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Department of Economics

To Bean or Not to Bean
- a study about farmers' resources and their decision to grow broad beans

Att odla eller inte odla – en studie om lantbrukares resurser och deras beslut att odla åkerböna

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Uppsala, June 2019

Emil Månsson | Jenny Öhlin

Abstract
Climate change and sustainability is discussed all over the world. In Sweden, as well as in many other countries worldwide, the food and agricultural system is one of the most important industries. It is both affected by and affecting climate change. Modern agricultural production relies on an increasingly higher use of resources and inputs to maintain a high production level of animal feed and human food. Expansion of legumes could improve resource efficiency and promote diversification of cropping systems which leads to a more sustainable agriculture. Despite all of the potential and benefits of growing more legumes, less than 2 % of the acreage in Sweden was used for legume production in 2018. Broad bean is one of the legumes that can be grown in large parts of Sweden and would be relatively easy to start growing.

This study aims to find differences and similarities among farmers who do and do not grow broad beans, to understand what the most determining resources are and how farmers use those resources to make decisions regarding crop planning. A mixed method approach is used in order to gain a deeper understanding through use of qualitative data, and quantitative data to conduct measurements. The data is collected through telephone-interviews with farmers in four counties in Sweden (Uppsala, Västmanland, Östergötland and Västra Götaland). The collected data is analyzed by both a qualitative thematic analysis and a quantitative statistical analysis to test several developed hypotheses.

The study concludes that the decision of crop is intimately linked to the business and the farmers' allocation of recourses. Mainly, the physical resources determine whether the farmer grow broad beans or not. Human resources also influence the decision making of farmers but do not heavily affect the specific decision to grow broad bean or not. In our study farmers' perception of the broad bean differ. Farmers who grow broad bean view them as an opportunity, while farmers who do not grow broad bean see it as a risk. Broad bean farmers are also more strategic and think in long-term perspective when planning their crop sequence. While the farmers who do not grow broad beans are more flexible and adaptable to changing prerequisites and circumstances. Uncertainty regarding an innovation is an obstacle for adoption. To reach a goal of growing more broad beans in the future, development of new varieties and delivery options could be a way to overcome this uncertainty and make it more suitable and attractive to adopt in to cropping systems.

Sammanfattning

Klimatförändringar och hållbarhet diskuteras över hela världen. I Sverige, liksom i många andra länder över hela världen, anses livsmedels- och jordbruksindustrin vara en av de viktigaste industrierna, som både påverkar och påverkas av klimatet. Modern jordbruksproduktion bygger på en ökad och högre användning av resurser och insatser för att upprätthålla en hög produktionsnivå för djurfoder och humankonsumtion. Expansionen av mer baljväxter i odlingen kan leda till bättre resurseffektivitet och medföra diversifiering av växtodlingen, vilket kan leda till ett mer hållbart jordbruk. Trots alla möjligheter och fördelar med att odla baljväxter utgörs mindre än 2 % av odlingsarealen i Sverige utav baljväxter. Åkerböna är en baljväxtgröda som kan odlas i större delen av Sverige, är relativt enkel att odla samt kräver inga specialmaskiner.

Denna studie syftar till att finna skillnader och likheter mellan lantbrukare som odlar och inte odlar åkerböna, för att förstå vilka som är de mest avgörande resurserna och hur lantbrukare använder dessa för att fatta beslut i sitt företagande. En kombination av kvalitativ och kvantitativ metod används för att göra det möjligt att både statistiskt jämföra och få en djupare förståelse av det empiriska materialet. Det empiriska materialet har samlats in via telefonintervjuer med lantbrukare i fyra län i Sverige (Uppsala län, Västmanlands län, Östergötlands län och Västra Götalands län). Den insamlade data har sedan analyseras genom både en kvalitativ tematisk analys och en kvantitativ statistisk analys för att testa ett antal hypoteser.

Studien visar att beslutsfattandet gällande val av gröda är nära kopplat till lantbrukarnas företagande och allokering av resurser. I huvudsak avgör de fysiska resurserna om lantbrukaren har förmåga att odla åkerböna eller inte. De humana resurserna påverkar också beslutsfattandet i allmänhet, men påverkar i hög grad inte beslutet att odla åkerböna eller inte. I vår studie skiljer sig lantbrukarnas uppfattning om åkerbönan som potential gröda. De lantbrukare som odlar åkerböna ser grödan som en möjlighet, medan de som inte odlar ser grödan som en risk. Lantbrukare som odlar åkerböna är mer strategiska och tänker långsiktigt när de planerar sin växtodling, medan lantbrukare som inte odlar åkerböna är mer flexibla och anpassningsbara till föränderliga förutsättningar och omständigheter. Osäkerhet för en innovation kan vara ett hinder för att implementera den i sitt företagande. För att nå ett mål om att odla mer åkerbönor i framtiden kan utvecklingen av nya sorter och leveransalternativ vara ett sätt att övervinna denna osäkerhet och göra åkerbönan mer lämpad och attraktiv att odla.

Abbreviations and technical terms

CAP: The Common Agricultural Policy
EFA: Ecological focus area
EU: The European Union
N: Nitrogen
SLU: The Swedish University of Agricultural Sciences

EFA: is an area of arable land upon which farmers carry out agricultural practices that are beneficial for the climate and the environment. It aims to improve biodiversity, and at least represent five percent of calculated arable area (Jordbruksverket, 2019).

Group 1: Farmers who grow broad bean
Group 2: Farmers who not grow broad bean

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1 Introduction

The introduction chapter presents the topic for this study. The problem background and problem statement are presented and followed by the aim of the study. The chapter ends with an overview of the structure in the report.

1.1 Background

Climate change is a constant and present issue in today’s society that is discussed among politicians, companies, and individuals (NordGen, 2019; Rivera-Ferre, 2008). Agriculture affects climate change just as much as climate change affects agriculture (Blanco *et al.*, 2017). In Sweden, as well as in many other countries worldwide, the food and agricultural system is considered to be one of the most important industries (Johansson *et al.*, 2014). Consumers are becoming more aware of how their dietary choices affect the environment. Companies and corporations are also following this trend by developing new products such as pasta and flour made partly from legumes to produce products healthier with higher protein and more fibre, which is more appealing for consumers (Kungsörnen, 2019). This new trend is creating a new demand for legumes in Sweden. Even though it is possible for farmers to grow legumes in Sweden, it is usually grown as feed for livestock and not commonly grown for human consumption (NordGen, 2019; European Commission, 2018). Modern agricultural production relies on high use of resources and inputs to maintain a high production level of animal-based products for human consumption (Emmerson *et al.*, 2016; Odegard & Van der Voet, 2014). As a consequence of an increasing world population, the demand for food and bioenergy will continue to increase as well (Emmerson *et al.*, 2016; Odegard & Van der Voet, 2014; Peltonen-Sainio & Niemi, 2012). By growing the legumes for direct human consumption, bio-resources are used more efficiently than if the legumes were used only as a livestock feed. A crop rotation including legumes will also bring diversification of cropping systems, reduce growth constraints and bring ecosystem services, such as renewable inputs of nitrogen (N) into crops and soil via biological N_2 fixation (Röös *et al.*, 2018; Peltonen-Sainio & Niemi, 2012; Jensen *et al.*, 2010).

Even though there are environmental benefits, economic incentives, and a high nutritional value for growing legume crops, they are grown on less than 2 % of the arable land in Europe (Reckling *et al.*, 2016a). This low level of legume production in Europe is associated with continuing trend towards specialization, and the advantages it brings with economies of scale (Reckling *et al.*, 2016a; Zander *et al.*, 2016). Globally though, legume production has increased since the 1980’s, with Canada being the leading producer and exporter of legumes today (Preissel *et al.*, 2015). Grain legumes are not as attractive in Europe, compared to countries like Canada and Australia. This is mainly due to high production intensity of cereals, leading to higher yield advantages of cereals over grain legumes. These differences cannot be compensated only by the price difference between grain legumes and cereals, especially not when the grain legumes are sold and used for animal feed.

The research project New Legume Food is striving to raise awareness about the different areas of use of legumes for human consumption (SLU, 2019). One of the project objectives is to identify strategies to expand legume use in Sweden. These strategies must be suitable for both the Nordic climate and the Nordic food diet while focusing on crop systems that generate ecosystem services. Different legumes have different prerequisites and are therefore limited geographically to certain areas in Sweden (Fogelfors, 2015).

Broad bean is one of the legumes that can be grown in larger parts of Sweden (Jordbruksverket, 2018) and would be relatively easy to start growing, because it uses several of the technologies used for grain production, such as the drilling machinery and combine harvesters (Bond *et al.*, 1980). Researchers and processors are currently developing techniques which can process broad beans into flour that could be used in food products for human consumption (SLU Grogrund, 2019; Johnsson, 2016). This type of innovation has the potential to increase the demand/interest for broad beans which would increase the price and, consequently, the gross margin for broad bean (Pindyck, 2009). Even though there are many benefits, as previously mentioned, there are also many challenges with growing legumes. They are often perceived as more difficult and riskier to grow than cereals (Ghadim *et al.*, 1996), which could have an influence on the farmers decisions and management of their farm (Öhlmér *et al.*, 1998).

1.2 Problem background

Climate change and sustainability is discussed all over the world. A third of the climate impact from households in Sweden originates from food production (WWF, 2019), which put agricultural practices in the light to become more resource effective. About 63 % of vegetable protein in EU is imported, with soybeans representing the largest share (European Commission, 2018) . The question is why, when we have the possibility to grow more protein crops in Sweden. An increase of planted legumes, such as broad bean, could contribute to a more sustainable agriculture, both from a financial and environmental standpoint (NordGen, 2019). The benefits of growing legumes for farmers is well known; it is a high protein crop which improves the nitrogen fixation and diversifies the crop rotation (Röös *et al.*, 2018; Jensen *et al.*, 2010). If legume growing would expand and focus on human consumption, it could also contribute towards lower production and consumption of meat resulting in positive environmental and health benefits (Röös *et al.*, 2018). The graphs below show the acreage of broad beans and peas in Sweden, and the distribution of broad beans and peas in the counties covered in this study (see Figure 1 and 2).

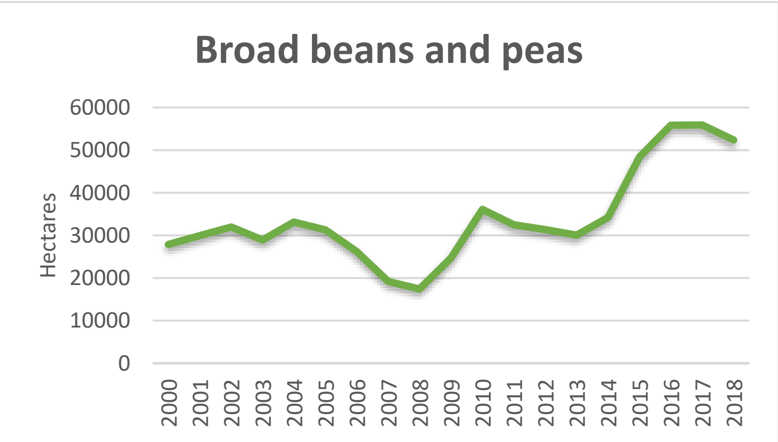

Figure 1. Total hectares of broad beans and peas in Sweden (Jordbruksverket, 2019)

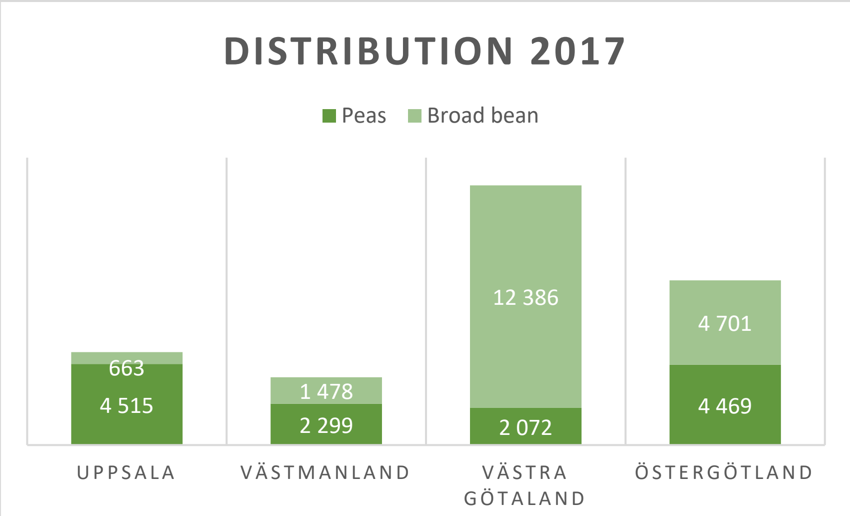

Figure 2. Distribution of broad bean and peas in hectares (Jordbruksverket, 2019a)

From the year 2000 to 2018, the acreage of broad beans and peas in Sweden has increased from 27 892 to 52 382 hectares, see Figure 1 (Jordbruksverket, 2019a). Cereals, especially winter wheat, is the dominant type of cultivated crop in Sweden, and also in the counties covered in this study (see Table 1). According to the researchers behind the research project New Legume Food, there is a potential to expand the acreage of legumes, such as broad beans, in Sweden (SLU, 2019). This could lead to a more resource efficient and more sustainable farming system. If researchers and processors successfully create food products based on broad beans it could lead to a higher consumer demand which potentially can raise the price for broad beans (Pindyck, 2009).

Table 1. Crop distribution in hectare (Jordbruksverket, 2018)

County	Winter wheat	Spring barley	Oats	Peas, Broad beans etc.	Sping wheat	Rye	Winter barley
Uppsala	27 600	35 002	7 534	5 574	10 197	655	768
Östergötlands	45 008	20 260	8 298	7 662	7 310	1 928	1 482
Västra Götalands	49 697	57 332	62 710	13 967	12 827	5 173	1 402
Västmanlands	14 343	20 308	12 384	3 357	6 774	161	471

Since legumes often are perceived as more difficult and riskier to grow than other crops, such as wheat and barley (Ghadim *et al.*, 1996), it is a challenge that the farmer must have in mind when making decisions about legumes in their crop rotation (Reckling *et al.*, 2016a). Sustainability is measured by using three parameters; financial, environmental, and social (Slaper & Hall, 2011). To become more sustainable in the agricultural sector, we must understand how decisions are made by farmers. Farming is a complex business affected by both uncontrolled and controlled elements. Weather for example which has a fundamental role in agricultural production (Hardaker & Lien, 2007; Moschini & Hennessy, 2001). How farmers choose to react to the circumstances around them and use their resources have been examined extensively by using decision-making theory (Öhlmér *et al.*, 2000). However, observations show that farmers' decision making cannot always be considered rational (Kahneman, 2003).

Previous published studies within decision-making describe an overview perspective of farmers' different processes that lead and link to different decisions (Öhlmér *et al.*, 1998). Decisions by farmers related to crop choice may not always adhere to the rules of crop rotations or principles of organic and conventional agriculture, since farmers also have to consider other practical aspects, such as access to machinery or arable land (Chongtham *et al.*, 2017; Itoh *et al.*, 2003). There are several studies on development of crop rotations (Dury *et al.*, 2013). These are examined with decision support and modelling tools and are based upon generic conditions and assumptions, which result in generic crop rotations. Studies that mainly use mathematical optimization techniques to assist in the agricultural production planning, do not reflect on the individual farmer's situation and decisions based on their behaviour and experiences (Bloisi, 2003; Rougoor *et al.*, 1998; Öhlmér *et al.*, 1998). It is for this reason that studies based on optimisation theory and prediction approaches only can be used on generally basis to explain decision-making, since they do not account for individuals' different prerequisites and preferences (Martin-Clouaire, 2017).

Recently, legume growth has been a common topic in student thesises. Olsson (2017) did a qualitative study for New Legume Foods to examine what barriers that exist and needs to be overcome by farmers and processors to increase the production of legumes in Sweden. The study was performed in Skåne, a region in the south of Sweden, which has a beneficial climate to grow different specialized crops. All farmers in the study did already grow some type of specialized crop, which may affect what attitude they had towards growing legumes. A study performed in other parts of Sweden might therefore give new and different perspectives. Olsson (2017) used an agroecology perspective to analyze the material, where Olsson mainly investigated what pre-conditions that are needed to grow more legumes. Why and how farmers make their decisions to grow legumes or not, were not considered.

Sweden's self-sufficiency of food today is approximately 50 % (LRF, 2019). Since farm businesses usually are operated as small enterprises by one or a few persons (Willock *et al.*, 1999), farmers' individual decisions affect what food is produced. Better understanding of how farm businesses use their resources to make decisions regarding the crop planning, might function as a base for policy-makers who want to create incentives for, and increase the self-sufficiency of food in Sweden (Sveriges Riksdag, 2015). Also, the conclusion of this study could help researchers understand what needs to be researched and developed in order for farmers to become more sustainable in their business.

1.3 Problem statement

A more sustainable agriculture business is desired and research regarding implementation of legumes can demonstrate the possible biological and environmental benefits (Röös *et al.*, 2018; Peltonen-Sainio & Niemi, 2012; Jensen *et al.*, 2010). Although we understand the potential and benefits of growing more legumes, less than 2 % of the acreage in Sweden were used for legume growth in 2018 (Jordbruksverket, 2018). Previous studies mostly focus on crop planning in general by optimization or modelling, and are not analyzing decision behavior based on resources and what types of crops are grown. Hence, a study based on a mixed approach could capture both soft values and hard facts regarding farmers' decision to grow broad beans. This new approach might result in new valuable insights that can be used to create an understanding for how farmers think regarding their crop decisions, and what should change in order to expand legume production in Sweden.

1.4 Aim

This study aims to find differences and similarities among farmers who grow broad beans and not, to understand which the most determining resources are, and how farmers use these to make decisions regarding crop planning. To reach the aim of the study, the following research question are going to be answered:

- What resources affect the farmer's decision to grow broad beans?
- How does the decision process differ between farmers who grow broad beans and farmers who do not grow broad beans?

1.5 Delimitations

This study focuses on the differences in the decision making process for farmers when choosing to cultivate the legume crop broad bean. The study does not include the entire food or feed value chain for legumes. The focus is solely on the farmers' perspective, resources, and why they decided to grow broad beans or not. Therefore, it is not considered whether the broad beans grown are used for animal feed or human consumption. The geographical focus is on the counties of Uppsala, Västmanland, Östergötland and Västra Götaland. The reason for choosing these locations is the empirical background which shows that legumes as a farming crop are more common in these geographical areas (Jordbruksverket, 2018a).

Based on the delimitations and chosen approach in the study, the results may not be generalized to every farmer's decision-behaviour in Sweden. On the other hand, the results of this study can provide useful insight about farmers' practical limitations and possibilities regarding production of legumes in Sweden. This could also create incentives for businesses on a processing level to develop products from broad beans.

1.6 Structure of the report

In this section the structure of the report is presented, which is also illustrated in Figure 3. The structure of this study begins with chapter one, an introduction chapter, that presents the background of the chosen topic, problem background and statement, followed by the aim of the study, research questions related to the study, and finally the delimitations are presented. Chapter two presents a literature review based of articles relevant for this study, to obtain a deeper understanding in the research field. Chapter three presents the theoretical framework that is used in this study, and the theoretical synthesis is explained. Chapter four presents the methodology and methods applied in this paper. The fifth chapter presents the empirical data and results. In chapter six the statistical analysis is presented. The implications of the results is furthermore analyzed and discussed in chapter seven. In chapter eight the conclusion of the study is presented, and also a short reflection on further research studies.

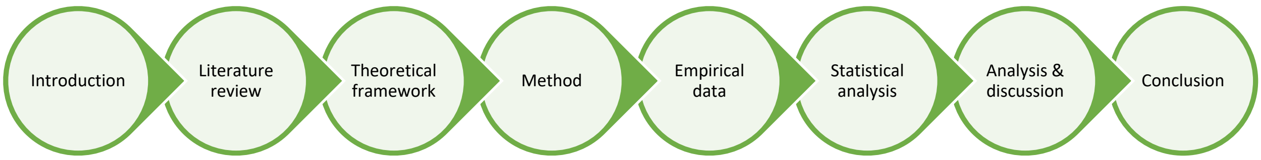

Figure 3. Illustration of the structure of the report (own processing)

2 Broad bean and literature review

This chapter begins with some background facts about broad bean. The chapter continues with presenting literature about legumes, broad bean, and crop planning along with the impacts they have from a biological, economic, and risk-analysis based perspective.

2.1 Broad Bean

Broad bean (*Vicia faba*) is an old crop and was discovered 8000 years ago in western Asia (Fogelfors, 2015; Cubero, 2011). The Swedish name varies with the size and use of the bean. The crop is called broad bean when the seed weight is between 0,15-0,65 grams while it can be called horse bean or fava bean if the seed is larger. In this study, broad bean is chosen as the name of the crop.

Broad bean is a one-year crop with a long vegetation period (Fogelfors, 2015). In a Swedish environment it is planted early in the spring and harvested as one of the last crops in the fall. The crop thrives on water-containing lime-rich soils and require a good supply of phosphorus and potassium. Since it needs good water supply during the growing season, it requires a drilling depth of about 6 to 8 cm to obtain an even germination. Hence, broad beans mature late and are not ready to harvest until the stalk and tubs have started to blacken and the seed has become hard. A water content of 18% is optimal at harvest of broad bean. Lower water content levels can cause the beans to crack. Complications at harvest may even occur if there are wet conditions or if the beans have not properly matured (Holstmark, 2007). If broad beans have to be stored for a longer time, they should be dried to a water content of 14-15% (Jonsson *et al.*, 2015). The drying characteristics between broad beans and cereals differ due to kernel size and chemical composition. Therefore, an available storage and drying facility with a good capacity, is important to maintain quality.

Broad bean has a high protein content, 29-33% depending on the cultivation conditions, and different varieties (Fogelfors, 2015). In addition, broad bean has a certain pre-crop value due to its nitrogen fixation of 20 kg N/hectare (Lindén, 2008). The pre-crop effect of broad bean implies that a yield increase about 10-12% compared to increased seed amount to the subsequent cereal gains monoculture.

The main constraint to increasing the frequency of broad bean in a crop rotation is attributable to the effects on soil-borne disease and pests (Jordbruksverket, 2018b; Fogelfors, 2015). It is recommended that the crop is not grown in the same field less than 6-8 years apart (Jordbruksverket, 2018b).

