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Abstract

The Swedish processor Findus contracts approximately 500 pea producers annually to secure the company's supply of green peas for human consumption. A production contract, which has had roughly the same design for decades, regulates the relation between Findus and the pea producers. Agriculture is typically a risky business. The main sources of risk in agricultural production are production risk and price risk. It can be questioned whether the current pricing model in the Findus pea production contract is optimal as the conditions facing a grain farmer have changed due to increased price risk in agricultural commodity markets.

The aim of this study is to examine, from the producer's viewpoint, the current production contract between Findus and its pea producers and whether there are alternative pea pricing models that are more effective for both contract parties given volatile agricultural commodity markets. A quantitative approach is used. The method consists of a telephone survey with a number of Findus pea producers and a mathematical programing model based on mean-variance (EV) analysis (Hardaker et. al., 1997) with historical data from a case farm.

The main findings are that the Findus pea production contract functions well in terms of motivation; the pea producers have incentives to maximize the integrated profit (Bogetoft & Ballebye Olesen, 2004). This is also verified by the results of optimization model and the survey. The differences between the examined pricing models are very small both in terms of expected net farm income, expected utility and risk. The value of incorporating Findus peas in the crop rotation is considered to be high. In the south western part of Skåne, Findus peas is the second most profitable crop in the crop rotation in terms of gross margin 3 (GM3). This can be explained by substantially lower costs compared to alternative crops, especially in terms of machinery costs.

Sammanfattning

Den svenska företaget Findus AB kontrakterar årligen cirka 500 ärtodlare för att säkra bolagets behov av gröna ärter avsedda för humankonsumtion. Förhållandet mellan Findus och ärtproducenterna regleras av ett produktionskontrakt, som i stort sätt har haft samma utformning i årtionden. Lantbruk är en riskfylld bransch där de huvudsakliga riskkällorna är produktions- och prisrisk. Det kan ifrågasättas om prissättningsmodellen i det nuvarande kontraktet är optimal då villkoren för spannmålsodlare har förändrats eftersom prisvolatiliteten på spannmålsmarknaden ökat under senare år.

Syftet med denna studie är att utifrån producenternas synvinkel undersöka det nuvarande produktionskontraktet mellan Findus och deras ärtproducenter och om det finns alternativa prissättningsmodeller som är mer ändamålsenliga för båda kontraktsparter med avseende på den ökade prisvolatiliteten på spannmålsmarknaden. Kvantitativa metoder har använts och består av en telefonundersökning med ett antal av Findus ärtproducenter och en matematisk programmeringsmodell baserad på kvadratisk optimering (Hardaker et. al., 1997). I modellen har historiska data från en fallgård använts.

De huvudsakliga slutsatserna är att Findus produktionskontrakt fungerar väl när det gäller motivation, ärtproducenterna har incitament för att maximera den integrerade vinsten (Bogetoft & Ballebye Olesen, 2004). Detta verifieras också av resultaten av optimeringsmodellen och enkätundersökningen. Skillnaderna mellan de undersökta prissättningsmodellerna är mycket små i termer av både förväntad nettoinkomst, förväntad nytta och risk. Värdet av att innefatta ärter odlade för Findus i växtföljden är hög. I sydvästra Skåne är Findus ärter den näst mest lönsamma grödan i växtföljden i form av täckningsbidrag 3 (TB3). Detta kan framförallt förklaras av väsentligt lägre maskinkostnader jämfört med alternativa grödor.

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1 Introduction

Production of agricultural commodities under contract is increasingly becoming more common and accounts for about 40% of the U.S. agricultural production (Hoppe & Banker, 2010). Typically, farmers use two different types of contracts: production and marketing contracts. The phenomenon is referred to as contract farming and can be defined as an agreement between one or more producer(s) and a contractor for the production of agricultural commodities under forward agreements, typically at predetermined prices (Bijman, 2008). Commonly, production and marketing contracts specify the type, quality, and quantity of the agricultural product for delivery at a future point in time. In contrary to a marketing contract, a production contract gives the contractor, typically a processor, significant control over a production process and input usage (Meuwissen *et. al.*, 2001). In production contracts, the farmer is committed to follow particular production methods and input regimes. Production contracts account for the majority of the U.S poultry, egg and hog production (MacDonald *et. al.*, 2004). Also, about 7% of the U.S. vegetable production is produced under production contracts.

Findus is a Swedish processor that by the use of production contracts has secured its supply of agricultural products for several decades. The company is a large Swedish processor of vegetables and one of the company's most important products are frozen green peas for human consumption (pers. comn., Persson & Påhlsson, 2012). Approximately 500 pea producers in Skåne and the south part of Halland are contracted annually and during the growing season of 2011, green peas were grown on 8000 hectares (pers. comn., Persson, 2012). The pea production contract, regulating the relationship between Findus and the farmers, has roughly been formulated in the same way since the start of Findus' green pea production. Green peas for human consumption is in Sweden only produced under production contracts. Thus, there is no spot market for green peas.

1.1 The Findus Pea Production Contract

In production of green peas for human consumption accurate planning is needed as the harvesting time of peas is essential for the outcome (pers. comn., Persson & Påhlsson, 2012). Ripe peas need to be harvested within 24 hours and frozen within 3 hours from harvesting. To maximize the length of the harvesting period and thus optimize the capacity of Findus' machinery and factory, Findus has about eight different pea varieties that are grown each year. Early varieties are fast growing and low yielding whilst late varieties are less fast growing but high yielding (pers. comn., Nilsson, J, 2012). Early varieties are planted on light, coastal and warm soils. As different varieties are suitable for different planting times and soil characteristics, the same variety is in general planted in the same geographical region year after year. The planting period starts in late March and ends in early June and the harvesting period stretches between late June and late August.

The pea production year is illustrated in *Figure 1* and starts in January when the pea price is negotiated between the pea producers, represented by the Pea Grower Association, and Findus (pers. comn., Persson & Påhlsson, 2012). The Findus' pea contract can be compared to a forward contract as the price is determined when the contract is entered (Tomek & Peterson, 2001). If the farmer chooses to grow peas, Findus delivers seed without charge and decides on what variety that each farmer shall plant. Findus consultants give agronomic advice concerning planting time, fertilizer recommendations and pest management, which must be respected by the pea producers. The pea producers provide the land and perform soil preparation, planting and plant protection. Findus decides on harvesting time and arranges for this without charge.

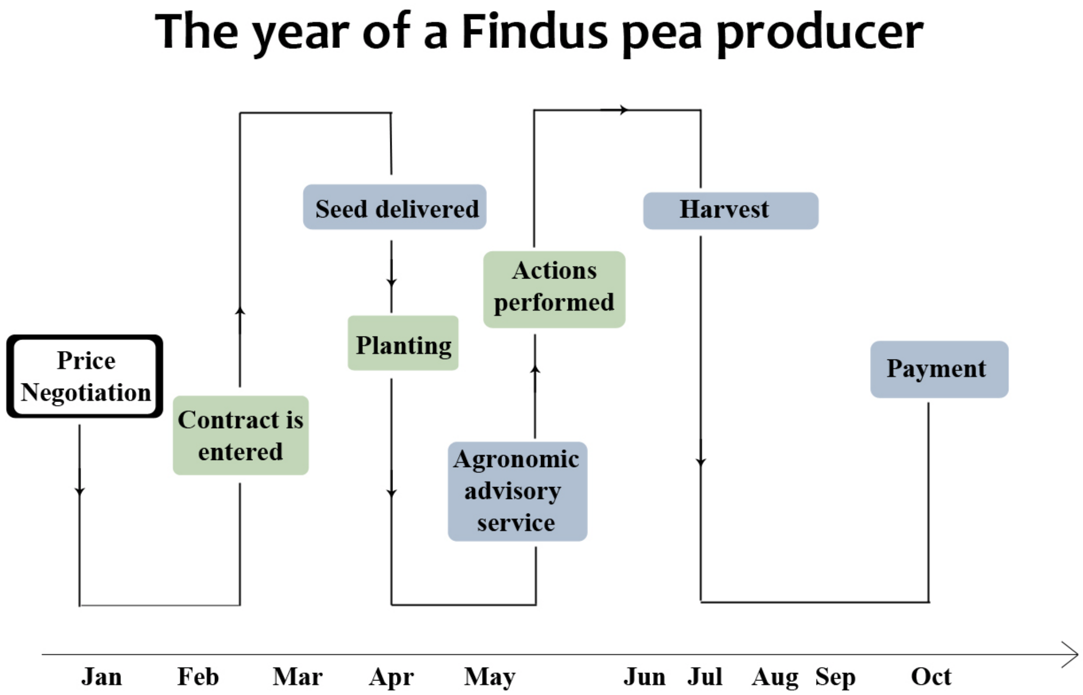

Figure 1. Schematic picture of the Findus pea production. Source: own modification.

The payment that the grower obtains is based on the tenderometer value (t-value) of the peas delivered to the processing plant in Bjuv (Findus Sverige AB, 2011). The t-value is a measure of the maturity and quality of raw peas. In order to obtain high quality of frozen green peas, the peas are normally harvested at a t-value of 100-110. The payment follows a price scheme for different varieties and t-values and a base price is calculated for a t-value of 100. In relation to the base price, the price increases for t-values below 100 and decreases for t-values above 100. This is due to that yield is positively correlated with the t-value. Thus, a lower yield is compensated with a higher price per kg. As the produced quality is unknown when the contract is entered, the exact price received is partly unknown until the peas are delivered to the plant. The price paid per kg of different varieties also varies as the average yield differs between varieties. Consequently, high yielding varieties receive a lower price per kg compared to low yielding varieties. The intention of the above described price scheme is that an individual farmer should be indifferent regardless of what variety that is grown. Hence, the pricing scheme for various varieties and t-values is adjusted for the yield potential of each variety based on field experiments. Fields that are harvested late receive an additional payment as the growth of the peas decreases when the days become shorter and colder. Accordingly, farmers that plant late and therefore harvest late are economically compensated.

If a field cannot be combined due to weather conditions, the producer is entitled to economic compensation (Findus Sverige AB, 2011). Moreover, the grower is guaranteed a minimum payment of 58% of the average payment of the year. However, the minimum payment cannot exceed 5100 SEK per hectare. Except for these limitations, Findus' total minimum payment paid to all producers, is restricted to 1 500 000 SEK. The producer does not receive any minimum payment if it is proven that the yield reduction is a result of the producer's negligence. Payment to the producer is due no more than 30 days after harvest, but no sooner than October 5th.

1.2 Problem

"*Agricultural production is typically a risky business*" (Hardaker *et. al.*, 1997, p. ix). Agricultural production is associated with primarily two sources of risk: price risk due to fluctuating prices and production risk due to weather conditions etc. (Chavas *et. al.*, 2010). Historically, agricultural markets around the world have been regulated in order to help farmers cope with risk (Hardaker *et. al.*, 1997). In the last decades, governments have altered their agricultural policies towards a more market oriented approach, for example the deregulation of the EU's Common Agricultural Policy in 1992. European farmers of today face a price risk that was previously absorbed by the market and price support policies (Matthews, 2010).

The price volatility for grain has increased substantially during the last five years and it is believed that relatively high price volatility will characterize grain markets in the future (Davelid *et al*., 2010). As shown in *Figure 2*, the volatility in spot prices for winter wheat has increased significantly during the period 1995-2005. Risk is a factor which influences decision-making as most individuals are risk averse when faced with risky incomes or wealth outcomes (Hardaker *et. al.*, 1997). The Findus pea producers' perception of the current pricing model and their expected utility of producing peas are affected by their risk exposure and the farmers' degree of risk aversion (Bogetoft & Ballebye Olesen, 2004).

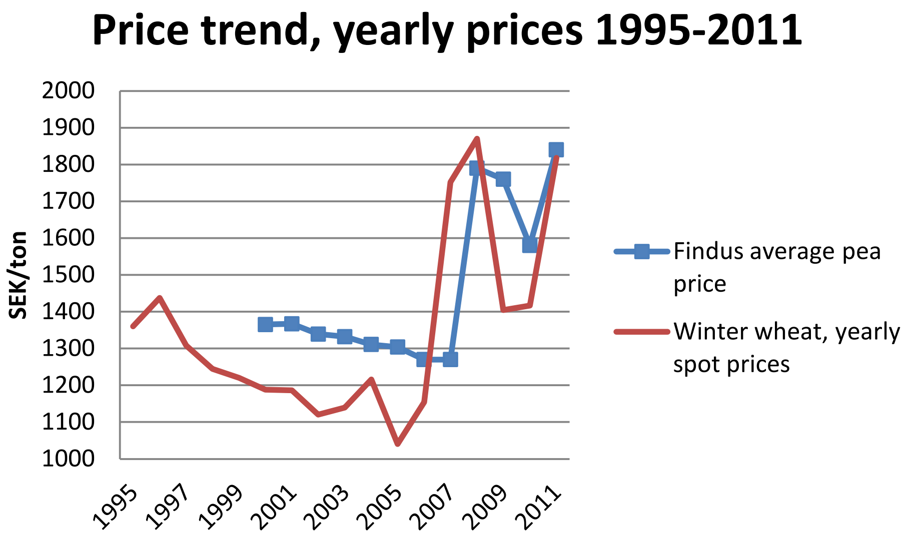

Figure 2. Historical spot prices on the Swedish market for winter wheat and historical average prices for Findus pea producers. Source: www, Jordbruksverket, 1, 2012; pers. comn., Persson; own modification.

It can be questioned whether the current pricing model in the Findus pea production contract is optimal due to changed market conditions. The increased volatility in grain markets implies that the pricing of Findus peas has become more difficult and that the volatility in pea prices also has increased. The Findus pea price negotiated in January is set partly in relation to the expected value of producing alternative crops such as malting barley. The expected value is based on historical gross margins. At the beginning of the growing season, the farmer chooses what crops to grow. The choice is dependent on crop rotation considerations but also on the expected value of different crops. If product prices for alternative crops increase during the current growing season in relation to last year's prices, it is reasonable to assume that some pea producers are dissatisfied with the pea price they receive. As shown in *Figure 2*, this may have been the case 2007, when the pea price was substantially lower than the winter wheat price. Therefore, the volatility in grain prices makes it difficult to evaluate the profitability of Findus peas relative to alternative crops, prior to the growing season. Consequently, the relative value of producing peas for Findus is uncertain in comparison to the value of producing alternative crops, e.g. winter wheat, malting barley, rapeseed etc. *Figure 3* graphically explains the pea producers' decision making process before signing the pea production contract. The pea producers' dissatisfaction may be avoided if the pea price to a greater extent follows the price movements of grain prices. Accordingly, it is interesting to study the effects on the pea producers' expected utility if the pea price to a greater extent is correlated with grain prices.

