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Potato farmers' decision-making under uncertainty.

- A study about farmers' reference points and domain specific risk preferences.

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Potato farmers' decision-making under uncertainty. - A study about farmers' reference points and domain specific risk preferences
Potatisodlares beslutfattande i en situation med osäkerhet – En studie om lantbrukares referenspunkter och risktagande inom olika områden.

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Abstract

Swedish agriculture has declined for several decades, and for potato cultivation, the decrease has been particularly dramatic. At the same time, Sweden has adopted a national food strategy that aims to increase the production of foodstuff in Sweden. If this strategy is to be realized, the trend of declining production must be reversed. To understand how the potato industry can develop, there is a need for better knowledge of how potato farmers make decisions under risk in potato cultivation. This study aims to understand how potato growers' revenue targets affect risk-taking in cultivation decisions, and how other factors affect farmers' willingness to take risks in their farm businesses.

Potato farmers are basically risk averse and the industry needs to find ways to shift the risk from the individual farmer to other actors in order to create a better functioning of potato market that generates higher yields and greater profits on the potato market. For instance, the average farmer is prepared to forgo a six percent increase in average revenue, if the increase will result in a greater increase in the fluctuation of annual revenue. Farmers' decision making is affected by their revenue targets, with a higher revenue target contributing to farmers being less risk-averse in cultivation in in the pursuit of increase revenue. There are also tendencies for a revenue target to function as a reference point for farmers to relate to. At the same time, the potato growers who have a desire to control and minimize the risks surrounding cultivation in the short term are also more willing to take more risks in the cultivation to maximize results in the longer term.

The study was conducted as a quantitative experiment with an experimental survey, where potato farmers answer questions about which of different revenue distributions they would prefer. The survey also included questions about respondents' potato cultivation, and which actions the they see as important in creating a more stable result for their business. The analysis uses statistical correlation tools and knowledge from previous studies from a Prospect theory perspective.

Sammanfattning

Det svenska lantbruket har minskat under flera år och för potatisodlingen har minskningen varit än mer dramatiskt. Därtill har Sverige antagit en livsmedelsstrategi som har som mål att öka produktionen av livsmedel i Sverige. För att uppfylla detta mål krävs det att trenden med minskad produktion av potatis bryts. För att förstå hur branschen skall kunna utvecklas krävs det en ökad förståelse för hur potatisodlare tar beslut och hanterar en tillvaro med osäker avkastning från potatisodlingen. Denna studie har främst fokuserat på hur potatisodlares inkomstmål påverkar risktagandet i odlingsbeslut, men även andra faktorer som påverkar odlarens vilja att ta risker i sitt lantbruksföretagande. Resultaten från studien visar att potatisodlare ogillar risk och är beredda att avstå viss avkastning för att minska risken i odlingen. Exempelvis skulle snittodlaren avstå en ökning på sex procent i medelavkastning från potatisodlingen, om den medförde en större ökning av fluktrationen i avkastningen.

Det som påverkar odlarna i studiens riskvilja är dels deras inkomstmål. Där ett högre inkomstmål bidrar till att lantbrukaren är mer villig att öka risken i odlingen för att öka sina intäkter. Det finns även tendenser på att inkomstmålet fungerar som en referenspunkt som lantbrukarna förhåller sig till. Där lantbrukarna är beredda att utsätta sig för den risk som krävs för att uppnå målet. Studien kan dock inte avgöra om det är inkomstmålet eller något närliggande monetärt mål som att täcka upp för sina kostnader eller uppnå en viss vinst som är viktigast för lantbrukaren på grund av att dessa mål endast har mindre skillnader. En annan del som påverkar odlarnas beslutsfattande är hur de uppfattar att deras egna kontroller av maskiner och odlingen stabiliserar avkastningen. De odlare som anser att deras egna kontroller är viktiga är också mer villiga att ta mer risker i odlingen. Dessa odlare anser även försäkringar och att följa regler är viktiga delar för att åstadkomma ett mer stabilt resultat.

Slutsatserna från studien är att de potatisodlare som har en vilja av att kontrollera och minimera riskerna runt odlingen också är mer villiga att ta mer risker i odlingen för att maximera resultatet på längre sikt. Dock är odlarna i grunden ovilliga att ta risker och marknaden behöver hitta sätt för att flytta risk från den enskilda odlaren till andra aktörer för att skapa en bättre fungerande potatismarknad som genererar högre avkastning och större vinster för marknaden i stort.

Studien är genomförd som ett kvantitativt experiment med en experimentellenkät där potatisodlare har fått svara på frågor om vilken av olika avkastningsfördelningar de skulle föredra. I enkäten inkluderas även frågor om potatisodlingen samt vilka handlingar som odlaren ser som viktiga för att skapa ett stabilare resultat för företaget. Enkäten spreds i sociala medier samt via utskick med hjälp av företag och fick in 21 svar som kunde analyseras. Dessa analyserades med hjälp av statistiska korrelationsverktyg och med kunskap från tidigare studier och Prospekt teorin.

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1 Introduction

People differ in the way they make decisions under uncertainty and risk. This study presents insight into how the individual's own revenue target affects their decision-making. This chapter presents a background including potato cultivation, agricultural risks, and decision making, followed by a problem description. After that, the problem statement, aim and scope is presented. The final section is a presentation of the structure of the rest of the report.

1.1 Background

The potato cultivation is an important crop for Swedish agriculture and society since it creates a large value in primary production with 1822 million SEK in 2012, which is 6.9% of the total value from the Swedish primary production (Eriksson *et al.* 2016). This value was created on only 0.9% of the total cultivated land. In the society potatoes are also important food since it is one of the food stuffs with the lowest carbon footprint per kilo in our diet, with 0.1 CO2e/Kg, compared to rice with a carbon footprint at 2 CO2e/Kg (Röös 2014). In 2017 the Swedish government adopted a national food strategy (Löfven & Bucht 2017). In this strategy, the main goal is to increase Sweden's self-sufficiency and profitability in the food sector. Potatoes are one of the foods that have the largest ability to increase the self-sufficiency of food in Sweden (Eriksson *et al.* 2016). Nevertheless, potato cultivation has decreased over several decades. One of the reasons for this decrease could be that it is a risky crop, with risk in several domains, for instance, high pathogen pressure.

1.1.1 Risk in agriculture

In agriculture risk and uncertainty always play a significant role. Farmers try to secure their yield by developing better control and production processes in their farming (Hardaker *et al.* 2015). Nevertheless, it seems risk and uncertainty are inevitable in agriculture. The risks that the farmers face comes from several different sources and domains (Miller *et al.* 2004). These can be directly related to the farm business and some would exist even without a farm, but still affect the farm business. Studies have shown that individuals' risk preferences can differ among various domains (Weber *et al.* 2002; Hansson, & Lagerkvist 2012).

The risk that is not directly related to the farm business but still affects it is the risk that relates to the farmer such as social or health risks. Health risk can be the risk of a heart attack and that is a risk that exists even without the farm but have a great effect on the farm business (Miller *et al.* 2004). Social risk relates to the social life of the farmer since the workload on the farmer relates to the possibility to participate in social activities outside the farm. Both domains are not risks for the farm business itself, but because of the close relationship between the farmer and the farm they are dependent on each other. The risks that are more related to the farm business is production, price, technology, financial, and political risks (Miller *et al*. 2004; Hardaker *et al.* 2015).

Production risk for crop growers is caused by unpredictable weather, disease, insect, and many other unpredictable factors (Miller *et al. 2004;* Hardaker *et al.* 2015). The weather is always unpredictable and will affect the yield of the crop by being too dry or too rainy conditions. Also, extreme weather with hail and flood can decrease the harvest. There is a possibility to build away some of these risks with irrigation and drainage or just insurance

against damage from extreme weather. Disease, insect, and other biological pests can destroy the crop. To protect against these risks farmers uses pest management system, which helps them to know when to use plant protection.

Price uncertainty has always been a significant factor for farmers' profitability, and it relates to both farm inputs and outputs (Miller *et al*. 2004; Hardaker *et al.* 2015*)*. The price risk is associated with the production risk. In the case of lower grain production on the aggregated market, normally it increases the grain price and gives the farmer a natural hedge. However, this may not hold for the individual farmer that gets lower production as such production does not affect the world price. The price changes due to the production can also create uncertainty since it is harder to plan the production with a fluctuating price. To avoid the price uncertainty the farmer can hedge prices in a future market or sell on contract. However, these future-markets do not exist for all crops.

Technology risk arises from the constant development of new techniques, methods, and products for farming (Miller *et al*. 2004). Technology risk is often viewed as a part of production risk but can also be a risk itself. New products such as chemicals, machines, and new crop varieties are being developed all the time and their beneficial effect can be proved in experimental culture. However, it might not be good/beneficial on a given farm because of varying conditions or that the farmer might be lacking the knowledge to obtain the full potential of new technology. The fast development of new technologies also contribute to uncertainty because a new method might be adopted, but even better methods can come close after. Were the first method becomes obsolete and the value of the method and its product disappears. To handle technology risk the farmer needs a strategy on when to adopt new methods and analyze how large the benefit of the technology is for his farm.

Financial risks come from how to finance the farm business (Hardaker *et al.* 2015). The farmer who uses borrowed funds needs to share a part of the profit to the capital owners and the debt capital is paid before the farmer can take out any salary. However, the farmer that uses borrowed capital opens a possibility to invest in new technologies, which increase profitability and can lower other risks.

Institutional risks is another type of risks that can affect farmers' income and it comes from the interaction with institutions (Miller *et al*. 2004). These risks arise from the risk of unfavorable policy changes like changes in trade agreement or subsidies schemes. In recent decades, governments around the world have changed the conditions for agriculture, towards a more liberal and market-oriented strategy after a long time with governments intervening to lower farmers' risks with quotas and guaranteed prices. (Babcock *et al.* 2003; Hardaker *et al.* 2015). This creates uncertainty for the farmer who no longer can rely on a guaranteed price. The legal institutions also cause uncertainty for the farmer with new rules for food safety and environmental control, as the rules are not always predictable.

All these types of risk affect the farm and they can be handled in several ways. The farmer can try to reduce risks by controlling and monitoring his crops or using crops with a stable demand (Miller *et al*. 2004). He can also use insurances or hedging to transfer the risk from the farmer to someone else for a cost to reduce his own risk. The farmer can also use a strategy to absorb risks and handle uncertain events without having a catastrophic result. In order to absorb risks, the farmer can reduce the debt to manage financial damage better or diversify the production on the farm to avoid a bad crop creating a big problem. Another strategy for the farmer is to create a business that is more flexible to uncertainties. This can be

managed by avoiding fixed costs from owning specialized equipment and having broader knowledge (Miller *et al*. 2004).

1.1.2 Decision making under risk

To be able to understand how people tackle risk the literature has been analyzing decision-making. Most economic theory on individual decision-making comes with the assumption that people behave rationally (Edwards 1954). In line with this assumption, the decision-maker has full knowledge when making a decision and clear and stable preferences. From that comes the assumption that the decision-maker maximizes utility and will make the same decision again if he is confronted with the same choices again and will maximize his utility.

The decision-making process is built on the following steps (Edwards 1954). First, the decision-maker needs to have different available alternatives to be able to make a choice. Secondly, the alternatives need to include some kind of outcome or outcomes, which have a value for the decision-maker so it will be possible for him to rank the alternatives. Finally, the decision-maker needs to have information about the probability of the different outcomes from the alternatives.

To evaluate utility from decisions is the most commonly used model the expected utility theory and it has served the purpose of being the normative as a model of rational choice in uncertain conditions (Rabin 2000; Babcock 2015; Tonsor 2018). Bernoulli (1954) proposed the expected utility theory in 1783. The main assumption the theory makes, is that decision-makers will increase their benefit from each gain. However, the increase in utility will decrease with every gain, which means that the decision maker becomes risk-averse.

However, Simon (1972) has listed three reasons why people are inconsistent with the normative model: limited access to information about options, uncertainty about the consequences and limited human computational abilities. This observation led him to the conclusion that an accurate model of decision-making should be based on the concept of bounded rationality (Simon 1955).

Simon (1990) argued that bounded rationality derives from computational capacities and the environment, which should work together. Throughout the decision process, people use their computation capacities in a specific environment which leads to satisficing but not optimal, choices.

Another utility model is the prospect theory that was developed by Kahneman and Tversky (1979; 1992). The purpose of prospect theory is to explain individuals' behavior under uncertainty, where the individuals' behavior is inconsistent with the expected utility theory. The main difference is that prospect theory does not value outcomes and instead value changes. These changes are gains or losses from neutral reference points and are making the model reference dependent. The individual reference points are not permanent and can change with time and experience. The gains and losses are not valued the same and a loss hurt more than a gain satisfies, this makes the individuals' loss averse.

1.2 Problem

Farmers that produce potatoes operate in an unusually risky economic environment even compared to other farmers (Walker *et al.* 1999). Potatoes are more vulnerable to production

risk as diseases, for instance, potato blight. Also, production risks that may arise from the weather are large for the potato farmers and about one percent of the total cultivation area in Sweden is not harvested every year because of the weather (Jordburksverket 2018). The fact that the potato is a food that sells directly to the consumer makes the visible quality more important with the peel and size, which creates even more quality risks for the potato farmer.

Potatoes are also an inelastic commodity, which is subject to unusually large price variations (Acs *et al*. 2009; Hueth & Ligon 1999). Figure 1 shows the price fluctuation in the table potato industry compared to wheat during this millennium and most of the price variation comes from unforeseeable shocks in supply. The potato farmers are also exposed to high technology risk due to a lot of specialized equipment, as an example is potatoes are harvest with a special Potato harvester, which has no value for the farm without the potato cultivation.

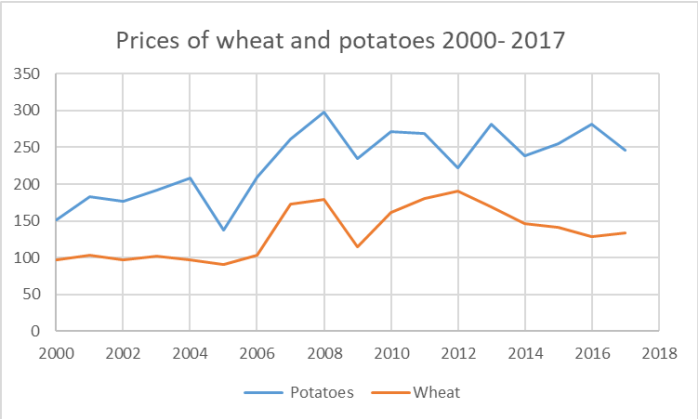

Figure 1. Prices of wheat and potatoes in Sweden 2000- 2017 (Own processing from Eurostat 2019)

Both production and price risk has increased for the potato farmers during the last decades. This comes from a shift in the table potato sector, where the farmers take more of the total risk in the sector and the wholesalers and stores take a smaller part of the total risk (Zachariasse & Bunte 2003). In addition to risk-shift, there is no price hedging market or other insurance schemes for the potato price, which makes it hard for the potato farmer to reduce exposure risk. Tomek and Gray (1970) argues however that price hedging on a market as the potato market do not necessarily lead to lower revenue volatility due to non interseasonal prices. During the time when the risk for the potato farmers has increased, the number of table potato farmers has decreased in Sweden, since 2000, the number of potato farmers has more than halved and is 2,500 in 2018 (Törnquist 2015; Jordburksverket 2018). This decrease is larger than the general decrease in Swedish agriculture.

Given the inevitable risky and uncertain agriculture, it is vital to understand farmers' decision-making (Harrison 2011). The understanding can be used to predict economic behavior, market outcomes and policy assessment, as well as individual risk analyses of the individual farmer. A greater understanding of the individual farmer's risk perception would give a possibility to increase the total value of the agricultural sector. Harrison (2011, p. 355) explain the problem:

> *We now have many rich models of behaviour, allowing structural understanding of decisions in many settings of interest for the design of agricultural, food and resource policy. But we also realise that there are some basic confounds to reliable inference about behaviour. These are not side technical issues. Risk attitudes can involve more than diminishing marginal utility, and we have no significant problems identifying alternative paths to risk aversion through probability weighting. Loss aversion is much more fragile, until we can claim to know the appropriate reference points for agents.*

If we admit that there is loss aversion from a reference point, it becomes vital to have a method that can evaluate what reference point farmers use. Today there are many elicitation methods that rely on hypothetical or non-hypothetical lottery-choice tasks (Holt & Laury 2002; Eckel & Grossman 2002) and domain-specific risk preference scales (Blais & Weber 2006; Hansson, & Lagerkvist 2012) or a combination of them (Reynaud & Couture 2012). The lottery-choice methods focus mostly on risk preferences that involve diminishing marginal utility and do it with small stakes and no real possibility for loss (Köszegi & Rabin 2006). In laboratory studies with no real (monetary) loss, it becomes easy to assume that the reference point is zero, which enables a clear view of the risk preferences for the individual subject. However, those tests will not show any loss aversion or determine the subjects' reference points (Köszegi & Rabin 2006).