2.2 Literature review

A literature review is one of the first steps in a research process (Bryman & Bell, 2015). The purpose of a literature review is to find out what is already known within the subject and what methods, theories, and concepts that have been used when studying the issue before. There may even exist contradictory evidence or conclusions. The literature review also functions as a base from where some of the hypotheses is formulated.

To find relevant articles for the literature review we used keywords. The following words were used: legume, broad bean, field bean, crop rotation, decision making, and farm management. Listed below (see Table 2) are the articles we found relevant for this study, along with what subject they focus on.

Table 2. The articles included in the literature review

	Biological	Economic	Risk
Preissel et al (2015)	Pre-crop benefits		
Stagnari et al (2017)	Sustainable break crop	Farm management	
Zander et al (2016)	High-level protein & biodiveristy	Gross margin	Yield & gross margin
Chongtham et al (2017)	Crop rotation		
Reckling et al (2016a)	Cropping plan	Economic performance	Complex cropping plan
Reckling et al (2016b)		Economic & enviromental evaluation	
Jouan et al (2019)		Transaction costs	Volatility
Ghadim et al (1996)			Risk aversion & risk premium
Reckling et al (2018)			Spread of risk

2.2.1 Biological aspects

Crop rotation is the sequence of crops on the same field. A crop rotation implies that crops generally are planted in a pre-determined order (Chongtham *et al.*, 2017). The crop sequence is determined by current and past decisions made by farmers based on what type of crops to grow in the current and subsequent growing seasons. The choice of crops included in a crop sequence can influence; soil fertility, nutrient cycling, risk of infestation by weeds, pests, or diseases, nutrient demand, crop diversity, and economic risk management. In practice, the crop sequence often changes over time as an adaptation to prevailing conditions, preferences, knowledge, and the different trade-offs which farmers must consider when choosing crops. According to Reckling *et al.* (2016a) farmers who implement legumes into their cropping system get a more complex cropping plan to manage. For example, legume crops need to be planted several years apart in the crop rotation due to their susceptibility to soil-borne diseases.

Pre-crop benefits are a crucial component of competitiveness of legumes (Preissel *et al.*, 2015). Legumes improve growing conditions and thereby increase the yield of subsequent crops in the crop rotation system. This effect of legumes has been analyzed in several reviews. There is also an economic balance of the trade-off between the N fertilization and the yield potential that is important to have in mind.

In general, legumes are not susceptible to the same pests and diseases as major cereal crops (Stagnari *et al.*, 2017; Preissel *et al.*, 2015). Legumes also act as a good intermittent crop, or alternative crop, used to separate the growing seasons of crops more frequently harvested. Intermittent crops are used to help with weed control, improve the soil structure, and increase the availability of plant nutrients, for instance, phosphorus and nitrogen.

In the context of sustainability within agriculture, the importance of the role legumes has been enhanced by emerging research in farm management (Stagnari *et al.*, 2017). Legumes deliver a unique combination of a high-level protein grain for food and feed, improvement of soil quality, contribution to enhanced biodiversity needed to support a positive environmental impact and contributing towards the reduction of greenhouse gas emissions (Zander *et al.*, 2016).

2.2.2 Economic aspects

Reckling *et al.* (2016a) states that the economic performance of legumes is a key driver responsible for their low adoption in cropping systems. Previous studies have shown that, as an individual crop, legumes in general have a lower gross margin than cereals and oilseed crops.

Previous studies highlight that legumes have an agro-economic potential that could be exploited more effectively (Reckling *et al.*, 2016b). In the same article by Reckling *et al.* (2016b), a framework was tested in two case studies. Economic, environmental, and agronomic data from Västra Götaland in Sweden and Brandenburg in Germany were used to compare cropping systems with and without legumes. In the case studies, the environmental impacts were lower for cropping systems with legumes than cropping systems without legumes, and the economic evaluation of the cropping system showed benefits for systems with legumes. They also demonstrated the importance of evaluating the effects of legumes in a cropping system considering rotational effects.

Results from recent research show that legumes are economically attractive at the rotation scale due to zero or negative opportunity costs, but the transaction costs are high (Jouan *et al.*, 2019). The opportunity cost at the farm level is connected to farmers often considering legumes as less profitable in the short run than other more common crops on the farm (e.g., wheat, rapeseed). In the long run, if farmers consider the decreased inputs (e.g., nitrogen fertilizers) and increased yields of subsequent crops by having legumes in the rotation, farmers can have a higher profitability.

2.2.3 Risk aspects

Legumes are considered to be riskier than more common crops because of their more variable yields from year to year (Ghadim *et al.*, 1996). However, there is no consensus on this characteristic in the scientific community (Jouan *et al.*, 2019). Considering the farmers’ risk aversion, legumes display a higher risk premium (the amount of money that a farmer is willing to pay to eliminate all risk) than those of other crops. This decreases the relative profitability of legumes even more.

Calculations based on yield data from German national statistics show that variation in yields of broad bean is lower than those of rapeseed and rye (Zander *et al.*, 2016). Some case studies report that the gross margin and volatility of field peas and broad beans are comparable to rapeseed, wheat or barley in four out of five case study regions. Given that the production risk of broad bean in some regions is comparable to competing crops and that cereals and legumes respond differently to weather conditions. Legumes can therefore also play an important role in diversifying risk in the cropping system on the farm. On the other hand, Reckling *et al.* (2018) concludes that yields of grain legumes are not naturally less stable than those of other spring crops in long-term experiments in northern Europe. One influencing factor is that legumes are more vulnerable to competition from weeds than cereals, because they are poor competitors for nutrients, establish slowly, and are more susceptible to disease.

2.2.4 Summary of literature review

The literature review in this study show that research exist on economic, biological and risk aspects of introducing legumes in cropping systems. In general, most of the studies identified in the literature review have been performed in other countries than Sweden. In a Swedish context there are only a few studies that examine the effects of legumes in cropping systems. For example, the study of Reckling *et al.* (2016b) focuses on nitrogen use and efficiency, but does not capture the dimensions of decision-making in the field of business administration. According to Öhlmér *et al.* (2000) it is of importance to take the decision making process in consideration when assessing farming as business. The problem is that there is no previous study that has focused on the decision making process concerning legume production in Sweden. How crop diversification affects a cropping system has been identified in the literature along with the advantages and disadvantages with different types of crop combinations. By applying theory concerning decision making, which is common practice in both international and Swedish business administration research, circumstances behind farmers' different actions and decisions may be identified. Therefore the presented literature review both serves a base from which our hypotheses is developed, and helps to create a deeper understanding about fundamental aspects of the farmers' business management decisions.

3 Theory

In this chapter, the theory is prestented. Theory is described as one or several statements that explains structures, relations, and phenomena upon which the reality is built upon (Vogt, 2005). The main theories in this study are resource-based view, decision-making theory, and diffusion of innovation. Together these will build the framework for how we will analyze the empirical data that is collected. The use of the decision-making theory to analyze the problem may facilitate the understanding of why farmers grow legumes or not.

3.1 Resource based view

In literature there are several theories which describe and explain the process for a decision to be made under different conditions. There are different ways to look at a firm's potential to gain competitive advantage and survive the competition (Landström & Löwegren, 2009). One dominating view that deals with this issue is the resource-based view (Furrer *et al.*, 2008; Barney, 1991; Wernerfelt, 1984). How a resource is defined depends on which field that is examined (Penrose, 1959). In the field of business administration, the definition of a resource is a supply or a source that could be transformed to produce a benefit for the firm (Wernerfelt, 1984).

The resource-based theory is a theoretical framework whose purpose is to explain how companies create competitive advantages through efficient use of resources and how these should be managed in order to remain sustainable over time (Eisenhardt & Martin, 2000). The resource-based theory provides the basis for creating an understanding of how companies create growth (Landström & Löwegren, 2009). This theory assumes all companies can be viewed as a concept of resources(Eisenhardt & Martin, 2000; Peteraf, 1993). These resources are heterogeneously distributed over different companies where differences in these resources persist over time. Resources are defined in several ways in the literature. Wernerfelt (1984) describe a resource as anything that could be thought of as a strength or weakness of a given firm.

The resources included in a firm can in many cases be both physical and human resources (Barney, 1991; Penrose, 1959). According to Brush *et al.* (2001), resources in a firm may be scaled from simple to complex. The simple scaled resource is often quantifiable and tangible, and the complex scaled is often more intangible and also related to human skills and knowledge. In the specific agricultural context, tillable land, machinery, seeds, fertilizers, storage and grain drying facilities are examples of physical resources. Human resources could in this context be labor such as machinery operators, farm managers and farm owners. Some resources are "invisible", such as knowledge and experiences (Hart, 1995). When it is an individual's asset, it is labelled tacit resources. When a group of people is formed to achieve a certain objective, and by that create a common resource, it is labelled socially complex resources.

The resource based view assumes that all farms have different resources which result in different preconditions and advantages (Barney, 2007). Farms do also depend on their geographical position, and the climate. Unpredictable factors such as weather can affect the farm and its profit which creates complex and unique situations every year for farmers (Hardaker & Lien, 2007; Moschini & Hennessy, 2001). Since this study mostly focuses on decision-making, the resources will be viewed as something that partly affect what decision is made. Also, how the farmers reason and allocate their resources, are important aspects.

3.2 Decision-making theory

The decision-making theory presented below is based on the decision process model presented by Öhlmér *et al.* (1998) and Öhlmér *et al.* (2000). It is supplemented with the affect attitudes and objectives of the farmer has on decisions (Willock *et al.*, 1999) and specifically in the context of crop planning (Dury *et al.*, 2013).

3.2.1 The decision process

A farm business is usually operated by one or few persons. Therefore, most decisions are made by a single person (Willock *et al.*, 1999). Decisions are not made in a specific sequential order, but a decision process go through certain phases which fulfill different functions (Öhlmér *et al.*, 1998). Öhlmér *et al.* (1998) identified eight common functions within a decision process: Values and goals, problem detection, problem definition, observation, analysis, development of intention, implementation, and responsibility bearing. *Values and goals* of the farmer influence what decision is made. This decision may also affect and change the values and goals of the farmer. Willock *et al.* (1999) uses other terms, attitude and objective, to describe what affects farmers' behaviors and thus their decisions. Attitude includes the farmer's attitude towards risk, innovation, environment, satisfaction with farming, stress (financial or unpredictable situations such as weather and sickness), bureaucracy that follows with new legislation and regulations, diversification and off-farm work. The farmer's attitude influences the objectives. A farm, like any other business, strives to maximize production and be profitable, but this might not be the main goal or top priority depending on the individual's attitude and values.

Values define what is important and what satisfy the needs of the individual (Öhlmér *et al.*, 1998). This affects what the individual aims for, what goals are defined set and what decisions are made in order to reach the goal. Values are also connected to how the result is perceived. *Problem detection* means that when an internal or external situation arises which causes a problem or an opportunity, the farmer realizes the situation and needs to address it. *Problem definition* is when the farmer defines the exact problem and what options are feasible to solve it. *Observation* refers to when the farmer oversees and gathers information about the different options. If new information is found, it could lead to a new or different decision. In the *Analysis* phase, the individual analyzes and calculates what will likely happen depending on the decision made. *Development of intention* decides which option seems to be the best and start preparing the *implementation*, which is the next phase. The needed resources are collected in order to implement the chosen option/solution. An evaluation is made to compare the result with the goal and learn for future decisions. What is learned from this decision could affect values and goals which determine what happen in the next decision process. *Responsibility bearing* is the phase which includes acceptance of how the decisions were made and who are responsible.

Although all the steps in the general decision-making process presented above are included, farmers' decision-making is more characterized by information search and problem detection rather than by analysis and choice (Öhlmér *et al.*, 1998). In comparison to other studies on decision making, Öhlmér *et al.* (1998) focused specifically on farmers and the process they experience in their decision-making. The conclusion reached is that the traditional decision-making process needs to be revised when the farmers' decision-making is examined. Since farmers' decision-making process is more complex than general decision-making, it is better explained by a matrix than that of a linear process with clear steps (Öhlmér *et al.*, 2000; Öhlmér *et al.*, 1998). This decision-making process together with the various elements and the four sub-processes function is Öhlmér *et al.* (1998) illustrated in Table 2. The four phases that farmers' decision-making process consists of are: problem detection, problem definition, analysis and selection, and implementation.

Table 2. Decision-making process model (Öhlmér et al., 1998).

	Subprocess			
Phase	Searching & Paying Attention	Planning	Evaluating& Choosing	Bearing Responsibility
Problem Detection	Information scanning Paying attention	________	Consequence evaluation, Problem?	Checking the choice
Problem Definition	Information search Finding options	________	Consequence evaluation, Choose options to study	Checking the choice
Analysis & Choice	Information search	Planning	Consequence evaluation, Choice of option	Checking the choice
Implementation	Information search Clues to outcomes	________	Consequence evaluation, Choice of corrective action(s)	Bearing responsibility for final outcome, Feed forward information

This model constitutes four phases including continuous ongoing sub-processes (Öhlmér *et al.*, 1998). The sub-processes are called: searching and paying attention, planning, evaluating and choosing, and bearing responsibility. Due to these continuous processes, farmers increase their knowledge and create a better understanding of the situation or problem.

The *searching and paying attention* process is the phase where the decision-maker searches for information with the purpose of reaching a specific target. Discovered problems and possible solutions are compared to create an understanding of the problem and find different possible outcomes. The outcome of a sub-process depends on the amount of information available and the objectives of the farmer.

The next sub-process is *planning*, which takes place only during the phase analysis and selection, due to that all information available is processed in this phase. *Planning* is part of the analysis, and the decision-maker continuously updates the plan when new information emerges. It is planned how different choices will affect the decision-maker in order to be able to choose the one that best corresponds to the desired outcome.

In the *evaluation and choosing* process, the decision-maker tries to predict the outcome of potential choices and their consequences. This process also considers to what extent the consequences will affect the farmer's business objectives and any other effects they may have. The decision model assumes that the farmer chooses the alternative that most likely results in goal fulfillment.

In the last sub-process *bearing reasonability*, the decision maker takes and understands his/her responsibility. During this sub-process, the farmer checks the choice by consulting with people in their surroundings, for example, other farmers, friends, and family. After a decision has been implemented, the farmer assumes responsibility by evaluating the decision and passing the information on to future decisions with similar bounds and likely outcomes.

3.2.2 Deciding the cropping plan

When deciding the cropping plan, the farmer has a lot of different aspects to consider and many complications with no obvious solution. A cropping plan partly depends on what values and goals the farmer has (Öhlmér *et al.*, 1998), and the constraints of agronomy, economy, resources, farmland, and climate (Dury *et al.*, 2013). Since all these factors can affect the decision, their decision making must be analyzed as a dynamic process. Dury *et al.* (2013) found that farmers' crop planning is an ongoing process which passes two phases, planning and adaption. The planning phase includes long-term thinking with strategic or tactical decisions. Most farmers in their study use the same plan that they used the previous years. Some farmers have a plan for the next one to four years, while others have no long-term plan deciding what crop to grow year to year. They act more spontaneously, are flexible and use short-term planning. As the time goes by, the cropping plan is updated and adapted to changing circumstances, such as market or price conditions. The decisions in this phase are only of tactical nature.

Farmers who base their crop rotation around their cropping system have ensured a robustness in their crop plan, but are not as flexible and adaptable to changes in their environment (Dury *et al.*, 2013). The farmers who decide yearly what crop they are going to grow, manage a changing context as well, but are not as good at considering what effect the past crops have on the next crop. Crop-planning should be viewed as a continuous process since the crop-plan being updated at least once per year, and sometimes several times per year. The farmer typically does not create a completely new crop plan. It is more of a re-design of the past crop-plan since the newest crop is always dependent on the previous ones. Even if farmers try to think strategically and make stable decisions, there are always uncertainties that must be dealt with. These decisions could be planned or unplanned, but either are due to a market opportunity or a sudden situation that arises.

The cropping plan on a farm does not often emerge from a single decision but from a dynamic decision making process (Dury *et al.*, 2013). This among other things, incorporates unanticipated situations such as lack of availability of particular seeds, weather conditions and market opportunities. Since many factors influence crop choice in a rotation, it is not always practical for crops to follow each other in strict, repetitive cycles. This is particularly true on arable farms that depend on cash crops rather than growing crops for livestock feed. Therefore, it is often more relevant in practice to discuss crop sequences rather than crop rotations. According to Dury *et al.* (2013) the main objective of farmers that drive cropping-plan decision-making is the dominant factor of income.

3.2.3 Decision making and risk

In order to understand and analyze the decision-making process, uncertainty and risk in future consequences and values are important factors to consider (Öhlmér *et al.*, 2000). An event is uncertain if the outcome of it is unknown, and become risky if the outcome changes the decision makers well-being (Öhlmér *et al.*, 2000; Robison & Barry, 1987). A risky outcome may result in increased or decreased well-being for the decision maker. In a decision makers' perspective, risk must not only be defined as something negative.

One common assumption in decision theory is that individuals are risk averse. In other words they try to avoid taking risks (Lindahl, 2000). It is important to take into consideration that all people have different attitudes and perceptions when they talk about risk (Hardaker, 2004). The more complex the risk is, the more difficult it becomes for the farmer to make an informed decision. For effective decisions to be taken, the farmer needs information concerning many aspects of the farming business. Farmers must find ways to deal with risk and protect themselves from the uncertainties in the future. According to Hansson and Lagerkvist (2012) and Hardaker (2004) most farmers are likely to be risk-averse. Therefore, farmers will, according to the theory, use different strategies to protect themselves against risk (Hardaker, 2004). This opposed to a risk-loving person selecting the alternative that gives the preferred outcome no matter the level of risk that comes with the selected alternative (Hardaker & Lien, 2007; Hardaker, 2004).

The farmer often has many roles in farm management (Öhlmér *et al.*, 2000). Managing the business and sales, book-keeping, the maintenance of buildings and mechanical operations on field, and taking care of animals are some of these examples requiring management. Farmers must also take care of their environment, their social life and their families. This has an impact on the farmers risk attitude and distribution of risk, and therefore also their decision making. Arrow (1974) observed, in the development of a risk-aversive behavior theory, that individuals' reluctance to take risks and the aversion to risk explains many observed phenomena in the economic world. In the context of agriculture, farmers show their attitudes to risk in many ways through hedging or using contracts, diversification in production, crop choices, insurance and cash reserves as some examples(de Mey *et al.*, 2016; Lien *et al.*, 2007; Hanson *et al.*, 2004; Hardaker, 2004). Similarly, the public sector shows its attitude towards farmers risk through various stabilization program, credits and subsidies (Arrow, 1974).

3.3 Diffusion of innovation

Diffusion of innovation is a concept describing how a new idea or innovation gets spread (Rogers, 1963). There are four elements in the process of diffusion: 1) innovation, 2) communication, 3) social system, 4) and time. 1) Firstly, an innovation is needed to diffuse. "An innovation is an idea perceived as new by the individual" (Rogers 1963, p. 13). The focus here is the behaviour of the human, the reaction to the idea. Therefore the idea does not have to be completely new. To transfer this innovation, there must be 2) communication and interaction between people within a social system. A 3) social system consists of a group of different individuals who are interested/involved in solving the same issue. These individuals represent different functions within the social system and could represent farmers from a certain region as well as firms from the industry or schools. Depending on the type of innovation, members within the social system could be dependent on the level of adoption in the system in order to be able to adopt the innovation themselves.

Rogers (1963) describes three different levels of decisions regarding innovation adoption. Level one means that an individual can adopt an innovation without being dependent on what others within the social system decides to do. However, individuals in the social system might become influenced by each other's decisions and act as a result of others' behaviour. Level two refers to an innovation that is based on a group activity and requires more individuals to adopt the innovation to be able to implement the idea. In level three, adoption of the innovation is not a choice for the individual. It could, for example, be a requirement in terms of a new legislation or regulations. 4) Time is the fourth element which highlights the time of the adoption process. From the moment when the individual becomes aware of the innovation, they must develop an interest, evaluate, and test the innovation before they fully adopt it. The difference between the adoption process and the diffusion process is that the adoption process examines the adoption of the innovation by an individual, while the diffusion process analyses how the innovation is spread within or between populations. The time of the adoption process vary amongst individuals and determines which adopter category they belong to. There are five categories: innovators, early adopters, early majority, late majority and laggards (see Figure 4).

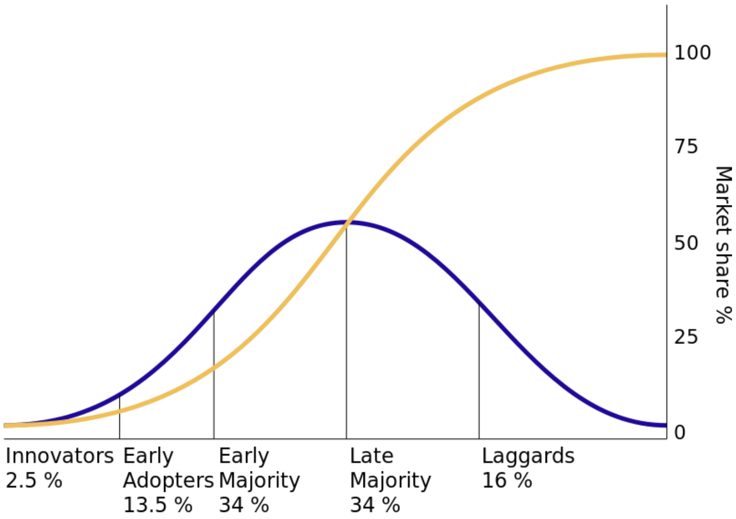

Figure 4. Diffusion of innovation adopters' groups (Rogers, 2003)

To find out to which category the adopters belong, the number of adopters can be plotted along a timeline (Rogers, 2003), which is illustrated in Figure 2. This usually results in a normal, bell-shaped curve, unless it is an accumulated plotted in which case it shows an S-curve with the steepest slope right above the maximum point of the bell-curve.

3.3.1 Innovation-decision process

From an individual perspective, the adoption of an innovation process occurs in five stages: 1) knowledge, 2) persuasion, 3) decision, 4) implementation, and 5) confirmation (Rogers, 1995). In comparison with Öhlmér *et al.* (1998) decision model which begins in problem detection, this model begins with an individual who receives new *knowledge* about an innovation. The next step is *persuasion* or when the individual forms an attitude towards the innovation, either positive or negative. *Decision* refers to the individual’s actions regarding rejection or adoption of the innovation. If the individual decides to adopt the innovation, the next step is the *implementation* where the new idea is put into use. After the implementation, the individual seeks *confirmation* from others about the adoption of the innovation. In case of criticising feedback, the individual might change their mind regarding the decision to adopt.