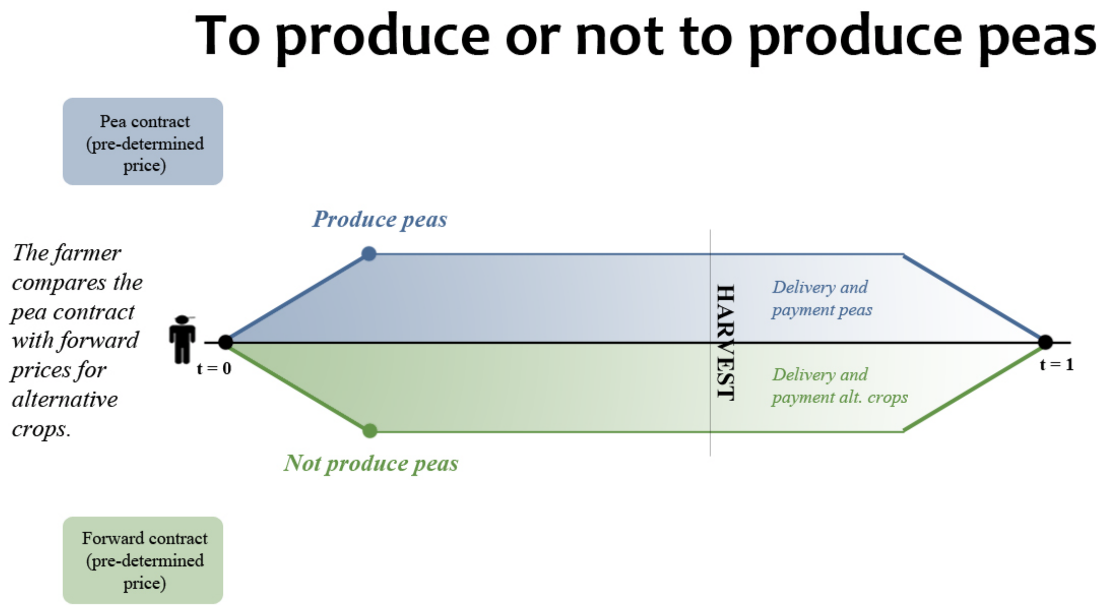

Figure 3. The figure visualizes the farmers' decision making process when he/she decides to produce peas or not to produce peas. Source: own modification.

Moreover, the increased price volatility in grain prices suggests that grain farmers' risk exposure has increased. There is an already existing significant production risk associated with green pea production because of high yield variability due to agronomic reasons (pers. comn., Persson & Påhlsson, 2012). Due to the increased price risk in crops sold on the open market and a significant production risk in pea production, farmers that produce peas on contract for Findus, face an increased total risk as grain farmers. There are many ways in which grain farmers can reduce their overall risk exposure; one way may be to reduce the risk of growing Findus peas. If Findus is less risk averse than the pea producers, the processor should bear a large share of the risk (Bogetoft & Ballebye Olesen, 2004). Hence, it is interesting to examine the distribution of risk between Findus and the pea producers in the current contract and whether the risk carried by the pea producers can be reduced. Moreover, it would be interesting to examine the change in the pea producers' return if Findus peas are not grown. This would give an indication of the value of incorporating Findus peas in the crop rotation system.

1.3 Aim

The aim of this study is to examine, from the producer's viewpoint, the current production contract between Findus and the pea producers and whether there are alternative pea pricing models that are more effective, for both contract parties, given volatile agricultural commodity markets.

More specifically, the aim is to examine if there are alternative pricing models that are more beneficial for both Findus and the pea producers. Reasonably, an alternative pricing model will not be accepted by both contract parties unless they are better off, i.e. both parties' expected utilities are increased (Petersson & Andersson, 1996).

The research questions are formulated as follows:

- *How does the current contract and pricing model function from the pea producers' perspective?*
- *Based on historical data, how do the pricing models affect the pea producers' risk and return?*
- *What is the value of incorporating Findus peas in the crop rotation?*

Our study examines the value of Findus peas in relation to alternative crops in the crop rotation. As Findus peas is only one crop in a pea producer's crop rotation, the value of Findus peas must be set in relation to the value of alternative crops. Thus, it is important to take all marketing and crop alternatives into account when modeling the managerial situation of a pea producer. The study is aimed at the following groups of readers: Findus, the Findus' pea producers, agricultural consultants and students of production economics and farm management. The study is relevant for Findus and the Findus' pea producers as the study's intention is to examine if the current contract situation between the pea producers' and Findus can be improved. Agricultural consultants in Skåne can use the thesis to gain additional knowledge of the value of incorporating Findus peas in the crop rotation.

1.4 Delimitations

The current production contract is examined from the pea producers' perspective as farm-level data is used. The impact of the alternative pricing models on the pea producers' risk exposure and return is therefore examined. In order to take preceding crop benefits into account and thus calculate the value of incorporating Findus peas in the crop rotation, only yield data with a known crop rotation can be used. Hence, data from a case farm is used. The model that is developed is valid explicitly for a single case and cannot directly be applied on other farm enterprises with a different crop rotation system than the case farm. However, as the typical crop rotation in the south western part of Skåne is rather straightforward with a limited number of choices, the generalizability of our results are tested (pers. comn., Yngvesson, 2012). The purpose of using a case farm is mainly to illuminate the typical effects of the different pricing models, not to determine the "exact" effects in monetary terms.

1.5 Outline

The chapter outline is illustrated in *Figure 4* below. Chapter 1, *Introduction* describes the current Findus pea production contract and introduces the problem regarding increased price volatility. The *literature review* describes relevant literature regarding applied contract design, explanatory factors of risk management and production contract pricing strategies. *Theoretical framework* gives an introduction to the theory of expected utility theory and risk preferences, which form the foundation for the mathematical programming model. It also describes the mean-variance (EV) approach and the quadratic risk programing model used. *Method* describes the risk attitude measurement scale used and how the survey was conducted. In addition, the applied quadratic risk programing model and the assumptions and calculations made are described. Chapter 5, *Results*, presents the results of the survey and the mathematical programming model. In the *Analysis and discussion* chapter the results are discussed in relation to the literature and theory presented in chapter 2 and 3. In addition, the generalizability of the results is evaluated. Finally, Chapter 7, *Conclusions*, gives the conclusions of this study as well as identifies further research areas.

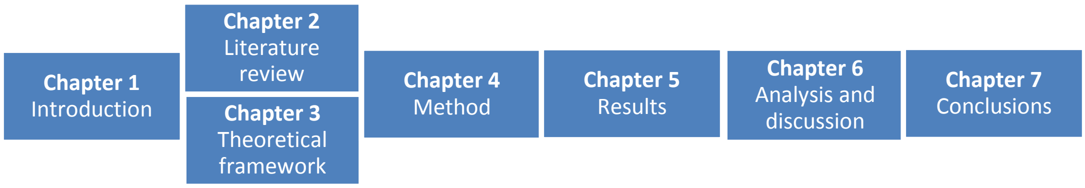

Figure 4. Illustration of the thesis outline. Source: own modification.

2 Literature review

The aim of the literature review is to provide a context in which the Findus contract and the Findus pea producers' risk attitudes can be understood. An extensive literature search was conducted; several databases and different combinations of relevant search terms were used. However, few empirical studies about production contracts and contract design which are relevant for this study were found. No empirical studies that examine an agricultural commodity marketed through a production contract in relation to alternative farm activities were found. Also, few empirical studies analyzing alternative marketing approaches in agricultural production furnish an overall framework (King *et. al.*, 1995). Commonly, the marketing alternatives are treated separately. In addition, only one study that deals with agricultural commodities only traded through production contracts were found. This may be explained by that information on contract terms and design is difficult to access due to the proprietary nature of contracts (Sykuta & James, 2004; Vermeulen et. al., 2008).

2.1 Applied Contract Design

Contract theory is to a large extent based on agency theory and transaction cost theory (Bogetoft & Ballebye Olesen, 2004). Agency theory tries to determine the most effective contract, given different goals or risk attitudes of the contract parties, in order to regulate the relationship between the principal and the agent (Jensen & Meckling, 1976). Furthermore, agency theory provides a theoretical framework for the design of optimal incentive schemes. Transaction costs arise from the need to bring sellers and buyers together and to define contract details, such as price and terms of payment (Milgrom & Roberts, 1992). Hence, minimization of transaction costs is essential in contract design. The study by Bogetoft & Ballebye Olesen (2002; 2004) is the only study found that in detail examines a pea production contract. The contract studied is a production contract between the Danish processor Danisco Foods and its pea producers. The contract is no longer in use as the Belgium company Ardo Group acquired the enterprise from Danisco Foods in the early 2000's (Lindgaard, 2001). Bogetoft & Ballebye Olesen (2002; 2004) discuss three central features of contract design: motivation, coordination and transactions costs. Motivation is the feature of contract design with greatest importance for this study as it mainly focuses on the pricing of the Findus pea production contract. In this section, the Danisco Foods production contract is described in detail, especially the pricing model, in order to compare the Danisco Foods contract with the Findus production contract.

Production of green peas for consumption demands highly accurate coordination as the timing of the harvest is crucial to the outcome (Bogetoft & Ballebye Olesen, 2004). Accurate planning is needed as harvesting must be synchronized to match the capacity of the combines and the capacity of the factory, whilst considering transport time from field to factory and the ripeness of the peas. To ensure a highly accurate coordination and an efficient harvest process, centralized decision-making is required. A centralized decision structure can be considered as the classical decision model within contract farming and is often used when a processor buys produce from a large number of small firms (Bijman, 2008). Centralized decision-making in the Danisco Foods' contract implies that the processor is in charge of most decisions such as amount of seed used, choice of variety, time of planting, production standard and harvesting. The pea producers in Denmark are organized in the Pea Growers' Association (Bogetoft & Ballebye Olesen, 2004). By organizing the pea producers in a growers' association, transaction costs are minimized as individual contracts with each producer are avoided. Instead, the Pea Growers' Association represents the producers in the contract negotiation with Danisco Foods.

Production contracts need to be designed in such a way that both parties are given a private interest in acting so that the integrated profit is maximized as people are assumed to act opportunistic (Bogetoft & Ballebye Olesen, 2004). Consequently, motivation is a fundamental element of contract design. The contract must provide both parties with profits or utilities at least equal to what the parties could obtain if not entering the contract, i.e. their reservation values. A farmer's reservation value can be defined as the profit from his/hers best alternative option. Farmers have different reservation values as their soil quality, skills and cost structure etc. differs. Hence, the price and pricing model are central in contract design. From the processor's viewpoint an optimal contract design would be if all the contracted producers receive exactly their individual reservation value. This is however not desirable if a processor contracts hundreds of producers as the transaction costs would exceed the benefits. Instead, the same contract has to be offered to all producers. The result is that skilled, low cost and/or best soil producers receive a payment higher than their reservation value, i.e. they receive more than they could obtain from an alternative use of their land.

Payments exceeding the producers' reservation values can be reduced by conditioning the payment to the producer on a signal that is associated with the producer's type, i.e. his or hers reservation value (Bogetoft & Ballebye Olesen, 2004). In agricultural production contracts, this is often achieved by letting the compensation be based on the output produced. This compensation scheme ensures that producers with large output potentials receive a high compensation. However, there is often an element of randomness affecting the relationship between actions and output (Bogetoft & Ballebye Olesen, 2002). This implies that the incentives based on output, exposes the producer to risk, as the quantity produced partially is determined by factors that the producer cannot control i.e. weather conditions and pests. The more risk-averse producers are, the larger is the cost of exposing them to risk.

2.1.1 Risk Sharing

Production contracts can be seen as risk-shifting contracts, in which the risk-shifter pays a type of premium to the risk-taker. In return, the risk-shifter obtains a guaranteed price (Meuwissen *et. al*., 2001). To minimize the cost of risk and uncertainty is an essential feature of contract design (Bogetoft & Ballebye Olesen, 2004). Generally, it can be assumed that the processor Danisco Foods has a weaker risk aversion and is a cheaper risk bearer than the pea producers. Danisco Foods has several other production lines and hence a high level of diversification. Furthermore, Dansico Foods is one division of the large corporation Danisco A/S. Thus, the owners of Danisco can diversify their investments in the capital market. As yields of different crops are positively correlated, farmers do not have the same possibility to diversify their production. However, it is not appropriate placing the entire risk on the cheapest risk bearer as this may have a negative effect on the other party's incentives to maximize the integrated profit.

Agricultural risk, i.e. variance in farm-level income, can be divided into price risk and production risk (Chavas *et. al.*, 2010). Production risk can be divided into general production risk and idiosyncratic risk (Bogetoft & Ballebye Olesen, 2004). General production risk refers to weather conditions, general vermin attacks etc. and idiosyncratic risk is related to those factors that affect the pea producers differently, for example weeds. Due to that farmers use different pea varieties and plant at different times, the general production risk experienced by farmers varies. The cheaper risk bearer, Danisco Foods, should take all risk except some element of the idiosyncratic risk as some risk must be borne by the farmers for incentive reasons. The payment to an individual pea producer is negatively affected by weed problems as this reduces the yield. This provides the producer with incentives to perform appropriate plant protection and thus maximize production. Consequently, the Dansico Foods' farmers bear some element of the idiosyncratic risk.

