothesized Mean Difference | 0 | |
| df | 21 | |
| t Stat | -1.949 | |
| P(T<=t) one-tail | 0.03239 | |
| t Critical one-tail | 1.720743 | |
| P(T<=t) two-tail | 0.06478 | |
| t Critical two-tail | 2.079614 | |

Source: Author's Calculations

**t-Test Adopters vs Non-Adopters**

| | *Adopters* | *Non-Adopters* |
|---|---|---|
| Mean | 85.5625 | 83.61538 |
| Variance | 114.6625 | 155.9231 |
| Observations | 16 | 13 |
| Hypothesized Mean Difference | 0 | |
| df | 24 | |
| t Stat | 0.444824 | |
| P(T<=t) one-tail | 0.330216 | |
| t Critical one-tail | 1.710882 | |
| P(T<=t) two-tail | 0.660433 | |
| t Critical two-tail | 2.063899 | |

Source: Author's Calculations

**t-Test Past-Adopters vs Non-Adopters**

| | *Past-Adopters* | *Non-Adopters* |
|---|---|---|
| Mean | 93.4 | 83.61538 |
| Variance | 90.04444 | 155.9231 |
| Observations | 10 | 13 |
| Hypothesized Mean Difference | 0 | |
| df | 21 | |
| t Stat | 2.135253 | |
| P(T<=t) one-tail | 0.022341 | |
| t Critical one-tail | 1.720743 | |
| P(T<=t) two-tail | 0.044681 | |
| t Critical two-tail | 2.079614 | |

Source: Author's Calculations

**Breusch-Pagan Test Results**

$H_0$: Constant Variance

Variables: Fitted Values of Years Growing

Chi- Square (1) = 39.87

Prob > Chi-Square= 0.0000

Source: Author's Calculations

**Hetprob Model Results**

| | |
|---|---|
| Number of Observations | 39 |
| Wald chi2(6) | 0.49 |
| Prob > chi2 | 0.9980 |

| *HasGrown* | *Coef.* | *Std. Error* | *z* | *prob* |
|---|---|---|---|---|
| GrossReturn | -.7738 | 2.115 | -0.37 | 0.714 |
| ExpProfit | 23.6782 | 61.9533 | 0.38 | 0.702 |
| FTEAc | 179740.7 | 510714.3 | 0.35 | 0.725 |
| Age | 5.0177 | 15.1996 | 0.33 | 0.741 |
| Age2 | -.01782 | .1324 | -0.13 | 0.893 |
| AC | 3.6092 | 10.0454 | 0.36 | 0.719 |
| Constant | -417.6343 | 1137.188 | -0.37 | 0.713 |

| | | | | |
|---|---|---|---|---|
| Lnsigma2 | | | | |
| Yield | .1599038 | .1433413 | 1.12 | 0.265 |

LR test of lnsigma2=0: chi2(1) = 2.87 Prob > chi2 = 0.0901

## Appendix F: Alternative Model Specifications

**Probit Model: Gross Return, Full-Time Employees/Acre, Age, Age$^2$, Potential Absorptive Capacity, Realized Absorptive Capacity**

| | |
|---|---|
| Number of Observations | 39 |
| LR Chi2 (6) | 41.38 |
| Prob > Chi2 | 0.0000 |
| **Pseudo $R^2$** | **0.8345** |

| *Has Grown* | *Coef.* | *Std. Error* | *z* | *p-value* |
|---|---|---|---|---|
| GrossReturn | -.0874996 | .1478214 | -0.59 | 0.554 |
| FTEAc | 15727.87 | 28808.35 | 0.55 | 0.585 |
| Age | 2.854545 | 5.858785 | 0.49 | 0.626 |
| Age$^2$ | -.0288371 | .0602939 | -0.48 | 0.632 |
| PAC | -.270271 | .8416204 | -0.32 | 0.748 |
| RAC | .5345212 | 1.167457 | 0.46 | 0.647 |
| Constant | -71.91448 | 149.6151 | -0.48 | 0.631 |

Source: Author

Notes: 6 failures and 18 successes completely determined

**No Change in Model Predictive Power**

| | **1's Observed** | **0's Observed** | |
|---|---|---|---|
| **1's Predicted** | 25 | 1 | 26 |
| **0's Predicted** | 1 | 12 | 13 |
| | 26 | 13 | 39 |
| **Accuracy** | 0.9615 | 0.9231 | **0.9487** |

Source: Author

**Probit Model: Gross Return per Acre, Full-Time Employees/Acre, Age Age$^2$, AC, Trial**

| | |
|---|---|
| Number of Observations | 24 |
| LR chi2(-1) | 33.10 |
| Prob> chi2 | . |
| Pseudo R2 | 1.000 |

| *HasGrown* | *Coef.* | *Std. Err.* | *z* | *p-value* |
|---|---|---|---|---|
| GrossReturn | -16.44675 | . | . | . |
| FTEAc | 1084555 | . | . | . |
| Age | 104.4563 | . | . | . |
| Age2 | -.3319602 | . | . | . |
| AC | 56.85195 | . | . | . |
| Trial | 0 | (omitted) | | |
| Constant | -5519.941 | | | |