3.3.2 Diffusion of innovation in a context of farming

Feder and O'Mara (1981) used diffusion of innovation to analyze adoption of hybrid seeds, chemical inputs and special cultivation practices. They noted that larger farms more easily than small farms were able to new technology. The reason seems to be that all farms face the same fixed costs. Hence, it results in a comparatively larger costs for smaller farms than larger firms. Larger farms also, in general, face more economic advantages in terms of better loan opportunities and preferential prices on inputs for their businesses. In order to equalise costs between farms and speed up adoption, subsidies are suggested (in a direct and indirect form) to smaller farms. However, there exist studies that show that farmers could be willing to adopt an innovation at a relatively high price. Furthermore, a rapid adoption would not be affected by a high cost of implementing the innovation (Fliegel & Kivlin, 1966). These farmers viewed it as a long-term investment which would pay back in the future.

Another obstacle towards adoption is uncertainty about the innovation (Feder & O'Mara, 1981). Adaption of new technology or practice is a learning process which indirectly costs money. However, the more adopters of the innovation, the more reduced the uncertainty will be for future adopters. Therefore, the authors also discuss a potential subsidy to early adopters. On the contrary, their conclusion is that the early adopters often comprises of higher income farmers which may not need the subsidies the most.

Research and teaching have an important role to play in the collective effort of the transition towards farming systems with more legumes (Voisin *et al.*, 2013). By supporting the actors to gain access to new ideas about farm management, academia could have a major function in the diffusion of innovations. The largest amount of advice and technical references are brought to farmers by other actors and organizations in the agricultural sector. The farmers' current requirements in terms of supply (in quantity, quality and stability) imply that they are not very inclined or trained to provide technical support on legume crops presently.

3.4 Theoretical synthesis

To reach the aim of the study, we have created a theoretical synthesis which will be our framework in the analysis. It is based on Öhlmér *et al.* (1998) decision making model, resource-based view, and diffusion of innovation as illustrated below in Figure 5.

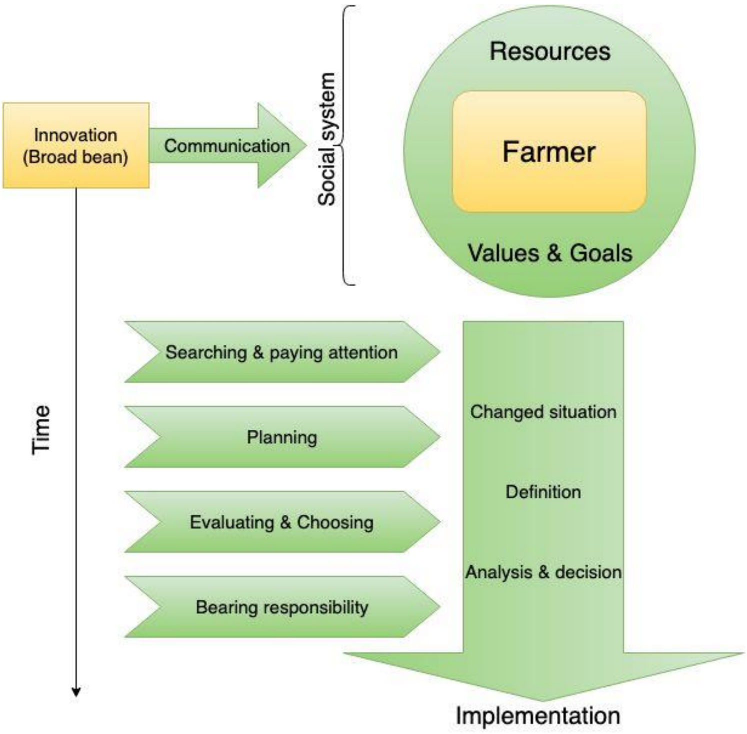

Figure 5. Decision making model (Own processing)

This model illustrates how the farmers are affected by different elements in a decision process. What resources the farmer has such as; human and physical, set limits, available opportunities, and influence over potential outcomes (Barney, 2007; Eisenhardt & Martin, 2000). Farms have similar resources, such as machinery and arable land, but different preconditions in terms of soil types, climate, monetary capital, and knowledge. Farmers are bounded to act along these restrictions. Resources are not necessarily fixed, and the farmer can allocate resources differently to create advantages. Farmers also have their personal values and goals influencing how farmers act (Willock *et al.*, 1999; Öhlmér *et al.*, 1998).

With the exceptions of preconditions and resources, the farmer constantly meets different situations that must be managed. By merging the decision-making process (Öhlmér *et al.*, 1998) and the innovation decision process (Rogers, 1995) we arrived at the model above. The biggest difference between these models is how the individual enters the decision process. The innovation decision process, in comparison with Öhlmér *et al.* (1998), starts with new knowledge rather than a detected problem. A situation arises which causes a problem, opportunity, or the new knowledge that is received (changed situation). The farmer defines the situation and forms an attitude towards it (definition). When the farmer has a clear understanding of the situation, he/she analyses and chooses the best option (analysis & decision). The decision is then made, and the solution is implemented (implementation). After a decision has been implemented, the farmer takes responsibility through feedback from their decision and uses the information for future decisions where the outcome of the previous decision affects the action.

The broad bean in this study is examined as an innovation defined as a new idea for the individual (Rogers, 1963). The broad bean is a well-known crop in Swedish agriculture but is only grown on 1% of the arable land in Sweden (Jordbruksverket, 2018a). Innovations are spread by communication through social systems (Rogers, 1963). Farmers are part of different social systems in which information and experience is exchanged. Some choose to adopt innovations, and some decide not to adopt. The time of the adoption process differs between individuals.

3.5 Summary of theoretical framework

Presented below is a summary of the literature review and theory which work as a base for the developed hypotheses.

Farmers who grow legumes need to manage a more complex cropping plan (Reckling *et al.*, 2016a). Broad beans need to be separated by 6-8 years (Jordbruksverket, 2018b) in a crop sequence, which could require a more stable crop plan (Dury *et al.*, 2013). Crop planning is a dynamic process and is constantly changing due to unforeseen circumstances. Farmers practice different approaches and tactics about crop planning. Even if farmers try to think strategically and make stable decisions, they can do not know the future and sometimes make uncertain decisions. Causes of uncertainty could be a market opportunity or a sudden situation that arise. Some farmers act more spontaneously, are flexible and use short-term planning while others have plans for several years ahead. Jouan *et al.* (2019) shows that farmers think legumes are less profitable than other crops such as wheat and rapeseed. Ghadim *et al.* (1996) argues that legumes often are perceived as risker and difficult to grow due to fluctuating yields. Other studies show beneficial effects of including legumes in the crop sequence (Röös *et al.*, 2018; Jensen *et al.*, 2010). Regardless, there are farmers who decide to grow broad beans and some who do not. Many different factors could lead to the decision to grow or not grow broad beans. Goals and values (Willock *et al.*, 1999; Öhlmér *et al.*, 1998) or different resources which result in different preconditions and advantages influence the decision (Barney, 2007). Farms do also depend on their geographical position and their climate (Jordbruksverket, 2018a; Barney, 2007).

3.6 Hypotheses

Based on this previous literature and theory, the following hypotheses were developed.

3.6.1 Resources

Hypothesis 1 – 6 tests whether the groups' resources differ. There exists different types of resources, physical and human (Barney, 1991; Penrose, 1959). Physical resources is tested with hypothesis 1, 2 and 3, while human resources are tested with hypothesis 4, 5 and 6.

1. Farmers who grow broad beans have larger acreage.
2. Farmer who grow broad beans have access to drying facilities.
3. If farmers grow broad bean, depend of their climate and vegetation period.
4. Farmers who grow broad bean uses more types of information sources.
5. Farmers who grow broad bean require more professional support.
6. Farmers who grow broad beans are more educated.

3.6.2 Decision making

The test of hypothesis 7 – 12 examines if there are any statistical significant difference between the groups in their decision making. Values and goals is a part of the decision process (Willock *et al*., 1999; Öhlmér *et al*., 1998), why hypothesis 7, 8 and 9 tests if there exists any difference between the groups regarding this. Hypothesis 10, 11 and 12 is tested to examine if there is any difference within the decision process among the groups, from the *changing situation* to the *implementation*.

7. It is more important for an organic farmer to grow broad beans.
8. Farmer who grow broad bean plan their crop sequence further into the future.
9. Farmers who grow broad bean update their crop plan more often.
10. Farmers who grow broad bean, focus more on crop rotation effects than price in their decision about crop planning.
11. Farmers who grow broad bean compare profitability to a less extent.
12. Farmers who grow broad bean perceive their profitability in the crop production lower than other farmers.

3.6.3 Innovation

With hypothesis 13 it is tested if there exist any significant difference between the group regarding innovations. An innovation is defined as an idea perceived as new by the individual (Rogers, 1963). A decision refers to the individual's actions regarding rejection or adoption of an innovation, and if the new idea is put into use or not (Rogers, 1995).

13. Farmers who grow broad beans are more open to try new things.

3.7 Alternative theories

To examine farmers decision making, other theories also could be used which have been excluded for this study. For example stakeholder theory and motivation theory. Stakeholder theory focuses of understanding different stakeholders needs and behaviours, which are affected or can affect a business (Freeman, 2010). By mapping up stakeholders with this theory, researcher can find a guideline to explore questions concerning business strategies and decision structure (Mintzberg, 1983). In this study we only focus on one type of stakeholder, the farmers' perspective, that theory does not suit the aim of this study. The motivation theory, "push and pull" includes several theoretical statement about how an individual or a group are affected by internal and external factors (Martin-Clouaire, 2017). Push- and pull theory identifies which factors generate certain behaviours. Thereby it creates a better understanding of how individuals act and why they prioritize certain things instead of others (Vik & McElwee, 2011). The underlying reason behind a specific decision can be explained by motivation theory, but in this study we take the whole decision process in consideration, and therefore exclude theories about motivation.

4 Methodology

This chapter presents the methodology along with a discussion about suitable research method, data collection, analysis of data, and finally a reflection about the quality assurance and ethical consideration of the study.

4.1 Research considerations

All researchers have their own way of thinking and views about what composes truth and knowledge (Bryman & Bell, 2015; Chilisa & Kawulich, 2012). These views guide the researchers and influence their way of thinking during a research process. The researcher's own beliefs as well as assumptions about society and the world around them can be summarized as his or her paradigm. A paradigm is defined as "a loose collection of logically related assumptions, concepts, or propositions that orient thinking and research" (Bogdan & Biklen 1998, p. 22). A closer examination of what supports the researcher's paradigm can lead to a better understanding of their research, which are their underlying philosophical assumptions about epistemology and ontology (Bryman & Bell, 2015; Sefotho, 2015).

The ontological position affects what way the research is carried out and how the research question is formulated (Bryman & Bell, 2015). Considerations of ontology are concerned with the nature of social entities and assumptions the researcher makes about the nature of organizations (Bryman & Bell, 2015; Sefotho, 2015; Mackenzie & Knipe, 2006). Ontology is not only about what reality is, but also what it entails and the relationships between objects (Hofweber, 2018). There are two primary schools of thought in ontology, the first being objectivism which perceives reality as exclusively and objectively existing, independent of its social actors (Bryman & Bell, 2015). The other, constructivism, argues that multiple realities and social phenomena exist that are continuously accomplished by social actors (Bryman & Bell, 2015; Chilisa & Kawulich, 2012).

Constructivism is the ontological position chosen for this study, since constructivism considers specific context with social actors making it easier to see if there are differences between them. Social phenomenon is unique for every different context, and therefore researchers must understand the social circumstances around what they are researching in order to gain knowledge and create or collect theory on the phenomenon (Bryman & Bell, 2015; Chilisa & Kawulich, 2012). A constructivism position suits this study because it better shows how social phenomena of decision-making processes are being handled by farmers in their cropping system.

What can be stated as acceptable knowledge in a research discipline is assessed through epistemological considerations (Bryman & Bell, 2015). Knowledge itself is traditionally divided into either specific and context-dependent ideas or universal and generalized ideas (Morgan, 2007). The forced contradiction between subjective and objective can be used to better understand the relationship between the researcher and the research process. Epistemology mainly deals with questions about whether the social world and natural science should be studied with the same principles (Bryman & Bell, 2015). According to Morgan (2007), one argument regarding this is the idea of "complete objectivity" is just as impossible to achieve as "complete subjectivity". In this study, a mixed approach is used which refers to what Morgan (2007) defines as pragmatic approach. This approach rejects the need to choose between a pair of extremes where research results are either completely specific to a context or an instance of some more generalized set of principles. By the use of mixed approach, both numerical observations and value judgements can be captured and analyzed which might lead to new insights within the agricultural sector. In this study the research paradigm uses constructivist and pragmatic pillars to not only represent the worldview of the authors, but also suit the research topic by proactively considering affected persons' or respondents' opinions and behaviors in their decision making (Bryman & Bell, 2015; Creswell, 2006).

4.2 Research approach

Deduction, induction and abduction are different approaches that can be used in research (Bryman & Bell, 2015). In this study, we use an abductive approach which is created to overcome the limitations of inductive and deductive approach. It allows the researcher to go back and forth in the research process. The hypotheses are partly generated from theory: existing literature about decision making, resource-based view, crop planning, and diffusion of innovation, but also from the gathered data. Instead of only focusing on confirming the preunderstandings, we can still form new conclusions from the data during the process (Ong, 2012). During the research process, the abductive approach allows the researcher to adjust and refine both theory and empirical data, in order to suit the aim of the study (Bryman & Bell, 2015).

Regarding the research approach there are traditionally two different alternatives, quantitative and qualitative (Bryman & Bell, 2015; Robson, 2011). According to Robson (2011) these two methodological approaches can be described as flexible or fixed designs regarding how the data collection is planned and executed. The two different approaches shall not be regarded as opposites. Instead the combination of these two approaches shall be viewed as highly synergistic (Robson, 2011; Eisenhardt, 1989). Mixed methods research provides strengths that offset the weaknesses of both quantitative and qualitative research (Creswell, 2006). It also provides more comprehensive evidence for studying a research problem than either a quantitative or qualitative research alone. The researchers are given permission to use all the tools of data collection available rather than being restricted to the types of data collection associated with the different approaches (Bryman & Bell, 2015; Creswell, 2006). In the field of business, mixed methods could also add value to a study by increasing validity in the findings and assisting with knowledge creation (Driscoll *et al.*, 2007). Another advantage of using mixed methods is the integration of soft and hard data. This could give the reader a broader picture and more confidence in the results and conclusions. Hence, it is a suitable method for this study, since it makes it possible to both gain a deeper understanding of the decision making through qualitative data, and quantitative data to conduct measurements. By using a mixed method we both can measure differences in statistical values, and at the same time gain an understanding behind the empirical results about *how* and *why* the decision-makers think when they make decisions.

4.3 Sample and delimitation

The chosen population for this study is farmers in the counties of Uppsala, Västmanland, Västra Götaland, and Östergötland (see Figure 6). The counties were chosen because most growing of broad bean in Sweden occurs in these regions (Jordbruksverket, 2018a), and there is a potential to grow more of it. The south part of Sweden, Skåne, was actively excluded although a lot of broad beans are grown there. The favorable climate in this area of Sweden gives farmers the ability to diversify and grow special crops such as sugar beets, quinoa and vegetables, which might be difficult to grow in other parts of Sweden. Therefore, it is more relevant for us to study the possibility to increase growth of broad bean in these other mentioned regions in the middle part of Sweden.

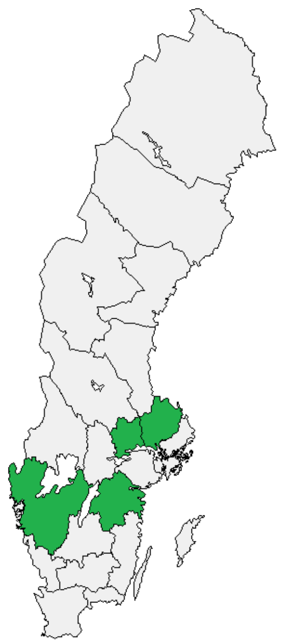

Figure 6. Map of Sweden, with selected counties in green (Own processing)

Due the recommendation of a sustainable cropping strategy, broad bean should be grown with a rotation of 6-8 years in the same field (Jordbruksverket, 2018b; Fogelfors, 2015). This usually requires larger acreage land, and therefore we have chosen to set 100 hectares as a minimum level in our sample. To find the population we used the Swedish Board of Agriculture's (Jordbruksverket) database, in which it is possible to search for individuals and companies who received agricultural subsidies. Based on the subsidies received, we calculated the approximate farm size (number of hectares). This gave us a list of farmers who most likely fulfill the criteria. Due to unnoticed variations in paid out subsidies (subsidies for organic farming differs from conventional farming), a few of the farmers in our sample cultivate less than 100 hectares.

From this list, a probability sample was made (Bryman & Bell, 2015; Robson, 2011). Farmers were randomly selected, and they all had the same probability to be chosen. To ensure a random selection of the sample in the study, the selection was computerized with a standardized function in Excel. In that way, the risk of human bias was eliminated (Bryman & Bell, 2015). The total number of farmers in these counties is about 18 400. Of these farmers, 3 020 farm over 100 hectares according to the statistics from the Swedish Board of Agriculture, which constitutes about 16 % of the farmers. Totally 150 farmers were included in the sample, and out of these farmers, 60 participated in the study. This resulted in a response rate of 40 %. 30 of the respondents grow broad beans, and 30 of them do not grow broad beans. This was a totally randomly result in the data collection.

Due to lack of contact information, individuals who did not answer the phone, or who choose to not participate, 90 people did not participate in the study. The farmers were contacted by telephone, either we conducted the interview immediately, or we scheduled a time that would fit the farmer's schedule. Several attempts were made to reach the individuals that did not answer. A few of the contacted individuals did not want to participate. The most common reason was that they only cultivate ley and felt that the study did not suit them.

The sample size should be appropriate for the chosen analysis method (Israel, 1992). For this study our sample is 60 respondents with 30 in each group. The recommended sample size for a statistical analysis is at least 30 units (Onwuegbuzie & Johnson, 2004). We may not be able to generalize from the sample to the entire population, due to the sample size. However, the sample size is large enough to perform the analysis as planned and will still bring valuable insights for the study (Bryman & Bell, 2015).

4.4 Data collection

There are some difficulties when collecting data from a large population due to time constraints and administrative concerns (Denscombe, 2018). The data in this study is collected with structured interviews made via telephone. Telephone interviews share several of the benefits that face-to-face interviews have (Carr & Worth, 2001). For example, reduction of misunderstandings and high response rate in comparison with a questionnaire. Other advantages of telephone interviews are the possibility to reach respondents on a geographically wider distance, and time and cost saving when a physical meeting does not have to be performed (Opdenakker, 2006). Face-to-face interviews could also have been problematic as the interviews were conducted during April, which is a period when farmers in the middle part of Sweden usually are busy with spring tillage and planting, which likely would have affected the response rate negatively. A main advantage of telephone interviews compared to self-completion questionnaires is a higher response rate (Robson, 2011). The farmers as respondents might be more willing to participate in the study if it does not require a physical meeting or if they can work at the same time. For example, they can drive the tractor and talk with hands-free devices. Since our objective was to obtain many respondents from different parts of Sweden, this method of interview fitted the study well as the interview could be booked at a time that fitted the farmer, and only took about 20 minutes of her/his time.

Even though the interviewer can interview people that are not easy to access, one of the disadvantages of telephone interviews is the reduction of social cues (Opdenakker, 2006). The interviewer does not see the respondent, which removes body language as a source of data. Even if some social cues are reduced, enough social cues remain available (voice and intonation) for conducting a telephone interview without a problem.

Structured interviews are a phenomenal method to gather data in both qualitative and quantitative studies (Bryman & Bell, 2015). It is performed by using a prepared questionnaire, where the purpose is to make the interviews as similar as possible. The questions were asked in the same order in all the interviews (see Appendix 3). Some of the questions were open but had pre-coded answers, and some had fixed choices. By using a prepared questionnaire, the questions will be asked in the same way to all persons and makes it easier to categorize and analyze the data (Robson, 2011). The questionnaire that was created had different themes based on our theoretical framework. Included is background information about the farmer and the company, their decision strategy about crop sequence, experience with broad bean, and innovation. The questionnaire had a comprehensive set of questions designed to minimize unneeded information.

The questionnaire was formulated to be simple and short as possible, and to ensure that the questions would be easy to understand, and the interview would not require too much time. Before using the questionnaire, we tested if the statements were clear, unambiguous and simple by conducted some test-interviews to farmers who fulfilled the criteria. This was also to facilitate our interview techniques for telephone-interview. The respondents for the test-interviews were asked to provide feedback, both on the questions themselves and how they were asked. The strategy of pre-testing is recommended when planning a telephone interview (Robson, 2011). After each test we conducted an evaluation and we updated or rephrased the questions to enhance the precision and relevant answers to the questions. During a telephone interview it is also important to use your voice in a correct way. The researcher should sound interested in the answers given by the respondent and try to talk clearly at a reasonable speed. In the process of designing a questionnaire for interviews it is common to include questions about the respondent's background, such as age, gender, education and type of enterprise (Jaworski & Kohli, 1993). This is conducted both to gather information about the characteristics of the population and to start the interview with simple questions. In the questionnaire used in this study we used introductory questions about total cultivated acreage, type of farming system, and number of years as a farmer in our questionnaire.

4.5 Unit of analysis and observation

The unit of analysis is described as the main element of the study, the subject of the “who” or “what” (Yin, 2007; Lewis-Beck *et al.*, 2004). Therefore, the unit of analysis is the component that is identified, described and analyzed in the study. There are some researchers that claim that there are distinct differences between unit of observation and unit of analysis (Lewis-Beck *et al.*, 2004). Unit of observation may be an individual person, while a unit of analysis can relate to the community in which the individual lives, based on data collected about individuals in the community. In this study, the unit of analysis are farmers in the four counties in the middle part of Sweden. Furthermore, the unit of observation is the sample of individual farmers who grow or do not grow broad bean.

4.6 Analysis method

After collecting the data, it must be analyzed (Bryman & Bell, 2015). Since both quantitative and qualitative data is collected in this study, different analytical methods will be used. The qualitative data, the open-question answers, is analyzed by a thematic analysis. The quantitative data is statistically analyzed. The statistical analysis, for this study T-test and chi-square, applies a significance level of 5 % and 10 % and is done with the statistical computer program Minitab.