Danisco Foods bears all price risk as the total payment to the pea producers is independent of the processor's marketing possibilities (Bogetoft & Ballebye Olesen, 2004). Moreover, forward contracts which determine an exact price to be paid, completely eliminate the farmer's price risk as the processor bears all the price risk (Heifner *et. al.*, 1993; Harwood *et. al*., 1999). From the starting point of harvest, Danisco Foods bears all production risk as the processor faces the loss if the peas cannot be harvested as green peas and therefore not sold at a premium (Bogetoft & Ballebye Olesen, 2004). The payment to the farmers is set in two steps. First, the factory payment, i.e. the total payment that Danisco Foods pays to the farmers, is determined. The factory payment is based on the mean yield among all farmers. Second, the factory payment is allocated among the pea producers. The farmers are grouped so that producers in the same group use the same pea variety, plant at the same time and experience the same conditions. The payment is first allocated among each group and thereafter allocated to the individual farmers and the average payment should be equal between all groups. This setup implies that groups with high production obtain a lower pea price per kg than groups with low total production. Hence, a high yielding producer increases the production in his or her group and lowers the group's price per kg. Accordingly, the incentives to maximize production are lowest for farmers with high production and highest for farmers with low production. As a result, farmers with the best soils do not obtain their reservation value and their motivation to grow peas for Dansico Foods is low.

Figure 5 illustrates Danisco Foods' factory payment and the division of general production risk. The Danisco pea producers are guaranteed a minimum payment of 4800 DKK per hectare (Bogetoft & Ballebye Olesen, 2004). Consequently, the processor bears the general production risk at very low yields. The processor pays one price per kg for the first 5500 kg per hectare and another lower price per kg for the residual quantity. At an average production above 5500 kg per hectare, the processor bears much of the general production risk as fluctuations in yields above this level have a large influence on the revenues to Danisco, but somewhat modest impact on the payment to the farmers. Danisco would have to take all general production risk if the factory payment was independent of the pea production. On the other hand, the slope of the factory payment would be the same as the marginal value of peas to Danisco Foods, if the farmers would have to bear all general production risk. The Danisco Foods' pea producers are paid in accordance with their performance in relation to the rest of the farmers in their group, rather than in absolute terms. Hence, an individual producer's performance is measured in comparison to other producers with the same prerequisites. Setting up the contract in such a way protects the farmers from some general production risk, without reducing the incentives for motivation. Nevertheless, they are not completely protected as the factory payment depends on the mean yield of the farmers.

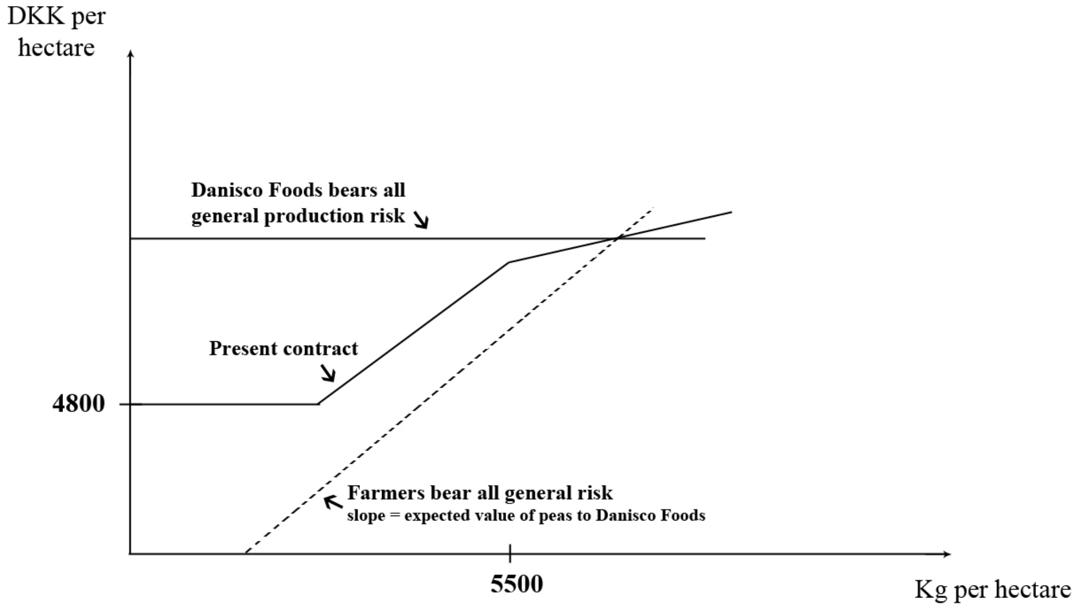

Figure 5. The Danisco Foods' factory payment and the general production risk. Source: Bogetoft & Ballebye Olesen, 2004, p. 86; own modification.

There is a conflict of interest between Danisco Foods and the farmers (Bogetoft & Ballebye Olesen, 2004). In general, to utilize the capacity of the factory, the processor wants to maximize the length of the harvesting period. Hence, some farmers have to plant very early and some have to plant very late, even though this decreases their yields. In turn, the farmers want to plant at a time so that their yields are maximized. The extended harvesting period results in a reduction of the total factory payment to the farmers. However, a production plan can be implemented without too much protest as the loss caused by planting at a less favorable time is shared between all farmers.

2.2 Explanatory Factors of Risk Management

This section forms an academic framework for the questionnaire used in the telephone survey to estimate the Findus pea producers' risk attitudes.

The way in which farmers handle risks associated with price volatility in commodity markets depend largely on the farmer's risk attitude (Pennings, 1998). Farm enterprises can in most cases be characterized as small and medium-sized enterprises (SMEs) (Pennings & Garcia, 2004). The decision process in SMEs differs from the one in large enterprise with different functional departments. Typically, the management of SMEs rests on one single manager and the ownership of SMEs is usually concentrated. Moreover, farm enterprises often are family run. Family firms are often described as conservative, resistant to change and introverted (Naldi et al., 2007). In such an organizational structure, a farm manager's risk aversion can be a strong motivation to manage risk (Pennings & Garcia, 2004). The central determinants of risk management behavior are risk attitude and risk perception. The concept of risk attitude refers to that mangers can be risk-averse, risk-neural or risk-seeking. However, before a manager is able to react, risk must be perceived. Risk perception can be defined as a manager's estimation of the degree of risk inherent in a situation. A manager will perceive the market as less risky if he or she is able to predict the market price of a commodity and will thus not attempt to reduce risk to the same extent as a manager who is not able to predict market prices. Managers will attempt to reduce risk by risk management strategies only when they perceive risk and are risk averse. Pennings and Garcia (2004) show that the interaction between risk attitude and risk perception is the primary explanatory factor of derivative use. Risk attitude and risk perception are psychological constructs and play an important part in the SME manager's decision making process and use of different pricing strategies.

There are several variables explaining farm manager's risk attitudes (Pennings & Smidts, 2000). Previous studies show that managers' innovativeness and market orientation are linked to their risk-taking behavior (Naldi, et al., 2007; Jaworski & Kohli, 1993). Innovativeness refers to the degree to which managers are open to new experiences and possess the ability to convert information about new ideas, products or services for their own use (Pennings, 1998). Responsiveness to changing market conditions often implies introduction or adoption of new products and services (Jaworski & Kohli, 1993). But there are risks associated with new products and services as these are less proven and the risk of failure is high. Hence, the manager's responsiveness to dynamic and uncertain market conditions are reflected in the manager's innovativeness and market orientation. In a study of Pennings & Smidts (2000), farm managers' risk attitudes were measured by studying a set of observable indicators: innovativeness, market orientation as well as revealed market behavior in terms of choice of pricing strategy. The authors conclude that farm managers who define themselves as risk-averse tend to be less market-oriented, less innovative, and more committed to reduce variations in profit margin.

2.3 Pricing Models Used in Production Contracts

In this section, literature about various pricing models used in agricultural commodity production contracts is presented. A Findus pea producer cannot choose how to market his or hers peas as there is no spot market for green peas. Thus, if a farmer wants to produce green peas, he or she must produce peas on contract for Findus. Accordingly, only pricing models common in production contracts are evaluated. The alternative pricing models evaluated in the QRP model are designed on the basis of the literature presented in this section.

Pricing of production contracts are relatively unknown due to the proprietary nature of contracts (Sykuta & James, 2004; Vermeulen et. al., 2008). However, compensation is most commonly based on performance and contracts often contain incentive clauses (MacDonald *et. al.*, 2004). Production contracts often do not specify the price of the commodity, but instead provide a price formula (Heifner *et. al.*, 1993). This is referred to as deferred pricing and the price in such a contract is based on a cash or futures price that is observed at a later point in time. Deferred pricing is common in agricultural production contracts and allows the farmer to speculate on a price increase while the farmer is guaranteed outlet for his or hers produce. Deferred pricing formulas commonly specify a certain base price and a differential relative to the base price. Often, a quotation for spot delivery of the same commodity at a central location serves as the base price. Deferred pricing formulas based on cash quotations are regularly used in production contracts for broilers, eggs and vegetables for processing.

Another pricing model used in production contracts is window pricing, which is a common risk management tool in North American hog production (Unterschultz et. al., 1998). A window contract is formulated with a secure minimum price floor and a maximum ceiling price. This type of contract can also be understood as equivalent to a situation where the producer purchases a put option from the processor, i.e. the contract provider, and the processor purchases a call option with identical value from the producer. When the reference market price for the commodity defined in the contract falls within the window, the producer obtains the reference price and thus bears all the price risk (Shao & Roe, 2003). When the reference price falls above the window, the processor pays the ceiling price. Correspondingly, when the reference price falls below the window, the processor pays the floor price and price risk is thus shifted to the processor. The reference price is commonly based on a spot or futures quotation of the same commodity. The use of window contracts provide farmers with an instrument that protects him/her from great losses but still gives the farmer the advantage of gaining from upward market movements as forward contracts do not. *"Conceptually, the producer removes price risk below the window floor in exchange for giving up price gains above the window ceiling"* (Unterschultz et. al., 1998, p. 724). Depending on the price range between the price floor and the ceiling, the window contract is comparable to either a hedge position established using futures or a straight cash position. The first case occurs when there is a narrow price range between the price floor and the ceiling and the latter case occurs when there is a wide price range.

The effectiveness of window contracts depends on their price and design, and must be beneficial for both the producer and the processor (Shao & Roe, 2003). The key issue in window contracts is how to determine the floor price and ceiling price of the contract. In existing industry contracts, the selection of the price window is often arbitrary (Unterschultz *et al.,* 1998). Floor and ceiling prices are often set symmetrically around a predetermined spot price or around the futures price of the same commodity. In the study by Unterschultz *et al.,* (1998) two methods for determining the price window are proposed: a confidence interval approach and a break-even approach. In the first method, the floor price is determined by the lower bound of the confidence interval of the distribution of the futures price. In the second method, the floor price is determined by the estimated breakeven price for hog finishing. Moreover, the price range is set by equating the premiums paid and received. Both this methods are defined as fixed-window contracts (Shao & Roe, 2003). Another type is moving-window contracts, which specify a floor price as a moving average of input prices. For instance, the floor price may be defined by a linear function of the sixth month moving average feed price whilst the ceiling price equals the floor price plus a fixed number.

3 Theoretical Framework

The aim of the theoretical framework, which forms the foundation of the mathematical programming model, is to provide tools for analyzing the current pricing model and the alternative pricing models. Being a farmer is connected with risks, in particular price risk and production risk. Hence, risk is associated with many of the decisions that a farmer needs to take. Ignorance of risk aversive behavior in farm planning models often result in plans that are not acceptable by the farmer or is disconnected to the decisions he or she actually makes (Hazell & Norton, 1986). The theoretical framework in this study explains the nature of decision making under uncertainty and is based on expected utility theory and risk preferences. Hence, these methods provide a basis for analyzing various types of contracts and pricing schemes. Accordingly, the theoretical framework is highly relevant within the context of the chosen problem.

3.1 Expected Utility Theory and Risk Preferences

A common approach for evaluating the impacts of risky choices on a farmer's wellness is by means of expected utility (E(U)) (Meuwissen *et. al.*, 2001). Expected utility theory is based on the criterion that rational decision makers always attempt to maximize their expected utility function (Varian, 1992). Utility maximization can be seen as a criterion for how choices are made by the producer. Individuals have different utility functions as people in general have different risk attitudes. Individuals' risk attitudes are usually explained graphically by utility curves (Hardaker *et. al.*, 1997; Debertin, 1986; Varian, 1992). Individuals are assumed to prefer more wealth compared to less wealth and therefore the utility curve will have a positive slope, as shown in *Figure 6* (Hardaker *et. al.*, 1997). In mathematical form, the expression may be written as:

$$U^{(\prime)}(w) > 0 \qquad (1)$$

If the first derivative of the utility function is positive for all w, it represents the relationship that more wealth or income is preferred to less (Hardaker et. al., 1997; Varian, 1992). Hence, the first derivative demonstrates how the marginal utility is affected if wealth increases with Δw. Different individuals can be described as risk averse, risk neural or risk loving. Most people are risk averse when faced with risky incomes or wealth outcomes (Hardaker *et. al.*, 1997). A risk averse farmer prefers a certain income in relation to an equally large income with a larger variance in income. This can graphically be shown as a concave function showing a decreasing marginal utility for an increasing wealth, as shown in *Figure 6*. The relationship can also be described by the mathematical equation:

$$U^{(\prime\prime)}(w) < 0 \qquad (2)$$

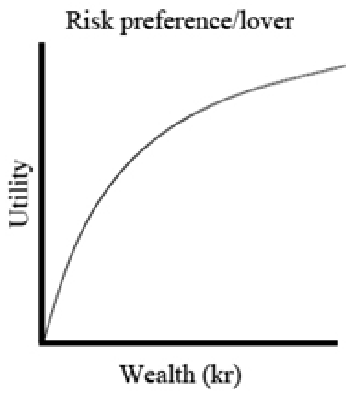

Figure 6. Utility function describing a risk averse individual. Source: Hardaker et. al., 1997; own modification.