The small stakes in most laboratory experiments can also be a problem even if studies have tested how different stakes affect subjects. Most research with different stakes has done as Reynaud and Couture (2012) with two different stakes, which do not show how or when the risk preferences change, just that they are changed.

Heath *et al.* (1999) described a reference point as a target, where the motivation to reach the target increases when the person approaches the target. The target thereby has a high marginal utility and the person is prepared to sacrifice more to reach the goal. In an agricultural context, it would be conceivable that the farmer's revenue target will affect how he makes decisions about cultivation.

1.3 Problem statement

Without a good hedging system and large quality risk, it is hard for potato farmers to avoid risk and these risks can lead to lower production. To be able to give farmers value-adding help it is essential to know more about how farmers make decisions under risk (Harrison 2011; Tonsor 2018). The reference point is vital to understand decisions because it is not only the risk preferences with diminishing marginal utility that determines the decision-making under risk (Kahneman & Tversky 1979; Rabin 2000; Harrison 2011). In particular, the reference point since it is the starting point for other vital elements in prospect theory, the loss aversion, and diminishing sensitivity. A possible reference point that the farmers use is the revenue target for the cultivation.

1.4 Aim and research scope

The purpose of this study is to widen the understanding of Swedish potato farmers' decision-making under risk, by using the revenue target as a reference point in a risk preference test.

(1) What affects Swedish potato farmers' risk preferences when they take decision under risk?
(2) How do potato farmers' revenue targets relate to their risk preferences in Sweden?

This study focuses on the revenue target as the primary reference point. Revenue can be seen as just a monetary figure because it needs the costs to determine whether it is good or bad. With that, a profit target would be more appropriate to evaluate the utility from. However, the farmers' profits differ because they calculate their own labor costs in different ways, some farmers do not include any cost for their own work in production and instead use the profit as a salary. The same with capital cost due to machines, which is also not a visible cost. This would make a given profit an actual loss if labor and capital costs were included. The revenue target is chosen due to its ability to involve both the price risk and the production risk. It is also a number that the farmer can easily relate to because it is the number he sees on the settlements and it can be compared cross different years. This makes it easier to create goals for revenue.

The focus is on the revenue target with both price and production risk, which is analyzed as a factor. This despite the risk preference for price and production risk may differ (Weber *et al.* 2002; Hansson, & Lagerkvist 2012). By not dividing them, the study is limited because it cannot say why the farmers have a certain risk preference. However, it is more important to explain potato growers overall risk preferences with both price and production risk. The potato farmers surveyed are autumn/winter table potato growers in Sweden in order to get a more homogeneous sample.

1.5 Structure of the report

This chapter discusses the background and importance of the study, it was followed by an overview of the research scope and delimitation of this study.

Chapter 2 – Theoretical perspective – This chapter presents the foundation of the conceptual framework this study uses with prospect theory. It also describes different eliciting risk methods used in this study and finally the conceptual framework of this study is described.

Chapter 3 – Methodology – This chapter presents the overall research design including the research methodology and sample selection. Followed by a discussion of the approach of the survey and analysis of this study use. This chapter also discuss the quality criteria and ethics of the study.

Chapter 4 – Empirical data – This chapter presents the data this study has collected with descriptive statistics for the different parts of the survey presented in tables and text.

Chapter 5 – Analysis – This chapter present the result of the different analysis methods this study use.

Chapter 6– Discussion – In this chapter is the empirical data and result from the analysis discussed from the view of the literature.

Chapter 7– Conclusions – This chapter presents the final conclusions that this study contributes to and the limitations of the study. Last comes some suggestions for future research.

2 Theoretical perspective

This study considers prospect theory as an alternative to expected utility theory to understand decision making under risk. Prospect theory is chosen over the more common expected utility theory since it is reference dependent (Kahneman & Tversky 1979). The reference-dependence is vital since this study examines a monetary target with the revenue target. The conceptual framework is an experiment with lotteries involving both gains and losses from a reference point to understand the farmers' risk preferences. The conceptual framework is built of ideas from the prospect theory and eliciting methods that is presented in this chapter.

2.1 Utility theory

A trade-off of the possible outcomes is a significant part of economic decision-making and risk and uncertainty is an important part of computing the outcomes. Peoples risk preferences describes how individuals handle risk in their decisions. Below is a presentation of the two most commonly utility theories in the field of decision-making, expected utility theory, and prospect theory.

2.1.1 Expected utility theory

Expected utility theory is the commonly used theory to describe decision-making under risk (Moschini *et al. 20*02). The theory explains how the rational man maximizes the expected utility in a situation that involves risk (Bernoulli 1954). The rational man gains utility from every increase in wealth and the expected utility theory explains the amount of utility from his risk preferences. The subject does also know his probabilities and outcomes for each option that he can choose between and his relative preference for each outcome. If there is a choice with two options and two possible outcomes, he calculates the probability-weighted average utility for each option. This makes it possible for him to make a rational decision about which option has the highest expected utility and it might not be the one with the highest expected return. In expected utility theory the humans are utility maximizers and not wealth maximizers (Moschini *et al. 20*02).

There are three significant types of risk attitudes; risk-averse, risk neutral and risk-seeking (Figure 2). According to the literature is most individuals risk-averse (Hardaker *et al. 20*15). Risk preferences do however differ between individuals and depends on many different factors like experience, age or gender. The risk-averse subject has a concave utility curve, which apply that every extra gain contributes with less utility (Hardaker *et al. 20*15). As an example, is the SEK that takes you out from poverty worth more utility than the SEK that makes you rich (Moschini *et al. 20*02). The risk-neutral subject has a straight utility curve. The risk-seeking subject has a convex utility curve. The risk-averse subject is willing to give up some expected wealth to be able to reduce some risk. The risk-seeking subject is willing to give up some expected wealth to have a chance to get more wealth.

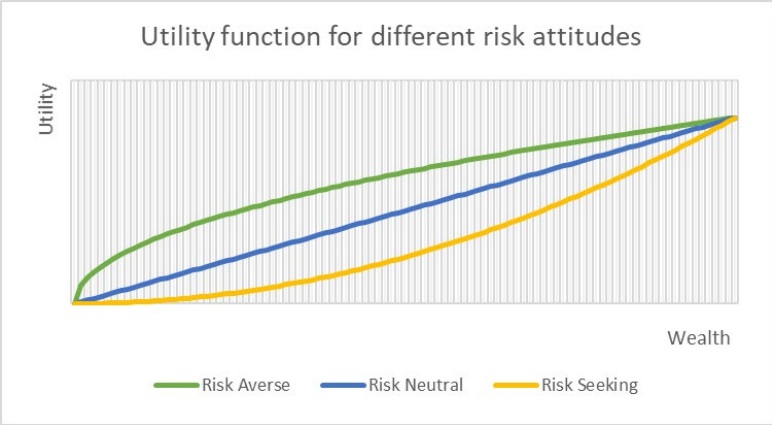

Figure 2. Utility function and shape for different risk attitudes (Own processing)

2.1.2 Prospect theory

Kahneman and Tversky (1979) first developed prospect theory in 1979, comprising the critique against expected utility theory and how it is explaining the decision making under risk. Kahneman and Tversky (1979) demonstrate that when people are confronted with risky prospect choices under laboratory settings, their preferences systematically violate the premises of expected utility theory. One of the article's main findings is that people underestimate outcomes that are merely probable in comparison to outcomes obtained with certainty, which was called the certainty effect. This effect contributes to risk-aversion regarding choices associated with sure gains and risk-seeking regarding choices involving sure losses.

Prospect theory captures these experimental pieces of evidence on risk-taking, including the recorded contraventions of expected utility (Kahneman & Tversky 1979). The model presented has a value assigned to gains and losses rather than to final assets, and probabilities are replaced by decision weights. According to the theory, people derive utility from gains and losses, which are measured relative to some reference point, commonly corresponding to the current asset position. The proposed S-shaped value function is defined on deviations from the reference point, it is generally concave for gains and convex for losses and steeper for losses than for gains (Figure 3).

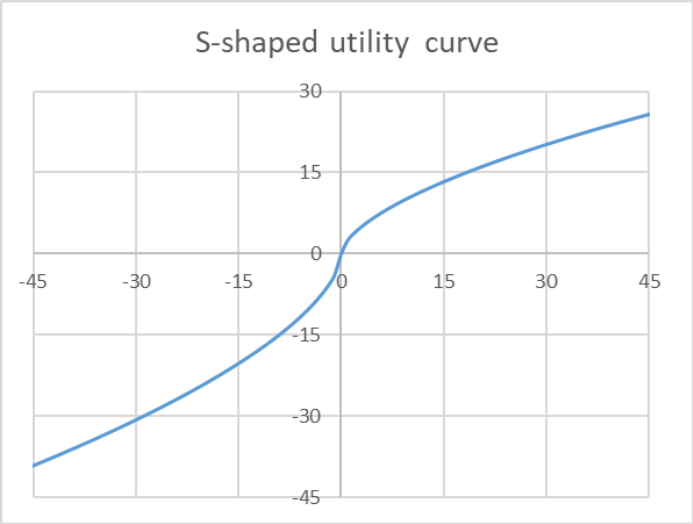

Figure 3. A hypothetical value function (Own processing from Kahneman and Tversky 1979)

In 1992, Tversky and Kahneman published Advances in Prospect Theory: Cumulative Representation of Uncertainty. In this article, Kahneman and Tversky developed a new version of prospect theory entailing cumulative decision weights instead of separable. This model applies to uncertain and risky prospects with any number of outcomes, compared to the old one, which was only valid for gambles with a maximum of two nonzero outcomes. In addition, it grants for various weighting functions of gains and losses and the weighting function is addressed to cumulative probabilities, e.g. probability of acquiring at least $200, or of losing $100 or more. The curvature of the weighting function explains puzzles about overweighting unlikely outcomes (the tails of probability distributions), which contributes to the understanding of why people buy insurances and participate in lotteries. The curvature of the value function reinforces the risk-aversion for gains and risk-seeking for losses.

Under prospect theory, an option is evaluated as:

$$V(f) = \sum_{i=-m}^{n} \pi_i v(x_i).$$

Where V(f) is the overall value of prospects, v(·) is the value function (increasing) and πi are the decision weights. The formula contains the four elements of prospect theory, namely reference dependence, loss aversion, diminishing sensitivity, and probability weighting.

Kahneman and Tversky (1979) state that loss aversion is a fundamental concept in decision making. According to the concept is a loss more painful than a similar gain and it creates a kink on the utility curve at the reference point, when leaving the loss domain and entering the gain domain. If the subject is more loss averse is the kink greater at the reference point. Loss aversion is also involved in several biases as endowment effect and status quo bias (Tversky & Kahneman 1991; Kahneman *et al.* 1991). These biases can be explained by the concept that, as something in an individual's possession will automatically be more valued by the individual just because it is in his possession. The thing the subject possess will, become a reference point for the subject and cost more to lose than it gave when it came. Tversky & Kahneman (1991) studies describe the level of loss aversion as losses are twice as painful compared to the pressure from gains. Heath *et al.* (1999) state that other studies have derived loss aversion factors between two and four.

Kahneman and Tversky (1979) state another important concept in all utility theory and it is diminishing sensitivity. It implies that the marginal value for one extra gain over the reference point decrease in value for every gain. For instance, an increase in revenue from 40 to 45 thousand SEK is less utility gaining than a change from 35 to 40 thousand if the reference point is 35 thousand. The same diminishing sensitivity is valid for losses and the difference between a loss on 100 and 200 is larger than a loss at 1100 and 1200 (Tversky & Kahneman 1991). This is what gives the S-shaped utility curve its characteristic formation (Figure 3).

2.1.3 Reference point

The reference point divides the outcome in what is a success and a failure (gains and losses) and is the neutral point in prospect theory, where the value is derived from (Tversky & Kahneman 1991). Most research has focused on a status quo reference point, which can be zero profit or zero income for a producer (Heath, *et al.* 1999; Köszegi & Rabin 2006). A non-status quo reference point could instead be a goal that the producer has. It can also be a past experience or just expected outcome. The different reference point is important since the assumption of diminishing sensitivity and loss aversion is reference dependent. Koop & Johnson (2012) and other researchers have studied decision-making using multiple reference points. Koop & Johnson (2012) used three reference points: the status quo, minimum requirement, and goal. Their setting focuses on the use of multiple reference points at the same time and how people act near them.

To show how the utility change near the reference point this study has created three problems that show how the marginal utility changes along the utility curve.

Problem 1. Think of two farmers Carl and Erik who cultivate potatoes. Carl wants to obtain a revenue from sales of 60 000 SEK/ha and Erik wants to obtain a revenue from sales at 50 000 SEK/ha. Both have the same cost and knowledge about potato cultivation. They have a cost of 40 000 SEK/ha. If than Carl and Erik get 55 000 SEK/ha. Who gets the most utility from the cultivation?

Here both have created revenue that exceeded the cost of the cultivation. Carl has however not reached his goal of 60 000 SEK/ha. With an assumption of only a status quo reference point, it creates the same value for them both from the cultivation. However, earlier studies show that with a problem like this will Erik get more value since he did reach his target (Heath, *et al.* 1999). This can be explained by a loss aversion and that Carl feels that he lost 5000 when he did not reach his goal.

Problem 2. Same problem as problem 1 but the difference is that this time the income increases to 60 000 SEK/ ha. What is the difference in value from problem 1 and who gets the most extra value?

Here both Carl and Erik reach their targets, both for zero profit and revenue targets. Carl gets extra value for reaching his reference point at the revenue target when going from the loss side to gain side of the utility curve. Erik moves away from the reference point, so he gets more value, but the marginal value goes down because of diminishing sensitivity. Carl, on the other hand, is in the part of the utility curve that has the highest marginal value from gains. Figure 4 shows the difference between Carl's and Erik's extra value with prospect theory's S-shaped utility curve and a reference point at their personal revenue targets. When the marginal

value of an extra 5000 SEK is higher for Carl becomes willing to sacrifice more to get them. The sacrifice may be exposing him to more risk in his cultivation.

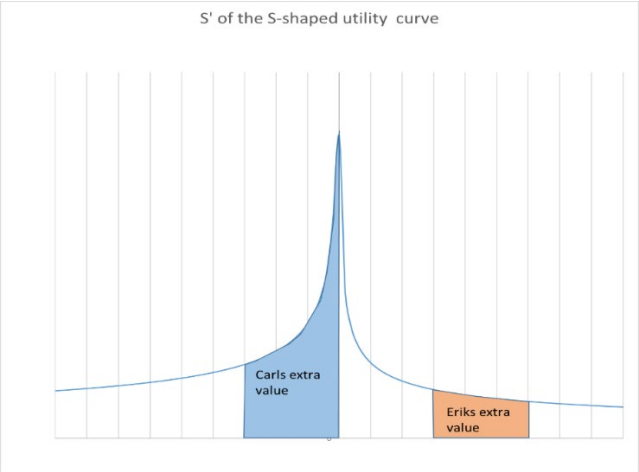

Figure 4. A derivative of the S-shaped utility curve (Own processing)

Problem 3. The same problem as problem 1 but the difference is that this time the income decreases to 50 000 SEK/ha. What is the difference in value from problem 1 and who have the greatest change in utility?

Here Erik reaches his revenue target, but Carl is further away from the target now than in problem 1. Carl goes from missing his revenue target with 5 000 SEK to 10 000 SEK. If Carl uses the revenue target as a reference point the value change in problem 3 becomes smaller than in problem 2 due to diminishing sensitivity in losses (Tversky & Kahneman 1991). Instead, if Carl uses the status quo (zero profit) as a reference point the change in problem 2 becomes smaller than in problem 3 due to diminishing sensitivity in gains. Erik still reaches his target and will not be exposed to any loss aversion, but diminishing sensitivity makes the marginal value change larger in problem 3 than in problem 2.