4.6.1 Thematic analysis

The thematic analysis is used to find patterns in a large amount of information by reducing the data into key words and what the respondents think of them (Bryman & Bell, 2015). Structuring the interview data by using thematic coding is a suitable analysis method in order to keep the information manageable (Robson, 2011). Therefore, the answers of the open-questions are divided into categories and coded to make it easier to analyze and more manageable. This approach of analysis is not clearly defined with a strict guideline of techniques for finding promising insights in the collected data. Thus, it can be viewed both as weakness and beneficial (Nowell *et al.*, 2017; Bryman & Bell, 2015). A weakness of the approach is that it does not leave much room for analyzing the language. This can lead to inconsistent patterns when it is not interrelated with its context. However, a benefit of the approach is that it offers flexibility to the researcher to adjust the analysis according to the information obtained (Nowell *et al.*, 2017). In order to arrive at a useful analysis with a large amount of information it requires well-structured work of the researcher (Bryman & Bell, 2015). In this study, a specialized software was not used to find and define themes. Instead the answers from the respondents were inserted in a spreadsheet in Excel to search and sort for themes.

4.6.2 Independent two sample T-test

An independent two sample T-test can be used to examine if there are any statistical differences in the mean between two groups from the same population (Dalgaard, 2008). It is assumed that the data stems originally from a normal distribution and is continuous. Since our sample consist of 60 farmers and both groups are at least 30 units, we can still use the T-test, even if it is not normally distributed (Wahlin, 2011).

There are two ways to know whether the null hypothesis should be rejected or not rejected (Wahlin, 2011; Dalgaard, 2008). Either by calculating the t-value and examining if it falls within the acceptance region/critical area, or by calculating the p-value. When performing the T-test in Minitab, a confidence interval is also received. The confidence interval shows with 95 % or 90 % (depending on chosen significance level) confidence an interval, in which the difference between the groups should be within. We use both 5 % and 10 % significance level for this study, which means that if the p-value is lower than 0,05 or 0,10, the null hypothesis should be rejected. If the null hypothesis is rejected, there is a strong statistical difference between the two samples being analyzed. If the null hypothesis is not rejected, there is no noticeable difference between the two samples. In this study, a t-test will be used for examining if there are any statistical difference between means of farmers who grow broad bean and the farmers who do not grow broad bean.

Null hypothesis H_0: $\mu_1 - \mu_2 = 0$
Alternative hypothesis H_1: $\mu_1 - \mu_2 \neq 0$

In order to conduct this analysis, the farmers were divided into two groups depending upon if they grow broad beans or not. Farmers included in group 1 grow broad bean while group 2 consists of the farmers who do not grow broad beans. Then we used different variables and a T-test to examine if there are any differences between these groups by comparing their means. Although the hypotheses are formed as one-tail tests, it is tested with two-tails to note if there are a difference in an unexpected way.

4.6.3 Chi-Square test

In order to examine if the sample is representative and it is possible to generalize the findings into the population, the statistical significance needs to be tested (Bryman & Bell, 2015). A null hypothesis is defined and indicates that no relationship exists between the two variables and the population. The rejection or no rejection of the null hypothesis determines whether the test is statistically significant or not. Rejection implies that a relationship exists between the variables and the population, and that it is statistically significant. To know whether the null hypothesis should be rejected or not rejected we calculate a p-value which tells how likely it is that the test is significant. Since the significance level is set to 5 %, the p-value should be lower than this to reject the hypothesis (Wahlin, 2011). A rejection of the null hypothesis implies that the hypothesis is true, and vice versa.

The chi-square test is a non-parametric analysis tool that measures if any relationships exist between two variables (Bryman & Bell, 2015; McHugh, 2013). To use the chi-square test, some requirements must be fulfilled. The data should be sorted into a contingency table. This table shows the frequency of an answer and allows two variables to be analyzed at the same time. The categories should be exclusive where only one category can be chosen by each subject. The studied groups must be independent and not related to each other. At least 80% of the cells in a chi-square test should have an expected frequency of 5 or higher, otherwise it might show a result which is incomplete (Bryman & Bell, 2015; McHugh, 2013; Wahlin, 2011). All cells should also have at least 3 in expected frequency (McHugh, 2013). The data should be categorical or ordinal. In this study a chi-square test will be used to test hypotheses with categorical answers.

In this study, we compare the two groups by examining if variables are independent or dependent. For example, if it is more common for farmers who grow broad bean to use a crop advisor. In that case, the relationship is tested between the variable broad bean and the variable crop advisors. This could reveal if there exist any statistical differences between the group of growers and non-growers of the broad bean.

H_0 : The variables are independent
H_1 : The variables are dependent

4.6.4 Type I and type II error

When statistical analysis is performed, there exists a risk for type I and type II errors (Bryman & Bell, 2015; Wahlin, 2011). Type I error means the risk of rejecting the null hypothesis although it is true. Type II error is the risk of not rejecting the null hypothesis when it should be rejected. The risk for type I error can be reduced by decreasing the significance level. However, this increases the risk for a type II error. A significance level of 5 % means that we take a risk by 5 % that the test shows that there is a relationship when none exist. In this study, we conduct the tests with both a 5 % and 10 % significance level to reduce the risk of error, especially a type II error.

4.7 Quality assurance

In research there are some different criteria to ensure quality of a study (Bryman & Bell, 2015). To achieve quality there are several research criteria that must be met. If these criteria are not fulfilled, the results and the credibility of the study can be questioned. The usual criteria for the evaluation of business administration research are reliability and validity (Golafshani, 2003). Reliability is the consistency of measurement (Robson, 2011) and the stability of measurement (Bryman & Bell, 2015). Thus, reliability depends on the trustworthiness of the data sources that have been used. In this study the chapter with literature review and theory consists of published articles and reports from scientific journals and course literature in business administration, which is trustworthy and reliable to use in this study. Validity relate to if measurement are accurate and if data is measured as intended (Golafshani, 2003), or to what extent empirical data answers the questions that were formulated or not (Yin, 2007). In order to make a study as valid as possible, it is important to use suitable measurement methods and measure what it is intended to measure (Bryman & Bell, 2015). Therefore, the data collection is required to be performed correctly, and then the data must be entered correctly into the data program Minitab and Excel.

There are different types of validity, i.e. internal validity, construct validity and external validity (Bryman & Bell, 2015). The internal validity arises if the conclusions are trustworthy and are bounded to the moment when the study was done. Internal validity can be increased if external factors that may affect the study are reduced. This might in many situations be impossible. The construct validity arises if the concepts used when conducting the study are well defined. To obtain construct validity it is important to have a well-structured and logical thesis design that is easy for a reader to follow (Cohen *et al.*, 2011). By pre-testing the questionnaire with some test-respondents, it reduces the potential of validity issues. This also makes it possible to add developments and clarifications in the questionnaire. Validity also includes consideration towards the people that participate in the study (Creswell & Miller, 2000). The sample consists of a homogenous group. All respondents are farmers in Sweden that face the same business regulations and laws. Hence, the empirical data is representative for all farmers in these counties with acreage larger than 100 hectares. Together with the structured interviews it gives the researcher a good understanding of the participants' viewpoints in the examined field (Bryman & Bell, 2015).

Generalizability is a concept for enhancing trustworthiness of a study, which also refers to external validity (Robson, 2011; Mathison, 2005). Generalizability concerns the degree the results of a study are applicable, i.e. if the results would be the same in another context with other respondents. This implies that research with quantitative data requires a representative sample (Bryman & Bell, 2015). Therefore, a representative sample has been taken into consideration in this study, since it is not appropriate to generalize the results outside the selected geographic area of farming. Thus, the results of this study can be relevant for comparable populations and helpful in other studies to understand decision making, i.e. farmers in another context.

Non-response analysis

In order to assess quality, it is important to do an analysis of non-responses in the data collection (Dahmström, 2011). A non-response analysis was performed to notice if participation in the study could be affected by the variables; county and acreage. This is the only accessible information about the non-respondents. Therefore these variables are tested. A detailed version is attached in Appendix 1. To test if there exists a statistically significant relationship between county and participation, a chi-square test was conducted (see Table A1). This test resulted in a p-value of 0,658 and, therefore, did not show any statistical relationship between county and participation. In order to examine whether participation is affected by acreage, a two sample T-test was conducted. The estimated difference between the respondents and non-respondents are 48,3 hectares. The participating farmers farm on average 285 hectares, compared to the non-participating farmers with 237 hectares. The obtained p-value for this test is 0,097 which is between the significance levels. This could indicate that farmers with larger acreage are more likely to answer the phone and participate in the study. However, it should be noticed that the acreage of participants is based on their stated acreage, while the acreage of non-participants is based on received subsidy. Organic farmers in Sweden receive higher subsidies per hectare than conventional farmers. This may affect the result since it sometimes differs between the subsidies obtained and the actual acreage reports during the interviews.

4.8 Ethical Considerations

According to Bryman and Bell (2015) it is important in a research process to consider how the data is gathered and how respondents and information are treated during the study. For example, to handle respondents' personal information with responsibility (Baxter, 2015). Practice for an ethical approach within a research project requires consent from the respondents (Israel, 2015). Consent includes voluntary participation and being informed about what the collected information will be used for, according to the General Data Protection Regulation (GDPR). Although the GDPR have not been designed specifically for research, we need to make some considerations to the research practice of this study. The GDPR demands that data processing is lawful, fair and transparent (Voigt & Von Dem Bussche, 2017). To be fair with research respondents includes respecting their rights and ensuring that the personal data is used in line with their expectations. Therefore, transparency is intrinsically linked to fairness (Bryman & Bell, 2015). We began the telephone interviews by informing the respondents about the study and what the information they share will be used for. We also informed the respondent that they are anonymous in the study. Although this topic might not be controversial, anonymity should still be adhered to for the comfort of respondents (Bryman & Bell, 2015). All respondents are presented in the study with a numerical code to increase the degree of anonymity.

5 Results

In this chapter the received data from the structured interviews is presented. The gathered data was collected and then sorted into an Excel-document. Since some questions had open ended answers, we categorized some of the answers to make it easier to oversee and interpret the data. How we perceive and interpret the answers may affect the data and might be seen as a part of the analysis (Bryman & Bell, 2015). The questionnaire was divided into four different parts: background information about the farmer and the firm, decision making regarding crop planning, perceptions of the broad bean, and innovations. The data will therefore be presented based on these different themes.

5.1 Background regarding farmer and the firm

Background information about the farmers gives an understanding of what values and goals, and resources the farmer has. In total 60 respondents/farmers were interviewed (see Table 3). The average age is 46 years old, where the youngest is 28 years old and the oldest 73 years old. Statistics from Jordbruksverket (2017) show that the average age in studied counties is 55 years. Regarding the question how long the respondents had been operating the farm business the average is 18.5 years. The majority of the respondents plan to run and work with their farming business until retirement. Information concerning the level of education was sought. It is divided into three levels; basic (high school), high basic (high school added with courses, usually connected to agriculture, machinery course etc.), and high (university studies). According to the respondents the answers were as follow; 13 basic, 25 high basic, and 22 high. Regarding the occupation, 56 of 60 respondents operate their farm as main occupation, and 4 of 60 respondents have other occupations besides their farming business.

Table 3. Number of respondents in chosen counties

County	Number of respondents	Grow broad bean	Not grow broad bean
Uppsala	17	5	12
Västmanland	13	4	9
Västra Götaland	14	12	2
Östergötland	16	9	7
SUM	60	30	30

The main reasons why the respondents manage a farming business are illustrated in Figure 7. Figure 7 shows that the most common answers was that they had a great interest in the agricultural sector, working with livestock and nature, and interest of seeing things grow.

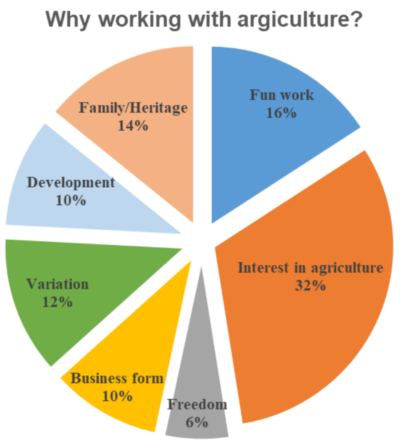

Figure 7. The main reason why the farmers manage a farming business

Most of the respondents have crop production as the main enterprise in their farming business, 33 of 60 (see Figure 8). Among the respondents, 38 farm according to a conventional production system, 17 run an organic production, and 5 a combination of both conventional and organic. The area of arable land among the respondents reveal a mean value of 285 hectare, median value of 245 hectare, and minimum share of 70 hectare and maximum share of 930 hectare. Most of the respondents (72%) are in the range of 70 and 350 hectare. Among the respondents 37 of 60 (62%) have access to drying and storage facility, that they may use to different extent use in their crop production.

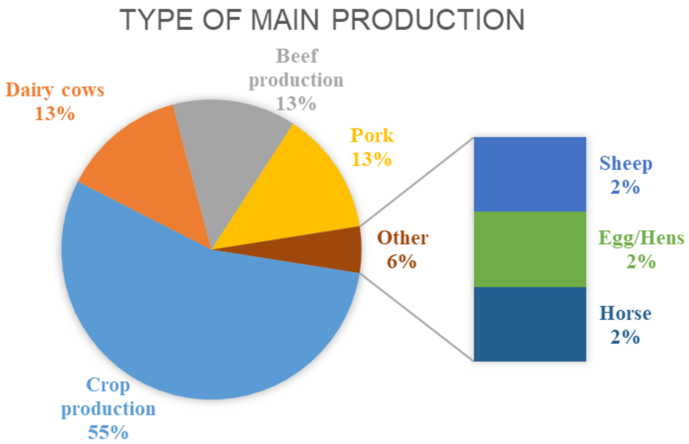

Figure 8. Type of main production in the farming business

Among the respondents winter wheat is the dominant (in number of hectares) crop in their crop production, followed by spring barely, forage, rape seed, oats and peas or broad beans. This follow the crop distribution in the selected counties that is illustrated in Table 4. Regarding the crop selection at the farm, 45-75% winter crops is the share that the majority of farmers display in our sample. The median value is 55% winter crops, and some of the farmers mentioned soil and climate condition as underlying factors.

Table 4 Acreage of winter wheat and broad bean/peas (Jordbruksverket, 2018a)

	Uppsala	Västmanland	Östergötland	Västra Götaland
Total acreage (hectare)	163 451	100 744	200 974	461 642
Amount Winter wheat (hectare)	38 691	20 151	57 741	73 022
Amount Winter wheat (%)	24%	20%	29%	16%
Amount Broad bean and Peas (hectare)	5503	3472	9334	14655
Amount Broad bean and Peas (%)	3%	3%	5%	3%

The respondents were asked about economic goals and other values regarding their business. Many of the respondents do not have any specific performance goals. Instead more general goals about economic stability and capacity for development. The respondents were also asked about how they perceived the profitability in their crop production on a scale 1 to 5, where 1 was very low profitability and 5 very good profitability (see Figure 9).

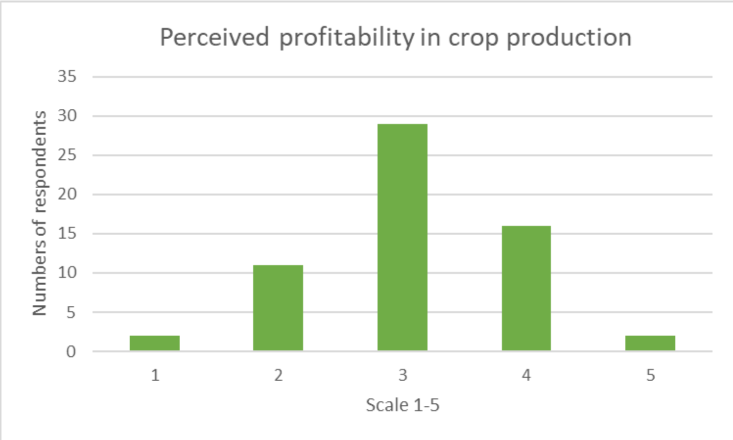

Figure 9. Perceived profitability in crop production

5.2 Decision making regarding crop planning

The farmers were asked about how they make decisions regarding their crop planning in order to understand how they gather information, sell their harvest and in which timeframe the do their crop planning. A summary of the answers from question 18 to 25 is presented below in Table 5. The farmers were asked what type of sources of information they use and base their decisions regarding their crop planning. The information sources they could choose from were: crop advisor, agricultural seller, media/internet, membership organizations, neighbors/colleges/friends etc. They could also add options if they had other sources. Other mentioned options were: courses, seminars, study visits, exhibitions, field walks, research published by SLU (Swedish University of Agricultural Sciences), feeling/intuition, and Facebook groups. All farmers use at least two different sources, and mention as many as five different. 72 % use any type of independent advisor regarding their crop planning. It differs substantially between the farmers to what extent they use advisors. It is approximately an even distribution from 1 – 12 times per year. A few use advisors more than that.

Most of the farmers produce and sell their harvest mainly to grain traders, both via different contracts and direct from harvest. About a quarter of the farmers produce grain for their own use, as livestock feed mostly. Only a few produce to sell to other farmers. However, some mentioned that they shift fields with neighbors who operate livestock production in order to diversify the crop sequence.

The length of farmers planned crop sequence varies quite a lot. Most farmers update it yearly. On the question if they compare profitability between crops, 82 % said they do. The most popular methods the farmers use for profitability comparison is; estimated calculations, count for the contribution margin, follow-up calculations, or compare price and yields. On the question which is the most determining factor when planning the crop sequence the most common answer were economy and expected yield, crop rotation effects and pre-conditions (soil, climate, risk for weed). Farmers with livestock production decided what crop to grow based on what is needed for it to be a qualitative animal feed. Four farmers plan their decisions along with what they think will be demanded from the market, while a three plan from a whole perspective level and access to resources such as time and machines. Many of the farmers said it is not only one thing that determine what crop to grow. It is more a combination of several factors, why some farmers could not say which one is the most determining factor. To the question of what is most important, if they have to choose between price and crop rotation effects, most farmers mentioned the crop rotation effects or that they cannot say that one matters more than the other.

Table 5. The answers regarding question 18-25

	Question	Answer options	Responses	%
18	Information sources	2	10	17%
	quantity	3	21	35%
	60	4	13	22%
		5	16	27%
18	Crop advisor?	Yes	43	72%
	60	No	17	28%
19	How often do you	1-2	11	26%
	use crop advisor?	3-6	14	33%
	Times per year	7-12	15	35%
	43	12 <	3	7%
		Never	17	
20	How is the harvest sold?	Grain traders	35	58%
	60	Produce for own use	15	25%
		Grain traders + own use	6	10%
		Other farms	1	2%
		Grain traders + other farms	2	3%
		Own use + other farms	1	2%
21	How long crop sequence?	1-2	13	22%
	years	3-4	19	32%
	60	5-6	18	30%
		7-8	9	15%
		8<	1	2%
22	How often do you revise	More than 5 times / year	3	5%
	the crop plan?	2-4 times / year	16	27%
	60	1 time / year	35	58%
		Every second year	3	5%
		Every third year or less	3	5%
23	Most determining factor	Access to resources/logistics	3	5%
	in choice of crop?	Pre-conditions + crop rotation effects	19	32%
	60	Economy, price and expected yield	18	30%
		Fit for animal feed	8	13%
		Demand from market	4	7%
		Advisor's opinion	1	2%
		Combination of several above	7	12%
24	Compare profitability	Yes	49	82%
	between crops?	No	11	18%
	How do you compare	Intuition	4	8%
	profitability?	Standardized calculations	4	8%
	49	Price and yield	13	27%
		Contribution margin/calculations	17	35%
		Follow up-calculations	11	22%
25	Most determining factor in	Price	11	18%
	the choice of crop?	Crop rotation effects	25	42%
		Both is as important	24	40%

5.3 Perception of the broad bean

One of the parts in the questionnaire was about farmers' perception of the broad bean. The information about farmers' perception of the broad bean gives an understanding of why they have chosen to grow broad beans or not. The questions asked, differed depending on if they grow broad bean or not. The farmers who grow broad bean answered question 26 to 32, while the farmers who do not grow broad bean answered question 33 to 35 instead.

5.3.1 Farmers who grow broad bean

A summary of the received answers from question 26 to 31 is presented below in Table 6.

Table 6. The answers regarding question 26-31

	Question	Answer options	Responses	%
26	For how long have you	1-3	4	13%
	grown broad bean?	4-6	8	27%
	Years	7-9	5	17%
		10-15	11	37%
	30	15<	2	7%
27	What is your broad bean	Produce for own livestock feed (+ sell)	13	43%
	used for?	Sold as livestock feed	11	37%
		Sold as seed	3	10%
	30	Sold for human consumption (+ feed)	3	10%
28	What is the main reason	Feed for livestock	10	33%
	for growing broad bean?	Diversify the crop sequence	12	40%
		Broad beans instead of peas	4	13%
	30	Ecological Focus Area	4	13%
29	Greatest benefit of	Pre-crop effects	12	40%
	growing broad bean?	High protein feed	6	20%
		Profitable/cheap crop	5	17%
		Easy-grown and hardy crop	6	20%
	30	Attention from others when growing it	1	3%
30	Biggest challenge of	Weed and pesticides	12	40%
	growing broad bean?	Late harvest	9	30%
		Difficult to dry	3	10%
		Sensitive towards droughts	2	7%
	30	Other	4	13%
31	What would make you	Larger acreage	14	47%
	grow more broad bean?	New/better varieties	5	17%
		Better price	3	10%
		Don't know, satisfied with current growth	5	17%
	30	Other	3	10%

Of the 60 participants in the study, 30 of them grow broad bean. The farmers have grown the broad bean for different length of time, from 1 to 30 years. The mean time is 9 years. Most of the produced broad bean is used as feed to the farmer's livestock or sold to others. A few grow broad bean for seed. Three individuals mentioned that they sell broad bean for human consumption where one of them stated that all of it is grown for human consumption but in a small scale. The two others revealed they mostly grow for livestock feed but to human consumption for fun and not to a large extent. A third of the farmers said that the main reason for growing broad bean is that it is a good feed for livestock. 40 % said that they grow broad bean to diversify the crop sequence, where the broad bean bring a good pre-crop effect and extend the growing season. Four farmers brought up the same benefits but also said they tried peas earlier, but were not satisfied with it and started to grow broad bean instead. Four farmers mentioned they mainly grow broad beans to fulfill the requirements of EFA (ecological focus area). Twelve of the farmers stated that the greatest benefit from growing broad bean is the pre-crop effects (especially the nitrogen fixation). Four of these farmers also mentioned the extended growth season since broad bean is harvested late compared to other common crops. It is easier for the farmers to plan the harvest and it become less work intense due to that the crops does not need to be harvested at the same time.