The degree of risk aversion varies among individuals and can be calculated by using the Arrow-Pratt measure of absolute risk aversion (Varian 1992; Hardaker *et. al.,* 1997).

$$r_a(w) = -\frac{U^{('')}(w)}{U^{(')}(w)} \qquad (3)$$

$r_a(w)$ is labeled the coefficient of absolute risk aversion, CARA, and describes the absolute risk aversion of an individual (Hardaker *et. al.,* 1997). If the coefficient assumes a positive value it indicates that the individual is risk averse. The basic assumption of CARA is that the preferred option in a risky situation is the same regardless of if there would be an addition or subtraction of a constant amount to the overall wealth. But the CARA assumption does not hold for all conditions. In general, it can be stated that decision makers have a tendency to take larger risks when they can afford it. In other words, diminishing absolute risk aversion is noticeable when companies or individuals have a secure financial position. Another condition for when CARA does not hold is when $r_a(w)$ is expressed in different monetary units and absolute risk aversion functions are compared between countries with different currencies. To enable the calculation even under the above conditions the coefficient of relative risk aversion, CRRA can be used. The measurement is calculated with the following equation:

$$r_r(w) = w * r_a(w) \qquad (4)$$

In this calculation the preferred option amongst a set of risky alternatives does not change when multiplying the wealth with a constant amount (Hardaker *et. al.,* 1997). In order to interpret the result, Anderson and Dillon (1992) suggest that the degree of risk aversion may be characterized in terms of the relative risk aversion coefficient $r_r(w)$. Hardaker *et al* (1997, p. 109) have compiled the information as follows:

1. $r_r(w)$ = 0.5, hardly risk averse at all
2. $r_r(w)$ = 1.0, slightly risk avers
3. $r_r(w)$ = 2.0, relatively risk averse
4. $r_r(w)$ = 3.0, very risk averse
5. $r_r(w)$ = 4.0, extremely risk averse

Expected utility (E(U)) can be translated into a monetary measure defined as the certainty equivalent (CE) (Hardaker *et. al.,* 1997). The certainty equivalent for every decision with risky payoffs denotes the certain sum of money, which a decision-maker would value as equivalent to the uncertain outcome of the risky prospect. CEs vary between different decision makers as people in general rarely have identical attitudes to risk, i.e. utility functions. To use CEs of risky alternatives instead of expected utility values are advantageous as CEs are more easily understood and can be quantitatively compared.

Risk averse individuals require compensation in order to accept alternatives with risky prospects (Hedberg, 1996; Milgrom & Roberts, 1992). The compensation must be based on the riskiness of the uncertain outcome and the individuals' degree of risk aversion to ensure that the expected utility of the risky alternative is higher than for the risk free one. This difference in expected utility between a risky and a risk free alternative is referred to as a risk premium. By definition, the certainty equivalent equals the expected income E(π) minus the risk premium (Hardaker *et. al.,* 1997). This relationship can mathematically be described as:

$$CE = E\big(U(\pi)\big) = E(\pi) - \frac{\varphi}{2} * Var(\pi) \qquad (5)$$

Where:
E(U(π))= The producer's expected utility of income from labor and capital
E(π)= Expected income from labor and capital
φ = Coefficient of absolute risk aversion
Var(π)= Variance of the producer's income from labor and capital

Equation 5 gives the expected mean-variance (EV) approach originally formulated by Markowitz and later developed by Freund. The EV approach is often used in portfolio analysis and can be applied in agriculture and farming in the context of "optimal" farm plans.

3.2 Mean-variance (EV) Analysis

Farm plans consist of different activities on farm level, e.g. different crops that can be produced on the farm. One principle of decision making under risk is that a farm plan has no certain income each year (Hazell & Norton, 1986). Rather, there are numerous possible income outcomes and in the context of mathematical programming, the actual outcome depends on the product sum of all c_j and x_j coefficients in the model. In mean-variance (EV) analysis, it is assumed that among alternative farm plans, a farmer's preferences are based on expected income $E(\pi)$ and the related variance in income, $Var(\pi)$. According to the EV efficiency criterion, a risk averse farmer prefers farm plan A compared to farm plan B if the expected income of farm plan A is greater than or equal to the expected income of farm plan B, and the variance of A is less than or equal to the variance of B (Hardaker *et. al.*, 1997). Hence, the model assumes that farmers trade expected income for reduced variance. Optimal farm plans are characterized by a minimum variance $Var(\pi)$ for an associated income level $E(\pi)$. The efficiency criterion only holds if the farmer has an outcome distribution that is normal or if the farmer's utility function is quadratic.

By the use of quadratic programming, optimal farm plans can be derived as a combination of risky prospects (Hardaker *et. al.*, 1997). The equation calculating the mean and variance for any portfolio mix involving x_j units of prospects j is given by:

$$\Pi = \sum_j x_j c_j \text{ and } Var(\pi) = \sum_j \sum_i cov_{ji} x_j x_i \qquad (6)$$

Where:
x_j = units, i.e. hectares, of activity *j*
c_j = expected average gross margin of activity *j*
cov_{ji} = covariance of gross margins for activities *j* and *i*

In the context of agriculture and choice of crop rotation, there are a number of constraints, such as agronomic, land, capital and labor constraints, affecting the optimal farm plan, i.e. x_j (Hardaker *et. al.,* 1997). The possible combinations of prospects form a convex curve that illustrates the feasible setting under given resource constraints, shown in *Figure 7.* The curve forms an efficient frontier and represents an efficient investment portfolio. Thus, any point on the frontier denotes an optimal farm plan and represents a solution for when the variance is minimized given an expected income and/or points for which the expected income is maximized for a given variance in income. Which specific farm plan that is chosen by a farmer is mathematically derived by the tangent to an efficient frontier. In the point of tangency, the individual's coefficient of absolute risk aversion is equal to the slope of the efficient frontier. An individual's coefficient of absolute risk aversion can be derived by using *Equation 4*, which can be rewritten as:

$$r_a(w) = r_r(w)/w \qquad (7)$$

This definition of $r_a(w)$ can be used when assessing risky prospects with small payoffs in relation to wealth, *w* (Hardaker *et. al.*, 1997). However, if risky prospects are assessed to have large payoffs relative to *w*, $r_a(w)$ can be derived by the assumption of permanent income (Y). In this case, wealth is equal to the capitalized value of future permanent income flows. *Equation 7* can then be rewritten as:

$$r_a(Y) = r_r(w)/Y \qquad (8)$$

A very risk averse individual has a steep tangent, $\frac{\varphi_1}{2}$, and chooses point 1 in *Figure 7*, with a low expected income and a low degree of risk. On the other hand, a somewhat risk averse individual has a less steep tangent, $\frac{\varphi_2}{2}$, and chooses point 2 in the figure. Points above the curve are not feasible as the constraints are not fulfilled and points below the curve are not optimal as it is possible to reach a higher degree of utility with the same degree of risk.

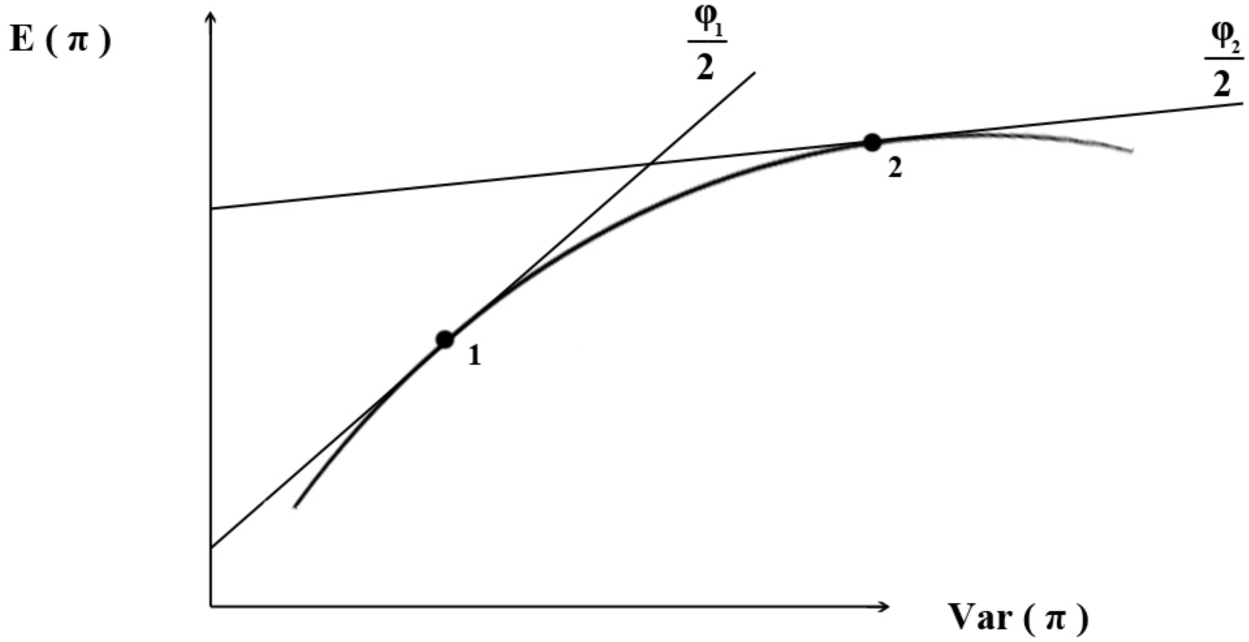

Figure 7. The tangency points between the efficient frontier and the tangents illustrate the optimal farm plan for two individuals with different degrees of risk aversion. A very risk averse individual prefers point 1 whilst a somewhat risk averse individual prefers point 2. Source: own modification.

3.3 Applied QRP Model

The mathematical programming model used in this study is a quadratic risk programming (QRP) model, which is based on mean-variance (EV) analysis. The optimization problem is formulated by combining *Equations 5* and *6*, which results in the following objective function:

$$Max\ Z_j = \sum_{j=1}^{n}\sum_{p=1}^{p} c_{jp}\, x_{jp} - \frac{\varphi}{2} * Var(\pi) \qquad (9)$$

Subject to

$$\sum_{j=1}^{n}\sum_{p=1}^{p} a_{ij}\, x_{jp} \le b_i,\ \forall\ \ i = 1 \dots m$$

$$x_{jp} \ge 0, \qquad \forall\ j = 1 \dots n$$

Where:

Max Z_j =	expected maximized utility
c_{jp} =	expected average gross margin of crop *j* with the preceding crop *p*.
x_{jp} =	units, i.e. hectares grown, of crop *j* with the preceding crop *p. n* is the number of possible activities, so that *j* = 1 to *n. p* is the number of possible preceding crops so that *p* = 1 to *P*.
φ =	coefficient of absolute risk aversion
$Var(\pi)$ =	variance in profits
a_{ij} =	activity *j*'s use of resource *i. m* is the amount of resources, so that *i* = 1 to *m*
b_i =	availability of resource *i*

The c_j values are based on historical yield data, cost structures and output prices. The yield and cost structure data used in our QRP model is based on data collected from a case farm. In order to represent the case farm's resource base and activities, a number of constraints are defined, see Chapter 4, section *4.2 Quadratic Risk Programming Model.*

The QRP problem is solved by maximising expected utility of net farm income for various values of absolute risk aversion coefficients $r_{a,}$ i.e. φ. Optimal farm plans are derived for each pricing model, thus efficient frontiers are derived representing the feasible setting given c_j-values and restrictions. The efficient frontiers indicate how the Findus pea producers would be affected by the, in this study, proposed new pricing models. *Figure 8* exemplifies two different efficient frontiers given two different pricing models. Which farm plan or pricing model that is optimal depends on the slope of the tangent, i.e. the pea producers' degree of risk aversion. Given the slope of the tangents illustrated in the figure, point 2 is preferred to point 1 as this point gives a higher level of utility.

The efficient frontiers are affected by the c_j-value for each farm activity, variances in gross margins and covariances of gross margins between different farm activities. The variances and covariances form a covariance-variance matrix of gross margins (GM) per hectare for all farm activities; see *Appendix 1* for the covariance-variance matrix. The tangent to each efficient frontier is derived by using *Equation 5* and *8* presented in Chapter 3. The latter equation is used to convert the pea producers' coefficient of relative risk aversion, derived from the survey results, to their coefficient of absolute risk aversion ($r_a(Y)$). *Equation 8* is used as crop production is the dominating activity at the case farm. Hence, the risky prospect assessed has a large payoff relative to *w*. *Y*, i.e. permanent income, in *Equation 8*, is represented by the case farm's expected net farm income for each pricing model. The tangency point of each efficient frontier equals the optimal farm plan which maximizes the Findus pea producers' expected net farm income given their degree of risk aversion.

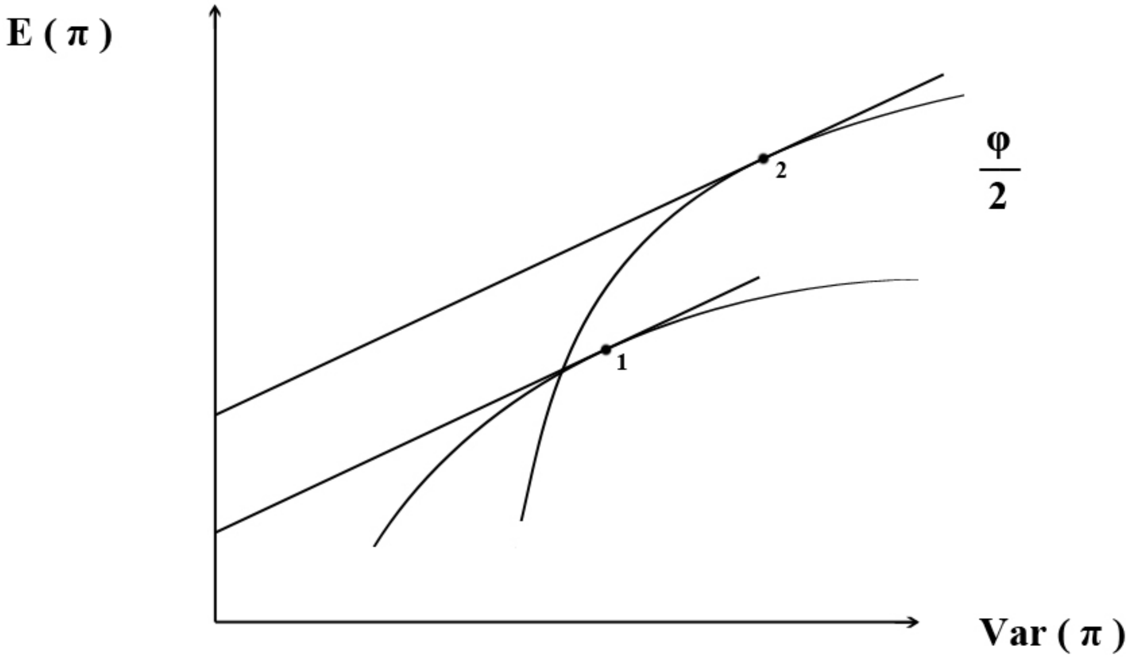

Figure 8. Different efficient frontiers plotted in the same figure. The optimal solution is given by the slope of the tangent. Source: own modification.