The theoretical framework shows the use of a reference-dependent utility theory as prospect theory has on potato farmers' decision making. The main differences with a non-status quo reference point is what happens near the reference point, with loss aversion and diminishing sensitivity (Tversky & Kahneman 1992). Figure 5 shows the differences in a utility curve between a non-status quo reference point (Series 1) and a status quo reference point (Series 2), where the status quo reference point curve overestimate the utility just under the reference point (40) and underestimate the utility over the reference point (60). These over and underestimations can change what prospect is preferred in decision with risk.

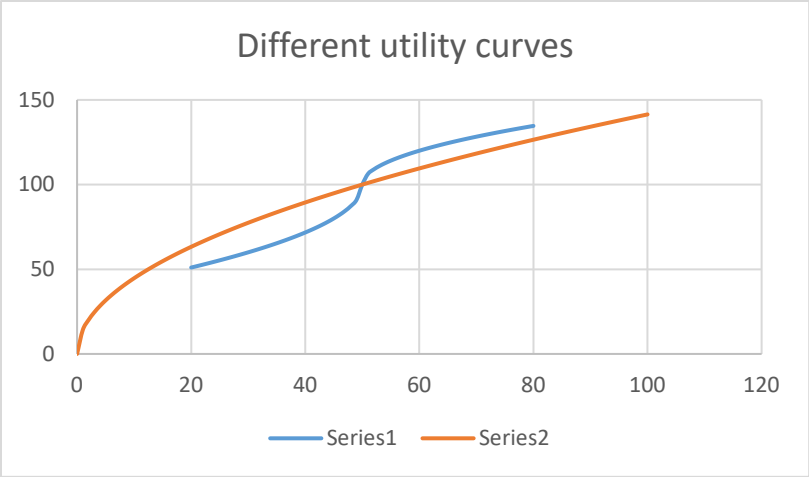

Figure 5. Different utility curves (Own processing)

2.2 Eliciting risk preferences methods

The fact that risk aversion is a well-established concept in both economics and behavioral science as well as having a precise mathematical definition makes it theoretically possible to reach high precision (Thomas 2016). However, the theoretical disagreements about the utility theory, have resulted in the emergence of several methods to measure risk aversion. Despite experimental research, there is currently no general method for modeling risk aversion (Charness *et al.* 2013). Charness *et al.* (2013) instead recommend that the researcher should use the methods that best fit into the research question and the subject pool the study use. Some selected methods for elicitation methods that are relevant to this study follows.

2.2.1 Eckel and Grossman method (EG)

Eckel and Grossman (EG) (2002; 2008) method is based on a lottery framing were the subjects choose one out of five gambles, with two outcomes and each with a 50% probability (Table 1). The first gamble has a sure payoff and the following had a higher expected payoff but also a higher standard deviation. A totally risk-averse subject in that situation would choose the first gamble and the moderate risk-averse subject would choose the gamble two to four. If the subject is risk-neutral or risk-seeking it will choose the last gamble five with the highest expected outcome (Eckel & Grossman 2002).

Table 1. Eckel and Grossman method (2002).

Choice (50/50 Gamble)	Low payoff	High payoff	Expected return
Gamble 1	16	16	16
Gamble 2	12	24	18
Gamble 3	8	32	20
Gamble 4	4	40	22
Gamble 5	0	48	24

A limitation with Eckel and Grossman's method is the ability to see the difference between risk-seeking and risk-neutral behavior. A more reason study from Reynaud and Couture (2012) used EG's method but increased the number of gambles to nine with three gambles that show on risk-seeking behavior. This to be able to compare the result with a Holt and Laury test. Reynaud and Couture (2012) did derive a higher constant relative risk aversion

(CRRA) coefficient at the EG test than the Holt and Laury test when testing it on French farmers. They did derive a CRRA coefficient that was equal to 0.62 and 1.02 for a low respectively high payoff. CRRA coefficient is the most popular function to show risk preferences, U(x) =(x^1−r)/(1−r), where r is the CRRA coefficient (Harrison *et al.* 2007; Menapace *et al.* 2015).

Eckel and Grossman (2002) did a test with different stakes to evaluate loss aversion. The test was divided into two stakes and they did not find any loss aversion in their lab setting different from previous studies by Kahneman *et al.* (1991), Tversky & Kahneman (1992). Charness *et al.* (2013) describe EG's method as a simple experiment were the subjects is normally is a paid.

2.2.2 The multiple price list method

There are several types of multiple price list methods and one of the most used is Holt and Laury's (2002) lottery method (Charness, *et al.* 2013). When using this method, a subject will choose between paired gambles in a list with two columns, Option A and Option B (Table 2). In most settings the payoff is constant between the rows in the column, but the probability changes between the rows. The subject chooses a preferred option between each of the paired gambles. In the first row Option A has a higher expected payoff and in all the rows after the expected payoff is increasing faster at Option B. In the last row Option B is certain to be the highest payoff. The subjects risk preferences are derived from when they switch from Option A to B. The very risk-seeking subject will choose Option B already in the first row and the totally risk-averse subject will choose B first in the last row.

Table 2. Multiple price list, from Holt and Laury (2002).

Option A	**Option B**	**Option A**	**Option B**
1/10 of $2, 9/10 of $1.60	1/10 of $3.85, 9/10 of $0.10	□	□
2/10 of $2, 8/10 of $1.60	2/10 of $3.85, 8/10 of $0.10	□	□
3/10 of $2, 7/10 of $1.60	3/10 of $3.85, 7/10 of $0.10	□	□
4/10 of $2, 6/10 of $1.60	4/10 of $3.85, 6/10 of $0.10	□	□
5/10 of $2, 5/10 of $1.60	5/10 of $3.85, 5/10 of $0.10	□	□
6/10 of $2, 4/10 of $1.60	6/10 of $3.85, 4/10 of $0.10	□	□
7/10 of $2, 3/10 of $1.60	7/10 of $3.85, 3/10 of $0.10	□	□
8/10 of $2, 2/10 of $1.60	8/10 of $3.85, 2/10 of $0.10	□	□
9/10 of $2, 1/10 of $1.60	9/10 of $3.85, 1/10 of $0.10	□	□
10/10 of $2, 0/10 of $1.60	10/10 of $3.85, 0/10 of $0.10	□	□

Tanaka *et al.* (2010) used another setting of the multiple price list method to evaluate risk preferences in Vietnamese villages. They focused on evaluating their behavior with the ideas from prospect theory. Their multiple price list involved three choice series to be able to examine probability weighting, loss aversion, and diminishing sensitivity. However, they did not examine reference point's dependence.

These types of tests can sometimes be hard to understand for the participants in a study (Reynaud & Couture 2012). Most of the multiple price list settings cannot differentiate between changes from diminishing sensitivity and probability weighting (Harrison 2011). Charness *et al.* (2013) describe these methods as complex and do mostly use paid subjects.

2.2.3 Questionnaires

Questionnaires are a common method for eliciting risk preferences and are often based on the subjects' self-reported beliefs about their risk preferences (Charness *et al.* 2013). The subjects' answer by rating different statements about their risk behavior on a graded scale. The questionnaires cannot estimate any coefficient for risk preferences. However, they can estimate how risk preferences differ between domains (Weber *et al.* 2002). According to Weber *et al.* (2002) do risk preferences differ between domains and it is important to understand to evaluate individuals' decisions. One often-used questionnaire is DOSPERT and it has 30 questions that show the risk preferences in different domains (Blais & Weber 2006).

Hansson and Lagerkvist (2012) did a study about domain-specific risk preference among farmers. In the study, Hansson and Lagerkvist (2012) created a risk preference questionnaire for farmers. Their design uses a two-sided measurement, one with expected benefits from risk-reducing actions and perceived risk. The subjects answering 25 statements about financial, production, environmental and social risk management tools on a Likert scale (Table 6, 7), from the benefit side as risk-reducing and the same statements from a perceived risk side. They used factor analysis to analyze the questionnaire and find three factors of risk preference domains. The first was *be up-to-date and in deliberate control of the cultivation*, the second was *carefulness and planning in the business in general*, the last factor was *progressive farming*. This questionnaire for farmers has been tested on Swedish farmers and the result was valid against the farmers' variation in profit, were the farmers that answered higher (more important) on the Likert scale had less variation in the profit for two of the three factors. The factor that was correlated with higher variation was progressive farming.

2.3 Conceptual framework

The utility theories describe how the utility is derived from a utility curve. This study considers prospect theory as an alternative theoretical framework to expected utility theory and conduct an experiment with lotteries involving both gains and losses. The prospect theory involves more dimension than the expected utility theory, so an eliciting method that evaluates risk preferences needs to be able to control for these variables (Harrison 2011). The model also needs to evaluate if the risk preferences are depending on loss aversion, reference dependence, diminishing sensitivity or probability weighting.

This study uses a type of EG method to be able to answer the research question, which is not commonly used with prospect theory. However, this study has another focus than most other research with prospect theory, when using a non-status quo reference point. EG method has good abilities to evaluate diminishing sensitivity for individuals using CRRA. The CRRA coefficient should be constant over different stakes, however, earlier studies including Reynaud and Couture (2012) shows that the CRRA coefficient increase when the stakes increase. When the CRRA coefficient changes it is like a kink in the utility curve, which can come from a passing a reference point (Tversky & Kahneman 1991). When using several EG tests it becomes possible to analyze how and why the CRRA coefficient change over different stakes, like in problem 1-3 earlier in this chapter (Chapter 2.1.3).

To be able to evaluate the effect of a reference point the subjects need to answer questions both above and below their reference point. Here the simplicity with the EG method makes it

easy to let the subjects answer several of similar questions with different stakes. The probability weighting effect can change the risk preferences in similar ways as diminishing sensitivity, which makes a separation of them needed to analyze the response from the experiment (Harrison 2011). EG is a good alternative because it does not change probability and thereby does not include probability weighting in the analysis. When probability weighting is excluded it limits the evaluation of the prospect theory, but it is not the focus of the study. With a similar method as Tanaka *et al.* (2010) it would be hard to give an answer about the reference point that the subjects are affected by, without adding several more series.

An experiment can change the probability or the outcome to examine how the participants change their decisions from a risk perspective. Eckel and Grossman (2002; 2008) used fix probabilities and changing outcomes. It is more common to change the probability of the outcome in experiments, as Holt and Laury (2002) did. Dave *et al.* (2010) conclude that if the test changes outcome instead of probability, a subject with lower mathematical skills will understand the test easier and gives a less noisy result and it is vital for this study get a less noisy result since it uses a small sample.

This study uses EG's method but with nine options in every gamble situation as Reynaud and Couture (2012). This makes it possible to have both risk-averse, risk-neutral and risk-seeking options. This study uses six risk-averse chooses, one risk-neutral choice, and two risk-seeking options. The subjects' answers five gambles situations with different stakes, to test their risk preferences both over and under their reference point. All probabilities in the experiment are 50 %, to make it simpler for the subjects.

3 Methodology

This chapter describes the methodology and designs this study uses to answer the research questions. It also includes a discussion about the quality criteria of the study and what ethical considerations have been done in the study.

3.1 Philosophical worldview

In most research the researchers' philosophical ideas are not revealed for the reader, however, they do still affect the research with design choice and view of knowledge. Creswell (2014) states that the researcher should reveal their philosophical worldview, to explain why their research is done the way it is. This study follows Creswell's (2014) description of the term worldview as beliefs that guide actions, others have called these paradigms epistemologies and ontologies. The researcher found himself in the paradigm that the literature discusses as post-positivism. Creswell (2014) describes the post-positivist worldview as a paradigm that tries to identify causes for different outcomes or the most likely reasons because post-positivists do not believe in the notion of any absolute true knowledge. This is shown in this study when the researcher tries to identify the relationship between revenue target and risk preference. The post-positivistic researchers are often found in the more quantitative research where they try to verify theories. This deductive approach to research is also something that this study uses when trying to verify the use of reference points described in the prospect theory.

The researcher in this study believes in Creswell's (2014) description of the post-positivist's intention with the study, to test great ideas with small discrete test and by that reduce the world into a set of measurable variables. These variables are often created from careful observations and developed into numeric variables. This is also the method used by this study when Kahneman & Tversky (1979) description of a reference point is used in a simple test to find out the relationship between revenue target and decision making.

3.2 Research approach

This study follows a quantitative research approach with an experimental research design. The literature describes the quantitative approach as an approach that enables the study to analyze trends in the field and explain why something occurs, as an overall tendency of individuals' behavior (Creswell 2012). This makes the quantitative approach a good fit since this research aims to find a relationship between variables. The approach also follows a more standardized structure, compared to the qualitative approach, which increases replicability of the study and makes it easier to test findings on other samples or populations (Creswell 2012; Bryman & Bell 2015). Replicability is important for this study because it uses a new model to test reference points and it is crucial to test it on other samples and populations to validate the model and results. A quantitative approach fits in with the researcher's post-positivistic worldview and his wish to develop relevant statements (Creswell 2014).

This study uses an experimental design. Quantitative researchers can use experimental design to determine whether an activity makes a difference in the result (Creswell 2014). The experimental design is chosen in this study because of its ability to test the influence of a

treatment (Creswell 2014). There are other methods to examine farmers' risk preferences, for instance, a case study that can give an in-depth insight into how the farmers think, which other methods cannot give. However, a case study comes with response bias and the insights effects are harder to measure and link to the prospect theory (Chidambaram *et al.* 2014).

The dependent variable in current study is individuals' risk preferences and it is treated with different stakes in gamble situations. The experiment uses a single-subject design since with the aim to analyze individuals (here farmers) and use that information to explain the group. Creswell (2012) describes the single subject design as a design where the subjects become their own control and thereby that make the control group obsolete. The single-subject design does also focus on trends in the answers and not only the answers in themselves.

3.3 Literature review

A literature review is a summary of journal articles, books and other documents about a subject (Creswell 2012). In this study, the literature review is in the theoretical perspective chapter and it is a thematic literature review. Creswell (2012) describe the thematic literature review as, a literature review that divides the literature in themes and discuss the major ideas instead of single studies. This approach is used in this study to get a greater explanation of the prospect theory and to create the experiment from eliciting methods. The search for literature is conducted on the internet and thru Google Scholar. For the utility theory search is keywords as "prospect theory", "expected utility theory", "reference point", and "loss aversion". Mainly literature that is written by Kahneman and Tversky is used since they are the main authors of the prospect theory, but also other articles that have more focus on reference points.

For the risk eliciting methods the focus is to find and evaluate different methods. To do this is the focus on summaries and handbooks that evaluate the methods as handbooks and summaries provide an overview of the literature with pros and cons. The keywords in the search are "field experiment", "experimental methods", "risk preferences" and "eliciting methods". When the eliciting methods are found and chosen, the original sources of the methods included in the literature review.

3.4 Sample selection

The sample is a vital part in most quantitative research since it determines what data that is collected (Creswell 2012). The researcher needs to identify the people and organizations, which generates the data needed to answer the research question. To be able to identify the subject in a study most a unit of analysis and a population be specified. This study uses a small sample due to the amount of time and planning needed to conduct a larger data collection. Hackshaw (2008) describe the strength and limitations with small samples as they are good because they can give fast answers to new research ideas. Small samples, however, lead to problem with the interpretation of the result, with large standard error and wide confidence interval. Another limitation related to studies with small samples relates to the generalizability and reliability of the results. However, a well-designed small sample study can create good conclusions that can be used in larger studies later (Hackshaw 2008).

3.4.1 Unit of analysis

The unit of analysis in this study is the individual potato farmer. Grünbaum (2007) argues that the unit of analysis is important in research to describe the analysis. According to Pinsonneault & Kraemer (1993), the unit of analysis can be divided into six classes; individuals, working group, department, organization, application or project. The unit of analysis is related to the research question and it is defined as the potato farmers as separate individuals. Individuals as the unit of analysis are chosen to be able to compare the differences within the farmer's choice. It would be able to see all potato farmers as a group and answer how potato farmers' make decisions. However, in such case the study would not been able to analyze the individual farmer's risk preference changes due to reference points.

3.4.2 Population description

By choosing a part of the population, a researcher creates a possibility to get more homogenous population and more appropriate sample. When using a more homogenous population it is easier to control for characteristics of subjects that might affect the relationship between the independent and dependent variables (Creswell 2012).

The chosen population in this study is active potato farmers in Sweden who cultivate at least two hectares autumn/winter table potatoes. The subject needs to be active potato farmers to understand the different revenues and uncertainty with potato cultivation. There are different sorts of potato cultivations and the table potatoes sell mostly to retail stores, peeling firm, packing plants or direct to consumers. Where the industry potatoes cultivators can sell to the processing industry as starch or crisps potatoes. The biggest difference between the table and industry potatoes is that the industrial potatoes are sold on contracts with fixed prices and the table potatoes are sold on a spot market without any fixed prices. That is why this study only focuses on table potatoes since it can create a more homogenous sample in the price risk domain.