Six of the farmers view the greatest benefit of the broad bean to be its high protein content which make it a good feed for livestock, and enable to reduce the use of soybean and replace with the broad bean instead. Other perceived benefits is that it is easy to grow and hardy crop that is rather cheap/profitable to produce. The biggest challenges with growing broad bean is the risk for weed and pesticides (40 %). To avoid this risk, the broad bean cannot be grown on the same field within 6-8 years which creates certain limitations to grow broad bean. Other mentioned challenges are the difficulties that stem from having the late harvest (30%). A late harvest means that it could be difficult to plant winter crops after the broad bean, as for example one of the most common crops; winter wheat. Another mentioned difficulty are to dry the broad bean. Droughts, obtain a stable yield and wild boars who damage in the fields. Almost half of the farmers revealed that they need larger acreage to grow more broad bean due to the recommendation to grow the crop more than 6-8 years apart. Five farmers stated that a better price could make them grow more broad beans than they already do. Five other farmers said they do not know what would make them grow more broad beans, because they are satisfied with the current crop distribution/differentiation.

5.3.2 Farmers who not grow broad bean

A summary of the received answers from question 33 to 35 is presented below in Table 7.

Table 7. The answers regarding question 33-35

	Question	Answer options	Responses	%
33	Why do you not grow broad bean?	Late harvest + difficult to dry	17	57%
		No need or experience + negative reputation	6	20%
		To small acreage	2	7%
		No access to drying facility	2	7%
	30	Other	3	10%
34	What would make you start grow	Better/earlier varieties	9	30%
	broad bean?	Better price or need for it	9	30%
		Other type of soil/more acreage	4	13%
		Access to drying facilities/deliver in harvest	3	10%
	30	Nothing	5	17%
35	Have you grown broad beans	No	22	73%
	before?	Yes	8	27%
	30			

The 30 farmers who do not grow broad bean were asked question 33 to 35 in order to understand what perceptions they have of the broad bean. The most common reason for not growing broad bean, based on our data, is since it matures late which causes difficulties with harvesting and drying. Six of the farmers did not feel a need for it, and had no experience with it, and had also mostly heard problems with growing it. A few mentioned other reasons such as: they had too a small acreage, no access to drying facilities. And think they is too complicated to work with the crop. The farmers were also asked what would make them start grow broad beans. Most common answer was a development of a bean variety that ripens earlier, or if the farmer would get paid a higher price or has need for it (as feed for example). More acreage or other type of soil would make some farmers consider growing broad bean. If it was possible to deliver directly at harvest or if they had better access to drying facilities, would make them more prone to grow broad beans. A few said nothing would make them start growing, some had already tried, felt too old, or just did not feel an interest in it. 22 of the farmers have never grown broad bean. Some of them had chosen to grow peas instead. The remaining 8 farmers had tried to grow for various periods of time, from one season to try it to farmers who grown it for 10 years.

5.4 Innovation

The questionnaire included questions about the farmers' attitude towards innovations to view whether this could affect the decision to grow broad beans or not. A summary of the answers to questions 36 to 38 is presented below in Table 8.

Table 8. The answers regarding question 36-38

	Question	Answer options	Responses	%
36	Would you describe yourself	1	1	2%
	as a person who like to try	2	11	18%
	new things?	3	19	32%
	Scale 1-5	4	23	38%
	60	5	6	10%
37	How fast do you adopt new	I test as soon as I hear of it	5	8%
	innovations?	I like to test, but wait until I see it works	32	53%
		I test when I see it is popular and used by many	19	32%
		It requires quite a lot to make me try new things	4	7%
	60	I like to do what I always do	0	0%
38	Have you tested to grow	Yes	50	83%
	a new crop?	No	10	17%
	60			

All the farmers answered the questions about innovation. The first of these questions was "Would you describe yourself as a person who like to try new things?". The respondents gave an answer based on a scale from 1 to 5 where 1 meant "not true at all" and 5 meant "very true". The answers are displayed in Table 7. The most popular answer was 3 and 4. To follow the question about the willingness to adoption of innovations, 50 of 60 respondents answered that they had tested to grow a new kind of crop that they never had grown before. The respondents that have not tested to grow a new crop, 10 of 60, mentioned that they instead gave priority to test different seed materials. The increased demand and trend towards more legumes in human food and livestock feed was discussed as a final question, where respondents mentioned that it is something they notice in relation to their farming business. Two third of the farmers answered that they notice a lot of talk about legumes in media, but it is noting that has an impact in their farming business at the moment.

The majority of the respondents, 56 of 60, expressed and believed that there is a potential to grow more broad beans and other legumes in Sweden in the future. Some of the respondents also mentioned that broad beans or other legumes maybe do not suit their farming business, in terms of soil and other cropping conditions, but still have a great interest in the debate and development of Swedish produced protein crops. To examine the adoption level of broad bean the respondents were asked about when they implemented the broad bean (see Figure 10). Among the respondents, the adoption was highest between the years of 2010 and 2015. Figure 11 show the accumulated adoption curve.

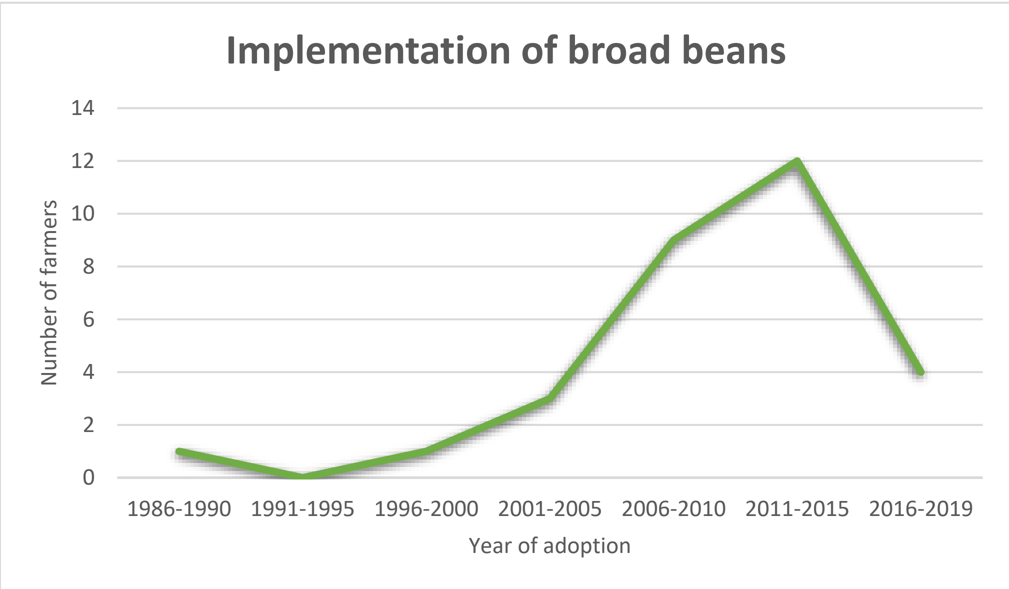

Figure 10. What year the farmers implemented broad beans into their crop production

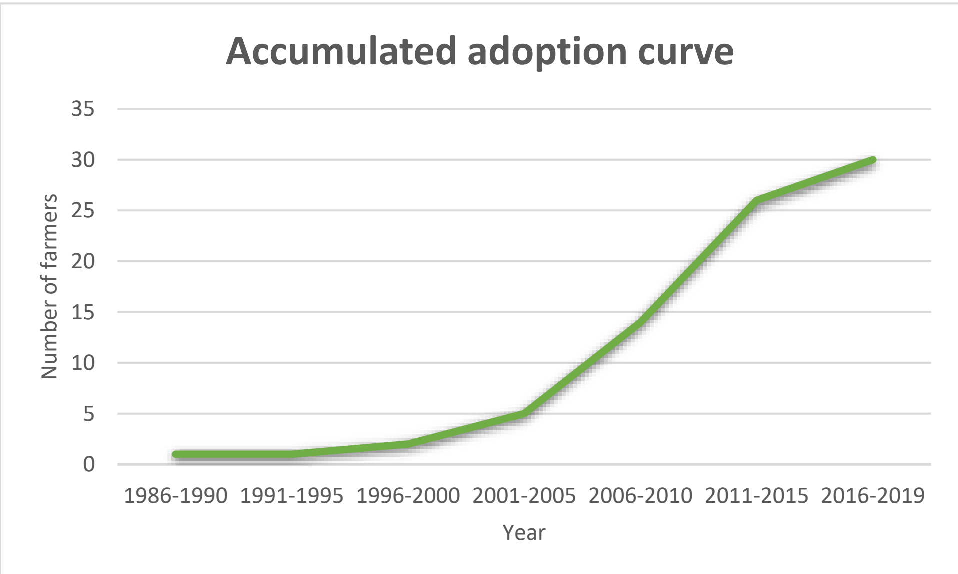

Figure 11. Accumulated adoption curve for implementation of broad beans

6 Statistical analysis

In this chapter, statistical analysis of the hypotheses are presented. Farmers who grow broad bean will be referred to as group 1, and farmers who do not grow will be referred to as group 2. The statistical analysis is performed in the program Minitab and this chapter include a summary of the analysis. We are searching for differences and similarities between these two groups by examining statistical relationships and if variables are dependent or not.

6.1 Hypothesis testing

The hypotheses are tested with either a T-test, chi-square test, or sometimes with both. Presented below is a shorter version of the statistical analysis, the detailed version is attached in Appendix 2.

6.1.1 Resources

Presented here, is the statistical analysis of the hypotheses connected to resources.

1. **Broad bean farmers have larger acreage.**

To test this hypothesis, an independent T-test was performed where the number of hectares (question 8) was used as the variable to compare mean between the groups. The T-test shows that the mean value for group 1 is 330 hectares and 240 hectares for group 2. The estimated difference is 90,1 hectares. The p-value amount to 0,073 which is a value in between the two chosen significance levels (0,05 and 0,10). This indicates that there might exist a statistical relationship between number of hectares and if farmers grow broad bean or not. Hence, we can either reject or not reject the null hypothesis with certainty.

2. **Farmers who grow broad bean has access to drying facilities.**

To test this hypothesis a chi-square test was performed to examine if there is any statistical significant relationship between the variable access to own drying facility and farmer that grow broad beans. The frequency table show that 25 from group 1 has access to drying facilities while 20 from group 2 has access which is a difference between the groups. However, the P-value of 0,136 is larger than 0,10 which means that we cannot state that there exists a statistically significant relation. Hence, the null hypothesis cannot be rejected.

3. **If farmers grow broad bean, depend of their climate and vegetation period.**

By using a chi-square test for this hypothesis, it is possible to find out if there are a significant relationship between the county where the farmer operate the farm and if they grow broad bean.

Percentage of farmer who grow broad bean in respective county from sample:

1: Uppsala	29 %
2: Västmanland	31 %
3: Västra Götaland	86 %
4: Östergötland	56 %

The chi-square test shows quite large difference between expected and observed frequencies, the p-value is 0,007 which is quite low. This low p-value indicate that there exist a strong statistical relationship between the variable county and cultivation of broad bean. The county, most likely affects if he/she can or will grow broad bean.

4. **It is more important for organic farmers to grow broad beans than for other farmers.**

For this hypothesis, we examined whether it exist a statistically significant relationship between organic and broad bean farmers, or not. This data was received from answers in question number 9.

Due to that the expected counts for category 3 (both organic and conventional) was less than five, this provides some uncertainty to the result. Another chi-square test was conducted without the four farmers who are both conventional and organic.

This second chi-square test is valid and by examines at the observed frequencies, it seems more common among group 1 to be organic farmer than among the farmers in group 2. 43 % of the farmers in group 1 are organic, while it is only 18 % of the farmers in group 2 are organic. In addition, the organic farmers are more likely to grow broad bean than farmers who are not, 71 % of the organic farmer belong to group 1 (grow broad bean). However, there are still many conventional farmers who grow broad bean. There are only a few of the organic farmer who do not grow broad beans (29%).

Given this second test, we obtain a p-value of 0,042 which is less than 0,05. That indicates that there exists a statistically significant relationship between the variables organic and broad bean. The null hypothesis is rejected and the hypothesis is confirmed: If a farmer is organic, it is more likely that he/she will grow broad beans.

5. **Farmers who grow broad bean uses more types of information sources.**

To test this hypothesis we used the answers from question 18 which reveals what different information sources farmers use regarding their crop planning. We quantified and used the number of different sources they use to examine if there exists any statistically significant relationship between number of information sources and broad bean. The distribution of answers reach from 2 to 5 different information sources where both groups follow a normal distribution.

There are some differences between how many information sources the groups use. This sample for example shows that more farmers from group 1 use five sources of information than farmers from group 2. The mean for group 1 is 3,73 and for group 3,433 which yield a difference of 0,3. Nevertheless, due to a p-value of 0,278 and the associate confidence interval, it cannot statistically verified that there exist a statistically significant difference in mean between the groups. Hence, the null hypothesis should be not rejected.

6. **Broad bean farmers require more professional help.**

In order to examine whether this hypothesis is true or not, the answers from question number 18 and 19 were used to perform a chi-square test.

Question 18: "Do you use an independent advisor regarding your crop production?".

In group 1, 24 of 30 respondents said that they use a crop advisor while in group 2, this number was 19. More farmers from group 2 do not use a crop advisor compared to group 1. However, since the p-value is 0,152 which is greater than both 0,05 and 0,10 it implies that we cannot say that the difference is statistically significant.

Question 19: "How often do you use any type of independent advisor regarding your crop production?".

When we compare observed values in the frequency table it is noticeable that more farmers from group 1 use advisors 3-6 times per year (9 from group 1 and 5 from group 2). However, when the observed values are compared to the expected value (7), there is not a major difference. The fact that there is no relationship is also confirmed with a high p-value of 0,541. The null hypothesis is consequently not rejected, the variables are found to be independent.

7. **Farmers who grow broad beans are more educated.**

To examine this hypothesis, the answers received from question 4 were used in a chi-square test. Category 2 and 3 were merged in order to test whether an education after high school would affect the choice of growing broad beans. In group 1, 25 of the respondents had received an education subsequent to high school while the same number in group 2 was 22. This means that a higher education may have an effect on the choice of growing broad beans or not. However, the p-value is 0,347 which cannot confirm this is statistically true. The null hypothesis is therefore not rejected.

6.1.2 Decision making

Below are the statistical analysis presented concerning hypotheses connected to decision making.

8. **Farmers who grow broad bean perceive their profitability in the crop production lower than other farmers.**

This hypothesis is tested with both a chi-square test and a T-test since the data is both continuous and divided into categories. *Question 16: "How do you perceive the profitability in your crop production?"* Answer options: Number between 1-5, 1: Very low, 5: Very good

The observed and expected frequencies in the chi-square test do not differ much. There are four cells with expected counts less than 5, which could make the test uncertain. The p-value is 0,844 which is a high number and greater than 0,05 and 0,10. Therefore, the null hypothesis is not rejected.

To ensure that the hypothesis is not rejected when it should not, the hypothesis is also examined with a two sample t-test. The mean for group 1 is 3,167 and for group 2 it is 3. The p-value of 0,452 shows that there exists no statistical difference between the groups.

9. **Farmers who grow broad bean compare profitability to a less extent.**

For this chi-square test, the data from question 24 were used. *"Do you compare profitability between crops?"*

Observed frequencies do not differ much from expected frequencies. The received p-value of 0,739 also demonstrates that there seems to be no statistically significant difference between the groups. The null hypothesis is not rejected.

10. **Farmers who grow broad bean, focus more on crop rotation effects than price in their decision about crop planning. Or farmer who do not grow broad bean focus more on price than crop rotational effects.**

A chi-square test were used to examine this hypothesis with data form question 25. *"What is the most determining factor when you decide what crop to grow, between price and crop rotation effects?"* Options: 1: Price, 2: Crop rotation effects, 3: Both equally crucial.

Based on the observed frequencies, it can be observed that more farmers in group 1 consider the crop rotation effects in their decision. Most of farmer who mainly consider price, belong to group 2. However, since the p-value is 0,371 and is greater than both 0,05 and 0,10, it is not possible to state that the variables are statistically dependent. The null hypothesis is not rejected.

11. **Farmer who grow broad bean plan their crop sequence further into the future.**

The variable is the length of farmers' crop sequence which was received from question 21. We examined if group 1 has a higher mean than group 2, namely, if group 1 in average has a longer planned crop sequence than group 2. For this analysis, a two sample T-test were used.

The mean for group 1 is 5,03 years, and 3,43 years for group 2 which gives an estimated difference of 1,6 years. The 95 % confidence interval is 0,589 – 2,611. The difference in years between the groups is, therefore, with 95 % confidence in between 0,589 years and 2,611 years. The p-value is 0,002 which is lower than a significance level of 0,05 and hence the null hypothesis should be rejected. This means that there exists a statistically significant difference in means between group 1 and 2. We can confirm our hypothesis since the mean of group 1 is greater than the mean of group 2.

12. **Broad bean farmers update their crop plan more often.**

To examine this hypothesis, we used the data collected with question 22, where the question was *"How often do you revise your plan regarding your crop plan?".* The respondents could choose between five different answers which was analyzed with a chi-square test.

The observed values were not far from the expected values in any cell of this test. The p-value of 0,158 is also above both 0,05 and 0,10 which implies that the null hypothesis should be not rejected. Hence, the variables are independent (grow broad bean and how often farmers update their crop plan). However, there are more than 20 % of the cells that have less than 5 expected frequencies. This might imply that the result is of this test becomes unreliable (Wahlin, 2011). To overcome this problem, category 1 and 2 were merged together as well as category 4 and 5, and then a new test was conducted.

The second test still have two cells with expected frequency less than 5. However, this frequency table show even clearer that there seems to be no statistically significant difference between the groups. A high p-value of 0,96 also support this assertion. The null hypothesis is therefore not rejected.

6.1.3 Innovation

In this section, the statistical analysis of the hypothesis connected to innovation will be represented.

13. Farmers who grow broad beans are more open to try new things.

To examine this hypothesis, the answers from question 36, 37 and 38 were used. In these questions, they could choose different options of how fast or willing they are to test new innovations, and when it was the last time they tried a new crop.

Question 36: "Would you describe yourself as a person who like to try new things, such as new innovations?" The answer for this question is a number between 1-5, where 1 is "not true at all" and 5 is "very true".

The data collected with question 36 were tested both with a chi-square test and a T-test. The chi-square test shows that the result could be invalid due to some expected values less than 1. To reduce this error, we excluded the answer in category 1 (one answer) to get a valid test result. This time a p-value of 0,162 was received.

This data was also tested with a T-test. The mean for group 1 is 3,433 and for group 2 it is 3,3. The p-value according to the T-test is 0,593 which is greater than 0,05 and 0,10, and the null hypothesis is not rejected. It cannot be statistically verified that group 1 is more willing to try new things than group 2 based on this test.

Question 37: "How fast do you test new innovations related to your crop production?" For this question they got to choose between 5 different categories, why it is examined with chi-square test.

The observed and expected frequencies do not differ much and the p-value is high (0,759) and greater than 0,05 and 0,10. There are also four cells with expected counts less than 5, which provides some uncertainty to the test. Therefore, the null hypothesis is not rejected. It cannot be statistically shown that these variables are dependable.

Question 38: "When was the last time you tested a new crop?" (In number of years)
Some of the farmers could not say when they last tried a new crop, therefore we only have data from 50 respondents in this test.

This test was performed with an independent two sample T-test to see if there are a difference in mean between the groups. The mean value for group 1 is 3,44 years and for group 2 it is 5,61 years. Group 1 has more recently tried a new crop since the estimated difference is -2,16 years. The p-value is 0,10 which is exactly the same value as the highest significance level. The confidence interval is -4,33; 0,00, the difference is with 90 % confidence within this interval. This indicate that it could be a difference between the groups. With a 5 %

significance level we not reject the null hypothesis, but with a 10 % significance level it is rejected.

6.2 Summary of hypotheses

Here is a summary of the tested hypotheses (see Table 9).

Table 9. Summary of the tested hypotheses

	Hypothesis	Analysis method	P-value	Null hypothesis
1	Farmers who grow broad bean have larger acreage	T-test	0,073	Uncertain
2	Farmers who grow broad bean has access to drying facilities	Chi-square	0,136	Not rejected
3	If farmers grow broad bean, depend of their climate and vegetation period	Chi-square	0,007	Rejected
4	It is more important for an organic farmer to grow broad beans	Chi-square	0,042	Rejected
5	Farmers who grow broad bean uses more types of information sources.	T-test	0,278	Not rejected
6	Farmers who grow broad bean require more professional help.	Chi-square	0,152	Not rejected
		Chi-square	0,541	Not rejected
7	Farmers who grow broad beans are more educated	Chi-square	0,347	Not rejected
8	Farmers who grow broad bean perceive their profitability in the crop production lower than other farmers.	Chi-square	0,844	Not rejected
		T-test	0,452	Not rejected
9	Farmers who grow broad bean compare profitability to a less extent.	Chi-square	0,739	Not rejected
10	Farmers who grow broad bean, focus more on crop rotation effects than price in their decision about crop planning.	Chi-square	0,371	Not rejected
11	Farmer who grow broad bean plan their crop sequence further into the future.	T-test	0,002	Rejected
12	Farmers who grow broad bean update their crop plan more often.	Chi-square	0,96	Not rejected
13	Farmers who grow broad beans are more open to try new things	Chi-square	0,162	Not rejected
		T-test	0,593	Not rejected
		Chi-square	0,759	Not rejected
		T-test	0,1	Uncertain

Three of the hypotheses is rejected and two is uncertain whether it is rejected or not since the p-value is in between 0,05 and 0,10. The rest of the hypotheses is not rejected. These hypotheses is further discussed in next chapter.

7 Analysis and discussion

This chapter presents a discussion of the empirical results and statistical analysis in relation to the theoretical framework of the study. To understand the farmers' crop decision making process we applied a theoretical synthesis (see 3.4) that, together with the literature review, describes what drives farmers to grow or not to grow broad beans. Furthermore, the chapter ends with a summarized discussion.