4 Method

The overall research approach can be viewed as quantitative and the methods applied consist of a telephone survey and a quadratic risk programming model.

In fixed or quantitative research designs, the study is fixed prior to the main stage of the data collection phase (Robson, 2002). Fixed designs are theory driven, which means that the method is determined by theory as the variables to be included in the study must be specified in advance. Thus, the researcher must have a deep understanding of the phenomenon studied prior to the data collection phase. Most commonly, data are numerical. In flexible or qualitative research designs, data are often non-numerical, i.e. in the form of words. Moreover, flexible designs develop during the data collection phase. A fixed research design was considered to be appropriate in our study as both the survey method and the mathematical programming method are theory driven. Thus, the applied methods are based on the literature and theoretical framework presented in chapters 2 and 3. In addition, the study focuses on the outcome, not the process, which indicates the use of a fixed design (Robson, 2002). Quantitative methods are concerned about the common, the average or the representative of a phenomenon. The intention of this study is to assess the outcome for the Findus' pea producers, as a group, if alternative pricing models are introduced.

4.1 Survey

The aim of the survey is to collect data about the Findus pea producers' motivation for growing peas and to estimate the farmers' risk attitudes. The Findus pea producers' risk attitudes are assessed since the farmers' degree of risk aversion affects the choice of optimal farm plan on the efficient frontier (Hardaker *et. al.*, 1997). It can be assumed that the pea producers have individual utility curves and thus individual risk attitudes (Varian, 1992). Yet, an overall degree of risk aversion valid for all Findus pea producers is estimated in accordance with literature (Pennings, 1998; Pennings & Smidts, 2000). The Findus pea producers' overall degree of risk aversion is described in terms of the farmers' coefficient of relative risk aversion ($r_r(w)$) and is later converted into their coefficient of absolute risk aversion ($r_a(Y)$), which is the risk measure used in *Equation 8*.

In accordance with literature, the Findus pea producers' degree of risk aversion is estimated by measuring their risk preferences, market orientation and innovativeness (Pennings, 1998; Pennings & Smidts, 2000). Data is collected through a survey method. A quantitative approach was considered most suitable for collecting data about the pea producers' opinions about the current contract and estimating the pea producers' degree of risk aversion. Moreover, various researchers have previously used quantitative methods for measuring managers' risk attitudes (Pennings, 1998; Pennings & Smidts, 2000; Jaworski & Kohli, 1993; Naldi *et. al.*, 2007; Meuwissen *et. al.*, 2000).

4.1.1 Choice of the Survey Method

A telephone survey is a survey method that is becoming increasingly more common (Robson, 2002). Robson describes telephone surveys as a method that "*Provide a means of capitalizing on many of the advantages of interview-based surveys while substantially reducing the time and resources involved in running face-to-face interviews by cutting out the travel requirement" (*Robson, 2002, p.253-254).

A survey consists most commonly of a questionnaire, largely or wholly comprised of fixed-choice questions (Robson, 2002). Other common features of a survey are that a small amount of data is collected in a standardized form from a reasonably large number of individuals and that the sample is representative of a population, which is known. The form of survey conducted in this study is telephone interviews. Self-completion questionnaires and face-to-face interviews were also considered but telephone interviews were considered superior. First, the data collection period is relatively short and the cost is low compared to face-to-face interviews (Robson, 2002). Furthermore, telephone interviews enabled us to include more respondents in the sample than would be possible if doing face-to-face interviews. The likelihood of errors in generalizing decreases when the relative size of the sample increases. After a discussion with statisticians at the Department of Economics it was concluded that a sufficient sample size was 10% of the whole population.

Face-to-face interviews could also have been problematic as the survey was conducted in April, a period when farmers in southern Sweden usually are busy with spring tillage and planting, which could have affected the response rate negatively. An important advantage of telephone interviews compared to self-completion questionnaires is a higher response rate (Robson, 2002). In addition, both Findus and the Pea Producer Association believed that the response rate would be the highest if using a telephone survey compared to self-completion questionnaires (pers. comn., Persson & Påhlsson, 2012; Svegrup, 2012). Telephone interviews also allow the respondents to ask questions about the questionnaire and the study, which was believed to increase the validity, i.e. that the statements or questions really measure what they claim to measure (Robson, 2002).

4.1.2 The Risk Attitude Scale

The scale designed for measuring the pea producers' risk attitudes in this project is based on a study by Pennings (1998), which investigates Dutch farmers' risk attitudes in the market for hedging services. Two major approaches of risk attitude measurements can be identified in the literature: measures derived from psychometrics and measures constructed using the expected utility framework (Pennings & Smidts, 2000). In the study by Pennings (1998), the risk attitudes measurement based on the expected utility framework consisted of a computer-guided interview in which the interviewee compared a certain outcome to a two-outcome lottery. The certain outcome was varied in order to eventually derive the respondent's utility curve. The measures derived from psychometrics were based on the Likert scaling procedure. Another study by Meuwissen *et. al.* (2000) investigates the perceived risk and risk management among Dutch livestock farmers by descriptive analysis. The respondents were asked to answer statements regarding their attitudes towards risk relative to other farmers with respect to production, marketing, financial issues, farming in general and if they feel that they in general are willing to assume more risks than other farmers. Most questions in their survey were closed questions and mainly formulated as Likert-type five point scale statements.

In our study, risk attitudes were measured by using a psychometric risk attitude scale as this method was considered superior to a method based on the expected utility framework due to several reasons. The measures constructed using the expected utility framework is time-consuming and require costly face-to-face interviews whilst psychometric scales can be completed fairly quickly and easy. Moreover, we did not have access to the Findus pea producers' email addresses and the producers' computer skills were unknown. Similarly to Pennings (1998), the Likert scaling procedure was selected to measure the pea producers' risk attitudes due to its proven good performance in measuring attitudes. The Likert scale consists of a number of statements within the same topic, which the respondent agrees or disagrees with by the help of a five-point or seven-point scale (Ejlertsson, 1996). The extremes are defined as *strongly disagree* respectively *strongly agree*. In our survey, a five-point scale was assessed to contain a sufficient number of answer categories for the respondents to choose between. A five-point scale was also considered as the maximum number of answer categories that could be used in a telephone survey.

The development of a Likert scale is made according to certain procedures, including gathering a pool of items, deciding on a response categorization system, conducting a large number of test-interviews and selecting items for a final scale through an item analysis (Robson, 2002). Pennings (1998) developed a Likert scale by generating a large pool of items related to a number of constructs such as innovativeness and market orientation, see Chapter 2. The selected items or statements, that were assumed to be related to risk attitude, were based both on previous research and formulated by the researcher himself. The initially selected items were evaluated through several test-interviews to test the appropriateness of the statements. Based on the tests, a final scale was developed through a purification of the initial scale. As our statements are based on the items used by Pennings (1998), the above mentioned steps of the Likert scaling procedure could be avoided.

When testing the construct validity of the risk attitude measurements used in the study by Pennings it was shown that the risk attitude measure derived from psychometrics correlates with the attitude and intention variables discussed in the literature chapter (Pennings & Smidts, 2000). Hence, a farm manager that describes himself/herself as more risk-averse seem to be less market-oriented, less innovative and more committed to reduce variability in profit margins.

The statements and questions of the questionnaire used in the survey are presented in *Appendix 2*. The questionnaire consists of two parts, one measuring the pea producers' risk attitudes and the other one referring to the pea producers' motivation for growing Findus peas. The questions were formulated as simple and short as possible so that they would be easily comprehended and so that an interview would not occupy too much time. To test if the statements were clear, unambiguous and simple, several test-interviews were conducted by both interviewers prior to the actual study. Moreover, this also facilitated our interview techniques. The respondents of the test-interviews were asked to give feedback on both the questions and how they were asked. The procedure of pre-testing is strongly recommended when planning a telephone interview (Robson, 2002). The author also illustrates how important it is to use your voice in a correct manner. The researcher should sound interested of the answers given by the respondent and talk clearly in a moderate speed. When designing interview guides it is common to include questions about the interviewee's background such as age, size of enterprise, position (Jaworski & Kohli, 1993). This is conducted both to gather information about the characteristics of the population and to start the interview with simple questions. A number of introductive questions about age, total cultivated acreage, and number of years as a Findus' pea producer were used in our questionnaire.

4.1.3 Selecting and Contacting Potential Participants

The total amount of pea producers contracted annually by Findus is approximately 500 farmers (pers. comn., Persson & Påhlsson, 2012). Findus' pea producers are divided into four groups depending on their geographical location. Accordingly, four lists comprising all pea producers contracted by Findus this year was provided by the processor. As soil characteristics in the areas differ, it was considered important that the survey would encompass producers in all the four regions. The response rate was projected to about 70%. In order to reach 10% of the population, it was therefore concluded that the sample needed to consist of 80 pea producers. A probability sampling technique with a systematic sampling approach was used to identify the sample (Robson, 2002). Hence, producers were selected by choosing every fifth person on the provided lists. Also, the sample contained equally many producers from each area. Prior to calling the selected producers, an introduction letter presenting the aim of the study, the procedure of the interview, a presentation of ourselves as researchers, and the voluntary nature of the study was posted to the producers, see *Appendix 3*. To clearly inform the respondent about the study is recommended by most literature within research methods. The introduction letter was mailed to the selected pea producers on March 23rd after retrieving contact information from Findus. To make sure that the farmers had received the letter, the telephone interviews were initiated about a week later. The calls began with confirming that the right person had answered and that he/she had received the letter. The respondent was asked if an interview could be conducted immediately or if he/she wanted to make an appointment for the interview. After calling an interviewee notes were taken regarding when the person was called, if he/she answered, when the person wanted to be called back or if the person did not want to take part in the study. This procedure ensured that respondents were not contacted unnecessary or that someone was forgotten.

4.1.4 Analysis of Survey Data

Telephone calls were made to all the 80 respondents who had received the introduction letter. Out of the 80 contacted pea producers, 65 participated in the telephone interview, 13 did not answer their phones and 5 chose not to participate. The answers of two participants were excluded from the data analysis as these answers were considered to be unreliable. This results in an overall response rate of 79%. Out of the overall response rate, the percentage of participants from producer group 1, described in section 4.1.3, was 27.0%. Furthermore, the percentage of respondents from group 2 was 20.6%, 27.0% from producer group 3 and 25.4% from group 4.

The main part of the questions in the questionnaire, performed in this study, was designed as closed questions. A questionnaire consisting of closed questions has the advantage of facilitating the process of coding, since numbers can be attached to each response option already when designing the questionnaire (Robson, 2002). The statements used in the questionnaire were treated in the same way. This simplified the summarization of the data since it did not require categorization of the answers to a limited number of categories to make the material comprehensible. Hence, as the respondents were asked to give standardized answers there was no need to further categorize them. Since most of the statements enabled that the respondents expressed their opinion on a five degree attitude scale, it was possible to enter the answers directly into an Excel file where all necessary calculations could be performed. This is in literature referred to as single-transfer coding and is often used for coding data from attitude surveys, since it reduces the number of coding errors.

Already when modeling the questionnaire it is important to decide what kind of data that is needed and how it should be analyzed (Robson, 2002). To ensure that the questionnaire used in this study was formulated so that the analysis would answer the aim we met with statisticians at the Department of Economics, SLU, who verified that our questionnaire was analyzable. Another important feature of a questionnaire is to make sure that the collected data is collected in a form that simplifies the entry process (Robson, 2002).

When carrying out the telephone survey some of the respondents had problems answering certain questions. For example, producers who did not grow sugar beets and had not done so in years had difficulties when answering the statement: *"The economic value of producing peas in comparison to sugar beets is high"*. When a pea producer could not answer a statement the interview continued and the statement which the farmer could not answer was left out when coding the answers. That participants could not answer statements was believed to appear randomly and only when the respondent honestly could not answer the statement. After collecting all data it was apparent that the answers on questions 5 and 6 were not reliable. These questions asked the participant to identify the division of production and price risk between the farmer and Findus on a rough scale with three alternatives. The participants did not interpret the questions in the same way and most of the respondents had difficulties in understanding and answering the questions. It is therefore chosen not to present the answers on these two questions.

When measuring constructs within the psychometric approach, such as risk attitude, it is a common approach to use scale-mean to numerically compile the answers based on the items (Pennings, 1998; Jaworski & Kohli, 1993). Our data was compiled in accordance with the methodology used in Pennings (1998). Hence, statements 7-23 were measured by calculating scale-mean and standard deviation for each statement. Questions 1-4, and 24 were compiled by summarizing the distribution of answers. In order to compile the statements, the answer distributions of some statements were inverted as the statements were formulated with different basis. Hence, when compiling statement 14 and 15 for the construct "risk preference", the answers of statement 15, "*I am able to predict grain spot prices*" were inverted as statement 14 is formulated as "*I consider the grain market as risky*".

4.2 Quadratic Risk Programming Model

Mathematical programming is a quantitative approach and has been used since the 1960s to model farm-level management decisions (Ekman, 2002). Given limited resources, farm models deal with the optimal organization of farm production. They often include a number of production activities representing production of different crops and livestock products. By the use of quadratic risk programming the optimal solution, i.e. the optimal farm plan can be derived (Hardaker *et al*., 1997). Instead of using a QRP model, linear risk programming models could have been used. Software available to handle non-linear objective functions has previously been less reliable and less available. Therefore, linear models such as MOTAD programming models have been widely used to find linear programming approximations to the QRP formulation. A disadvantage of MOTAD models in comparison to QRP models is that MOTAD models are less exact and produce more approximative solutions.