In 2018 there were 2568 table potato producers in Sweden according to Swedish Board of Agriculture statistic, which cultivated 15992 hectares of potatoes (Jordburksverket 2018). The number of potato producers are overestimated in the statistic from the Swedish Board of Agriculture since some producers use other farmers land to produce potatoes. The table potatoes market is dived into two main groups: new potatoes (20%) and autumn/winter potatoes (80%) (Jordburksverket 2018). The new potatoes market starts when the first potatoes leave the ground in May. This market is characterized by a high price at the beginning and the price decreases until the end of the season. The autumn/winter potatoes have more constant price over the season but can change from season to season. The large price difference during the season can make it difficult to understand revenue targets per hectare since the harvest time is so vital to the outcome. Törnquist (2015) describe that 60 percent of the farmers cultivate less than two hectares, these are excluded from this study since there cultivation is so small that can have problem to answer some of the questions. It is about 1000 farmers in the selected population.

3.4.3 Sample

The population work as a frame that the sample can be picked from (Creswell 2012). There are two main sampling methods probability sampling and nonprobability sampling. The sampling method a study choose is depending on several factors, the amount of rigor the

study seeks, characteristics of population and availability of participants to the study. In probability sampling, creates a sample of individuals that is representative of the population. This is the most rigorous sampling method and creates internal validity and a greater ability to generalize from the sample. Nonprobability sampling is not as rigorous as probability sampling and it creates a sample from individuals that are available, convenient, or representative for some characteristic that the study seeks (Creswell 2012).

This study uses a nonprobability sampling since its ability to reach as many potato farmers as possible. According to Cook *et al.* (2002) disappears most of probability samples advantages when the response rate is low, and it is vital to this study to get as many participants as possible. This study uses two methods to find participants. First, a convenience sample where the survey is sent out from an organization to its members, further in the report referred to as *Sample 1*. Secondly, a convenience sample where the survey diffused on social media (Facebook and LinkedIn), further in the report referred to as *Sample 2*. They are separated since Sample 1 is a more homogenous sample because they sell their potatoes together. It does also create a possibility to compare the samples in the analysis.

3.5 Experimental design

The subject is tested with the test described in the Conceptual framework (2.3). At the beginning of the test, the subjects get information about the test and what real life situation it simulates. The experiment is divided into five different lottery tests with different stakes that should represent an uncertain situation of potato cultivation. Where the subjects choose the favorable cultivation option. All the farmers in the study are treated units and are exposed to the same multiple treatments. Charness *et al.* (2012) describe a limitation that occurs when just using one treatment and it is that it becomes harder to evaluate changes between the tests. This due to the changes can both come from the different stakes and the fact that the subjects answered a similar question before

The experiment is based on EG's (2002) method and as it every option has two possible events a high outcome and a low outcome and all probabilities in the experiment is 50 % to make it simpler for the subjects (2.3). Table 3 shows the payoff for the first test of the five tests. The low payoff decreases with 3750 SEK between every Cultivation option for the first six options. After that the decreases is changed to 1875 SEK for the seventh and eighth option and the last decrease is 7500 SEK for the low payoff. The subject does not get information about the expected payoff for the options. The potential revenues in gambles are derived from what is a possible average revenue per hectare and are controlled by potato cultivation consultants and the pilot study. The average revenue per hectare is believed to be 75 000 SEK. This amount is in the second most risk-seeking alternative in the first gamble (lowest stake gamble) and is the safe option in the last gamble (highest stake gamble). This to be able to involve the average revenue in all risk classes from risk-seeking to most risk-averse cultivation options. This creates a possibility for a farmer with a reference point at the average revenue and high diminishing sensitivity, to answer both risk-seeking and risk-averse options in the different gambles and still be maximizing the utility in the gamble situations.

Table 3. EG test 1

Choice	Event	Payoff	Probability (%)	Expected payoff	CRRA ranges
1	A	37500	50 %		
	B	37500	50 %	37500	r>4.91
2	A	33750	50 %		
	B	45000	50 %	39375	1.64<r<4.91
3	A	30000	50 %		
	B	52500	50 %	41250	0.75<r<1.64
4	A	26250	50 %		
	B	58750	50 %	42500	0.55<r<0.75
5	A	22500	50 %		
	B	65000	50 %	43750	0.43<r<0.55
6	A	18750	50 %		
	B	71250	50 %	45000	0.20<r<0.43
7	A	16875	50 %		
	B	73750	50 %	45312.5	-0.26< r <0.20
8	A	15000	50 %		
	B	75000	50 %	45000	-0.36< r <-0.26
9	A	7500	50 %		
	B	78750	50 %	43125	r <-0.36

Table 3 shows the payoff in the first EG test the other tests have higher payoffs and the stakes increase from the first test with factors of 1.28, 1.52, 1.76 and 2, the factors are adapted to get more even numbers. By using CRRA the risk coefficient for each option is constant for all the stakes. All cultivation options with an r-value >0.20 are referred to as risk-averse options (1-6) and all options with an r-value <-0.26 is referred to as risk-seeking options (8-9) and the last option as risk neutral (7). When the CRRA values is the same over the stakes to understand how the stakes affect the subjects' willingness to take risks near there reference point is enabled.

This study also includes a risk preference questionnaire. The questionnaire that is used is Hansson and Lagerkvist (2012) questionnaire for farmers as it has been validated on Swedish farmers. Both DOSPERT and Hansson and Lagerkvist (2012) questionnaire is domain specific, however, some of the questions in the DOSPERT questionnaire is quite aggressive like "Having an affair with a married man/woman". This type of question can lower the willingness to respond, therefore the method is not chosen. Hansson and Lagerkvist (2012) questionnaire works as a control test for the farmers and their risk preferences.

3.6 Data collection

Gathering of data to evaluate the potato farmers' preferences is performed through a survey because there is no previous data available. The survey has a self-reporting preference approach to reveal farmers' preferences. The survey has four parts, first some entering question, just to be able to tell the people who are not in the population that they do not have to answer any more questions. After that, the EG experiment with five gamble tests. The next part is Hansson and Lagerkvist risk preference questionnaire and finally questions about the potato cultivation and revenue targets.

The survey is created in Netigate, which is an online survey program. A Survey program is preferred due to its ability to retrieve more information from the responders' through measuring and controlling their actions when answering the survey. In addition, when the survey is net-based the possibility to reach participants over a larger area increases, without any addresses. The farmers in Sample 1 get three reminders with two weeks apart. Sample 2 involves social media and is posted three times on different channels. The diffusion on social media does not reach the same people every time. One problem with this diffusion is that the number of potato farmers that is given a chance to answer the survey is unknown.

The subjects in this experiment are not paid. In most experiments the subjects are paid based on how they answer, to ensure real incentives (Harrison & List 2004). This study uses different stakes to understand changes in behavior. When using different stakes, it is important to avoid incentives to another stake because the incentive to be paid can be greater than the incentive to answer the favorable gamble option. To create a small incentive the farmers are offered to receive a summary of the risk assessment from the researcher. In addition, Holt and Laury (2002) have found that there are no significant differences in the observed decisions between gambles situation with hypothetical or real payoffs.

Before the survey was sent out to the potato farmer a pilot test was performed. A pilot test was done to determine if the subjects in the study are capable to participate in the survey and if they understand the questions (Creswell 2012). The pilot study involved potato farmers and potato consultants to test and comment on the survey before the real survey was distributed. To secure an industry-specific language and representative values in the survey. The test round was during the first week of March 2019. The data collection of the final survey was later the same month.

3.7 Experiment analysis

This section describes the study's analytical framework, which is based on previous studies and the theoretical perspective. The analysis describes the data and test it to evaluate the farmers' risk preferences. To summarize the self-reported risk preferences part is a factor analysis performed (Hansson & Lagerkvist 2012). To analyze the data from the survey, this study uses Statistical Package for the Social Science (SPSS) and Excel.

3.7.1 Coding and cleaning the data

When the experiment is finished, the data from the sample is displayed using descriptive statistics including mean and standard deviation. It is also presented in a graphical manner to get a better understanding of the data and detect whether there are some odd behaviors or outliers (Creswell 2012). All subjects that does not belong in the stated population are removed from the analysis. There are some main questions that the participants need answer to be included in the analysis such as, the five EG tests and revealing their revenue target. The revenue target is a sensitive variable since it is filled in by the subject. If a subject answer in thousands of SEK instead of SEK (80 instead of 80 000) this is corrected by the researcher and counts as a valid number. Other answers which are not possible revenue targets on the lower side are removed because the researcher cannot know if the subject has an extremely low revenue target or if the participants have stated their profit target. Outliers on the high side that is non-possible revenue target such as 600 000 (which is eight times as big as the

estimated revenue) is treated as if the subject just added an extra zero by mistake and is counted as 60 000.

3.7.2 Factor analysis

To be able to evaluate the information from the risk preference questionnaire this study uses a factor analysis. This is the same analysis that Hansson and Lagerkvist (2012) used on the questionnaire. This study uses SPSS for the factor analysis. The factor analysis is chosen because it has been validated for this questionnaire. As extraction method this study uses Maximum likelihood since it can compute a wide of set indexes to describe the goodness of fit for the model (Osborne *et al.* 2008). This study uses a rotated factor analysis, the method for the rotation is Direct Oblimin. The most common rotation method is Varimax (Osborne *et al.* 2008). This study does not use Varimax since it cannot evaluate data that is correlated. The data in the questionnaire is most likely correlated since all questions involve risk and that is why this study uses the Direct Oblimin. To evaluate the quality of the factor analysis this study uses two measurements. First, the Kaiser-Meyer-Olkin (KMO) measure for the model. The KMO can be between 0 and 1 and needs to be over 0.5 for the matrix to be considered as suitable for factor analysis (Williams *et al.* 2010). The second quality measure is the factor loading that needs to be over 0.3 in factor loading. Williams *et al.* (2010) state that 0.3 is the minimum factor loading that should fit in factor analysis and the factor loading should preferably be over 0.5 to be significant. The factor loading of 0.3 is lower than the 0.4 that Hansson and Lagerkvist (2012) used to be significant in their study. To decide the numbers factor is the most common way to examine the Eigenvalues (Williams *et al.* 2010). According to some literature is all factors with an Eigenvalue over 1 are valid factors. However, Osborne *et al.* (2008) state that the number of factors is adjusted to the data and not follow the rule of the thumb, which is also how this study chooses the number of factors.

To test the reliability of the factors in the factor analysis is Cronbach's alpha is used. Cronbach's alpha should be between 0.7 and 0.9 (Tavakol & Dennick 2011). A too low value indicates poor inter-relatedness between items and the items should be reviewed or discarded. An alpha that is too high indicates that some of the items are redundant and testing the same question in a different guise.

3.7.3 Dependent test

To evaluate farmers' risk preferences this study uses a combination of within and between-design, to create more understanding about the respondents (Charness *et al.* 2012). The within-design focuses on what is it that changes the subjects risk preferences and how the risk preferences change over different stakes. The most common used rank correlation method is the Spearman rank correlation (Creswell 2012). The Spearman rank and Kendall correlation can compare a continuous independent variable with a continuous dependent variable (Croux & Dehon 2010). However, Croux and Dehon (2010) did show that the correlation measurement is more robust and efficient than Spearman rank correlation for small sample sizes. Therefore, do this study uses Kendall correlation and not the more commonly used Spearman rank.

To the between-design a couple of focus variables are chosen and divided into two groups to be able to see differences between different groups. The statistical tests that are used for the between-design is the Mann–Whitney U test. Both Kendall correlation and Mann–Whitney U can be used on non-parametric data (Creswell 2012).

3.7.4 Reference point test

To analyze whether the subject's responses depend on the revenue target as a reference point, a simple model is created. The model estimates what cultivation option the subject should choose in the different stakes if the subject was following a reference point. The model is built on three criteria. The first criterion, to estimate a cultivation option the farmers' revenue targets needs to be possible to reach in the test. As an example, if the subject's revenue target is 80 000 SEK, the model will not to estimate a cultivation option for that subject in the first test, due to the highest possible outcome in that test is 78 750 SEK. The second criterion, the subject is estimated to choose the most risk-averse option that is over their revenue target. The option can both be risk-seeking and risk-averse and differ over the EG test, due to that individuals are risk-seeking in losses. However, the subject will choose the most risk-averse option due to loss aversion. The final criterion, the subject is estimated to choose the most risk-neutral alternative when the lower outcome in the option is over their revenue target. This makes the subject act more risk-neutral when the stake goes up over their revenue target. As an example of the model, a subject with a revenue target at 75 000 is estimated to choose the risk-seeking option 8 on the first test and the totally risk-averse option 1 in the last test.

This model does focus on loss aversion to examine the reference point. This is explained by the prospect theory as the kink in the utility curve at the reference point and that a loss is more painful than a similar gain (Kahneman & Tversky 1979). This makes the subjects reference point hunters that will try to reach the reference point in this model, where they are estimated to choose the option that makes them reach their reference point. The last part where the subject is estimated to be more risk neutral is also explained by loss aversion because when the loss domain of the utility curve disappears becomes the overall utility curve straighter and the subject should act less risk-averse.

3.8 Quality criteria

Validity and reliability are two fundamental elements in the evaluation of instruments and the results of a study (Creswell 2014). The instruments can be surveys, interviews or other tests. The instruments can measure everything from the adoption of innovation to the subjects' risk preferences. Validity concerns to what extent the instrument measures what it is intended to measure. The reliability on the other hand refers to the ability the instrument has to be consistent in its measurements. Reliability and validity are closely connected. For an instrument cannot be valid if it is not reliable, but it can be reliable without being valid.

3.8.1 Reliability

Creswell (2012) describe several tests and methods to check if the collected data and result are reliable, for instance, using summaries measurement to avoid errors in one question and control variables as Cronbach's alpha. This study uses factor analysis to summarize items to factor to get more reliable answers and Cronbach's alpha and KMO to test the reliability in factor analysis.

3.8.2 Validity

The possibilities that the final ideas are not correct is something that experimental designs need to address (Creswell 2012). There are some different types of validity that is important

in experimental research. They are construct, external, statistical conclusion, and internal validity. Cook *et al.* (2002) state that experimental research needs to focus on construct, external, and statistical conclusion validity instead of internal validity. This because if a researcher focuses on increasing internal validity, it can be at the cost of decreased construct or external validity and reduce the validity of the study (Cook *et al.* 2002). The different validity measures are discussed from this studies perspective below.

Construct validity refers to the validity of the experiment and if it tests the right thing or construct (Salkind, 2010). It is the special treatments, observations, and settings on which collected data are transferable to a more abstract construct that the experiment wants to measure (Cook *et al.* 2002). This study focuses on understanding the revenue target as a reference point and it is no previous studies to relay on, which would make it clear if the study measures what it wants to measure. To ensure construct validity this study uses eliciting methods that have been validated to measure risk preferences. This experiment also ensures construct validity by using the CRRA coefficient for risk preferences that several other studies have used and reached valid results. The study uses two different analysis methods to create a possibility to triangulate and control effect on the risk preferences. Also, Hansson and Lagerkvist's (2012) questionnaire is validated to test risk preferences, these control variables create construct validity since they all measure risk preferences from different perspectives. Nevertheless, the conclusions about the reference point need to be confirmed by other studies to be fully generalizable.

External validity is the validity that describes if the causal relationship holds outside the sample, to other individuals, settings, treatment, outcomes (Cook *et al.* 2002). To increase the generalizability to the wider population it is important to select an appropriate sample, which is not possible in this study because the subjects are not selected. However, this study control for how appropriate the sample is. The study does also control for differences in the factors, where the sample is not appropriate. Another vital part of external validity is the generalizability over time (Creswell 2012). This is discussed in the method discussion to describe how the result can differ over time. At last, it will be hard to generalize from this study due to the small sample since it comes with high risk for an inappropriate sample. When the sample is small is the result sensitive for extreme subjects, which can change the results. Extreme subjects in this study can be very risk-averse subjects with a high reference point (revenue target), which makes him act less risk-averse in the EG tests, but still, act more risk averse than the farmers with lower reference points. This study does not control for any overall risk preference and that makes this type of problem more problematic.