Note: 13 failures and 11 successes completely determined

Source: Author

**Probit Model: Gross Return per Acre, Full-Time Employees/Acre, Age Age$^2$, AC, SC**

| | |
|---|---|
| Number of Observations | 39 |
| LR Chi2 (6) | 40.04 |
| Prob > Chi2 | 0.0000 |
| **Pseudo $R^2$** | **0.8065** |

| *Has Grown* | *Coef.* | *Std. Err.* | *z* | *p-Value* |
|---|---|---|---|---|
| GrossReturn | -.0636558 | .0560553 | -1.14 | 0.256 |
| FTEAc | 10406.55 | 9706.046 | 1.07 | 0.284 |
| Age | 1.608298 | 1.65403 | 0.97 | 0.331 |
| Age$^2$ | -.0155234 | .0165879 | -0.94 | 0.349 |
| AC | .1645339 | .1275643 | 1.29 | 0.197 |
| SC | .0731882 | .113992 | 0.64 | 0.521 |
| constant | -46.22473 | 46.33316 | -1.00 | 0.318 |

Source: Author

Note: 6 failures and 15 successes completely determined.

**Lower Model Predicitive Power**

| | 1's Observed | 0's Observed | |
|---|---|---|---|
| **1's Predicted** | 24 | 1 | 25 |
| **0's Predicted** | 2 | 12 | 14 |
| | 26 | 13 | 39 |
| **Accuracy** | 0.9231 | 0.9231 | **0.9231** |

Source: Author

**OLS Model: Gross Return per Acre, Expected Profitability, Full-Time Employees, Acres, Age, Age$^2$, AC, SC**

| | |
|---|---|
| Number of Observations | 39 |
| Prob > F | 0.003 |
| $R^2$ | 0.5126 |
| **Adjusted $R^2$** | **0.3827** |
| Standard Error | 2.7015 |

| *YearsGrowing* | *Coef.* | *Robust Std. Err.* | *t* | *p-Value* |
|---|---|---|---|---|
| ExpectedProfit** | 1.4574 | 0.6533 | 2.23 | 0.033 |
| Age** | 0.6618 | 0.3033 | 2.18 | 0.037 |
| Age2** | -0.0077 | 0.0035 | -2.20 | 0.035 |
| Trial*** | 3.33186 | 1.0166 | 3.28 | 0.003 |
| SC | -0.01329 | 0.0441 | -0.30 | 0.765 |
| AC | 0.00436 | 0.0332 | 0.13 | 0.896 |
| GrossReturn | 0.00502 | 0.0053 | 0.94 | 0.353 |
| FTEAc* | 1126.0398 | 617.5272 | 1.82 | 0.078 |
| constant | -14.8291 | 7.6274 | -1.94 | 0.061 |

***Significant at a 1% Level; **Significant at a 5% Level; *Significant at a 10% Level

Required Gross Return per Acre not significant

Source: Author

**OLS Model: Same variables as Probit Model**

| | |
|---|---|
| Number of Observations | 39 |
| Prob > F | 0.0308 |
| $R^2$ | 0.3363 |
| **Adjusted $R^2$** | **0.2119** |
| Standard Error | 3.0524 |

| *Years Growing* | *Coef.* | *Robust Std. Err.* | *t* | *p-Value* |
|---|---|---|---|---|
| ExpProfit | 1.0514 | 0.6875 | 1.5292 | 0.1360 |
| Age*** | 0.8913 | 0.3014 | 2.9572 | 0.0058 |
| Age2*** | -0.0100 | 0.0036 | -2.8085 | 0.0084 |
| AC | 0.0117 | 0.0219 | 0.5355 | 0.5960 |
| GrossReturn | 0.0004 | 0.0075 | 0.0593 | 0.9531 |
| FTEAc | 1575.6497 | 1180.5132 | 1.3347 | 0.1914 |
| constant | -19.4106 | 7.3982 | -2.6237 | 0.0132 |

***Significant at a 1% Level

Source: Author

**OLS Model: Expected Profitability, Full-Time Employees per Acre, Age, Age$^2$, Trial, SC, AC, Marketing**

| | |
|---|---|
| Number of Observations | 39 |
| Prob > F | 0.003 |
| $R^2$ | 0.5026 |
| **Adjusted $R^2$** | **0.3700** |
| Standard Error | 2.729 |

| *Years Growing* | *Coef.* | *Robust Std. Err.* | *t* | *p-Value* |
|---|---|---|---|---|
| ExpProfit | 1.2066 | 0.8202 | 1.471 | 0.152 |
| Age** | 0.6615 | 0.2574 | 2.570 | 0.015 |
| Age2** | -0.0077 | 0.0030 | -2.553 | 0.016 |
| Trial* | 2.7880 | 1.4553 | 1.916 | 0.065 |
| SC | -0.0037 | 0.0490 | -0.076 | 0.940 |
| AC | -0.0022 | 0.0266 | -0.083 | 0.934 |
| FTEAc | 1206.3178 | 1271.3598 | 0.949 | 0.350 |
| Marketing | 0.5692 | 1.5296 | 0.372 | 0.712 |
| constant | -10.9268 | 4.6437 | -2.353 | 0.026 |

**Significant at a 5% Level; *Significant at a 10% Level

Source: Author