The aim of the quadratic risk programming model used in this study is to evaluate how different pricing models affect the Findus pea producers' risk and return and the value of incorporating Findus peas in the crop rotation. The input data used in the QRP model is partly based on data collected from a case farm. The case farm is situated in Götalands södra slättbygder; yield survey district 1211 in accordance with SCB's division of arable land, see *Appendix 4* (Statistiska centralbyrån, 2011). The total acreage of the farm is 345 hectares and crops grown at the farm are winter wheat, malting barley, sugar beets, winter rapeseed and finally green peas grown on contract for Findus. The chosen case farm is a typical farm for the south western parts of Skåne as the cropping system and crop rotation are representative for the area (pers. comn., Nilsson, C, 2012; pers. comn., Yngvesson, 2012). Moreover, the case farm has well-documented yield and output price data for several years.

4.2.1 Preceding Crop Benefits

Research shows that crop yield is affected by the preceding crop (Ohlander, 1996); this relation is illustrated in *Table 1.* The case farm has had a similar crop rotation system during a long time period. The yield data of the case farm is affected by the preceding crop in the rotation. Thus, to calculate expected average gross margins per hectare, i.e. cj-values, for different crops with different preceding crop alternatives, it is necessary to eliminate the preceding crop benefits that already exist in the data. This is achieved by calculating the yield level under the assumption of monoculture, i.e. only one crop is grown, no crop rotation in accordance with Samuelsson (2003). This study focuses on the benefits of including peas in the crop rotation system. The model therefore only considers different preceding crop alternatives for winter wheat and rapeseed as peas is a reasonable preceding crop alternative only for those two crops (Fogelfors, 2001). Malting barley cannot be preceded by peas as the protein level of the malting barley then tends to be too high. There are numerous farm activities associated with production of winter wheat and rapeseed. Depending on preceding crop benefit, four different gross margins per hectare of winter wheat produced and two different gross margins per hectare of rapeseed produced are introduced, i.e. Winter $\text{wheat}_{\text{peas,}}$ Winter $\text{wheat}_{\text{rapeseed}}$, Winter $\text{wheat}_{\text{malting barley,}}$ Winter $\text{wheat}_{\text{winter wheat}}$, $\text{Rapeseed}_{\text{malting barley}}$ and $\text{Rapeseed}_{\text{peas}}$.

Table 1. Preceding crop benefit value (kg/hectare). Source: Ohlander, 1996; Blomquist & Larsson, 2009; Andersson & Wall, 2009.

	Succeeding crop				
Preceding crop	Winter wheat	Malting barley	Rapeseed	Sugar beets	Peas
Winter wheat	-	100	1100	4300	1000
Malting barley	300	-	800	4300	300
Rapeseed	1100	400	-	3200	1000
Sugar beets	-	800	-	-	1000
Peas	1000	550	300	3200	-

4.2.2 Restrictions

A number of restrictions affecting the optimal solution must be taken into account when designing the model. *Table 2* presents the restrictions used in the optimization model. First, the occurrence of plant diseases imply that crop rotation is desirable. In accordance with Fogelfors (2001), the maximum acreage of rapeseed cannot exceed one sixth of the total acreage and the maximum acreage of peas must be less than or equal to one seventh of the total acreage. However, the result of the telephone survey, presented in section 5.1, shows that the average percentage of peas in the crop rotation system is 7.5% amongst the Findus pea producers. With respect to this, the maximum number of hectares of peas that can be produced in the model is determined to 7.5% of the total acreage. Second, the maximum number of hectares of sugar beets that can be produced in the model equals 20% of the total acreage as this corresponds to the average percentage of sugar beets in the crop rotation in south western Skåne (pers. comn., Yngvesson, 2012). Third, depending on timely aspects, winter crops such as winter wheat and winter rapeseed cannot be grown after sugar beets. The acreage of winter wheat is restricted to 150 hectares in accordance with the owner of the case farm's advice. Lastly, the acreage of malting barley is restricted to 25% of the total acreage in accordance with the typical crop rotation in south western Skåne (pers. comn., Yngvesson, 2012).

In addition to the above stated restrictions, a number of crop rotation restrictions are formulated. This year's acreage of a crop with a given preceding crop cannot exceed last year's acreage of the preceding crop. *Equation 10* is formulated for a crop activity *j* with the preceding crop *p*.

$$x_{jp} \leq \sum_{p=1}^{P} x_{jp,} \neq j \qquad \forall \;\; j = 1 \dots n \; (10)$$

The inequality denotes that the hectares of crop *j* cannot exceed last year's acreage of the preceding crop *p*. x_{jp} is defined as the number of hectares grown, of crop *j* with the preceding crop *p*. Moreover, the total acreage of various crops grown after a specific preceding crop cannot exceed the total acreage of the preceding crop. This is illustrated by *Equation 11*.

$$\sum_{j=1}^{n} x_{jp} \leq \sum_{p=1}^{P} x_{jp} \qquad \forall \;\; j = 1 \dots n \, , p = 1 \dots P \quad (11)$$

Equations 10 and *11* are used when formulating the restrictions regarding crop rotation, CR, in *Table 2*.

Table 2. The table shows the restrictions used in the QRP model.

	WW_{peas}	WW_{rape}	WW_{mb}	WW_{ww}	$RAPE_{mb}$	$RAPE_{peas}$	MB	SB	PEAS	type	RHS
Acreage	1	1	1	1	1	1	1	1	1	=	345
Max WW[1)]	1	1	1	1						<=	150
Max RAPE					1	1				<=	57.5
Max PEAS									1	<=	25.9
Max SB[2)]								1		<=	69
Max MB[3)]							1			<=	86.3
CR[4)] **peas**	1					1			-1	<=	0
CR rape		1			-1	-1				<=	0
1 CR mb			1		1		-1			<=	0
2 CR mb	-1	-1	-1	-1			1	-1		<=	0

1) Winter wheat, 2) Sugar beets, 3) Malting barley, 4) Crop rotation

4.2.3 Gross Margin Calculations

In this section the assumptions and calculations of the gross margins are described. The gross margin of each crop is evaluated through the use of enterprise budget calculations in Agriwise. Agriwise is a software program for agricultural enterprise budget calculations developed by SLU and used by agricultural consulting firms and banks in Sweden. This is a commonly used method in agriculture as common costs, e.g. maintenance costs and depreciation of machinery, often are difficult to allocate to a specific activity (Nilsson *et al*., 1983). This is due to that many resources in an agricultural firm can be used within different production activities, e.g. the production of different crops. Gross margin (GM) can be defined as the contribution of an activity to the coverage of common costs and any possible profit. There are different GM measures depending on the share of common costs included in the gross margin calculation. The gross margin measure calculated in our study is GM3, which is a profit measure used in Agriwise. The Agriwise measure GM3 allocates the largest proportion of common costs. See *Appendix 5* for an overview of the enterprise budgeting method.

The cj-values used in the QRP model equal expected average gross margins per hectare for each farm activity *j*. Enterprise budget calculations have been conducted for all years, 2002-2011. Some adjustments of the costs estimated in Agriwise were made when calculating the gross margins in terms of GM3 in Agriwise. First, the case farm's actual machinery costs in terms of depreciation, maintenance, cultivation system and operating time have been applied in the calculations for each crop. This was considered important since the machinery costs of growing green peas for Findus are substantially lower compared to other crops. The lower machinery costs can be explained by non-existing harvesting and transportation costs, less application of fertilizer and plant protection and therefore also less operating time. Hence, if no adjustments are made, the value of producing peas for Findus is underestimated.

Replacement costs form the basis for the depreciation costs. The machinery is considered to have an economic lifetime of 15 years. After this time period, the residual value of the machinery is calculated to 20% by using a present value formula stated by Svensson (1988). Hence, the depreciation cost is projected to 5.4% by dividing [1 minus the residual value] with the economic lifetime of the machinery. The replacement and maintenance costs of the case farm's machinery were mainly estimated by the use of *Databoken* in Agriwise (www, Agriwise, 1, 2012). To adjust 2011 year's estimated maintenance and depreciation costs for the years 2002-2010, a production price index was used (www, Jordbruksverket, 2, 2012). Machinery capacity was estimated with the use of the software programme STANK in MIND developed by Jordbruksverket. Some minor adjustments to the machinery costs mentioned above were made after verifying the estimations with the owner of the case farm. The real net user cost of capital used in this study is based on a study by Lagerkvist (1999) and amounts to 6%. The costs calculated in the enterprise budgets are validated by an acknowledged senior agricultural consultant and the person managing Agriwise (pers. comn., Yngvesson, 2012; pers. comn., Karlsson, 2012).

Agriwise is not used for calculating the income for each crop and year as yield and output price data is not taken from Agriwise. Historical yield data is obtained from the case farm for the time period 2002-2011 for all crops except peas, for which data only exists for 2004-2011. The income for sugar beets has been calculated by the use of output prices retrieved from Agriwise and yield data obtained from the case farm. The output prices used to calculate the income for peas are obtained from Findus and refer to the annual average pea price across all pea varieties at t-value 100 during the years 2004-2011. The case farm's actual received pea prices are not used in the QRP model because this would prevent us from comparing the current pricing model with the alternative pricing models as these are based on the average payment for all varieties. Moreover, the case farm has grown different varieties during the time period 2004-2011, which further complicates the comparability between years. The payment follows a price scheme for different varieties and t-values and the base price is calculated for a t-value of 100. Therefore, the average annual pea price across all varieties at t-value 100 obtained from Findus, is converted to a pea price consistent with the case farm's actual t-value. By converting the t-values, the pea prices used in the gross margin calculations correspond with the case farm's actual yields.

The output prices used for the remaining crops are limited to cash prices, i.e. spot prices and forward prices. To model realistic and up to date pricing strategies used by Swedish farmers, it has been assumed that 2/3 of the total harvest of winter wheat, malting barley and rapeseed is sold at spot prices and 1/3 is sold at forward prices (pers. comn., Yngvesson, 2012). The Swedish producer cooperative Lantmännen offers forward contracts for winter wheat, malting barley and rapeseed. These contracts have only been available on the market from November 2008. Consequently, Lantmännen's forward prices are used for the years 2009-2011. For the remaining years, 2002-2008, modified futures prices from Matif and Liffe are used to simulate Lantmännen's forward prices. The futures prices are modified by deducting a basis which is calculated by comparing Lantmännen's forward prices with the futures prices from Matif and Liffe. Thus, an average percentage difference is calculated and deducted from the original futures prices. Lantmännen's forward prices were obtained from Katarina Gillblad at Agronomics and the futures prices were acquired from Lantmännen Cerealia, Malmö.

To make the choice of growing Findus peas comparable to the choice of growing winter wheat, malting barley, rapeseed or sugar beets, some assumptions are required. As green peas cannot be stored it is assumed in our model that all crops are sold at harvest, i.e. nothing is stored at the farm. Hence, the spot prices used are monthly averages during harvest for each year during the time period 2002-2011 (www, Jordbruksverket, 1, 2012). Spot prices for winter wheat and malting barley refer to average monthly prices for August to October and rapeseed prices refer to average monthly prices for September and October. Moreover, we assume that the farmer has two alternatives in March: to produce or not produce peas for Findus, see *Figure 3*. The Findus contract, which can be defined as a forward contract, is signed in March. To make a rational decision, the farmer needs to be able to enter forward contracts for grain at the same point in time as the Findus contract is signed. Thus, forward contracts for grain used in our model are entered in March and have an expiry date at harvest, i.e. September-November. The futures used in this study are entered in February or March and expires at harvest.

The revenues for each crop and year also include farm payments, i.e. subsidy per hectare, received from the European Union for cultivated crop areas in the southern part of Skåne (www, Agriwise, 2, 2012; pers. comn., Callman, 2012). The change in EU policy regime regarding sugar beet production has been taken into consideration. After calculating both revenues and costs, the covariance-variance matrix and cj-values used in the QRP model could be completed. The calculated cj-values were enumerated to 2011 year's price level with a consumer price index (www, Statistiska centralbyrån, 2012).

4.3 Ethics in Research

Ethical considerations inevitably arise in research designs where data is collected from people (Oliver, 2003). Ethical issues should be considered from the early phases of a research project. Typically, the following aspects are discussed concerning ethical guidelines in research: informed consent, confidentiality, the role of the researcher and consequences (Kvale & Brinkmann, 2009). Something that is central throughout the whole research project is that the researcher should treat participants in a way that help to preserve their dignity (Oliver, 2003). In other words, it should be avoided to cause harm, anxiety or distress to participants.

To fully inform participants about a research project before they agree to take part is an important principle in social research (Oliver, 2003). This is important in order for the participant to be in a position to give his/hers fully informed consent. The potential participants in the survey were through the introduction letter carefully informed about the purpose of the project and the main features of the research design. Moreover, it was clarified that the producers were asked to participate on a voluntarily basis and that they had the right to withdraw from the project at any time. The producers that agreed to participate in the survey were given further information if they had questions, but no actual questions or statements were given out in advance. Another central ethical principle in research is that the participant should be offered anonymity in a research report (Oliver, 2003). Put differently, private data identifying the respondents should not be disclosed (Kvale & Brinkmann, 2009). All respondents in the telephone survey were guaranteed that their personal data were not to be disclosed, i.e. all interviewees were to be treated confidentially. Similarly, anonymity in the written report was guaranteed to all participants. Moreover, the case farm is treated anonymously in accordance with the ethical considerations presented above.

The consequences of a research project need to be considered with respect to the participants, including possible harm to the participants (Kvale & Brinkmann, 2009*). "Perhaps the key issue is that in order to place research on a firm moral footing, there should at least be the intent to improve the human condition"* (Oliver, 2003, p. 12). The aim of our project is to examine if there are alterative pricing models, which imply that both contract parties are better off compared to the current pricing model. Our intention is therefore to examine if the pea producers' and Findus' contract situation can be improved. The role of the researcher is fundamental to the ethical aspects of a research project (Kvale & Brinkmann, 2009). This involves the researcher's integrity and the researcher's sensitivity to moral issues. For instance, the role of the researcher is important in how data are interpreted and presented as there are number of ways in which data can be interpreted. Thus, the researcher should indicate that there are alternatives in terms of how data are interpreted to avoid that an inexperienced reader assumes that the data can only be analyzed in one way.

4.4 Alternative Pricing Models

The pricing models that are examined are the pricing model in the current contract, deferred pricing and window pricing. The pricing models formulated should be viewed as rough schematic models rather than exact pricing models.