Statistical conclusion validity is reached by using appropriate statistical methods and understanding of the statistical result (Creswell 2012). This is created by using analysis methods that have been validated on the test, for instance, factor analysis for Hansson and Lagerkvist questionnaire. This study also uses robust tests as Kendell tau rank and Mann–Whitney U test to decrease the possibility that extreme subjects in the small sample affect the statistical result. To understand the independent and dependent variables earlier studies are used and discussed, both when creating the test and analyzing the result.

Internal validity relates to the possibility to conclude from the cause and effect relationship between the independent and dependent variables (Creswell 2012). This can best be created by using a probability sampling, which ensures that the researcher does not need to worry about many assumptions about the sample (Cook *et al.* 2002). However, this study does not use probability sampling and by that internal validity from the sample selection is low. The

researcher believes that the total validity of the study would have been decreased if it had used a probability sampling. First, since fewer people would have answered the survey and by that a smaller part of the population. Secondly, when using probability sampling and the response rate is low, the benefits of using a probability sample is low (Cook *et al.* 2002). Instead of using probability sampling is concepts from earlier studies are used to create better internal validity. For instance, the age effect is controlled because of Hardaker *et al.* (2015) state that age affects risk aversion.

3.8.3 Ethics

In any research, it is vital to ensure the subjects well-being, dignity, and rights (Creswell 2012). In an experiment ethics are even more important since the researcher uses treatments on the subjects (Creswell 2012). The treatment in this study cannot harm the subjects and all get the same treatment. The subjects are informed that the survey is voluntary. The subjects are normally paid in experimental studies (Harrison & List 2004). To avoid any deception, it is even more ethical crucial to inform the subjects in this study, that the survey is voluntary and what they can get from participating. This is done on the opening letter to the survey were the subjects are informed about the focus of the study and that they can get a summary in Swedish if they participate, to avoid any deception problem.

The subjects in the study are anonymous to avoid any registration of personal data. Not even the researcher knows who has been answering the survey since it used an open link when the survey is distributed. This to avoid any subjective analysis of the answers. It is also important to inform the subjects what data is collected and how it will be used, both to avoid deceiving the subjects and follow the General Data Protection Regulation (GDPR) directive. GDPR directive demand that all personal data that is processed is done so in a lawful, fair and transparent way (Mourby *et al.* 2018). This information has been given to the subjects in the opening letter of the survey and no personal information is stored except e-mail addresses to the people that want a summary. To avoid any connection to the subjects are the email addresses not stored with or connected to any answers.

4 Empirical data

This chapter will give an understanding of the data and how it relates to the population and other studies. The chapter starts with a description of the subjects and the average answer on every question and their relation to the population. After that is the result of the experimental test described. The web-based questionnaire was closed after 5 weeks with a total of 36 participants. Of these 36 participants, 23 had completed the entire survey. 21 were valid responses that contributing to the analysis. Below, the personality and demographics of the 21 respondents that will be in the main analysis are presented.

4.1 Demographics

Table 4 shows the demographics of the respondents in this study. The result is for the 21 valid after all in valid answers is removed.

Table 4. The potato farmers' demographics.

	Average	Std.	N	Min	Max	SUM
Gender (% Men)	86%		21	0	1	
Age	50.8	11.6	21	24	72	
Year as an active potato farmer	25.4	12.3	20	5	47	
Household's total income depending on potato cultivation (%)	44%	31%	21	2%	100%	
Yield in tonnes per hectare Autumn/Winter table potatoes	45.2	11.0	21	26	78	
Cultivated land of potatoes	28.3	25.2	21	5	100	595
Production of Autumn/Winter table potatoes (tonnes)	1147	1240	21	46.5	5100	24080
Revenue target per hectare for the potato cultivation (SEK) (1 euro= 10.5 SEK)	92 857	34 517	21	50 000	175 000	
Amount of the cultivation that is irrigated	58%	43%	21	0%	100%	
Autumn/Winter table potatoes of the potato cultivation (%)	87%	24%	21	5%	100%	
New potatoes of the potato cultivation (%)	10%	21%	21	0%	95%	
Industry potatoes of the potato cultivation (%)	3%	12%	21	0%	50%	

Potato farmer

The potato farmers' age was between 24 and 72, with a mean of 51. In Sweden, 49 % of the Crop farmers are over 60 and just 4 % under 35 (Jordburksverket 2017). Of the 21 subjects were it three women (14 %). The same number for Swedish crop farmers is 11%. Gender distribution within the respondent group is near the average in the sector and there are only three women because of that will this study not analyze any gender differences. The average farmer has cultivated potatoes for 25 years and all farmers have been cultivating potatoes for at least five years. This makes their answers about their potato cultivation trustworthy since all are experienced potato farmers. However, one farmer stated more years as an active potato farmer than years old and his result for years active were removed from the answers. Figure 6 shows the education distribution of the subjects. Most of the participants in this study have a Post-secondary education within an agricultural area.

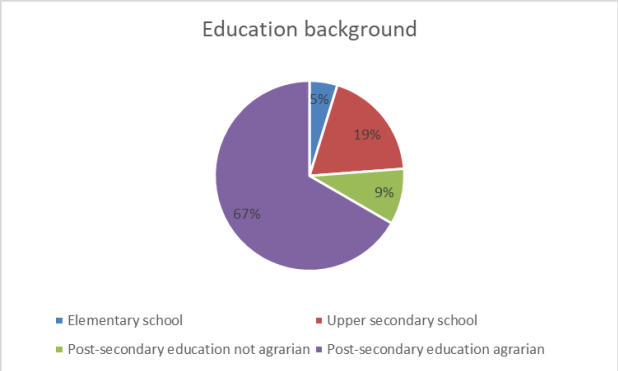

Figure 6. Education distribution (Own processing)

Potato cultivation

The potato farmers in the study cultivates at an average of 28 hectares of potatoes within the range of 5 to 100 hectares per farmer. The total amount for the 21 subjects is 595 hectares, and the total amount for all the 36 participants is 933 hectares. In Sweden, it is 15993 hectares potato cultivation (Jordburksverket 2018). One farmer cultivated less than two hectares of autumn/winter potatoes, he is excluded from the analysis since he is not in the stated population. Most of the 21 farmers cultivate most autumn/ winter potatoes, however, one farmer cultivates most fresh potatoes and only a smaller amount autumn/winter potatoes.

The potato cultivation is important for the farmers with an average importance for the household economy of 44%. There are only two farmers that state importance under 15%. The revenue targets that the farmers' states are between 50 and 175 thousand SEK per hectare. The average potato farmer states a revenue target at 93,000 SEK per hectare. As, one farmer stated a revenue target at 20,000 SEK per hectare was removed from the further analysis because 20,000 is too low to be a revenue target. The average farmer state that he can irrigate is 58% of the cultivation, with most farmers at either 0 or 100%.

The average yield from the autumn/winter potatoes is 45 tonnes per hectare. 45 tonnes per hectare is eleven tonnes over the average yield for table potatoes in Sweden (Jordburksverket 2018). There are two explanations to the difference, the statistical average yield of 34 tonnes per hectare include fresh potatoes, and most farmer in this sample comes from Halland. The farmers in Halland have the highest yields in Sweden with 38 tonnes per hectare, including fresh potatoes with lower yields. More than half of the farmers in this study are active in Halland (Figure 7). Halland is one of the bigger potato areas in Sweden with 11% of the potato cultivation. The overrepresentation of farmers from Halland is an effect of that the organization that sends out Sample 1 is active in Halland. All the respondents from Halland and Skåne County are in Sample 1.

The average total harvest of autumn/winter table potatoes is 1150 tonnes per farmer and 24080 tonnes in total. These 24080 tonnes equals to 5% of the total production of autumn/winter potatoes in Sweden. With all the 36 participants in the study included, they make up 7% of the total production of autumn/winter potatoes in Sweden.

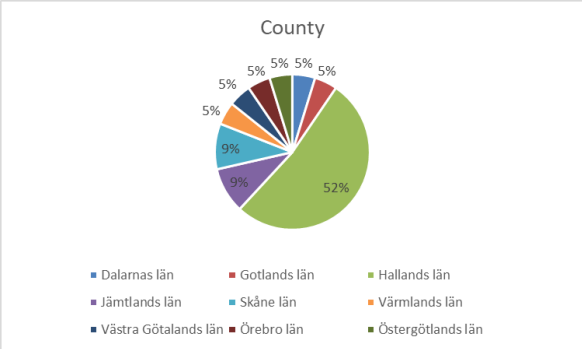

Figure 7. County distribution (Own processing)

4.2 EG tests

The gamble experiment consists of five tests with different stakes in each test. Table 5 shows the statistics for the five tests. In the tests is 9 the most risk-seeking and 1 is the most risk-averse while the risk-neutral respondent chooses 7.

Table 5. Experiment statistics

	Average for the subjects all 5 tests	Std. for the subjects' average of the 5 tests	Test 1 Smallest stakes	Test 2	Test 3	Test 4	Test 5
N	21	21	21	21	21	21	21
Mean	4.41	1.08	4.81	4.48	4.33	4.14	4.29
Median	4.2	0.89	4	4	4	4	4
Std. Deviation	1.65	0.63	2.21	2.17	1.68	1.82	2.05
Skewness	.737	0.92	.576	.904	1.223	.914	.647
Minimum	2.20	0	2	2	2	2	1
Maximum	8.20	2.72	9	9	9	8	9

The respondents' mean in the EG tests was 4.4. This shows a risk-averse behavior in general in the group of subjects. The subjects' individual means range from 2.2 to 8.2 with only one subject that has a mean over 7 and shows a risk-seeking behavior in this test. The subjects' consistency in their answer varies from one subject that is entirely consistent on all tests to another subject has a standard deviation on 2.7 on his five tests.

The results from the EG tests reveal the subjects' risk preferences. The results in the tests can be described with a CRRA coefficient, which describes the individuals risk preferences gamble situation. The subjects' mean and median value is four or near four and that option has a CRRA coefficient at $0.55<r<0.75$. The mode value is three and it has a CRRA coefficient at $0.75<r<1.64$. The cultivation option three involves a wider range of CRRA coefficients compared to the less risk-averse option. Due to this range difference, it is better to use mean and median values than the mode value. The CRRA coefficient becomes 0.65 if when using the midpoint of the range.

The ability to compare the mean is depending on the skewness of the data. The data in, all answers are skewed and by that not normally distributed. Also, the different skewness can be

a limitation to the analysis. The skewness of the answers to the tests is from 0.576 on test 1 to 1.223 on test 3. There can be a problem with such a large difference in Skewness if they don't look the same. Figure 8 shows the distribution of the answers for the different tests.

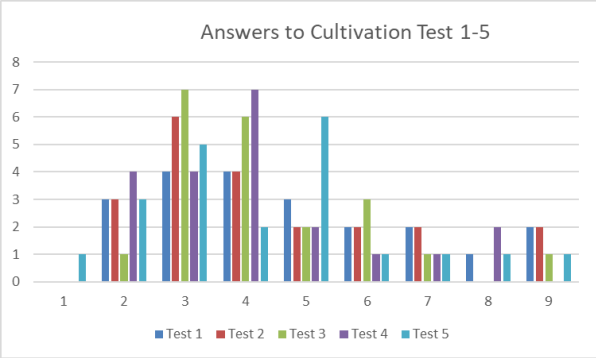

Figure 8. Distribution on answers on Test 1-5(Own processing)

4.3 Risk preferences questionnaire

The risk preference questionnaire is divided into two parts. The first part showed in Table 6 obtains actions that stabilize the net income. The subject ranks the actions from 1 to 7, where 1 means not important and 7 very important. The second part in Table 7 focuses on actions that can cause volatility for the net income. Here the subjects also rank the actions from 1 to 7, where 1 stands for to a small extent and 7 to a large extent.

Table 6. Stated positive preferences

Actions to obtain a stable net income	Average	Std.	N	Min	Max
1. Paying bills on time	6.05	1.43	21	2	7
2. Using a checking account or other short-term credit options to their full extent	4.95	1.66	21	2	7
3. Having a balanced crop rotation	6.14	0.85	21	4	7
4. Maintaining a low debt-equity ratio	4.24	1.18	21	2	7
5. Having full insurance	5.76	1.37	21	3	7
6. Diversifying farm activities	5.10	1.67	21	1	7
7. Participating in machinery collaboration or contract machinery	4.62	1.80	21	1	7
8. Purchasing inputs in good time	5.38	1.60	21	1	7
9. Regularly testing machinery such as sprayer and seed drill	5.81	1.40	21	3	7
10. Practicing minimum tillage	3.90	1.73	21	1	7
11. Continually discussing the business with professional advisors	4.90	1.61	21	2	7
12. Searching for information before making decisions	5.81	1.50	21	1	7
13. Having thorough, documented monitoring of production	5.48	1.21	21	4	7
14. Producing the highest quality, even if this implies e.g. having to work more	6.00	1.10	21	4	7
15. Following regulations (e.g. for environmental subsidies)	5.52	1.40	21	3	7
16. Having employees	4.05	2.16	21	1	7
17. Having newer and well-maintained machinery	5.38	1.56	21	2	7
18. Having access to temporary help if needed	4.24	1.89	21	1	7
19. Having access to crop drying and storage facilities (either own facilities or through collaboration with other farmers)	5.48	1.91	21	1	7
20. Selling on contract	3.90	1.67	21	1	7
21. Participating in study circles and courses that are relevant for the business	4.43	1.57	21	2	7
22. Having good contact with neighbors	5.10	1.79	21	1	7
23. Having time to participate in social activities	4.57	1.78	21	1	7
24. Thinking progressively and searching for possibilities to develop the business	6.14	0.96	21	4	7
25. Getting family to share thoughts about the business and getting them to support the work	5.52	1.50	21	1	7

Table 6 shows what the participating farmers stated as the most important actions to stabilize the income. Comparing to the answers in Hansson and Lagerkvist (2012) study with the same questioner the mean valued for the items were similar. The biggest difference is in *Maintaining a low debt-equity ratio* were the subjects in this study answer 1.01 lower than in Hansson and Lagerkvist (2012) study. The *Having newer and well-maintained machinery*, on the other hand was 1.01 higher in the current study compare to Hansson and Lagerkvist (2012). The social actions *Having good contact with neighbors* and *Having time to participate in social activities* was 0.69-0.88 lower in this study compared to Hansson and Lagerkvist (2012) study

The farmers states that: *Thinking progressively and searching for possibilities to develop the business; Having a balanced crop rotation; Producing the highest quality, even if this implies e.g. having to work more; Paying bills on time* as the most important actions, all with a mean at six or over. All these means except *paying bills on time* is higher in this study compared to Hansson and Lagerkvist (2012) study. The farmers' states that the least important are: *Practicing minimum tillage; Selling on contract; Having employees*. It is the same three as in Hansson and Lagerkvist's (2012) study with the only difference that having employees is 0.91 higher in this study.

Table 7. Stated negative preferences

Actions that can cause volatility for the net income	Average	Std.	N	Min	Max
1. Not paying bills on time	4.71	2.12	21	1	7
2. Not using a checking account or other short-term credit options to their full extent	4.43	1.99	21	1	7
3. Not working with a balanced crop rotation	4.62	2.06	21	1	7
4. Not maintaining a low debt-equity ratio	5.00	1.61	21	1	7
5. Not having full insurance	4.57	2.09	21	1	7
6. Not diversifying farm activities	4.38	1.80	21	1	7
7. Not participating in machinery collaboration or contract machinery	4.29	1.85	21	1	7
8. Not purchasing inputs in good time	4.48	2.02	21	1	7
9. Not regularly testing machinery such as sprayer and seed drill	4.38	2.04	21	1	7
10. Not practicing minimum tillage	3.76	2.05	21	1	7
11. Not continually discussing the business with professional advisors	4.24	1.89	21	1	7
12. Not searching for information before making decisions	4.86	1.98	21	1	7
13. Not having thorough, documented monitoring of production	4.57	1.66	21	1	7
14. Not producing the highest quality, if this implies e.g. having to work more	5.00	1.97	21	1	7
15. Not following regulations (e.g. for environmental subsidies)	4.33	2.03	21	1	7
16. Not having employees	3.95	1.88	21	1	7
17. Not having newer and well-maintained machinery	4.19	2.14	21	1	7
18. Not having access to temporary help, if needed	4.14	1.85	21	1	7
19. Not having access to crop drying and storage facilities (either own facilities or through collaboration with other farmers)	4.19	2.20	21	1	7
20. Not selling on contract	3.62	1.63	21	1	7
21. Not participating in study circles and courses that are relevant for the business	3.43	1.96	21	1	7
22. Not having good contact with neighbors	3.67	2.13	21	1	7
23. Not having time to participate in social activities	3.67	1.96	21	1	7
24. Not thinking progressively and searching for possibilities to develop the business	5.00	2.02	21	1	7
25. Not getting family to share thoughts about the business and getting them to support the work	4.52	2.09	21	1	7

Table 7 shows what the participating farmer states as the factors that create most volatility for the net income. Comparing to the answer in Hansson and Lagerkvist's (2012) study is the answers in this study lower with an average of 0.4. The only action with a mean that is more

than 0.2 higher than Hansson and Lagerkvist (2012) study is *Not having employees,* which is 0.6 higher. The biggest differences are in the social factors such as *Not having good contact with neighbors* and *Not having time to participate in social activities,* where the mean is 1.3 higher in Hansson and Lagerkvist's (2012) study.