7.1 Resources

Below is a discussion of the farmers' resources and what differences we have observed between group 1 and 2 in our statistical analysis, along with previous literature. A discussion follows on how this is linked to the theory of resource-based view. The resources are divided into categories of physical and human resources.

7.1.1 Physical resources

The physical resources discussed in this study are acreage, drying facilities, and location. Due to soil-borne disease and pests, the broad bean cannot be grown on the same soil too frequently, needing at least 6-8 years separation between harvests (Jordbruksverket, 2018b; Fogelfors, 2015). This could be an explanation why it is more likely that a farmer with a larger acreage tends to grow broad bean which is also confirmed by the test of hypothesis 1 (number of hectares). The hypothesis indicates that there is a statistically significant relationship between the acreage and if farmers grow broad bean or not. The farmer's acreage is therefore an important resource and determining factor which influences if the farmer decides to grow broad bean or not.

When the farmers were asked why they do not grow broad bean or what the challenges with growing them are (question 30 and 32), many mentioned the problems of late ripeness. This makes it difficult to harvest when the soil becomes too wet, or the beans have matured unevenly maturity (Holstmark, 2007). The challenge of the drying process was also mentioned. Broad beans require a drying facility with good capacity to maintain the quality (Jonsson *et al.*, 2015). Farmers who do not have access to drying facilities or the ability to deliver directly from harvest, find it complicated to grow broad beans. Given hypothesis 2, we note that there is a difference in frequencies between the groups in terms of access to an own drying facility. However, the test does not reveal a statistically significant relationship. When examining the farmers who grow broad beans, but do not have an own drying facility, it shows that they collaborate and sell as feed directly to other farms, which is why they may not have a need for a drying facility. Even though a statistical difference cannot be shown between the groups, it still shows how important access to drying facilities is for farming and growing broad bean (Jonsson *et al.*, 2015). If farmers from group 2 would like to grow broad bean, and the access to drying facility is what hinders them, a contract with a livestock farm could be the solution to maintain broad bean in the business.

Sweden is a geographically diverse country that comprises many different regions and cultures (Larsson, 2006). In this study, farmers from four different counties are included. Although it is possible to grow broad bean in all of the chosen regions, the acreage in each county differs. The crop is more frequently grown in Västra Götaland and Östergötland than in Uppsala and Västmanland (Jordbruksverket, 2018a). In our analysis, we tested if it is true that growing broad bean is perceived as preferable among farmers in these counties, or if there could be another reason that more hectares of broad beans exists here. Testing hypothesis 3, we confirmed that it is more common among farmers to grow broad bean in

Västra Götaland and Östergötland. As mentioned before, the broad bean ripens late; which is most likely the primary reason why farmers operating where fall arrives earlier perceive more problems with growing broad beans.

Organic farmers face more restrictions than conventional farmers (Jordbruksverket, 2019b). They cannot use the same methods to reduce pests and diseases due to regulations of organic farming. To increase the nitrogen in the soil, organic farming uses crops with nitrogen fixation like legumes or ley. This is why broad beans, in this context, can be seen as a physical resource used by farmers (Barney, 1991; Penrose, 1959). Being an organic farmer may be associated with values or attitudes of the farmer. Through the test of hypothesis 4, we received a p-value < 0,05 which indicates that the broad bean is a more valuable resource for organic farmers than non-organic. We can also interpret the result as the value of organic farming being more important among group 1 than group 2.

7.1.2 Human resources

Information, advisor's expertise and education are examples of human resources which are used by farms. This can be in the form of tacit resources and socially complex resources (Hart, 1995). The farmers in the study mentioned that they use various types of information sources. From written information (magazines, media, Facebook), to meetings with crop advisors and discussions with family members or a neighbour. The perception that the broad bean is riskier and more difficult to grow compared with cereals (Reckling *et al.*, 2016a; Ghadim *et al.*, 1996), lead us to test if there are any difference between the groups in use of human resources. Through hypothesis 5 it was tested if group 1 uses more types of information sources. This test gave a p-value of 0,278, while not a high value it is still above the significance level for our testing. Voisin *et al.* (2013) stated that most of the advice and technical references are brought to farmers by other actors and organizations in the agricultural sector. Based on hypothesis 6, a test was performed if group 1 uses more support from crop advisors. This data reveals a difference between the two groups, but this difference is not statistically significant. A lower p-value of 0,152 was received when testing if they used advisors or not. However, it is still not significant. Hypothesis 7 tested the level of education. Even if group 1 was more educated than group 2, it could not be statistically verified. The hypothesis tests of human resources do not show any statistical significant difference. It cannot be proven that these resources determine whether a farmer will grow broad beans or not.

7.2 Decision making

Below, we discuss how values and goals affect the decision process. Followed by the phases in the decision process regarding crop decisions.

7.2.1 Values and goals

Values (attitudes) and goals (objectives) are a fundamental part of decision making (Willock *et al.*, 1999; Öhlmér *et al.*, 1998). Willock *et al.* (1999) stated that a farmer wants to maximize production and be profitable just like any other business. Most of the farmers said that their main goal is to be profitable enough to have a sufficient wage and be able to do necessary investments in their farm. They reasoned: "To be a farmer is not only a job, it is a way of life (lifestyle)" and "fun and developing work". They value that they have a flexible job where they work with their interests in livestock, nature, and crop production and not necessarily profit maximization. One of the arguments against growing broad bean is that farmers think it is less profitable (Jouan *et al.*, 2019). Hence, it was tested if this view or perception of profitability differs between the groups. Hypothesis 8 was tested if group 1 perceives their profitability to be lower than group 2. Based on responses, group 1 perceived their profitability as higher than group 2. But this finding this could not be statistically supported. Based on hypothesis 9, it was tested if group 1 compares profitability to a lesser extent than group 2, but no difference could be statistically proven. The test of hypothesis 10 showed whether group 1 focuses more on crop rotation effects than price in comparison with group 2. In response frequencies it could be observed that group 1 focused more on crop rotation effects than group 2, however the statistical analysis could not confirm this. It appears, based on the tested hypotheses, that there are no statistically significant differences between the groups regarding these types of values and goals.

Farmers plan their cropping system to have different functions to fit their specific business (Dury *et al.*, 2013), which is influenced by the individual's values and goals (Willock *et al.*, 1999; Öhlmér *et al.*, 1998). Based on the empirical results, the most important functions of the cropping system include; optimization of the use of resources, taking advantage of arable land/soil conditions, and achieving economic and biological stability.

The most frequently mentioned benefit of growing broad beans was the pre-crop effects which could decrease the costs of inputs in the crop production, especially nitrogen fertilizer. The economic savings of biological fixation of nitrogen from broad beans depend on the price of synthetic nitrogen fertilizer and the cost of work effort (Jouan *et al.*, 2019).

The empirical results show that farmers who do or do not grow broad beans have different reasons for it. Many farmers in group 1 mentioned that they produce broad bean for livestock feed and to diversify their crop system, while farmers in group 2 said that the broad bean does not fit their specific farm (soil, climate, acreage etc.) and/or that they do not have a need for the broad bean. If an outcome of a decision is uncertain it is viewed as a risk (Öhlmér *et al.*, 2000; Robison & Barry, 1987). Farmers are in general risk averse (Hardaker, 2004), but group 1 who have a reason for growing broad bean, sees an opportunity in growing it. Group 2 who do not have a need for it, focus more on the risks of growing it. They think it is too uncertain and difficult, but if there is a higher price for broad beans, they might be willing to consider taking the risks linked to the late ripeness and harvest. Farmers who do not have a specific need for the broad bean, perceived it as more profitable and stable to grow crops such as wheat and barley, and will not likely switch to broad bean.

7.2.2 The decision process

In the decision-making process, there are three phases before the *implementation*; *changed situation*, *definition* and *analysis/decision* (see Figure 5 in 3.4). A *changed situation* refers to new knowledge received or external factors which create an opportunity or a problem. *Definition* is the phase where the farmer forms an attitude towards the situation, examines the options and what risks that follow the different options. Uncertainties and risk are significant features in agricultural production, and especially in crop production (Öhlmér *et al.*, 2000). In the *analysis/decision phase*, the various options are compared to make a final optimized decision for the individual. The *implementation* phase includes both the implementation and an evaluation after the implementation, in which feedback is used to understand what can be improved next time.

The choice to grow broad bean among the farmers in group 1 started as some type of emerging situation, either an opportunity or problem. The most commonly mentioned reasons are a need for a more diversified crop sequence due to decreasing yields and lack of nitrogen in the soil, a qualitative feed for animal production which is produced in a more ethical and environmentally friendly manner or to fulfill requirements for a new regulation such as EFA. Given the empirical results, we note what is needed for farmers in group 2 to start growing broad beans. Earlier varieties, better price, more acreage, a specific need for it in the farming system, and access to drying facilities or delivery options. The farmers in group 2 that have tried broad beans before went through the whole process just as group 1, except that they evaluated the situation and felt that it was not worth it. This shows that farmers continuously evaluate and try to improve their crop production.

A practical example of a *changed situation*, mentioned by some respondents, is the CAP and the introduction of EFA in 2013 (Dänhardt *et al.*, 2017). To receive this subsidy, farmers need to fulfill criteria where only a few crops were acceptable to grow in their area. Broad bean is one of these crops. The *definition* phase in this case would be when farmers receive the information and start examining which different alternatives there are to receive the subsidy. The *analysis and decision* is when the farmer compares what is the best option for them, which crop would fit best, or if it would outweigh the subsidy. Their decision leads to next step, *implementation*. For some of the farmers in this study, the implementation of broad bean has been their solution to this problem. The *implementation* phase also includes an evaluation, so before the farmer decides to again grow broad beans the next year, an evaluation is made. In this phase, it is found that some farmers in group 2 had reconsidered and exchanged the broad bean for peas instead.

Another *changing situation* requiring a decision process is the desire to decrease the use of soy beans in animal production, due to the awareness about its bad effect on the environment and climate and for farmers to save money (Naturskyddsföreningen, 2010). This is both a problem and an opportunity for the farmer. The farmer wants to have as little effect as possible on the climate and produce at a cost-efficient level. The farmer *defines* the situation when considering what other crops there are that have the right quality and attributes as a feed, and how easy it is to buy and grow. In the *analysis and decision* phase, the best option is chosen, which is broad bean for 50% of the respondents in the study.

When Dury *et al.* (2013) examined crop planning decisions, they found that farmers plan their crop sequence differently. Some think strategically and plan in a long term perspective, while others are more spontaneous and plan only one year ahead. Since broad bean requires at least 6-8 years between it is planted on the same field (Jordbruksverket, 2018b; Fogelfors, 2015), and contribute to a more complex crop plan (Reckling *et al.*, 2016a), the farmers in group 1 should be more strategic in their crop planning. Thus, hypothesis 11 and 12 were developed to analyze if this is true. The statistical analysis could confirm that group 1 in general plan their crop sequence further into the future than group 2. This means that farmers who choose to grow broad beans must be more strategic in their crop planning, which result in that they cannot be as flexible as farmers who grow cereal crops (Dury *et al.*, 2013). The farmers from group 2 could therefore adopt quickly to changing circumstances since they are not as bound to a strict crop sequence like the farmers from group 1. Farmers' decision process is not linear, it is an ongoing process where they go back and forth between the different phases and sub-processes (Öhlmér *et al.*, 2000; Öhlmér *et al.*, 1998). Farmers in group 1 are more strategic and long-term thinking in their crop decision than farmers in group 2. However, the test of hypothesis 12 showed that farmers from group 2 oversee or rethinking their crop plan as often as farmers from group 1.

7.3 Innovation

An innovation can be explained as an idea that is perceived as something new by the individual (Rogers, 1963). The broad bean is a well-known crop in Swedish agriculture (Jordbruksverket, 2019a; Fogelfors, 2015), which is why farmers may not describe it as an innovation. However, new varieties are being developed, and a potential market may arise (SLU Grogrund, 2019), which could give it the attribute as an innovation. Innovations are adopted for various reasons (Rogers, 2003). We identified these as the most common motivations for adopting the broad beans as a new crop: development to meet an increased demand of a specific products, diversify crop production to gain more biodiversity and biological benefits, spread the economic risk in the farming business, or an interest for challenges.

An innovation is both an opportunity and a way to potential future opportunities (Rogers, 1995; Feder & O'Mara, 1981). Many of the farmers said they like to try new innovations, if they have a strong belief and interest in the innovation and a high level of utility for implementing it into the business. To examine whether the broad bean could be an indicator for a farmer being an early adopter or not, the hypothesis 13 was tested with data from three questions. The two first questions were based on their own perception, they answered what they think matched them best. The test of these question did not indicate that there is any statistical difference between the groups. However, the third question was based on when they last tried a new crop. The p-value from this test is 0,10 which tells us that there might be a relationship. Farmers in group 1, according to themselves, have more recently tried a new crop. Even though we do not find that the difference is statistically significant, it is interesting that it seems to differ between how farmers perceive themselves compared to their actions. This might be an effect of that people perceive themselves as something they want to be, but are not.

As discussed above, the available recourses on the farm is a strongly influencing factor in the farmers' decision making. Regarding the level of adoption in the crop production, a frequently mentioned incentive among the respondents was to diversify their crop system, and to find and grow crops that are more resilient and tolerant to extreme weather conditions, such as extremely wet or extremely dry conditions. The farmers expressed that new crops usually were implemented due to of curiosity and interest in diversification in developing new crop enterprises. For example, there is a farmer who recently began growing different berries since it is a more unusual production system and intriguing business. Usually farmers implement new crops in a small scale at first to not take a too big of a risk.

7.4 Summarized discussion

Resources set limits, create opportunities, and influence what is possible to do (Barney, 2007; Eisenhardt & Martin, 2000). The farmers in this study all have different resources in terms of the climate they operate in, how many hectares they cultivate, what machinery they possess, and the level of education or experience etc. By using resources efficiently, farmers can create competitive advantages and become sustainable over time (Eisenhardt & Martin, 2000). From the discussion above, we can observe that some of the resources between the groups differ. Whether the farmer has access to these resources or not influences if the farmer is likely grow broad bean. The resource-based view is based on the assumption that all companies are heterogeneous and consist of different resources (Eisenhardt & Martin, 2000; Peteraf, 1993).

The manager evaluates the resources in order to allocate them efficiently and create advantages. In this study, farmers can, for example, choose what they grow every year according to the resources they have (machinery, drying facilities, knowledge, education etc.) and choose how to allocate resources to reach their goals. However, some resources are found to set limits on the possibility of growing broad bean. These are: which county the farmer operates in, if they have enough acreage, and if they have access to drying facilities or can deliver beans directly at harvest. Other resources such as education, experience, information sources, and advisors may influence decisions in general, but it does not heavily affect the decision to grow or not to grow broad bean. In the context of growing broad beans, the physical resources seem to be determining factor, and human resources do not have a major effect.

The values and goals of the individual affect what decisions are made (Willock *et al.*, 1999; Öhlmér *et al.*, 1998). The study shows that the farmers desire to have a fun, developing, and suitable lifestyle which requires economic stability but not necessarily profit maximization. However, no differences between the groups, in terms of values, could be found. Depending on what specific goals the farmers have with their business, the farmer will design the cropping system to fit their needs. Decision making is therefore affected by the farmers aim and utility of growing broad bean. An example of this would be if a farmer has livestock production on their farm or an opportunity to sell to a neighbor who operate livestock production. Then, the farmer is more likely to decide to grow broad bean. This study shows that group 1 focuses on the benefits of growing broad bean believing the benefits preponderate the risks. Group 2 does not perceive the same benefits or market opportunities in the cultivation of broad bean, which makes the decision to grow broad beans uncertain and risky (Öhlmér *et al.*, 2000; Robison & Barry, 1987).

The decision making among both groups is characterized by the same phases and functions. Why some decide to grow broad beans, and some did not could depend on what they consider to be the optimal solution in the analysis/decision phase. It could also differ in the evaluation phase where they realize that broad beans do not suit their farm conditions or they find a better alternative crop. Another difference in decision making is that group 1 must be more strategic in their crop decision (Dury *et al.*, 2013), as they must consider several different cultivation factors concerning the growth and harvest of broad beans (Jordbruksverket, 2018b; Fogelfors, 2015). This means that they usually have a more long-term planning horizon in terms of crop sequence than group 2. The crop planning for group 2 is easier to adjust and more flexible to changing circumstances (Dury *et al.*, 2013).

Why farmers in this study chose to adopt and implement broad beans into their cropping system was affected by their goals. Some mentioned goals of development to meet an increased demand of a specific products, or an interest in challenges as the reasons they grew broad beans. Another reason was to diversify crop production to promote biodiversity and biological benefits that reduce the economic risk in the farming business. Among the respondents in our study, many view them self as open-minded farmers with a great willingness to adopt innovations, but no differences between the groups were revealed. However, when it was tested for when the last time farmers tried a new crop group 1 had a lower average, meaning group 1 have generally tried a new crop more recently than group 2.

Even if innovation can be, or trigger, an opportunity (Rogers, 1995; Feder & O'Mara, 1981), our results show that there exist barriers preventing an innovation from being adopted. What barriers hinder the farmers to adopt a new crop differ from farmer to farmer, and is a part of the innovation-decision process (Rogers, 1995). The physical resources have a crucial effect in the decision to grow broad bean, and therefore also in the adoption of it as an innovation.

Also, uncertainty for an innovation is an obstacle for adoption (Feder & O'Mara, 1981). Many of the respondents mentioned the late ripening as a problem, which cause uncertainty in harvest time and a risk for complicated harvest in wet conditions. Development of new varieties could be a way to overcome this uncertainty and make it more suitable and attractive to adopt in the cropping system.

8 Conclusions

In this chapter the conclusions are presented by answering the research questions. This study aims to find differences and similarities among farmers who grow broad beans and not, to understand which the most determining resources are, and how farmers use these to make decisions regarding crop planning. To reach the aim each research question is answered in followed section.

What resources affect the farmer's decision to grow broad beans?

The crop planning decision is intimately linked to the farmers' allocation of resources. Primarily it was the physical resources determining whether the farmer could grow broad beans or not. These are: which county the farmer operates in, available amount of acreage, access to drying facility and the ability to directly deliver at harvest. Human resources such as education, experience, information sources, and advisors may influence the decision making in general, but do not heavily affect the decision to grow or not grow broad bean.

How does the decision process differ between farmers who grow broad beans and farmers who do not grow broad beans?

The farmers' values about farming in the two groups are similar. However, their perception of the broad bean based on their own experience or the experience of others differs. Farmers who grow broad bean spot an opportunity, while farmers who do not grow view it as risk. This opportunity seems connected to if they produce broad bean as a feed for their own use or within a contract. Farmers who do not grow broad beans have either; implemented broad beans previously and after an evaluation decided to stop growing it. Or in the analysis phase decided to grow another crop, or never considered it as an option. Farmers who grow broad beans have both decided to grow this crop in the analysis phase, and after the evaluation decided to continue. Broad bean farmers are more strategic and think in long-term perspective when planning their crop sequence, due to the broad bean's cultivation requirements. On the other hand, farmers who do not grow broad beans are more flexible and adaptable to changing circumstances.

The cultivation of broad bean in Sweden and the opportunity to expand it could be a way to develop a more sustainable agricultural sector. The barriers that hinder farmers to adopt a new crop may differ from farmer to farmer. The biggest of these obstacles typically has to do with uncertainty in the new crop. To reach the goal of growing more broad beans in the future, development of new varieties and delivery options could be a way to overcome this uncertainty and make it more suitable and attractive to adopt in cropping systems.

Further research

Further research in the field of decision making in farming business is needed, since farming has different decisions and decision-making processes from other businesses. This study is limited to four counties in Sweden. Due to the difference in cropping conditions and crop rotation, it would be of interest to test if the results of the study differ in other crop producing regions in Sweden. For politicians, the information about the legumes and the decision making in farming business could be insightful when forming future agricultural policies. In order to develop further understanding in the food and agricultural industry, this study could be used and complemented by adding further research about the value-chain for broad beans in Sweden.

References

Arrow, K. (1974). Essays in the theory of risk-bearing, Amsterdam and Oxford. North-Holland Publishing Company.
Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of management,* 17(1), pp. 99-120.
Barney, J.B. (2007). *Resource-based theory creating and sustaining competitive advantage*. Oxford ;: Oxford University Press.
Baxter, K. (2015). *Understanding your users : a practical guide to user research methods*. 2nd ed. ed. (Interactive Technologies. Amsterdam, Netherlands: Morgan Kaufmann.
Blanco, M., Ramos, F., Van Doorslaer, B., Martínez, P., Fumagalli, D., Ceglar, A. & Fernández, F.J. (2017). Climate change impacts on EU agriculture: A regionalized perspective taking into account market-driven adjustments. *Agricultural Systems,* 156, pp. 52-66.
Bloisi, W. (2003). *Management and organisational behaviour*. European ed. ed. Maidenhead: McGraw-Hill Education.
Bogdan, R.C. & Biklen, S.K. (1998). *Qualitative Research in Education. an Introduction to Theory AndMethods*.
Bond, D., Lawes, D. & Poulsen, M. (1980). Broadbean (Faba bean). *Hybridization of crop plants*(hybridizationof), pp. 203-213.
Brush, C.G., Greene, P.G. & Hart, M.M. (2001). From initial idea to unique advantage: The entrepreneurial challenge of constructing a resource base. *Academy of Management Perspectives,* 15(1), pp. 64-78.
Bryman, A. & Bell, E. (2015). *Business research methods*. 4. ed. ed. Oxford: Oxford University Press.
Carr, E.C.J. & Worth, A. (2001). The use of the telephone interview for research. *NT Research,* 6(1), pp. 511-524.
Chilisa, B. & Kawulich, B. (2012). Selecting a research approach: paradigm, methodology, and methods. *C Wagner, B Kawulich, & M Garner, Doing social research: A global context,* pp. 51-61.
Chongtham, I.R., Bergkvist, G., Watson, C.A., Sandström, E., Bengtsson, J. & Öborn, I. (2017). Factors influencing crop rotation strategies on organic farms with different time periods since conversion to organic production AU - Chongtham, Iman Raj. *Biological Agriculture & Horticulture,* 33(1), pp. 14-27.
Cohen, L., Manion, L. & Morrison, K. (2011). *Research methods in education*. Milton Park, Abingdon, Oxon, [England] ;: Routledge.
Creswell, J. (2006). Understanding mixed methods research,(Chapter 1). *EriȘim adresi: http://www. sagepub. com/upm-data/10981_Chapter_1. pdf*.
Creswell, J.W. & Miller, D.L. (2000). Determining validity in qualitative inquiry. *Theory into practice,* 39(3), pp. 124-130.
Cubero, J. (2011). The faba bean: a historic perspective. *Grain legumes,* 56, pp. 5-7.
Dahmström, K. (2011). *Från datainsamling till rapport : att göra en statistisk undersökning*. 5. uppl. ed. Lund: Studentlitteratur.
Dalgaard, P. (2008). *Introductory statistics with R*. 2. ed. ed. (Statistics and computing. New York: Springer.
de Mey, Y., Lauwers, L., Van Passel, S., Vancauteren, M. & Wauters, E. (2016). Determinants of risk behaviour: effects of perceived risks and risk attitude on farmer's adoption of risk management strategies AU - van Winsen, F. *Journal of Risk Research,* 19(1), pp. 56-78.