4.4.1 Deferred Pricing

Deferred pricing is common in production contracts and the price in such a contract is often based on a cash or futures price that is observed at a later point in time (Heifner *et. al.*, 1993). As there is no spot market for green peas, the deferred pricing formula used in this report cannot be linked to a spot or futures price for green peas. Instead of growing peas, the Findus pea producers can choose to produce other crops in the crop rotation. Hence, the pea price has been designed as a formula consisting of spot and forward prices for winter wheat, malting barley and rapeseed according to the following equation:

$$PEAprice = 0.25 * WWprice + 0.25 * MBprice + 0.3238 * RAPEprice \qquad (12)$$

The spot and forward prices used in the price formula are the same prices as those used in the calculations of gross margins for each crop and year. Only commodities for which it is possible to retrieve market prices and that are grown on the case farm, are included in the price formula. Hence, the commodities included in the formula are winter wheat, malting barley and rapeseed. There is no open market price for sugar beets as sugar beet production is regulated by a quota system. The weights for each price presented in *Equation 12* are calculated by solving the formula iteratively in Excel. The price formula is determined so that it complies with two notions. First, the deferred price should decrease the uncertainty of the relative value of producing peas in collaboration with Findus in comparison to the value of producing other crops during the years 2004-2011. Accordingly, the deferred price should have a higher correlation with the upward and downward movements in grain prices under the same time period. Second, the price formula should be designed in a way so that the average price during the years 2004-2011 under the deferred pricing model is equal to the average price under the current pricing model. The price under the current pricing model refers to the average annual price in öre/kg across all pea varieties at t-value 100. Hence, the pea price in the deferred pricing model also refers to an average price across all varieties. An average deferred price equivalent to the current average price is considered satisfactory as Findus today has a sufficient number of contracted pea producers. Thus it can be assumed that the current pea price is accepted by the pea producers. The weights assigned to each commodity in the formula are estimated in order to comply with the above stated concepts.

4.4.2 Window Pricing

Two window pricing models are formulated in this study. As the literature on window contracts, the window pricing models in this report are formulated with a secure minimum price floor and a maximum ceiling price (Unterschultz et. al., 1998). The reference market price that gives the window price are in our models based on spot and forward prices for winter wheat, malting barley and rapeseed as there is no spot price for green peas (Shao & Roe, 2003). However, the concept is the same in terms of that the Findus pea producers remove risk below the window floor in exchange for giving up gains above the window ceiling (Unterschultz et. al., 1998). Both window pricing models can be defined as fixed-window contracts (Shao & Roe, 2003). Moving-window contracts have not been used in this study as the input prices in green pea production are assumed to be rather stable.

The window 1 pricing model is a development of the deferred pricing model as the price formula used in the deferred pricing model is applied in the window 1 pricing model. In addition to the formula, a floor price is introduced in the equation. The floor price equals the estimated breakeven price for green pea production. The breakeven price equals the average production cost of 4300 SEK per hectare calculated in the enterprise budget for Findus peas. Moreover, a ceiling price of 8700 SEK per hectare is inserted into the price formula. The ceiling price is set so that the average payment per hectare received by Findus producers during the years 2000-2011 becomes the symmetrical center around the floor and ceiling price. The price formula can be expressed in the following equation:

$$PEAprice/ha = 4300 + \big((0.25 * WWprice + 0.25 * MBprice + 0.3238 * RAPEprice) * 0.476\big) * kg\ peas/ha \leq 8700 \qquad (13)$$

According to the formula, the minimum payment per hectare becomes effective when the hectare payment falls below 4300 SEK and the maximum payment becomes effective when the payment exceeds 8700 SEK per hectare. This enables the farmer a secure payment ranging from 4300-8700 SEK per hectare. Similarly to *Equation 12*, the weights for each price presented in *Equation 13* are calculated by solving the formula iteratively in Excel so that it complies with earlier mentioned notions, see section 4.4.1. As a floor price is introduced, it is reasonable that the price per kg above 4300 SEK per hectare is lower compared to *Equation 12*. Thus, the weight 0.476 is introduced.

The window 2 pricing model is based on the current pricing model. Hence, the average annual price in öre/kg across all pea varieties at t-value 100 is used in window pricing model 2. As in the other pricing models, the pea prices are adjusted to the case farm’s actual t-value for each year. Moreover, the floor price and ceiling price used in the window 1 pricing model are applied. Hence, the pea producers are guaranteed a minimum payment of 4300 SEK per hectare but cannot receive more than 8700 SEK per hectare.

5 Results

In this chapter the results of the telephone survey and quadratic risk programming model are presented. In addition, the Findus pea producers' overall degree of risk aversion is estimated.

5.1 Survey

The average respondent of the conducted telephone survey is a 51.5 year old man that farms 280 hectares in total. On average, the interviewed pea producers grow peas on 7.5% of their total cultivated acreage and the average producer has grown peas for Findus during six of the last ten years.

5.1.1 Risk Attitude

Statements 7-15 in the survey, aim to measure the risk attitudes of Findus pea producers. The statements are evaluated by calculating scale-means and standard deviations for all statements, see *Table 3* for an overview of the results.

The participants' degree of market orientation is measured by two statements. The first one referring to if the producers perceive themselves to be updated about the market prices of the products they produce. When summarizing the answers the scale-mean is 4.16, on the used five degree scale, and the standard deviation is calculated to 1.1. The second statement claims that the farmers adapt to changes in the grain market. This statement generated a scale-mean of 3.68 and a standard deviation of 0.97. Combining these two items give an overall score of market orientation of 3.92 on a five degree scale, where 1 indicates low market orientation and 5 indicates a high degree of market orientation.

The pea producers' risk preferences are also tested by using two statements. The scale-mean of the statement *"I consider the grain market as risky"* is 3.33 and the standard deviation sums up to 1.12. The other statement claims that the producer is able to predict grain prices and resulted in a scale-mean of 2.16 and a standard deviation of 0.93. Combining items 9 and 10 give an overall score of risk preference of 3.62 on a five degree scale, where 1 indicates a low perception of risk and 5 indicates a high perception of risk. Hence, the respondents estimate that the degree of risk inherent in selling grain is relatively high as the average sum of the two items is above 3.

The degree of innovativeness is measured by two statements in the questionnaire. The first one claiming that the respondent buys new products before his colleagues. The scale-mean on this statement is 2.69 and the standard deviation 1.12. The second statement, *"I like experimenting with new ways of doing things in my enterprise"* results in a scale-mean of 3.38 and a standard deviation of 1.11. Combining these two items give an overall score of innovativeness of 3.04 on a five degree scale, where 1 indicates low innovativeness and 5 indicates a high degree of innovativeness.

The last construct, risk attitude scale is in this study measured by three questions. *"I am more concerned about making a large loss than to forgo a significant profit"* gives a scale-mean of 3.31 and a standard deviation of 0.86. The next statement claims that the respondent would rather be safe than sorry, and gives a scale-mean of 3.43 with a standard deviation of 0.95. The scale-mean of the statement *"I am willing to take higher financial risks when selling my grain, in order to realize higher average yields"* is 3.14 and the standard deviation is 0.98. Combining items 13, 14, and 15 give an overall score of risk attitude of 2.80 on a five degree scale, where 1 indicates a low degree of risk aversion and 5 indicates a high degree of risk aversion.

Table 3. Mean and standard deviation for questions 7-15.

Question	Mean	Standard deviation
7	4.16	1.1
8	3.68	0.97
9	3.33	1.12
10	2.16	0.93
11	2.69	1.12
12	3.38	1.11
13	3.31	0.86
14	3.43	0.95
15	3.14	0.98

5.1.2 The Pea Producers' Motivation for Growing Findus Peas

The result of statements 16-19 seek to reveal the interviewed pea producers' motivation for producing peas. The motivation is studied by asking the respondent to indicate on a five degree scale the extent to which he/she perceives the economic value of producing peas in comparison to alternative crops as high. The alternative crops are rapeseed, winter wheat, malting barley and sugar beets. The result is presented in *Table 4* below. The table shows that the respondents consider the value of producing sugar beets and rapeseed to exceed the value of growing peas. The value of producing malting barley is comparable to the value of growing peas whilst the value of growing winter wheat is somewhat lower than the value of producing peas.

Table 4. Findus pea producers' opinion about the economic value of growing Findus peas in comparison to other crops. A score below 3 indicates that the alternative crop is considered more profitable than peas.

	Rapeseed	Winter wheat	Malting barley	Sugar beets
Average	2.51	3.38	3	2.14
Standard deviation	1.04	0.99	0.91	1.01

The last set of statements, 20-23 seek to give an indication about how the pea producers perceive the present contract design, the current pricing model and their attitude towards some possible changes, see *Table 5* for an overview. This is examined with four statements in the survey. The first one stating *"I am satisfied with the financial compensation I receive from Findus for producing peas"* resulting in a scale-mean of 2.49 and a standard deviation of 1.08. The next statement claim that the respondent prefers that the pea price is specified when the contract is signed. This statement results in an average score of 3.94 and a standard deviation of 0.98. The third one states that the producer would prefer that the pea price follows grain prices to a greater extent. When summarizing the answers, the scale-mean sums up to 2.94 and the standard deviation to 1.28. The fourth and last statement in the survey, *"I am willing to take higher financial risks when producing peas, in order to realize higher average yields"* gives a scale-mean of 2.87 and a standard deviation of 1.07.

Table 5. Mean and standard deviation for questions 26-29.

Question	Mean	Standard deviation
20	2.49	1.08
21	3.94	0.98
22	2.94	1.28
23	2.87	1.07

In question number 24, the respondents are asked to rank three identified benefits of producing Findus peas, starting with the most important one. The most common ranking (52%) is the following sequence:

1. Preceding crop benefits and crop rotation
2. Easy crop to grow as it results in a reduced work load, etc.
3. Economically beneficial crop

Hence, preceding crop benefits and crop rotation is considered to be the greatest benefit of growing Findus peas. Finally, the participants are asked if there is anything in the pea production contract that they would like to change. 8 respondents or 13% state that they receive their payment too late, instead they would prefer if the payment is made no later than 30 days after harvest. About 11% of the respondents report that a major drawback of producing peas for Findus is soil compaction caused by combines at wet weather conditions during the harvest period. The producers also state that they would prefer economic compensation when these damages occur. 6 participants state that the pea price should correlate with grain prices to a greater extent. Several producers (6 respondents) are dissatisfied by the fact that they always plant late as this increases the production risk due to higher risk of drought. A proposed solution is to rotate the planting time among the pea producers. About 5% of the interviewed farmers indicate that they believe that quantity, in terms of yield, is more profitable than producing peas of high quality, i.e. t-values above 100 are more economically advantageous than t-values below 100. Some farmers state that the minimum payment should be increased and that pea production is not profitable for the years when a minimum payment is received.

5.1.3 Risk Attitude of the Findus Pea Producers

The results of the telephone survey show that the respondents' overall degree of risk aversion is not extremely low nor extremely high. The farmers are market orientated, they do not perceive the grain market as extremely risky, they like experimenting with new ways of doing things in their enterprises and they are willing to take on a higher degree of risk if offered financial compensation. However, the survey result indicates that the respondents are unable to predict prices in the grain market and that they do not invest in new products before their colleagues do it. Moreover, they are more concerned about making a large loss than to forgo a significant profit and they make decisions in accordance with the expression "*I would rather be safe than sorry*".

Based on the survey results and the study by Pennings (2004), the Findus pea producers are considered to be relatively risk averse. In accordance with the classification made by Hardaker *et. al.*, (1997) the pea producers' coefficient of relative risk aversion is then 2.0.

5.2 Quadratic Risk Programming Model

In this section the result of the QRP model is presented. First, the case farm's optimal farm plan given the current pricing model is described. Second, the result of the optimization model when applying the alternative pricing models, i.e. deferred pricing, window pricing 1 and window pricing 2, is presented. The overall result of the QRP model is illustrated in *Figure 9* and depicts the efficient frontiers and the tangent for each pricing model, see section 3.3. The case farm's expected net farm income and coefficient of variation (CV) are calculated for each model given the assumptions made in section 6.2. The CV is calculated as the standard deviation divided by the expected income and indicates the riskiness of the expected income (Sterte, 2011). The CV measure enables comparison between data with different magnitudes. Lastly, the case farm's change in expected net farm income when not producing peas is compared to the situation when peas are produced, for each pricing model.

5.2.1 Current Pricing Model

In *Table 6*, the case farm's average income, cost and gross margin per hectare for each crop during the time period 2002-2011 is presented. Income minus cost gives GM3 for each crop. GM3 is the measure used in the QRP model. However, GM1, see *Appendix 5*, is also included in the table as this measure is commonly used by farmers and agricultural consultants (pers. comn., Yngvesson, 2012). An example of the enterprise budgets formulated is presented in *Appendix 6.* The appendix contains the enterprise budgets for Findus peas and winter wheat preceded by rapeseed for 2011. Note that the GM3 values in *Appendix 6* do not correspond to the GM3 values in *Table 6* as the values in *Table 6* are average gross margins for all years. Sugar beets is undoubtedly the crop in the case farm's crop rotation with the highest average income, costs and gross margin. The second most profitable crop is peas grown on contract for Findus and the third most profitable crop is rapeseed planted after malting barley. Note that peas are the second most profitable crop in spite of the fact that the income per hectare is the lowest of all crops. Rapeseed preceded by malting barley is more profitable than rapeseed planted after peas although the cost of nitrogen is lower for the latter farm activity as the preceding benefit is by far higher for malting barley, see *Table 1*. Winter wheat preceded by peas is the most profitable winter wheat crop alternative as the cost of nitrogen is reduced whilst the yield is increased. The other winter wheat activities have the following sequence in terms of gross margin: WW_{rape}, WW_{mb} and lastly WW_{ww}. The profitability of malting barley is equivalent to WW_{peas}, WW_{rape} and $RAPE_{mb}$ but higher for the other activities for winter wheat and rapeseed.

Table 6. Average income, cost and gross margins per hectare (SEK), GM1 and GM3, for the years 2002-2011 calculated for the crops in the crop rotation system given possible preceding crop benefits. All numbers in 2011 year's price level.