5 Analysis

This chapter starts with a factor analysis for the risk preference questionnaire. This is followed by a dependent test, with Kendall's correlation and Mann Whitney U tests. Finally, the reference point test to examine how dependent the farmers are of their revenue targets as a reference point.

5.1 Factor analysis

It was possible to create a factor analysis for the benefit side but not for the perceived risk side, due to a large correlation between the items. The data set is small, and it creates a problem for the factor analysis to build significant factors, due to the ratio between numbers of participants and items is under 1 (Osborne *et al.* 2008).

The perceived risk domains have several positive correlations between items that are over 0.9 and 20 of the 25 items have a correlation over 0.75 to at least one other item. It would have been possible to create a factor analysis, but it would not represent the individuals' self-reported preferences and not possible to replicate. Later in the analysis is only the average answer for all the perceived risk domains that are tested as a factor for the risk preferences. Hansson & Lagerkvist (2012) did also have higher correlation between the items on the perceived risk side but they were able to create factors.

A factor analysis is created for the benefit domains, due to the small number of participants it was necessary to reduce the items in the analysis (Table 8). The items with the lowest KMO measure for the individual statement were removed one by one. To be able to increase the total KMO coefficient for matrix. When the KMO coefficient for the matrix did reach 0.5 were instead the items with the lowest factor loadings removed one by one, until all factor loadings were over 0.3. The final version of the factor analysis is shown in Table 8 and it is a rotated factor matrix with 15 items and three factors. Ten items have been removed to create a valid factor analysis (with a larger sample would it probably be more items in the final matrix).

The lowest Eigenvalue on the three factors is 2.5, a fourth factor would have an Eigenvalue of 1.3. However, in this case, three factors much larger Eigenvalues than a couple of factors near 1 and that is why this study just creates three factors. The final matrix has a KMO measure of 0.554 for the whole model and 0.448 to 0.665 for the individual statements. The Cronbach's alpha for all the factors is over 0.75, which is good and creates reliability to the factors (Tavakol & Dennick 2011).

Table 8. Rotated factor matrix, benefits domains

	Factors		
	1.Benefits from being in the social environment	2. Benefits from planning and carefulness as an individual farmer	3. Benefits from being well informed and leaning from others
23. Having time to participate in social activities	1.000		
21. Participating in study circles and courses that are relevant for the business	0.682		
22. Having good contact with neighbors	0.662		
5. Having full insurance		0.960	
8. Purchasing inputs in good time		0.764	
15. Following regulations (e.g. for environmental subsidies)		0.742	
9. Regularly testing machinery such as sprayer and seed drill		0.721	
13. Having thorough, documented monitoring of production		0.573	
14. Producing the highest quality, even if this implies e.g. having to work more		0.510	
24. Thinking progressively and searching for possibilities to develop the business		0.356	
11. Continually discussing the business with professional advisors			0.953
25. Getting family to share thoughts about the business and getting them to support the work			0.749
4. Maintaining a low debt-equity ratio			0.536
12. Searching for information before making decisions			0.522
17. Having newer and well-maintained machinery			0.429
Cronbach's alpha	0.822	0.855	0.785
Inter-item correlation	0.485-0.68	0.143-0.795	0.123-0.703
Corrected item-total correlation	0.63-0.776	0.445-0.871	0.396-0.727
Kaiser-Meyer-Olkin measure of sampling matrix	0.554		
Kaiser-Meyer-Olkin measure of individual statement	0.448-0.665		
Extraction Method: Maximum Likelihood. Rotation Method: Oblimin with Kaiser Normalization. Rotation converged in 5 iterations.			

Table 8 shows the three factors and the items in them. The items have factor loadings from 0.356 to 1. There are no items in the model that have a factor loading over 0.35 to other factors than the one they are in. Below follows a description of the three factors and after that Table 9 which shows the correlation between the factors.

Factor 1 comprises three items, which all relate to social interaction with other people. These are items reflecting a person that is described with *Benefits from being in the social environment.* This factor consists of items with high factor loadings, between 0.6 and 1, which creates a significant factor

Factor 2 comprises seven items that mostly relate to security of a yield. The items include: having full insurance; following regulations; buying inputs in good time; producing the highest quality; testing and controlling the machinery and production. These are items reflecting a person that is described with *Benefits from planning and carefulness as an individual farmer*. This factor has diversified factor loadings from 0.35 to 0.96. The low

factor loading on thinking progressively and searching for possibilities to develop the business makes it to a less significant item for the factor.

Factor 3 comprises five items that mostly focus on getting information and advice from others, but also on protecting oneself against large unexpected financial costs. Except for the part with the high financial cost, these the items reflecting a person that is described with *Benefits from being well informed and learning from others*. This factor has diversified factor loadings from 0.43 to 0.95. According to Williams *et al.* 2010 do factor loading needs to be at 0.5 to be significant the factor, due to that is not having newer and well-maintained machinery with 0.43 significant but is still important for the factor.

Table 9. Factor correlation matrix factor analysis

	1. Benefits from being in the social environment.	2. Benefits from planning and carefulness as an individual farmer.	3. Benefits from being well informed and leaning from others.
1. Benefits from being in the social environment.	1.000	0.031	0.000
2. Benefits from planning and carefulness as an individual farmer.	0.031	1.000	0.171
3. Benefits from being well informed and leaning from others.	0.000	0.171	1.000

Table 9, shows that there is low or even no correlation between the factors. This means that the factors do not affect each other and the subject risk references for the different factors can differ.

Hansson and Lagerkvist (2012) did have more answers on their survey which contributed to a more robust factor analysis where they did not need to reduce the numbers of items as much as this study. The factors in this study cannot be directly transferred to the factors Hansson and Lagerkvist (2012) study in part because this study use fewer items and because the factors describe different behavior.

5.2 Dependent test

The relationship between the factors is tested in two tests. In Table 10 is the subjects divided into two groups and are tested to see differences between the groups. The groups are chosen from different focus factors to understand how the factors change the answers. In Table 11 is the correlation tested to show the dependence between different factors.

The factors in Table 10 are the following: *Sample*, the survey is divided into two samples, Sample 1 and Sample 2; *Time*, this controls if there is any difference between the respondents that answer the survey fast or slow, the first group did answer the survey in less than 20 min; *Irrigation possibility*, irrigation is a vital risk-reducing action for many potato farmers, this test if there are any risk preference differences between the farmers, with lower or higher possibility irrigate. The first ones have an irrigation capacity of less than 60% of the potato cultivation and then those with more than 80% of the cultivation. The gap between the groups is only there to reinforce the difference between the groups and it is no farmers between the groups; *Average harvest*, first the ones that have an average harvest at 45 tonnes per hectare or less, then the ones with a higher harvest; *Total harvest*, control for the larger farmers that have a harvest of over 900 tonnes autumn/winter table potatoes. The first are the ones that have a total harvest under 800 tonnes then the ones with over 900 tonnes; *Active years*, the

first is the farmers that have been active for less than 30 years; *Revenue target*, this is the main factor in the analysis and first, are the subjects that have a revenue targets at 80 000 SEK per hectare or less. After that comes the ones with a revenue targets over 100 000 SEK per hectare; *Part of household income,* the first is the ones where the household is less than 35% dependent on potato cultivation and then those where the household economy is more 50% dependent on potato cultivation; *Agrarian University*, the first is the subjects that have an education from an agrarian university and then the rest; *Halland*, the first is the subjects that have their potato cultivation in the county of Halland and then the rest; *Age*, first is the subjects that are under 50 years old.

Table 10. Factor relationships, Mann Whitney U test

	Average all EG test	EG test 1	EG test 2	EG test 3	EG test 4	EG test 5
Average all subjects	4.41	4.81	4.48	4.33	4.14	4.29
Sample 1	4.29	4.79	4.14	4.14	4.14	4.21
Sample 2	4.66	4.86	5.14	4.71	4.14	4.43
Time < 18 min	3.95	4.27	4.00	4.18	3.64	3.64
Time > 20 min	4.92	5.40	5.00	4.50	4.70	5.00
Irrigation possibility < 60%	4.89	5.18	4.73	4.45	4.91	5.18**
Irrigation possibility > 80%	3.88	4.40	4.20	4.20	3.30	3.30**
Average harvest ≤ 45 tonnes/ha	4.96	5.33	4.78	4.67	5.00	5.00
Average harvest > 45 tonnes/ha	4.00	4.42	4.25	4.08	3.50	3.75
Total harvest potatoes < 800 tonnes	4.65	5.00	4.50	4.42	4.67	4.67
Total harvest potatoes > 900 tonnes	4.09	4.56	4.44	4.22	3.44	3.78
Active years < 30	4.47	4.67	4.50	4.33	4.42	4.42
Active years > 30	4.33	5.00	4.44	4.33	3.78	4.11
Revenue target ≤ 80 000 SEK/ha	3.51***	3.82*	3.27***	3.64	3.27**	3.55
Revenue target ≥ 100 000 SEK/ha	5.40***	5.90*	5.80***	5.10	5.10**	5.10
Part of household income < 35 %	4.70	4.90	4.50	4.80	4.60	4.70
Part of household income ≥ 50 %	4.15	4.73	4.45	3.91	3.73	3.91
Agrarian University	4.47	4.86	4.43	4.36	4.29	4.43
Not an Agrarian University	4.29	4.71	4.57	4.29	3.86	4.00
Halland	4.53	4.91	4.36	4.27	4.45	4.64
Rest of Sweden	4.28	4.70	4.60	4.40	3.80	3.90
Age < 50	4.38	4.70	4.40	4.40	4.30	4.10
Age ≥ 50	4.44	4.91	4.55	4.27	4.00	4.45

*. Extracted P-value at the 0.10 level (2-tailed). **. Extracted P-value at the 0.05 level (2-tailed) ***. Extracted P-value at the 0.01 level (2-tailed)

Table 10 shows the mean in the EG tests for the chosen factors. There are some differences for most of the factors, however, there are only significant differences in mean for the *Revenue target* and *Irrigation possibility*. When focusing on the EG tests it is the difference between the tests and how they are correlated that is interesting. Overall are no big differences between the tests. To be able to understand how the different stakes effect the individual is

correlation used. Table 11 shows that the correlation of EG test 1 to the other EG tests has a decreasing trend with the size of the stake, from a positive correlation at 0.809 for EG test 2 down to a positive correlation at 0.195 for EG test 5. The correlation between EG test 1 and 5 is not significant. EG test 3 has however a high correlation to all other EG tests, with positive correlation coefficients at 0.467-0.667. EG test 4 is also highly positive correlated with EG test 5, with a correlation factor at 0.77. Below are the differences that are because of the Revenue target, Benefits from planning and carefulness as an individual farmer, and some other factors analyzed.

5.2.1 Revenue target

The revenue target has a highly positive correlated with choice in EG tests. The farmers with revenue targets over 100 000 SEK are also less risk-averse. For the average cultivation option is the difference significant with an extracted P-value at 0.01 in a Mann Whitney U test between the farmers with low and high revenue targets. The Kendall's correlation in Table 11 between the average cultivation option and revenue target is significantly positive correlated with a P-value under 0.01 and a correlation factor at 0.466.

Separately, the five different tests vary with a correlation from highly significant to non-significant. The correlation factors are positive and between 0.285 and 0.478 and there is no trend in the correlation (Table 11). Accordingly, the Mann Whitney U test does show a similar result, with significant differences in EG test 1, 2 and 4. The subjects with low revenue targets have no trend over the five tests. For the subject with high revenue targets, it is however a shift after the first two tests with mean answers at 5.9 and 5.8 down to 5.1 for the three remaining tests.

The mean CRRA coefficient is 1.2 for the subjects with low revenue targets and 0.49 for the subjects with high revenue targets. The difference in revenue target range from 50 –- 175 thousand SEK. This difference is too big to be explained by higher goal if the less risk-averse farmers. These CRRA coefficients are in line with Reynaud and Couture's (2012) study on French farmers that did derive on an average CRRA coefficient of 0.62 and 1.02 respectively for a low and a high payoff.

Looking at the results with an empirical lens, the average farmers rather forgo a 6.6% increase in expected revenue to avoid that the low income decrease with 35.7%. The farmers with a high revenue target do forgo an increase of 3.6% in expected revenue to avoid that the low income decrease with 25%. These costs of risk are high, and it can be a potential problem for the table potato sector, if the farmers cannot reduce their risk.

5.2.2 Benefits from planning and carefulness as an individual farmer

Benefits from planning and carefulness as an individual farmer are the factor with the highest correlation to the EG tests, with a positive correlation to the average cultivation option at 0.522 and a P- value under 0.01 (Table 11). To further clarify, the correlation between the average cultivation option and benefits from planning and carefulness as an individual farmer is positive. It applies if the farmer that state that these questions secure the income from the farm, is also less risk-averse. The average benefits from the preference questionnaire are also significant at a level under 0.05 and a positive correlation value at 0.343. However, the benefits from planning and carefulness as an individual farmer are derived from the benefits side in the self-reported preference questionnaire, so probably is a correlation for the average

benefits the same correlation as the one in benefits from planning and carefulness as an individual farmer. Also, this is confirmed by that Average benefits and Benefits from planning and carefulness as an individual farmer is highly correlated with each other.

On the separate tests is the correlation positive and highest on test 1 and 2 with a correlation at 0.585 and 0.653 (Table 11). In test 3, 4 and 5 is the correlation positive but lower with correlation values from 0.362 to 0.278. However, all correlations are significant except for EG test 5.

Table 11. Factor correlation matrix Kendall's correlation

	Amount of the cultivation that is irrigated	Average harvest/ha	Cultivated land of potatoes	Production of Autumn/Winter table potatoes	Average all EG test	EG test 1	EG test 2	EG test 3	EG test 4	EG test 5	Average benefits	Benefits from being in the social environment	Benefits from planning and carefulness as an individual farmer	Benefits from being well informed and learning from others	Average perceived risk	Revenue target per hectare	Household's total income depending on potato cultivation (%)
Amount of the cultivation that is irrigated	1.000	.411*	.550**	.455**	-.063	.022	.033	-.075	-.085	-.178	.137	.042	.140	.005	.140	.162	.397*
Average harvest/ha	.411*	1.000	.416*	.605**	-.109	-.016	.053	-.153	-.248	-.228	.090	-.198	.054	-.084	.084	.005	.122
Cultivated land of potatoes	.550**	.416*	1.000	.733**	.055	.062	.153	.005	-.081	-.011	.216	-.010	.272	.272	.153	.228	.423*
Production of Autumn/Winter table potatoes	.455**	.605**	.733**	1.000	.029	.025	.133	-.106	-.120	.015	.223	-.120	.230	.077	.134	.169	.301
Average all EG test	-.063	-.109	.055	.029	1.000						.343*	.063	.522**	.174	.145	.466**	-.095
EG test 1	.022	-.016	.062	.025		1.000	.809**	.530**	.385*	.195	.343*	.147	.585**	.101	.121	.314	.031
EG test 2	.033	.053	.153	.133		.809**	1.000	.608**	.454*	.331	.438**	.144	.653**	.252	.170	.441*	.090
EG test 3	-.075	-.153	.005	-.106		.530**	.608**	1.000	.667**	.467**	.146	-.048	.362*	.011	.011	.285	-.159
EG test 4	-.085	-.248	-.081	-.120		.385*	.454*	.667**	1.000	.770**	.186	.005	.335*	.042	.058	.478**	-.189
EG test 5	-.178	-.228	-.011	.015		.195	.331	.467**	.770**	1.000	.152	.000	.278	.052	-.077	.387*	-.165
Average benefits	.137	.090	.216	.223	.343*	.343*	.438**	.146	.186	.152	1.000	.391*	.654**	.429**	.551**	.345*	.066
Benefits from being in the social environment	.042	-.198	-.010	-.120	.063	.147	.144	-.048	.005	.000	.391*	1.000	.212	.077	.067	.263	.289
Benefits from planning and carefulness as an individual farmer	.140	.054	.272	.230	.522**	.585**	.653**	.362*	.335*	.278	.654**	.212	1.000	.327*	.303	.407*	.104
Benefits from being well informed and learning from others	.005	-.084	.272	.077	.174	.101	.252	.011	.042	.052	.429**	.077	.327*	1.000	.553**	.253	.114
Average perceived risk	.140	.084	.153	.134	.145	.121	.170	.011	.058	-.077	.551**	.067	.303	.553**	1.000	.144	-.015
Revenue target per hectare	.162	.005	.228	.169	.466**	.314	.441*	.285	.478**	.387*	.345*	.263	.407*	.253	.144	1.000	.160
Household's total income depending on potato cultivation	.397*	.122	.423*	.301	-.095	.031	.090	-.159	-.189	-.165	.066	.289	.104	.114	-.015	.160	1.000

*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed)

5.3 Reference point test

The reference point test is an estimations model described in 3.7.4 Reference point test, with the purpose to test how much the farmers' answers are dependent on their revenue target. The model estimated answers from most risk-seeking to most risk-averse. Only six of the 21 subjects got an estimation on EG test 1. The rest of the farmers had to high revenue targets. The model estimated 80 responses of a total of 105 tests.