Denscombe, M. (2018). *Forskningshandboken : för småskaliga forskningsprojekt inom samhällsvetenskaperna*. Fjärde upplagan. ed. Lund: Studentlitteratur.

Driscoll, D.L., Appiah-Yeboah, A., Salib, P. & Rupert, D.J. (2007). Merging qualitative and quantitative data in mixed methods research: How to and why not.

Dury, J., Garcia, F., Reynaud, A. & Bergez, J.-E. (2013). Cropping-plan decision-making on irrigated crop farms: A spatio-temporal analysis. *European Journal of Agronomy*, 50, pp. 1-10.

Dänhardt, J., Nilsson, L., Hristov, J., Alkan Olsson, J., Brady, M., Olsson, P., Smith, H.G. & Clough, Y. (2017). Ekologiska fokusarealer i samverkan: Utvärdering av effekter på ekosystemtjänster, jordbruk och administration.

Eisenhardt, K. (1989). Building theories from case study research. *Academy of Management Review*, 14(4), pp. 532-550.

Eisenhardt, K.M. & Martin, J.A. (2000). Dynamic capabilities: what are they? *Strategic management journal*, 21(10-11), pp. 1105-1121.

Emmerson, M., Morales, M., Oñate, J., Batáry, P., Berendse, F., Liira, J., Aavik, T., Guerrero, I., Bommarco, R. & Eggers, S. (2016). How agricultural intensification affects biodiversity and ecosystem services. In: *Advances in Ecological Research*55) Elsevier, pp. 43-97.

EuropeanCommission (2018). *Rapport från kommissionen till rådet och Europaparlamentet - om utvecklingen av vegetabiliska proteiner i Europeiska unionen*. Brussels, Belgium: European Commission.

Feder, G. & O'Mara, G.T. (1981). Farm Size and the Diffusion of Green Revolution Technology. *Economic Development and Cultural Change*, 30(1), pp. 59-76.

Fliegel, F.C. & Kivlin, J.E. (1966). Attributes of Innovations as Factors in Diffusion. *American Journal of Sociology*, 72(3), pp. 235-248.

Fogelfors, H. (2015). *Vår mat : odling av åker- och trädgårdsgrödor : biologi, förutsättningar och historia*. 1. uppl. ed. Lund: Studentlitteratur.

Freeman, R.E. (2010). *Strategic management: A stakeholder approach*: Cambridge university press.

Furrer, O., Thomas, H. & Goussevskaia, A. (2008). The structure and evolution of the strategic management field: A content analysis of 26 years of strategic management research. *International Journal of Management Reviews*, 10(1), pp. 1-23.

Ghadim, A.K.A., Pannell, D.J., Bennett, A. & Stewart, V. (1996). Farmers' Risk Perspective on Adoption of Legume Crops. *Agronomy - Science with its Sleeves Rolled Up.* Toowomba: Proceedings of 8th Agronomy Conference 1996.

Golafshani, N. (2003). Understanding Reliability and Validity in Qualitative Research. *The Qualitative Report*, 8, pp. 597-607.

Grogrund-SLU *Framtidens åkerböna för mat och foder*. Available at: https://www.slu.se/centrumbildningar-och-projekt/grogrund/projekt/framtidens-akerbona-for-mat-och-foder/ [2019-05-12].

Hanson, J., Dismukes, R., Chambers, W., Greene, C. & Kremen, A. (2004). Risk and risk management in organic agriculture: Views of organic farmers. *Renewable Agriculture and Food Systems*, 19(4), pp. 218-227.

Hansson, H. & Lagerkvist, C.J. (2012). Measuring farmers' preferences for risk: a domain-specific risk preference scale. *Journal of Risk Research*, 15(7), pp. 737-753.

Hardaker, J.B. (2004). *Coping with risk in agriculture*. 2nd ed. ed. Wallingford, Oxfordshire ;: CABI Pub.

Hardaker, J.B. & Lien, G. (2007). Rationalising risk assessment: Applications to agricultural business. *Australasian Agribusiness Review*, 15(6), pp. 75-93.

Hart, S.L. (1995). A Natural-Resource-Based View of the Firm. *The Academy of Management Review,* 20(4), pp. 986-1014.
Hofweber, T. (2018). *Logic and Ontology*. Summer 2018. ed. (The Stanford Encyclopedia of Philosophy: Metaphysics Research Lab, Stanford University. Available from: https://plato.stanford.edu/cgi-bin/encyclopedia/archinfo.cgi?entry=logic-ontology.
Holstmark, K. (2007). Ekologisk odling av åkerböna. *Jordbruksverket*.
Israel, G.D. (1992). Determining Sample Size. *Florida Cooperative Extension Service.* Institute of Food and Agricultural Sciences, University of Florida.
Israel, M. (2015). Research Ethics and Integrity for Social Scientists: Beyond Regulatory Compliance. In. 2. ed. London: SAGE Publications Ltd. Available from: https://methods.sagepub.com/book/research-ethics-and-integrity-for-social-scientists-2e.
Itoh, T., Ishii, H. & Nanseki, T. (2003). A model of crop planning under uncertainty in agricultural management. *International Journal of Production Economics,* 81-82, pp. 555-558.
Jaworski, B.J. & Kohli, A.K. (1993). Market orientation: antecedents and consequences. *Journal of marketing,* 57(3), pp. 53-70.
Jensen, E.S., Peoples, M.B. & Hauggaard-Nielsen, H. (2010). Faba bean in cropping systems. *Field Crops Research,* 115(3), pp. 203-216.
Johansson, G.A., Jonasson, L., Rosenqvist, H. & Yngwe, K. (2014). *Skånskt lantbruk - En snabb blick in i framtiden till år 2025*.
Johnsson, K. (2016). Stort intresse för svenska bönor. *Jordbruksaktuellt*, Available from: https://www.ja.se/artikel/49772/stort-intresse-fr--svenska-bnor.html [2019-04-24].
Jonsson, N., Lundin, G. & Sundberg, M. (2015). Konservering och lagring av åkerböna vid svåra skördeförhållanden.
Jordbruksverket *Jordbruksföretag och företagare 2016 - Agricultural holdings and holders in 2016*. Available at: http://www.jordbruksverket.se/webdav/files/SJV/Amnesomraden/Statistik,%20fakta/Foretag%20och%20foretagare/JO34/JO34SM1701/JO34SM1701/JO34SM1701%20TEST_ikortadrag.htm [2019-06-01].
Jordbruksverket (2018a). *Jordbruksmarkens användning 2018* (Sveriges officiella statistik - Statistiska meddelanden, 2018).
Jordbruksverket (2018-10-04). *Åkerbönor i växtföljden*. Available at: http://www.jordbruksverket.se/amnesomraden/odling/jordbruksgrodor/akerbonor/vaxtfoljd.4.3229365112c8a099bd980006509.html [2019-04-19].
Jordbruksverket (2019a). Beställd statistik - åkerbönor och ärt. beslutsstod@jordbruksverket.se: Jordbruksverket.
Jordbruksverket *Ekologisk produktion*. Available at: http://www.jordbruksverket.se/amnesomraden/miljoklimat/ekologiskproduktion.4.2ada1a6113d67e0bac48000503.html [2019-05-12].
Jouan, J., Ridier, A. & Carof, M. (2019). Economic Drivers of Legume Production: Approached via Opportunity Costs and Transaction Costs. *Sustainability,* 11(3), p. 705.
Kahneman, D. (2003). Maps of bounded rationality: Psychology for behavioral economics. *American economic review,* 93(5), pp. 1449-1475.
Kungsörnen *Produkter - Bönpasta*. Available at: https://www.kungsornen.se/produkter/pasta/spaghetti/bonpasta-spaghetti/ [2019-02-05].
Landström, H. & Löwegren, M. (2009). *Entreprenörskap och företagsetablering : från idé till verklighet*. 1. uppl. ed. Lund: Studentlitteratur.

Larsson, S. (2006). *Sveriges jordbruksområden - En redovisning av jordbruksområden och växtzoner i svenskt jord- och trädgårdsbruk*. Sveriges Lantbruksuniversitet: Institutionen för Växtproduktionsekologi.
Lewis-Beck, M.S., Bryman, A. & Liao, T.F. (2004). The SAGE Encyclopedia of Social Science Research Methods.
Lien, G., Hardaker, J.B. & Flaten, O. (2007). Risk and economic sustainability of crop farming systems. *Agricultural Systems,* 94(2), pp. 541-552.
Lindahl, M. (2000). Bankens villkor i låneavtal vid kreditgivning till högt belånade företagsförvärv. *Linköping: UniTryck*.
Lindén, B. (2008). Efterverkan av olika förfrukter: inverkan på stråsädesgrödors avkastning och kvävetillgång - en litteraturöversikt. *Rapport - Sveriges lantbruksuniversitet, Avdelningen för precisionsodling,* 14.
LRF (2019-03-28). *Självförsörjning*. Available at: https://www.lrf.se/politikochpaverkan/foretagarvillkor-och-konkurrenskraft/nationell-livsmedelsstrategi/sjalvforsorjning/ [2019-05-30].
Mackenzie, N. & Knipe, S. (2006). Research dilemmas: Paradigms, methods and methodology. *Issues in educational research,* 16(2), pp. 193-205.
Martin-Clouaire, R. (2017). Modelling Operational Decision-Making in Agriculture. *Agricultural Sciences,* 8(07), p. 527.
Mathison, S. (2005). Encyclopedia of Evaluation. *Reference Reviews,* 19(7), pp. 30-31.
McHugh, M.L. (2013). The chi-square test of independence. *Biochemia medica,* 23(2), p. 143.
Mintzberg, H. (1983). *Power in and around organizations*142): Prentice-Hall Englewood Cliffs, NJ.
Morgan, D.L. (2007). Paradigms lost and pragmatism regained: Methodological implications of combining qualitative and quantitative methods. *Journal of mixed methods research,* 1(1), pp. 48-76.
Moschini, G. & Hennessy, D.A. (2001). Uncertainty, risk aversion, and risk management for agricultural producers. *Handbook of agricultural economics,* 1, pp. 87-153.
Naturskyddsföreningen (2010). *Soja som foder och livsmedel i Sverige - konsekvenser lokalt och globalt*Andra upplagan). Stockholm, Sverige: Naturskyddsföreningen.
NordGen (2019). *Nordic Agriculture and Climate Change - Mitigation and Adaptation : Recommendations from leading researchers and private companies within the Nordic plant breeding*. (NordGen Publication Series. Alnarp, Sweden.
Nowell, L.S., Norris, J.M., White, D.E. & Moules, N.J. (2017). Thematic analysis: striving to meet the trustworthiness criteria. *International Journal of Qualitative Methods,* 16(1), p. 1609406917733847.
Odegard, I. & Van der Voet, E. (2014). The future of food—scenarios and the effect on natural resource use in agriculture in 2050. *Ecological Economics,* 97, pp. 51-59.
Olsson, C. (2017). *Expanding the grain legume food production in Southern Sweden - Qualitative insights from producers and representatives from the food industry*. Diss. Alnarp, Sweden: Alnarp Sveriges lantbruksuniversitet.
Ong, B.K. (2012). Grounded Theory Method (GTM) and the Abductive Research Strategy (ARS): a critical analysis of their differences. *International Journal of Social Research Methodology,* 15(5), pp. 417-432.
Onwuegbuzie, A.J. & Johnson, R.B. (2004). Mixed method and mixed model research. *Educational research: Quantitative, qualitative, and mixed approaches*, pp. 408-431.
Opdenakker, R. (2006). Advantages and Disadvantages of Four Interview Techniques in Qualitative Research. *2006,* 7(4).
Peltonen-Sainio, P. & Niemi, J.K. (2012). Protein crop production at the northern margin of farming: to boost or not to boost. *Agricultural and Food science*, 21(4), pp. 370-383.

Penrose, E. (1959). *The Theory of the Growth of the Firm*: Oxford university press.
Peteraf, M.A. (1993). The cornerstones of competitive advantage: A resource-based view. *Strategic management journal*, 14(3), pp. 179-191.
Pindyck, R.S. (2009). *Microeconomics*. 7. ed. ed. Upper Saddle River, N.J: Pearson Education International.
Preissel, S., Reckling, M., Schläfke, N. & Zander, P. (2015). Magnitude and farm-economic value of grain legume pre-crop benefits in Europe: A review. *Field Crops Research*, 175, pp. 64-79.
Reckling, M., Bergkvist, G., Watson, C.A., Stoddard, F.L., Zander, P.M., Walker, R.L., Pristeri, A., Toncea, I. & Bachinger, J. (2016a). Trade-offs between economic and environmental impacts of introducing legumes into cropping systems. *Frontiers in plant science*, 7, p. 669.
Reckling, M., Döring, T.F., Bergkvist, G., Stoddard, F.L., Watson, C.A., Seddig, S., Chmielewski, F.-M. & Bachinger, J. (2018). Grain legume yields are as stable as other spring crops in long-term experiments across northern Europe. *Agronomy for Sustainable Development*, 38(6), p. 63.
Reckling, M., Hecker, J.-M., Bergkvist, G., Watson, C.A., Zander, P., Schläfke, N., Stoddard, F.L., Eory, V., Topp, C.F.E., Maire, J. & Bachinger, J. (2016b). A cropping system assessment framework—Evaluating effects of introducing legumes into crop rotations. *European Journal of Agronomy*, 76, pp. 186-197.
Rivera-Ferre, M.G. (2008). The future of agriculture. Agricultural knowledge for economically, socially and environmentally sustainable development. *EMBO reports*, 9(11), p. 1061.
Robison, L.J. & Barry, P.J. (1987). *Competitive firm's response to risk*: Macmillan.
Robson, C. (2011). *Real world research*3): Wiley Chichester.
Rogers, E.M. (1963). *Diffusion of Innovations*. New York, United States of America: The Free Press of Glencoe.
Rogers, E.M. (1995). *Diffusion of Innovations*Fourth Edition). New York, United States of America: The Free Press. Available from: https://books.google.se/books?hl=sv&lr=&id=v1ii4QsB7jIC&oi=fnd&pg=PR15&ots=DLWxtPUu7V&sig=CQMeKixzl6-DSayjAV4fGnmusC0&redir_esc=y#v=onepage&q&f=false.
Rogers, E.M. (2003). *Diffusion of innovations*. 5. ed. ed. New York: Free press.
Rougoor, C.W., Trip, G., Huirne, R.B. & Renkema, J.A. (1998). How to define and study farmers' management capacity: theory and use in agricultural economics. *Agricultural Economics*, 18(3), pp. 261-272.
Röös, E., Carlsson, G., Ferawati, F., Hefni, M., Stephan, A., Tidåker, P. & Witthöft, C. (2018). Less meat, more legumes: prospects and challenges in the transition toward sustainable diets in Sweden. *Renewable Agriculture and Food Systems*, pp. 1-14.
Sefotho, M.M. (2015). A researcher's dilemma: Philosophy in crafting dissertations and theses. *Journal of Social Sciences*, 42(1-2), pp. 23-36.
Slaper, T.F. & Hall, T.J. (2011). The Triple Bottom Line: What Is It and How Does It Work? *Indiana Business Review*. Indiana, USA: Indiana Business Research Center, IU's Kelley School of Business.
SLU (2019). New Legume Food - A research blog at SLU, the Swedish University of Agricultural Sciences. http://blogg.slu.se/new-legume-foods/about-the-project/ [2019-02-05].
Stagnari, F., Maggio, A., Galieni, A. & Pisante, M. (2017). Multiple benefits of legumes for agriculture sustainability: an overview. *Chemical and Biological Technologies in Agriculture*, 4(1), p. 2.

SverigesRiksdag *Sveriges självförsörjningsgrad av livsmedel*. Available at: https://www.riksdagen.se/sv/dokument-lagar/dokument/interpellation/sveriges-sjalvforsorjningsgrad-av-livsmedel_H310595 [2019-05-30].

Wahlin, K. (2011). *Tillämpad statistik : en grundkurs*. 1. uppl. ed. Stockholm: Bonnier utbildning.

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic management journal*, 5(2), pp. 171-180.

Vik, J. & McElwee, G. (2011). Diversification and the entrepreneurial motivations of farmers in Norway. *Journal of small business management*, 49(3), pp. 390-410.

Willock, J., Deary, I.J., McGregor, M.M., Sutherland, A., Edwards-Jones, G., Morgan, O., Dent, B., Grieve, R., Gibson, G. & Austin, E. (1999). Farmers' Attitudes, Objectives, Behaviors, and Personality Traits: The Edinburgh Study of Decision Making on Farms. *Journal of Vocational Behavior*, 54(1), pp. 5-36.

Vogt, W.P. (2005). Dictionary of Statistics & Methodology.

Voigt, P. & Von Dem Bussche, A. (2017). *The EU General Data Protection Regulation (GDPR): A Practical Guide*. Cham: Springer International Publishing.

Voisin, A.-S., Gueguen, J., Huyghe, C., Jeuffroy, M.-H., Magrini, M.-B., Jean-Marc, M., Mougel, C., Pellerin, S. & Pelzer, E. (2013). *Legumes for feed, food, biomaterials and bioenergy in Europe: A review*34).

WWF *Tema: Biffen*[2019-04-17].

Yin, R.K. (2007). *Fallstudier : design och genomförande*. 1. uppl. ed. Malmö: Liber.

Zander, P., Amjath-Babu, T., Preissel, S., Reckling, M., Bues, A., Schläfke, N., Kuhlman, T., Bachinger, J., Uthes, S. & Stoddard, F. (2016). Grain legume decline and potential recovery in European agriculture: a review. *Agronomy for Sustainable Development*, 36(2), p. 26.

Öhlmér, B., Göransson, B. & Lunneryd, D. (2000). Business management. With applications to farms and other businesses. *Smaaskriftsserien-SLU, Institutionen foer Ekonomi (Sweden)*.

Öhlmér, B., Olson, K. & Brehmer, B. (1998). Understanding farmers' decision making processes and improving managerial assistance. *Agricultural Economics*, 18(3), pp. 273-290.

Appendix 1 Non-response analysis

Chi-square test for statistical relationship between county and participation. Yes: participant, no: did not participate.

Table A1. 1. Chi-square test for testing the relationship between county and participation.

Chi-Square Test for Association

Rows: County Columns: 1: Yes, 2: No

	Uppsala	Västmanland	Västra Götaland	Östergötland	All
1	17	13	14	16	60
	(14)	(14)	(16)	(16)	
2	18	22	26	24	90
	(21)	(21)	(24)	(24)	
All	35	35	40	40	150

Chi-Square Test

	Chi-Square	DF	P-Value
Pearson	1,607	3	0,658
Likelihood Ratio	1,595	3	0,66

Two sample T-test for test of statistical relationship between acreage (hectares) and participation. Yes: participant, no: did not participate

Table A1. 2. Two sample T-test for testing the relationship between acreage and participation.

Two-Sample T-Test and CI: No; Yes

Descriptive Statistics

Sample	N	Mean	StDev	SE Mean
No	90	237	157	17
Yes	60	285	195	25

Estimation for Difference

Difference	Pooled StDev	95% CI for Difference
-48,3	173,3	(-105,4; 8,8)

T-Test

Null hypothesis H_0: $\mu_1 - \mu_2 = 0$

Alternative hypothesis H_1: $\mu_1 - \mu_2 \neq 0$

T-Value	DF	P-Value
-1,67	148	0,097

Appendix 2 Statistical analysis

1. **Broad bean farmers have larger acreage.**

Table A2. 1. T-test for testing the relationship between acreage and broad beans.

Descriptive Statistics: Hectare

Broad bean	N	Mean	StDev	SE Mean
1	30	330	203	37
2	30	240	179	33

Estimation for Difference

Difference	Pooled StDev	95% CI for Difference
90,1	191,3	(-8,8; 189,0)

T-Value	DF	P-Value
1,82	58	0,073

2. **Farmers who grow broad bean has better access to drying facilities.**

Table A2. 2. Chi-square test for testing the relationship between drying facilities and cultivation of broad beans.

Chi-Square Test for Association

Rows: Broad bean Columns: Drying facilities

	1	2	All
1	25	5	30
	(22,5)	(7,5)	
2	20	10	30
	(22,5)	(7,5)	
All	45	15	60

Chi-Square Test

	Chi-Square	DF	P-Value
Pearson	2,222	1	0,136
Likelihood Ratio	2,256	1	0,133

3. **If farmers grow broad bean, depend of their climate and vegetation period.**

Table A2. 3. Chi-square test for testing the relationship between county and broad beans.

Chi-Square Test for Association

Rows: Broad bean Columns: County

	U	V	VG	Ö	All
1	5	4	12	9	30
	(8,5)	(6,5)	(7)	(8)	
2	12	9	2	7	30
	(8,5)	(6,5)	(7)	(8)	
All	17	13	14	16	60

Chi-Square Test

	Chi-Square	DF	P-Value
Pearson	12,198	3	0,007
Likelihood Ratio	13,119	3	0,004

4. **It is more important for organic farmers to grow broad beans than for other farmers.**

Table A2. 4. First chi-square test for testing the relationship between organic and broad beans.

Chi-Square Test for Association

Rows: Broad bean Columns: Organic?

	Organic	Conventional	Both	All
1	12	16	2	30
	(8,5)	(19,5)	(2)	
2	5	23	2	30
	(8,5)	(19,5)	(2)	
All	17	39	4	60

Chi-Square Test

	Chi-Square	DF	P-Value
Pearson	4,139	2	0,126
Likelihood Ratio	4,233	2	0,12

2 cell(s) with expected counts less than 5.

Table A2. 5. Second chi-square test for testing the relationship between organic and broad beans.