The model estimated 14 right answers of a total of 80 estimated answers, with the accuracy of 18% (see blue marked squares in Table 12). This is slightly higher than a random pick with an accuracy of 11%. The mode answer three would have given 26 right answers from the 105 tests. However, the model gives an answer that has an error that is one or less 53 times of the 80 answers or accuracy of 66%, (see green market squares in Table 12). Compared to the top three mode values that would have given 64 right answers or accuracy of 61%. The mean deviation of the estimations is 1.5 with a standard deviation of 1.4. The mean deviations for the separate tests are highest on EG test 2 with 2.1 and lowest on EG test 4 with 0.9 in deviation mean.

The estimation model has better results when the expected risk-neutral revenue in the EG tests is close to the farmers' revenue targets. When estimating the answers where the farmers' revenue target is less than 17 thousand away from expected risk neutral revenue, gives the model 10 right answer and 31 answers, with an error at one or less in 37 estimations, showed in the light green field in Table 12. These estimations have an accuracy of 27% right answers and 84% with an error at one or less.

Table 12. Reference point test

Revenue target	EG test 1			EG test 2			EG test 3			EG test 4			EG test 5		
50 000	4	3	1	3	2	1	4	2	2	3	3	0	3	4	1
50 000	4	3	1	3	2	1	4	2	2	5	3	2	5	4	1
50 000	4	3	1	3	2	1	3	2	1	2	3	1	2	4	2
60 000	2	5	3	2	3	1	3	2	1	2	1	1	2	3	1
70 000	5	6	1	5	4	1	4	3	1	4	2	2	5	1	4
75 000	3	8	5	3	4	1	3	3	0	2	2	0	1	1	0
80 000	6			5	5	0	4	4	0	4	3	1	5	2	3
80 000	6			4	5	1	5	4	1	4	3	1	3	2	1
80 000	3			4	5	1	4	4	0	3	3	0	5	2	3
80 000	3			2	5	3	3	4	1	3	3	0	3	2	1
80 000	2			2	5	3	3	4	1	4	3	1	5	2	3
100 000	9			9	9	0	9	6	3	4	4	0	4	3	1
100 000	7			7	9	2	4	6	2	4	4	0	4	3	1
100 000	7			7	9	2	7	6	1	5	4	1	3	3	0
100 000	5			4	9	5	2	6	4	2	4	2	2	3	1
100 000	3			3	9	6	3	6	3	3	4	1	3	3	0
100 000	2			3	9	6	5	6	1	6	4	2	7	3	4
120 000	8			6			6			7	6	1	6	5	1
125 000	9			9			6			8	6	2	9	5	4
175 000	5			6			6			8			8		
175 000	4			4			3			4			5		

6 Discussion

In this chapter, the result of the survey and analysis is discussed with earlier research and its implications for the farmer and the potato sector overall. Also, the method and the generalizability of this study are discussed.

6.1 Potato farmers risk preferences

The farmers' risk aversion can lower the production since the average farmer does rather forgo a 6 % increase in revenue if it contributes to an increased in the revenue volatility. In a market, that functions well is this not a problem due to that other actors can take over the risk from the farmers. However, this is not as easy in the potato market as in other markets due to the structure of the market. The potato market lacks these simple risk transfers methods as price hedging or other price insurances.

A price hedging system for table potatoes would make it easier for the farmers to plan their production and by that decrease the price risk in their production (Miller *et al*. 2004). When the farmers can plan their production increases also the efficiency in their cultivation. However, as Tomek and Gray (1970) argue, it is not sure that a hedging system would have any positive effect on the potato market due to the potato itself. One of the main price-setting factors in other hedging markets as wheat is the stock that can be transferred to next year (Tomek & Gray 1970). The table potato market does not transfer any potato stock between seasons and the stock should empty in June the year after harvest, which contributes to more price uncertainty before the harvest. This is something that is shown in Figure 1 where the potato price fluctuates more between the years than the wheat price. In a potato price hedging market would the risk for the buyer because there are no stock and the price premium the farmer needs to pay.

The price of potatoes depends on the total harvest that season (Tomek & Gray 1970). This gives a natural hedge for the farmers since when the yield is lower increases the price (Miller *et al*. 2004; Hardaker *et al.* 2015*)*. Other crops that have a larger world market becomes this hedge low, but since the potato market is mostly a local market with few farmers becomes this hedge larger. The natural hedge and the fact that there is no interseasonal stock make it harder for an outside actor to move risk from the farmers through a hedging market. This because the outside actor would have a harder time predicting prices and the risk premium that the potato farmer would be willing to offer would be low due to the natural hedge. This makes it possible for a cooperative solution were the farmers help each other just to avoid the full damage from a total crop failure that the natural hedge doesn't protect against.

From the factor analysis, three factors were created the first factor *Benefit from being in the social environment*. This factor involves social risks that are indirect risks for the farmer (Miller *et al.* 2004). This factor does not have any correlation to the answers in EG tests (Table 11). The lack of correlation indicates that these two risk domains are separate from each other and the farmer's view of social relations does not affect how the farmer takes risks in his cultivation. These results confirm earlier studies from Weber *et al.* (2002) and Reynaud and Couture's (2012) conclusions that social risk preferences are separated from financial risk preferences and the result in EG tests.

Benefits from planning and carefulness as an individual farmer factor have proven to affect the risk preferences in the EG tests. This factor includes actions that Miller *et al.* (2004) describe as risk-reducing actions, with actions as having full insurance, buy inputs in good time and follow regulations. These actions can describe a farmer that does not want to take any risk. Nevertheless, the farmers that rank this factor as more important for reducing volatility in the result are less risk-averse in the EG tests. This inconsistency can be explained by the differences in the measurement of risk behavior between the tests. The EG tests focus only on a person's willingness to take risks compared to Hansson and Lagerkvist's (2012) questionnaire were the farmer should rank different actions. It is likely that the farmer that is more offensive and take risks in the cultivation also needs and finds the actions that can save him if something goes wrong. Hardaker *et al.* (2015) and Miller *et al.* (2004) describes, to reduce production risk can the farmer create strategies to avoid a destroyed harvest. These strategies can involve the actions in *Benefits from planning and carefulness as an individual farmer* factor and do not avoid the farmer from maximizing the revenue. Instead, developing strategies can increase revenues from cultivation. As a nonagricultural example, the person who climbs Mount Everest takes more risk than other people. However, the same person does probably have better risk awareness than others when it comes to health and food because the person needs it.

Benefits from being well informed and leaning from others factor does not affect the answers in the EG tests. Most of the actions that are included in this factor involve getting information before making decisions. This to be able to make better decisions and by that lower the risk. When the individuals have more information can the decisions be made rational and maximize the utility as according to Edwards (1954). The farmers that see these actions as actions that reduce the volatility of the result do by that want to take more rational decisions to reduce their risk. The farmers in the EG test do have the full information with clear possibilities which make it possible to make rational decisions. However, with real-life decisions is it not possible to make these rational decisions (Simon 1990). This means that this factor can have a different effect on real-life decisions as the EC test lacks uncertainty in the decisions.

When the potato farmers are risk-averse, affects it the potato market. First, there is a possible consequence that the farmers choose not to grow potatoes at all since it is a risky crop. This creates a risk premium for the potato farmer which create higher profits for the farmer that still cultivate potatoes. The technology risk in the potato cultivation can make it even harder for farmers to enter the potato market because of the large initial cost for special machinery (Acs *et al*. 2009). This hinders risk-averse farmers from start cultivate potatoes. However, this study did find that the potato farmers are not less risk-averse than the farmers in Reynaud and Couture's (2012) study. That potato farmers are not less risk-averse even if they grow a risky crop that potatoes can cause even more farmers to stop cultivate in the future.

Another effect farmers risk-aversion have on the potato market is that they will produce potatoes less effective. That effect could come from farmers that use more plant protection products than the economically and environmentally optimal amount to reduce the risk of pests or perhaps not use plant beneficial products due to production risks (Miller *et al*. 2004). This would make the average potato farmer less profitable in their cultivation.

6.2 Reference point

The potato farmers' risk preferences have been tested in this thesis, to understand how it is affected by the revenue target as a reference point. The estimation model is very simple but did show some interesting results. The model estimated the right answer for the whole spectrum of choices from the most risk-averse to the most risk-seeking in the EG test. The estimation model had, however, some problems with the predictions when estimating choices were expected revenue is far away from the revenue target. This tendency goes against that it is the right utility curve that is estimated. Koop and Johnson (2012) advocate that a person uses more than one reference point in their decisions. This can be a possible explanation to the tendency in the answers since further away from the reference point might another reference point affect the decision. It would also be explained by Tversky and Kahneman's (1991) explanation of reference point as something that is not fixed and do change due to other expectations. When the possible outcome is low or high might the reference point shift due to the expectation of outcome have changed and not because of the risk preferences have changed. The EG tests do use an interval of outcomes and it is that the expectations are created from. These closed intervals change the expectation of possible outcomes and by that change the reference point in the test. The expectations of possible loss or profit over the target can disappear so the reference point can change. It becomes by that hard to see if the changes risk preferences come from changing reference point, loss aversion or diminishing sensitivity.

Heath *et al.* (1999) state that the subjects make decisions based on their targets to achieve their goal. Also, Kahneman and Tversky (1979) point to the same direction with the S-shaped utility curve where the marginal utility is highest just under the reference point. This extra willingness to reach the revenue target is visible in by certainty in the answers from the farmers. However, the farmers do not have any big kink in their answers. It can be that there is no clear reference point or just a problem with the EG test. Also, Eckel and Grossman (2002) did not find any signs of a kink in the utility curve due to loss aversion. The EG method may have a problem with detecting loss aversion from how the gambles are created. This can depend on how the gambles are created with closed intervals, which can change the expectations and by that changing reference points. However, it needs more research to conclude any answers.

The differences in the CRRA coefficient between the stakes can also reveal the reference point. There are no big trends overall but a downward going trend for the subject with high revenue targets (revenue targets over 100 000 SEK), where the average goes from 5.9 in test 1 to 5.1 in the last three tests. These subjects cannot reach their revenue targets in EG test 1 and 2. These farmers are by that only acting in their loss domain if the revenue target is their reference point. The shift in risk aversion after test 2 can be a result of a risk-seeking behavior in the loss domain or loss aversion, which is proposed by Kahneman and Tversky (1979) in the prospect theory. With the explanation that diminishing sensitivity in the loss domain makes the farmers with high revenue targets less risk-averse in test 1 and 2. In the same way that Tversky and Kahneman (1991) did prove that the difference between a loss of 100 and 200 is larger than between 1100 and 1200. Loss aversion can also explain the shift between the first two EG tests and the later ones because the utility curve has a kink at the reference point and if the choice options are only in the loss domain there is no kink. Without the kink, the utility curve becomes straighter and shows the same behavior as lower diminishing sensitivity and less risk aversion.

The small sample makes it hard to evaluate any exact trend in the answers and if they follow a certain reference point. Also, the possibility of other monetary targets that can affect the references point makes it hard to evaluate the real reference point. These other targets can be profit goals or cultivation costs both with and without labor costs. Also, the problem to determine if the changed risk preferences come from a change in reference point, loss aversion or diminishing sensitivity, which makes it even harder to determine a reference point for the potato farmers. However, the farmers are affected by their revenue targets when they make decisions.

6.3 Generalization from this study

When generalizing from this study it is important to understand the sample and construct of the study. To be able to generalize from a sample it is important to have an appropriate sample to create external validity (Cook *et al.* 2002). The sample in this study differs from the stated population in some parameters, which can make it inappropriate. The farmers in this study have higher potato harvest per hectare than the average potato farmer and more of them are from Halland. The fact that several of the farmers are from Halland can be both positive and negative for the generalizability. This due to that a larger sample in one area makes the sample more appropriate for that area and easier to generalize to other areas (Cook *et al.* 2002). In this study with a sample were a lot of the farmers come from Halland can create a more generalizable sample than a sample with a more appropriate distribution between the areas, because it reduces the effect of other disturbing factors. However, the subjects from Halland are all potato farmers from Sample 1 that is farmers who sell their potatoes together. When selling together can the price risks be affected due to the same selling procedure, and this can make it more uncertain to generalize to other farmers, however, there are just small differences between Sample 1 and 2 answers.

When generalizing from a study it is vital to know what the study has examined. This study focused on risk preferences and used two tests in the survey to examine them. Both these tests should measure risk preferences with two different focus. The results show that higher risk awareness for the factor *Benefits from planning and carefulness as an individual farmer* and questions from Hansson and Lagerkvist's (2012) questionnaire overall are positively correlated with less risk aversion on the EG tests. The positive correlation goes against that they would both have measured risk preferences due to if they did it would have been a negative correlation. Both the tests have been validated to measure risk preferences in different settings, so the inconsistency in the result is probably in the construct. As discussed earlier measure the tests different things first do the EG test measure a will to maximize the revenue even if the risk increases. Secondly, Hansson and Lagerkvist's (2012) questionnaire does measure the stabilizing effect action has on the result. When people have well function strategies with actions will they be risk-averse in some domains but can still try to maximize their revenue. When generalizing from this type of studies it is important to know what type of risk domain the study has controlled for.

6.4 Method discussion

There are some limitations to this study from how it is executed. The sample size is small, with only 21 valid full answers and a total of 36 responders to the survey. There is two explanation to the low numbers of full answers. The length of the survey, the survey had a

median time of just over 20 minutes. Also, that survey is sent out during planting season in April. Hansson and Lagerkvist's (2012) study was also a long survey that was sent out during April and they had a response rate below 50%, which they explained to the length of the study. The length of this study did probably contribute to the fact that 13 of the 36 participants in the study did not fulfill the survey.

6.4.1 Sending period

The survey was sent out during April, which most likely affects the results of the study in several ways. First, it can be hard to fir the subjects to answer the survey because of the work-intense period. Secondly, the sending period is important since the reference point is influenced by aspirations, expectations, and norms (Tversky & Kahneman 1991). Tversky and Kahneman (1991) describe that the reference point is never stable and can change by a change in expectations. For potato cultivation revenue expectations not stable over the season due to production risks that affect the yield and price fluctuations that affect the selling price. These expectations change that can affect the reference point and needs to be accounted for when sending out the survey. As an example, the summer drought in 2018 probably had influenced the subjects' revenue expectations and by that the reference points during that season due to lower expected yield. This makes it harder to compare revenue targets in the middle of the season when the crop already has been affected by production risk as weather conditions. If the survey is sent out during a time of the year where the current season does not affect the result. It will also be easier to generalize from the study because the external validity would be increased.

The best time to send out a survey that tests on potato farmers' revenue targets is probably in January or February. This is not the most intensive work period and the farmers can allocate time to answer the survey. It is also a good time to avoid seasonal effect on the reference point because the current year's potato cultivation has not yet affected the reference point and it has been a few months since last year's harvest.

6.4.2 Level of stakes

In a study like this is it important to use the right level of stakes, which evaluating the answers on different stakes. The estimation model in this study could only estimate six of the 21 subjects on the first test because most farmers had higher revenue targets than expected. Furthermore, two subjects had too high revenue targets to be estimated in any test. The utility curve that Kahneman and Tversky (1979) describe in prospect theory is S-shaped and when using too low stakes is only the curve under the reference point estimated. It would have been preferable to have slightly higher stakes to get more information about the farmer. Mostly to be able to get more information about how they act when the stakes go above their revenue targets. When lacking that information in this study, it becomes hard to estimate the full effect of loss aversion. Now the answers to the EG tests were divvied into three groups (1-2, 3 and 4-5) that have a high correlation between the tests within the group but less between the groups. This increases the ability to have a slightly greater distance between the stakes without losing any descriptive ability for the small changes.

To get a more explanatory result the stakes should probably change a bit. The lowest stakes for this population would preferably be increased with a few thousand SEK. The distance between the stakes can be increased to be able to get more describing results. With the result from this study, it would be better to have a difference between the stakes of 50 % of the first

stake, because this would contribute to an understanding of the larger trends in the utility curve. This would give a safe value at 40 thousand on the first test and 120 on the last test.

7 Conclusions

The current study aimed to get a wider understanding of potato farmers' risk preferences and include revenue target as a reference point. Two main theoretical conclusions can be made. First, the monetary targets as revenue targets affect the decision making and it can explain how farmers make larger decisions. This study cannot conclude that the revenue target is a reference point because it uses a small sample and that there is no large kink in the answers which would have been a sign of a reference point.

The second theoretical conclusion is the importance of understanding what type of risk preferences a certain risk preference questionnaire or eliciting method control for. The two risk preference tests (EG tests and Hansson and Lagerkvist's questionnaire) were used to measure risk preferences obtained opposite results. From this inconsistency, this study concludes that the tests measure the risk preferences in two different domains. The first domain reflects the will to increase the expected revenue even if it comes with more risk. The second domain reflects the will to do actions and build up strategies to secure the result. These domains are connected because the farmer that wants to increase the profit also needs to face higher risks in the production, which creates a need for actions and strategies that secure the result and lower the risk. Unlike the farmer who makes the same safe choices every year and will not need a well-structured strategy of actions to reduce the risk in the production.

The empirical conclusions arise from that the potato farmers are risk-averse and that this can be a potential problem for the sector in Sweden since it can make the farmers less productive. The risk aversion can result in lower production of foodstuff in Sweden, something that would mean that it will be impossible to reach the aim of the national food strategy, with an increased part of domestically produced foodstuff. However, if it becomes possible for the potato farmers to reduce their risk or become less risk-averse, it would instead stop or even turn around the negative trend with a lower number of farmers that cultivate potatoes. Price insurance can reduce the price risks however the potatoes own specific with a fluctuated price and no interseasonal stock will make it hard to create a market with price insurance. There are other ways for the farmer to reduce his risk in several domains for instance, would an increased the number of potato products reduced the quality risks.

To make the potato farmers less risk-averse in the price and production domains based on this study can conclude that the farmers need to become more aware that their action makes a difference. This due to those farmers who perceive the risk-reducing effects from action as monitoring and test the cultivation and machinery or feel the security insurances and follow the regulations are also less risk-averse in decisions that can increase their income. For advisors and policymakers, it is therefore important to understand that the farmers need to believe in the risk-reducing actions and create risk-reducing strategies to become less risk-averse in their potato cultivation decisions.

In the real-life decisions that the farmer makes is not as clear as the decisions in the EG tests the farmers get two possible outcomes and comes instead with a lot of uncertainty. This uncertainty can change the decision that the farmer makes even more for the farmers that want to make rational decisions with full information. In this study did the will of making rational decisions not affect the risk preferences, however it is not clear how this factor affects potato farmers' decisions about their cultivation.

There are some limitations related to the conclusion in this study due to the size of the sample. The small sample reduces the reliability of the results and creates a need for a replication to be validated. With the small sample comes also the problems with how appropriate the sample is because it does not represent the whole stated population and by that give less reliable conclusions. These generalization problems can be reduced with a replication study on potato farmers or farmers with similar products that can validate the conclusions from this study.

Another limitation of the presented research here is that price and production risk has been studied as a single variable. This has resulted in that any difference in risk aversion between price and production risks has not been detected. For the potato market with several large risks, it is vital to understand price and production risk aversion separately. This is something future research should focus on to create a better understanding of farmers' risk preferences.

This study does not use any control group, which can be a limitation to the study since potato farmers cannot be viewed as a group compared to others. This study compares the result to other studies with farmers, but it does still limit the possibility to conclude if the potato farmers risk-aversion compared to other farmers. Also, limits the possibility to understand why the farmers cultivate a risk crop like potatoes. This study does only use farmers' answers in the analysis and not any real decisions they make in their potato cultivation. In future studies this is something that can be included, however, this most come with a larger ethical consideration because it means that the farmers reveal more personal information.

Furthermore, it is still a need for more studies that involve subjects' non-status quo reference points, because it is a vital part to determine what theoretical perspective decision making should have and build models from.

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Appendix

Survey on income uncertainty

Hi.
We conduct a study on how potato growers make decisions when the outcome is unknown. It is voluntary to participate but your participation would be very helpful in understanding how potato growers' income uncertainty affects the farmers' behavior. The study examines how your choices are uncertain situations and return goals affect how you make decisions in your potato cultivation.

The study is conducted by the Swedish University of Agricultural Sciences (SLU) and your answers will only be used for research purposes. The study is also completely anonymous, which means that your answers cannot be connected to you as a person. You can get a summary in Swedish about the results of the study if you state your mail on the last page of the study or send me an email via the address below. Again, this will not be recorded along with your responses.

The study intends to lead to an increased understanding of how the large variation in returns affects the behavior of potato growers. Understanding can then be used to better design help for the individual farmer. For instance, in the form of calculation basis or risk diversification products such as harvest insurance and custom sales contracts. We have estimated that it takes about 25 minutes to answer the entire questionnaire.

Thanks in advance Daniel Pettersson
For questions about the study, please contact me by email: dapn0003@stud.slu.se or telephone 0734-349415.

Anonymous questionnaire - For research purposes only

1. During a normal year, how does the distribution look between different kinds of potatoes in your cultivation? (Divide 100% into the following three categories.)
    1. Autumn and winter table potatoes
    2. New potatoes
    3. For Industry (Chips, Starch, etc.)
    4. Other

If you do not grow any autumn/winter food potatoes, you can stop here. Thanks for your participation.
2. How much of your cultivation do you have the opportunity to irrigate?

3. When you grow autumn/winter food potatoes what is your average harvest per hectare for harvest in August or later?

4. How many hectares of potatoes do you grow a normal year?

You should now answer five consecutive tests on which income distribution you prefer to get from your potato cultivation. In the test, we consider situations with financial risks in the shape of income uncertainty from potato cultivation. Income includes only sales value and not your costs for growing potatoes. The differences between the five tests are that the safe-income changes. A test consists of 9 different cultivation alternatives where you should choose the cultivation alternative as you

prefer. Where the first is a safe choice, everyone then increases the higher income and the lower income drops. All consist of identical probabilities (50/50). Since there are only two levels on each proposal, the situations become hypothetical, but we ask you to answer them as if you were facing a real cultivation decision.

Example:
In the first test, you are faced with a choice of income with a safe cultivation alternative about one income of SEK 37,500 per hectare. You may also prefer a cultivation alternative such as entails a 50% chance of getting an income of SEK 52,500 and a 50% chance of getting an income SEK 3,000 per hectare or one of the other choices.
In the test, we offer you 9 different cultivation alternatives. For each cultivation choice, there are two incomes possible (a low income or high income) with identical probabilities (50/50). You should now choose your favorite among the 9 cultivation options and to mark that box. You have to choose an option to proceed. Income includes only sales value and not your costs for growing potatoes.

1. Mark your preferred income distribution opportunities

Cultivation options 1	Income	Chance
High	37 500	50%
Low	37 500	50%
Cultivation option 2	Income	Chance
High	45 000	50%
Low	33 750	50%
Cultivation option 3	Income	Chance
High	52 500	50%
Low	30 000	50%
Cultivation option 4	Income	Chance
High	58 750	50%
Low	26 250	50%
Cultivation option 5	Income	Chance
High	65 000	50%
Low	22 500	50%
Cultivation option 6	Income	Chance
High	71 250	50%
Low	18 750	50%
Cultivation option 7	Income	Chance
High	73 750	50%
Low	16 875	50%
Cultivation Option 8	Income	Chance
High	75 000	50%
Low	15 000	50%
Cultivation option 9	Income	Chance
High	78 750	50%
Low	7 500	50%

In the test, we offer you 9 different cultivation options. For each cultivation choice, there are two incomes possible (a low income or high income) with identical probabilities (50/50). You should now choose your favorite among the 9 cultivation options and to mark that box. You have to choose an option to proceed. Income includes only sales value and not your costs for growing potatoes.

2. Mark your preferred income distribution opportunities

Cultivation options 1	Income	Chance
High	48 000	50%
Low	48 000	50%
Cultivation option 2	Income	Chance
High	57 600	50%
Low	43 200	50%
Cultivation option 3	Income	Chance
High	67 200	50%
Low	38 400	50%
Cultivation option 4	Income	Chance
High	75 200	50%
Low	33 600	50%
Cultivation option 5	Income	Chance
High	83 200	50%
Low	28 800	50%
Cultivation option 6	Income	Chance
High	91 200	50%
Low	24 000	50%
Cultivation option 7	Income	Chance
High	94 400	50%
Low	21 600	50%
Cultivation Option 8	Income	Chance
High	96 000	50%
Low	19 200	50%
Cultivation option 9	Income	Chance
High	100 800	50%
Low	9 600	50%

In the test, we offer you 9 different cultivation options. For each cultivation choice, there are two incomes possible (a low income or high income) with identical probabilities (50/50). You should now choose your favorite among the 9 cultivation options and to mark that box. You have to choose an option to proceed. Income includes only sales value and not your costs for growing potatoes.

3. Mark your preferred income distribution opportunities

Cultivation options 1	Income	Chance
High	57 000	50%
Low	57 000	50%
Cultivation option 2	Income	Chance
High	68 400	50%
Low	51 300	50%
Cultivation option 3	Income	Chance
High	79 800	50%
Low	45 600	50%
Cultivation option 4	Income	Chance
High	89 300	50%
Low	39 900	50%
Cultivation option 5	Income	Chance
High	98 800	50%

Low	34 200	50%
Cultivation option 6	Income	Chance
High	108 300	50%
Low	28 500	50%
Cultivation option 7	Income	Chance
High	112 100	50%
Low	25 650	50%
Cultivation Option 8	Income	Chance
High	114,000	50%
Low	22 800	50%
Cultivation option 9	Income	Chance
High	119 700	50%
Low	11 400	50%

In the test, we offer you 9 different cultivation options. For each cultivation choice, there are two incomes possible (a low income or high income) with identical probabilities (50/50). You should now choose your favorite among the 9 cultivation options and to mark that box. You have to choose an option to proceed. Income includes only sales value and not your costs for growing potatoes.

4. Mark your preferred income distribution opportunities.

Cultivation options 1	Income	Chance
High	66 000	50%
Low	66 000	50%
Cultivation option 2	Income	Chance
High	79 200	50%
Low	59 400	50%
Cultivation option 3	Income	Chance
High	92 400	50%
Low	52 800	50%
Cultivation option 4	Income	Chance
High	103 400	50%
Low	46 200	50%
Cultivation option 5	Income	Chance
High	114 400	50%
Low	39 600	50%
Cultivation option 6	Income	Chance
High	125 400	50%
Low	33 000	50%
Cultivation option 7	Income	Chance
High	129 800	50%
Low	29 700	50%
Cultivation Option 8	Income	Chance
High	132 000	50%
Low	26 400	50%
Cultivation option 9	Income	Chance
High	138 600	50%
Low	13 200	50%

In the test, we offer you 9 different cultivation options. For each cultivation choice, there are two incomes possible (a low income or high income) with identical probabilities (50/50). You should now choose your favorite among the 9 cultivation options and to mark that box. You have to choose an option to proceed. Income includes only sales value and not your costs for growing potatoes.
5. Mark your preferred income distribution opportunities.

Cultivation options 1	Income	Chance
High	75 000	50%
Low	75 000	50%
Cultivation option 2	Income	Chance
High	9 000	50%
Low	67 500	50%
Cultivation option 3	Income	Chance
High	105 000	50%
Low	6 000	50%
Cultivation option 4	Income	Chance
High	117 500	50%
Low	52 500	50%
Cultivation option 5	Income	Chance
High	130 000	50%
Low	45 000	50%
Cultivation option 6	Income	Chance
High	142 500	50%
Low	37 500	50%
Cultivation option 7	Income	Chance
High	147 500	50%
Low	33 750	50%
Cultivation Option 8	Income	Chance
High	150 000	50%
Low	30 000	50%
Cultivation option 9	Income	Chance
High	157 500	50%
Low	15 000	50%

The income of your company may be different from year to year. Here are several measures that can be used to affect the oscillations. The measures are certainly perceived to be of different importance different people depending on how the individual situation looks. We ask that you now mark on the seven-point scale how important you think the following measures are, for your company to achieve such a stable result (net profit before tax) as possible.
In your answers, we ask you to consider how important these measures are or could be just you.

1. Paying bills on time
2. Not using a checking account or other short-term credit options to their full extent
3. Having a balanced crop rotation
4. Maintaining a low debt-equity ratio
5. Having full insurance
6. Diversifying farm activities
7. Participating in machinery collaboration or contract machinery
8. Purchasing inputs in good time

9. Regularly testing machineries such as sprayer and seed drill
10. Practicing minimum tillage
11. Continually discussing the business with professional advisors
12. Searching for information before making decisions
13. Having thorough, documented monitoring of production
14. Producing the highest quality, even if this implies eg having to work more
15. Following regulations (eg for environmental subsidies)
16. Having employees
17. Having newer and well-maintained machinery
18. Having access to temporary help if needed
19. Having access to crop drying and storage facilities (either own facilities or through collaboration with other farmers)
20. Selling on contract
21. Participating in study circles and courses that are relevant for the business
22. Having good contact with neighbors
23. Having time to participate in social activities
24. Thinking progressively and searching for possibilities to develop the business
25. Getting family to share thoughts about the business and getting them to support the work

People often see risks in situations where the outcome or consequences are not known, as in situations where the outcome can be negative. However, the attitude to uncertainty is personal and we are interested in your "gut feeling" for the extent to which the following aspects create instability and uncertainty about the performance of your farm. Mark your answer to the seven-point scale. In your responses, we ask you to determine the extent to which these aspects create instability and uncertainty for the result for your company.

1. Not paying bills on time
2. Using a checking account or other short-term credit options to their full extent
3. Not working with a balanced crop rotation
4. Not maintaining a low debt-equity ratio
5. Not having full insurance
6. Not diversifying farm activities
7. Not participating in machinery collaboration or contract machinery
8. Not purchasing inputs in good time
9. Not regularly testing machineries such as sprayer and seed drill
10. Not practicing minimum tillage
11. Not continually discussing the business with professional advisors
12. Not searching for information before making decisions
13. Not having thorough, documented monitoring of production
14. Not producing the highest quality, if this implies eg having to work more
15. Not following regulations (eg for environmental subsidies)
16. Not having employees
17. Not having newer and well-maintained machinery
18. Not having access to temporary help, if needed
19. Not having access to crop drying and storage facilities (either own facilities or through collaboration with other farmers)
20. Not selling on contract

21. Not participating in study circles and courses that are relevant for the business
22. Not having good contact with neighbors
23. Not having time to participate in social activities
24. Not thinking progressively and searching for possibilities to develop the business
25. Not getting the family to share thoughts about the business and getting them to support the work

1. How many years have you grown potatoes?
2. What is your target for sales value for potato cultivation? (only revenue in removed the costs nine hectares for the cultivation of potatoes) crowns per hectare
3. How likely you are to achieve this income measure
4. Is this income target pronounced as something you are trying to achieve
5. Is this income target higher than just covering the costs of cultivation?
6. Approximately how much of the household's total income depends on potato cultivation?
7. Gender
8. Age
9. In which county do you run your agriculture
10. What best describes your education background

Elementary school
Upper secondary school
Post-secondary education not agrarian
Post-secondary education agrarian

Thank you for allocating your time to participate in this study. It will be a great help to analyze how income uncertainty affects potato growers. Do you want to if you have a small summary of the study in Swedish, can you register your e-mail below. This will be sent out when the study is published. Again, thank you very much for your participation.
Daniel Pettersson

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Thank you for your participation