Chi-Square Test for Association

Rows: Broad bean Columns: Organic?

	Organic	Conventional	Missing	All
1	12	16	0	28
	(8,5)	(19,5)		
2	5	23	0	28
	(8,5)	(19,5)		
Missing	0	0	4	*
All	17	39	*	56

Chi-Square Test

	Chi-Square	DF	P-Value
Pearson	4,139	1	0,042
Likelihood Ratio	4,233	1	0,04

5. **Farmers who grow broad bean uses more types of information sources.**

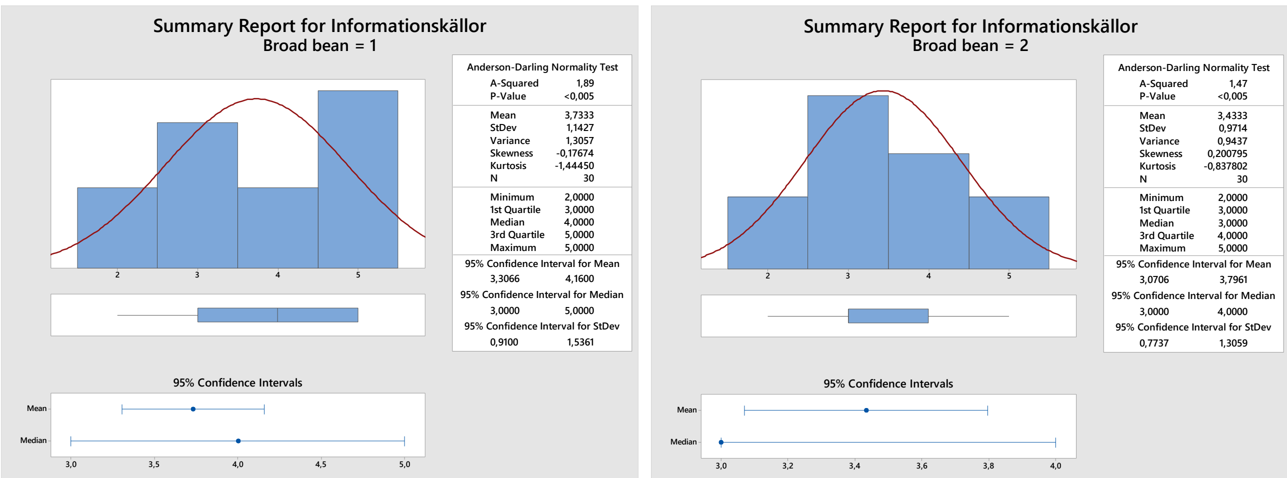

Figure A2. 1. Graphical summary for the use of different information sources. Group 1 (left) and group 2 (right).

Table A2. 6. T-test for testing the relationship between number of information sources and broad beans.

T-test

T-Value	DF	P-Value
1,1	58	0,278

Descriptive Statistics: Information sources

Broad bean	N	Mean	StDev	SE Mean
1	30	3,73	1,14	0,21
2	30	3,433	0,971	0,18

Estimation for Difference

Difference	Pooled StDev	95% CI for Difference
0,3	1,061	(-0,248; 0,848)

6. Broad bean farmers require more professional help.

To examine this hypothesis the answers from question number 18 and 19 were used.
"Do you use an independent advisor regarding your crop production?" 1: Yes or 2: No.
In group 1, 24 of 30 respondents said they use a crop advisor while in group 2, this number was 19.

Table A2. 7. Chi-square test for testing the relationship between crop advisor and broad beans.

Chi-Square Test for Association
Rows: Broad bean Columns: Advisor

	Yes	No	All
1	24	6	30
	(21,5)	(8,5)	
2	19	11	30
	(21,5)	(8,5)	
All	43	17	60

Chi-Square Test

	Chi-Square	DF	P-Value
Pearson	2,052	1	0,152
Likelihood Ratio	2,075	1	0,15

"How often do you use any type of independent advisor regarding your crop production?".

1: 1-2 times per year
2. 3-6 times per year
3: 7-12 times per year
4: More than 12 times per year
5: Rarely or never

Table A2. 8. Chi-square test for testing the relationship between crop advisor and broad beans.

Chi-Square Test for Association

Rows: Broad bean Columns: Crop advisor

	1	2	3	4	5	All
1	6	9	7	2	6	30
	(5,5)	(7)	(7,5)	(1,5)	(8,5)	
2	5	5	8	1	11	30
	(5,5)	(7)	(7,5)	(1,5)	(8,5)	
All	11	14	15	3	17	60

Chi-Square Test

	Chi-Square	DF	P-Value
Pearson	3,104	4	0,541
Likelihood Ratio	3,149	4	0,533

2 cell(s) with expected counts less than 5.

7. Farmers who grow broad beans are more educated.

Table A2. 9. Chi-square test for testing the relationship between education and broad beans.

Chi-Square Test for Association

Rows: Broad bean Columns: Education

	1	2+3	All
1	5	25	30
	(6,5)	(23,5)	
2	8	22	30
	(6,5)	(23,5)	
All	13	47	60

Chi-Square Test

	Chi-Square	DF	P-Value
Pearson	0,884	1	0,347
Likelihood Ratio	0,89	1	0,345

8. Farmer who grow broad bean plan their crop sequence further into the future.

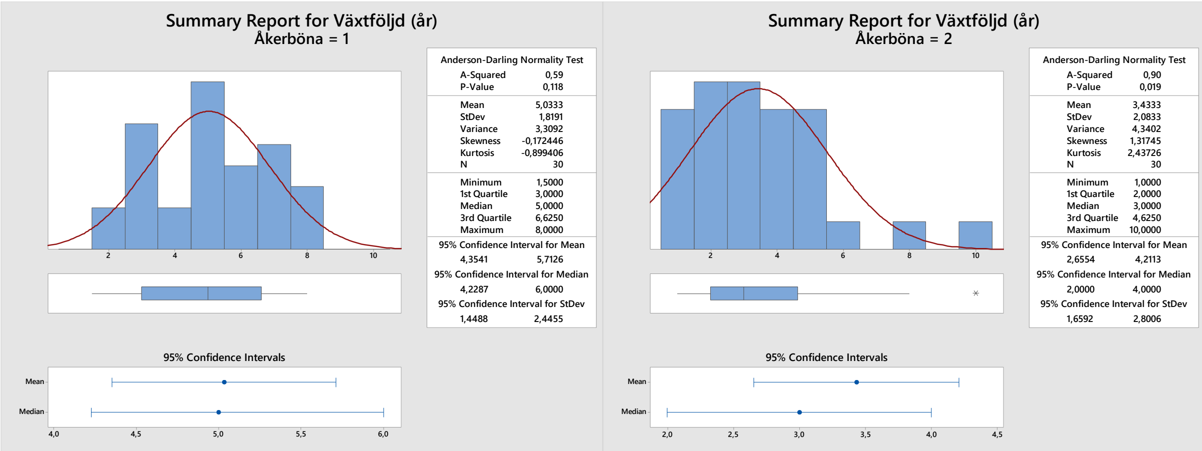

Figure A2. 2. Graphical summary for the length of crop sequence. Group 1 (left) and group 2 (right).

Table A2. 10. T-test for testing the relationship between length of crop sequence and broad beans.

Estimation for Difference

Difference	Pooled StDev	95% CI for Difference
1,6	1,956	(0,589; 2,611)

Descriptive Statistics: Crop sequence (year)

Broad bean	N	Mean	StDev	SE Mean
1	30	5,03	1,82	0,33
2	30	3,43	2,08	0,38

T-test

Null hypothesis H_0: $\mu_1 - \mu_2 = 0$

Alternative hypothesis H_1: $\mu_1 - \mu_2 \neq 0$

T-Value	DF	P-Value
3,17	58	0,002

9. **Broad bean farmers update their crop plan more often.**

To examine this hypothesis, we used the data collected with question 22, where the question was *“How often do you update/change your plan regarding your crop plan?”*. The respondents could choose between five different answers:

1: More than 5 times per year
2: 2-4 times per year
3: 1 time per year
4: Every second year
5: Every third year or more rarely

Table A2. 11. First chi-square test for testing the relationship between crop plan update and broad beans.

Chi-Square Test for Association

Rows: Broad bean Columns: Q22

	1	2	3	4	5
1	2	7	18	0	3
	(1,5)	(8)	(17,5)	(1,5)	(1,5)
2	1	9	17	3	0
	(1,5)	(8)	(17,5)	(1,5)	(1,5)

Chi-Square Test

	Chi-Square	DF	P-Value
Pearson	6,612	4	0,158
Likelihood Ratio	8,937	4	0,063

6 cell(s) with expected counts less than 5.

Table A2. 12. Second chi-square test for testing the relationship between crop plan update and broad beans. Category 1 and 2 is merged, and category 4 and 5 is merged.

Chi-Square Test for Association

Rows: Broad bean Columns: Q22

	2	3	4	All
1	9	18	3	30
	(9,5)	(17,5)	(3)	
2	10	17	3	30
	(9,5)	(17,5)	(3)	
All	19	35	6	60

Chi-Square Test

	Chi-Square	DF	P-Value
Pearson	0,081	2	0,96
Likelihood Ratio	0,081	2	0,96

2 cell(s) with expected counts less than 5.

10. Farmers who grow broad bean, focus more on crop rotation effects than price in their decision about crop planning, or, farmer who do not grow broad bean focus more on price than crop rotational effects.

Question 25: *"What is the most determining factor when you decide what crop to grow, between price and crop rotation effects?"*
Options: 1: Price, 2: Crop rotation effects, 3: Both play as big role

Table A2. 13. Chi-square test for testing the relationship between determining factor and broad beans.

Chi-Square Test for Association
Rows: Broad bean   Columns: Q25

	1	2	3	All
1	4	15	11	30
	(5,5)	(12,5)	(12)	
2	7	10	13	30
	(5,5)	(12,5)	(12)	
All	11	25	24	60

Chi-Square Test

	Chi-Square	DF	P-Value
Pearson	1,985	2	0,371
Likelihood Ratio	2,002	2	0,367

11. Farmers who grow broad bean compare profitability to a less extent.

For this chi-square test, the data from question 24 were used. *"Do you compare profitability?"* In the columns, one means "yes", they compare profitability between crops, and 2 means "no", they do not compare profitability.

Table A2. 14. Chi-square test for testing the relationship between comparing profitability and broad beans.

Chi-Square Test for Association
Rows: Broad bean   Columns: Compare profitability

	1	2	All
1	25	5	30
	(24,5)	(5,5)	
2	24	6	30
	(24,5)	(5,5)	
All	49	11	60

Chi-Square Test

	Chi-Square	DF	P-Value
Pearson	0,111	1	0,739
Likelihood Ratio	0,111	1	0,739

12. **Farmers who grow broad bean perceive their profitability in the crop production lower than other farmers.**

This hypothesis is tested with both a T-test and a chi-square test. *"How do you perceive the profitability in your crop production?"*

Answer option: Number between 1-5, 1: Very low, 5: Very good

Table A2. 15. Chi-square test for testing the relationship between profitability and broad beans

Chi-Square Test for Association

Rows: Broad bean Columns: Profitability

	1	2	3	4	5	All
1	1	5	13	10	1	30
	(1)	(5,5)	(14,5)	(8)	(1)	
2	1	6	16	6	1	30
	(1)	(5,5)	(14,5)	(8)	(1)	
All	2	11	29	16	2	60

Chi-Square Test

	Chi-Square	DF	P-Value
Pearson	1,401	4	0,844
Likelihood Ratio	1,413	4	0,842

4 cell(s) with expected counts less than 5.

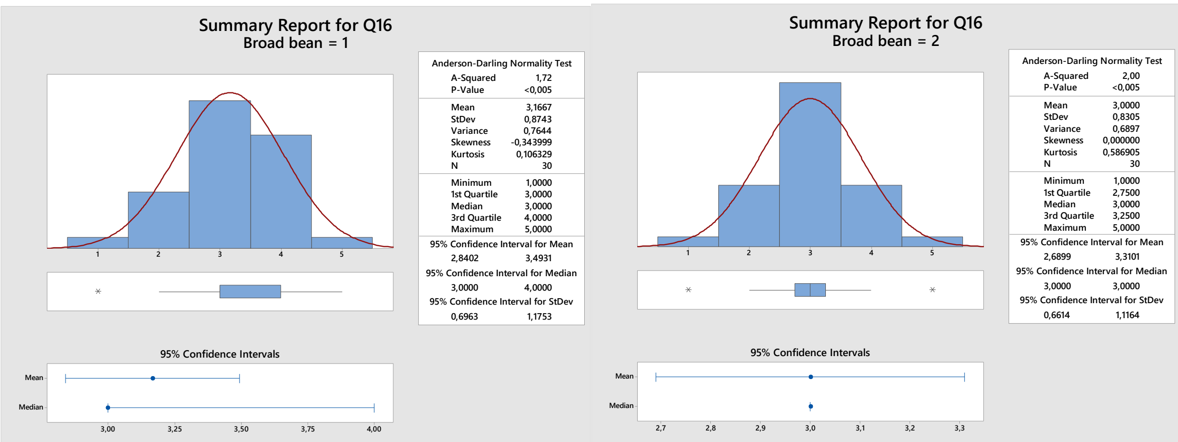

Figure A2. 3. Graphical summary of perceived profitability among group 1 (left) and group 2 (right).

Table A2. 16. T-test for testing the relationship between perceived profitability and broad beans.

Descriptive Statistics: Profitability

Broad bean	N	Mean	StDev	SE Mean
1	30	3,167	0,874	0,16
2	30	3	0,83	0,15

Estimation for Difference

Difference	Pooled StDev	95% CI for Difference
0,167	0,853	(-0,274; 0,607)

T-Test

T-Value	DF	P-Value
0,76	58	0,452

13. Farmers who grow broad beans are more open to try new things.

To examine this hypothesis, the answers from question 36, 37 and 38 were used. In these questions, they could choose different options of how fast or willing they are to test new innovations, and when it was the last time they tried a new crop.

Question 36: "Would you describe yourself as a person who like to try new things, such as new innovations?" The answer for this question is a number between 1-5, where 1 is "not true at all" and 5 is "very true".

Table A2. 17. Chi-square test for testing the relationship between willingness to try innovations and broad beans

Chi-Square Test for Association

Rows: Broad bean Columns: Willing to try new

	2	3	4	5	Missing	All
1	4	13	9	4	0	30
	(5,593)	(9,661)	(11,695)	(3,051)		
2	7	6	14	2	0	29
	(5,407)	(9,339)	(11,305)	(2,949)		
Missing	0	0	0	0	1	*
All	11	19	23	6	*	59

Chi-Square Test

	Chi-Square	DF	P-Value
Pearson	5,135	3	0,162
Likelihood Ratio	5,228	3	0,156

2 cell(s) with expected counts less than 5.

Table A2. 18. T-test for testing the relationship between willingness to try innovations and broad beans.

Descriptive Statistics: Willing to try new

Broad bean	N	Mean	StDev	SE Mean
1	30	3,433	0,898	0,16
2	30	3,3	1,02	0,19

Estimation for Difference

Difference	Pooled StDev	95% CI for Difference
0,133	0,962	(-0,364; 0,630)

T-Test

T-Value	DF	P-Value
0,54	58	0,593

Question 37: "How fast do you test new innovations connected to your crop production?" For this question they got to choose between 5 different options, why it is examined with chi-square test.

Table A2. 19. Chi-square test for testing the relationship between time to adopt innovations and broad beans.

Chi-Square Test for Association

Rows: Broad bean Columns: Q37

	1	2	3	4	All
1	2	18	8	2	30
	(2,5)	(16)	(9,5)	(2)	
2	3	14	11	2	30
	(2,5)	(16)	(9,5)	(2)	
All	5	32	19	4	60

Chi-Square Test

	Chi-Square	DF	P-Value
Pearson	1,174	3	0,759
Likelihood Ratio	1,178	3	0,758

4 cell(s) with expected counts less than 5.

Question 38: "When was the last time you tested a new crop?" (In number of years)

Table A2. 20. T-test for testing the relationship between willingness to try innovations and broad beans.

Descriptive Statistics: Q38

Broad bean	N	Mean	StDev	SE Mean
1	27	3,44	2,85	0,55
2	23	5,61	5,96	1,2

Estimation for Difference

Difference	Pooled StDev	95% CI for Difference
-2,16	4,55	(-4,76; 0,43)

T-Test

T-Value	DF	P-Value
-1,68	48	0,1

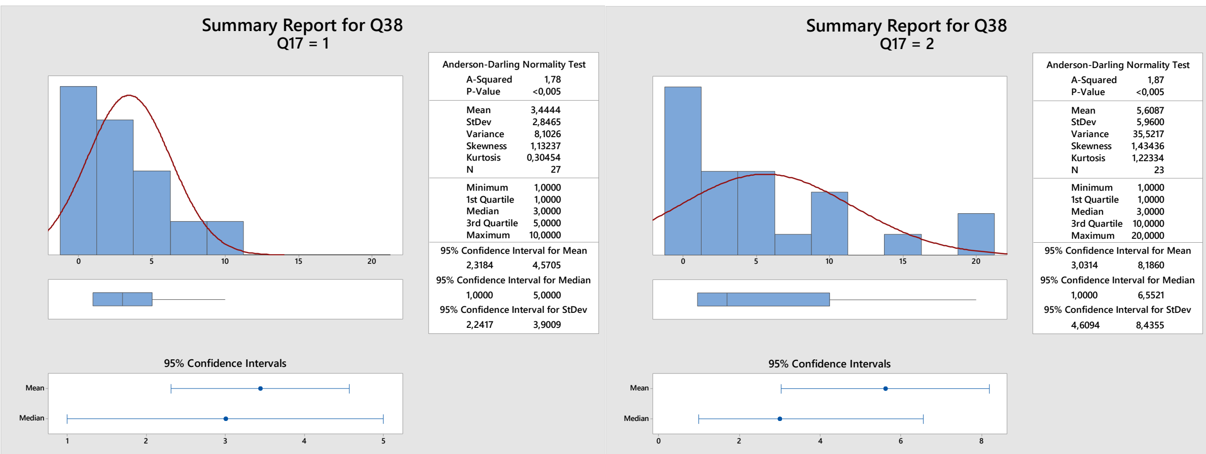

Figure A2. 4. Graphical summary of last time farmers tested a new crop. Group 1 (left) and group 2 (right).

Appendix 3 Questionnarie

Important information before the interview starts:

☐ The study is done for a thesis that will be published.
☐ Participation is voluntary and the respondent is able to cancel at any time.
☐ All participants will be anonymized.
☐ Consent and approval from the respondent is required for the material to be used (GDPR)

Questionnaire – telephone interview

Code:____
Date: ____
County: ____

Part 1: Background about the farmer

1. Age?
2. How long have you driven agriculture?
3. How long do you plan to run agriculture?
4. Do you have any post-secondary education?
5. Is the farming activity your main occupation?
6. What is the main reason why you farming?

Part 2: Background about the farming business

7. What is your main production line?
8. How many hectares of arable land?
9. Is cultivation conventional or organic?
10. What do you grow for crops? Mention the largest crops in the area
11. Percentage of how much of the crops are autumn-seeded and spring-seeded, respectively.
12. Do you have the option of storing and drying in-house?
    If YES: Capacity _____ ton/h Storage ______ ton
13. Have you implemented environmental measures in your production? Which? Why?
14. What do you have financial goals with your agriculture?
15. Do you have other goals?
16. How do you perceive the profitability in your crop production?

1: Very low. 2: Low 3: Satisfactory 4: Good, 5: Very good.

17. Do you grow broad bean?*****

Part 3: Frågeställningar med förutbestämda svarsalternativ eller öppna svar

18. How do you obtain information for decisions about your plant culture? What are the main sources of information?
    ☐ Adviser
    ☐ Agricultural seller
    ☐ Media/Internet
    ☐ Member organisation
    ☐ Neighbours/Colleagues/Friends
    ☐ Other_________________

19. How often (during a year) do you use any type of independent advisor or advisory service regarding your crop production?
    - ☐ 1-2 times/year
    - ☐ 3-6 times/year
    - ☐ 7-12 times/year
    - ☐ 12 or more times/year
    - ☐ Never or very rarely

20. How do you mainly sell your harvest?
    - ☐ Contract with grain traders
    - ☐ Direct delivery to other farms
    - ☐ Production for own use
    - ☐ Other______________

21. How far into the future do you plan your crop rotation and crop selection? (unit year)
22. How often do you revise your crop planning?
    - ☐ More than 5 times/year
    - ☐ 2 - 4 times/year
    - ☐ 1 times/year
    - ☐ Every two years
    - ☐ Every three years or more rarely

23. What is most determining factor in your decision of crop rotation/choice of crop?
24. Do you compare profitability between crops? If YES, How?
25. What is most determining factor when you decide what crop to grow, between price and crop rotation effects?
    - ☐ Price
    - ☐ Crop rotations effects
    - ☐ Both equally crucial

Part 4: Questions about broad bean

*If YES in question 17 (grow broad bean)

26. For how long have you grown broad beans? (Number of years)
27. What is your broad bean used for?
    - ☐ Sales for livestock feed
    - ☐ Sales for seed
    - ☐ Sales for human food
    - ☐ Own livestock feed
    - ☐ Other__________________
28. What is the main reason why you grow broad beans?
29. What do you experience is the greatest benefit of growing broad beans?
30. What do you see as the biggest challenge of growing broad beans?
31. What would make you grow more broad beans?
32. Would a higher price make you grow more broad beans?

*If NO in question 17 (not grow broad bean)

33. Why do you not grow broad beans?
34. What would make you start growing broad beans?
35. Have you cultivated broad beans before? If YES, when and why did you quit?

Part 5: Questions about innovation

36. When it comes to innovations such as new cultivation techniques or crops, would you describe yourself as a person who likes to try new things?

1: Not correct at all. 2: Correct part, 3: Neutral in the question, 4: Strongly agree, 5: Completely correct.

37. How fast do you test new innovations related to your crop production?
    - ☐ I test as soon as I hear of it
    - ☐ I like to test, but wait until I see it works
    - ☐ I test when I see it's popular and used by many
    - ☐ It requires quite a lot to make me try new things
    - ☐ I like to do what I always do

38. When was the last time you tested a new crop (In number of years), and which was it?
39. Concluding discussion: *An increased demand/trend for more vegetable products to reduce meat consumption. Is this something you notice? Do you see any potential in growing legumes in the future?*