	WW_{peas}	WW_{rape}	WW_{mb}	WW_{ww}	$RAPE_{mb}$	$RAPE_{peas}$	MB	SB	PEAS
Income	14299	14433	13357	12954	13324	11953	11910	24815	10832
Costs	10618	10795	10795	10795	9587	8981	8254	13 739	4248
GM3	3680	3638	2562	2159	3737	2971	3656	11076	6584
GM1	7880	7843	6767	6363	7462	6656	7163	16193	9131

The pea producers' coefficient of absolute risk aversion ($r_a(Y)$) is estimated to 0.000001 by the use of *Equation 8*. By the use of the estimated $r_a(Y)$, the case farm's optimal farm plan is derived. The case farm's optimal farm plan given the current pricing model is illustrated in *Table 7*. The farm activities SB, PEAS, $RAPE_{mb}$, $WW_{peas,}$ MB and WW_{rape} are maximized in terms of the restrictions shown in *Table 2*. Except for the above mentioned activities, it is optimal to grow 23.0 hectares of WW_{mb}. Thus, the crop rotation consists of 30.8% winter wheat, 16.7% rapeseed, 25.0% malting barley, 20.0% sugar beets and 7.5% Findus peas.

Table 7. Combinations of crops that give highest expected return when considering the farmer's degree of risk aversion.

	WW_{peas}	WW_{rape}	WW_{mb}	WW_{ww}	$RAPE_{mb}$	$RAPE_{peas}$	MB	SB	PEAS
Hectare	25.9	57.5	23.0	0.0	57.5	0.0	86.3	69.0	25.9
Percentage	7.5%	16.7%	6.6%		16.7%		25.0%	20.0%	7.5%

5.2.2 Alternative Pricing Models

The case farm's optimal farm plan is identical in all pricing models, see *Table 7*. In *Figure 9*, the efficient frontier and the tangent for each pricing model is graphically derived. According to *Figure 9*, the current pricing model is the model that results in the lowest standard deviation i.e. the lowest risk, and is therefore graphed to the left of all other alternatives. The deferred pricing model is the alternative that gives the highest standard deviation and also the highest expected net farm income of the four alternatives. As shown in *Figure 9*, the pea producers' degree of risk aversion is of minor importance as the slopes of the efficient frontiers are so steep in relation to the slopes of the tangents. A small decrease in standard deviation, results in a large decrease in expected net farm income.

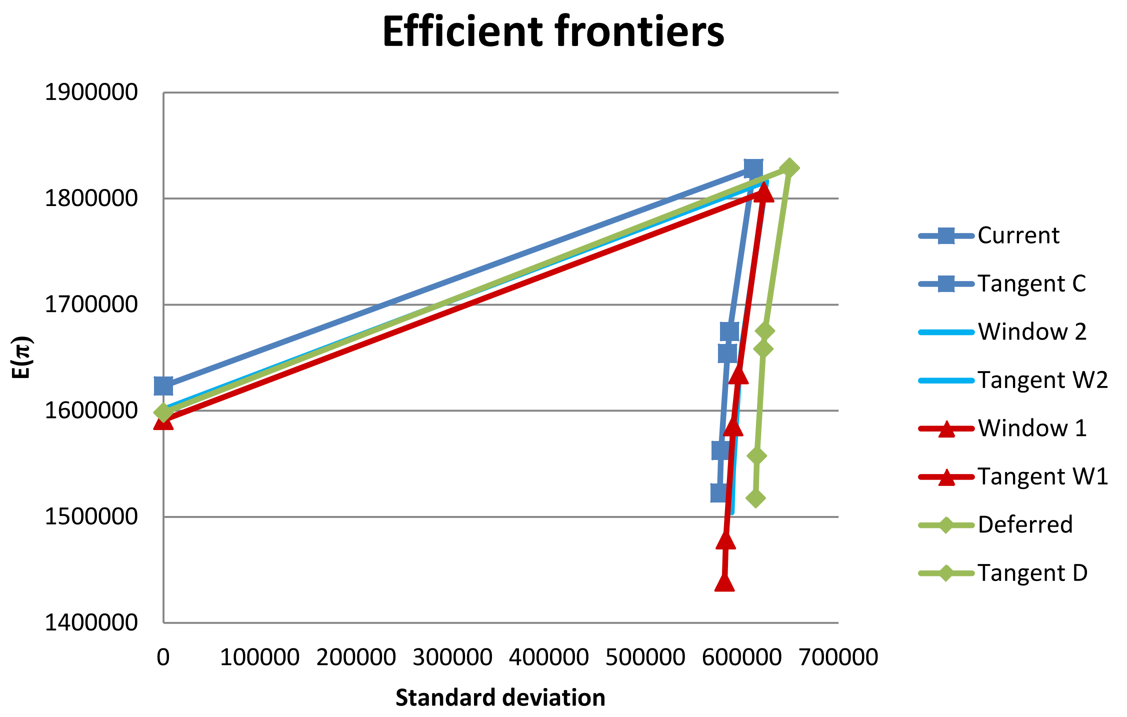

Figure 9. Efficient frontiers and tangents for the different pricing models; Current contract, Deferred pricing model, Window pricing model 1 and Window pricing model 2. Source: own modification.

Table 8 shows the case farm's expected net farm income, coefficient of variation (CV) of the expected net farm income, the expected utility for each pricing model and the case farm's change in expected net farm income when not producing peas compared to the situation when peas are produced. Which is already shown in *Figure 9*, the deferred pricing model is the pricing model with the highest expected net farm income and the highest risk in terms of variation in expected net farm income. However, given the Findus pea producers' degree of risk aversion, the current pricing model yields the highest expected utility. Nevertheless, the differences in expected net farm income, CV and expected utility between the pricing models are quite small. As the pea producers' coefficient of absolute risk aversion ($r_a(Y)$) is so small and thus has a small impact on the optimal solution, the expected utility measure (E(U)) for the various pricing models is only somewhat lower compared to the $E(\pi)$ measure. When Findus peas is excluded from the case farm's crop rotation, the expected net farm income decreases for all pricing models with between 129 520 and 152 092 SEK. This equals a loss in expected net farm income of 375 to 441 SEK per hectare given the case farm's total acreage.

Table 8. The pricing models effect on the case farm's net farm income (SEK) and expected utility.

	Current	**Deferred**	**Window 1**	**Window 2**
E(π)	1 828 163	1 828 696	1 806 124	1 816 267
CV(E(π))	33.5%	35.5%	34.5%	34.4%
E(U)	1809438	1807622	1786739	1796737
E(π)-E(π) No peas	151 559	152 092	129 520	139 663
E(π)-E(π) No peas/ha	439	441	375	405

As shown by *Table 8*, the alternative pricing models do not reduce the case farm's overall risk, instead the overall risk increases compared to the current contract situation when the alternative pricing models are introduced. However, when examining the case farm's risk exposure associated only with historical gross margins per hectare of Findus peas, the CV values of the alternative pricing models are lower than the CV value of the current pricing model, see *Table 9*. The window 2 pricing model, which is based on the same price as the current pricing model, has the lowest CV value, followed by the deferred pricing model, the window 1 pricing model and lastly the current pricing model.

Table 9. Coefficient of variation and GM3 for the four different pricing models per hectare.

	Current	**Deferred**	**Window 1**	**Window 2**
CV	31.1%	25.1%	29.2%	24.2%
GM3	6584	6605	5732	6124

This is due to that the pea price of the current pricing model does not correlate with grain prices to the same extent as the pea price in the alternative pricing models. When relating the pea price to grain prices, the total variance of the case farm's expected net farm income increases, which implies an increase in the overall risk exposure. That the CV value of the window 2 model is the lowest can be explained by the fact that the variance in the pea price decreases as the ceiling price becomes effective. As shown by *Table 9*, the deferred pricing model gives the highest expected gross margin per hectare of peas followed by the current pricing model, the window 2 pricing model and lastly the window 1 pricing model. The lower gross margins of the window pricing models can be explained by that the window ceiling becomes effective due to the case farm's high yields.

6 Analysis and discussion

This chapter analyzes and discusses the results of the telephone survey and the QRP model presented in chapter 5 in relation to the *Literature review* and the *Theoretical framework*. The headings in this chapter are based on the research questions stated in the *Introduction*. The generalizability of the results of the QRP model is also discussed.

Our contribution to research is that we study a contract crop in relation to alternative crops in the crop rotation. Hence, in a decision making context, combinations of crop activities can be viewed as different portfolios, i.e. farm plans. Marketing strategies for one crop activity can therefore not be assessed in isolation from marketing strategies for alternative crops; instead an overall farm-level analysis for evaluating a contract crop is conducted.

6.1 How Do the Current Contract and Pricing Model Function?

The current production contract between Findus and its pea producers' is to a great extent formulated similarly to the Danisco Foods pea production contract described by Bogetoft & Ballebye Olesen (2002; 2004). In accordance with the literature, the Findus pea production contract is formulated in a way that ensures a highly centralized decision making structure, which is the classical design of production contracts (Bijman, 2008). Centralized decision making is necessary in green pea production as the harvest must be highly synchronized since green peas for human consumption are highly perishable. Moreover, Findus contracts about 500 pea producers each year which makes accurate planning crucial. Thus, coordination of planting time and choice of pea variety is essential in order to synchronize the harvest to match the capacity of the combines and the plant in Bjuv.

Findus offers only one contract and one price scheme to all producers, which minimizes the transaction costs (Bogetoft & Ballebye Olesen, 2004). This implies that Findus must offer a price above the reservation value of some growers to attract a sufficient number of producers. The intention of the price scheme in the Findus contract is to ensure that an individual producer receives the same average payment per hectare regardless of variety. This setup ensures that the farmer is equally well off regardless of variety. However, high yielding farmers receive a higher payment per hectare, as their yield per hectare is higher, compared to low yielding farmers. Compared to the Dansico Foods pricing model described in chapter 2, the pricing model in the current Findus contract has a different setup. The payment to an individual Danisco farmer was less dependent on yield as the average payment to the Danisco farmers was the same in all groups. Thus, high yielding Danisco farmers could be perceived as negatively discriminated and low yielding farmers may be regarded as positively discriminated. As a result, the highest yielding Dansico pea producers did not obtain their reservation values. This is not the case in the Findus contract as the farmers are paid in accordance with their performance in absolute terms, rather than in relative terms. Hence, the payment is based on the individual farmer's output regardless of the output of others. The Findus contract therefore creates incentives for high yielding farmers to enter the Findus contract and all farmers are motivated to maximize their yield and therefore the integrated profit.

In contract design it is important to motivate both parties to act so that the integrated profit is maximized (Bogetoft & Ballebye Olesen, 2004). The contract must provide both parties with profits or utilities at least equal to what the parties could obtain if not entering the contract, i.e. their reservation values. The results in *Table 6* show that Findus peas is the second most profitable crop in the crop rotation after sugar beets. On the contrary to the pricing model of the Danisco Foods contract, high yielding Findus producers may receive a payment that exceeds their reservation value. According to the results of our QRP model, the case farm's gross margin for Findus peas is higher than for most other crop activities. The case farm's reservation value can be defined as the profit from the farm's best alternative option (Bogetoft & Ballebye Olesen, 2004). Rapeseed and malting barley are the alternative crops to peas as these three crops are the only preceding alternatives to winter wheat. In accordance with literature, the case farm's reservation value for peas can be defined as the highest gross margin for rapeseed and malting barley. Hence, the case farm's reservation value is 3737 SEK, see *Table 6*. Consequently, the case farm obtains a payment from Findus higher than the farm's reservation value. This may be due to that the case farm has a low cost structure, better soil and growing conditions and/or that the case farm is characterized by a higher level of managerial skills (Bogetoft & Ballebye Olesen, 2004).

The case farm's cost structure is typical and a production cost of 4300 SEK per hectare for Findus peas is regarded as a reasonable average production cost (pers. comn., Yngvesson, 2012). Our case farm is situated in a region characterized by very good soils and growing conditions compared to the rest of the Findus pea production area. A comparison of the case farm's historical average yields for a ten year period with historical average standard yields in the same region, i.e. SCB's yield survey district 1211, has been conducted (Statistiska centralbyrån, 2011). The comparison was made for all crops in the case farm's crop rotation except for Findus peas as this data is not available. The comparison between the case farm and yield survey district 1211 shows that the case farm's average yields are considerably higher for rapeseed and sugar beets and comparable to winter wheat and malting barley, see *Table 10*. Consequently, the case farm is considered to be characterized by a higher level of managerial skills and/or facing more favorable climate and soil conditions than farmers in his region. In respect to the above reasoning, the case farm has a high reservation value compared to the average Findus pea producer and it is explained by the case farm's good soil and managerial skills and thus high yields. The high reservation value can however not be explained by a low cost structure as the case farm's cost structure is average. In spite of the case farm's high reservation value, the gross margin for peas exceeds the gross margins of winter wheat, malting barley and rapeseed.

Table 10. The table shows the case farm's average yields in relation to the average yields of yield survey district 1211.

	Winter wheat	Malting barley	Rapeseed	Sugar beets
Case farm	8888	6506	3679	54893
1211	8846	6567	3319	51715
% Difference	0.48%	-0.94%	9.79%	5.79%

Findus strives to maximize the length of the harvesting period, which may lead to a conflict of interest between Findus and the farmers (Bogetoft & Ballebye Olesen, 2004). Thus, some famers have to plant at a point in time which is not agronomically optimal. In general, it can be said that the same variety is planted in the same geographical region (pers. comn., Nilsson, J, 2012). Therefore, it can be assumed that farmers in some areas tend to plant early and farmers in other areas tend to plant late. Some participants in the telephone survey state that they are dissatisfied as they each year tend to be assigned to plant late, which they think has a negative impact on their yield as the risk of drought at a late planting time is increased. However, as an individual farmer should be indifferent between the choice of variety, the loss caused by planting at a less favorable time is shared between all farmers (Bogetoft & Ballebye Olesen, 2004). In addition, fields that are harvested late receive an additional payment which further compensates these farmers. Whether the farmers that have to plant late are completely compensated or not is not examined in this study. As the farmers cannot affect at what t-value their peas are harvested, it is important that the price scheme for each variety is formulated so that the t-value has no effect on their payment per hectare. Nevertheless, some respondents in the survey indicate that t-values above 100 are more profitable than t-values beneath 100.

Our survey results indicate that the Findus pea producers are rather content with how the contract and pricing model are formulated. The survey result shows that the majority of the respondents prefer a predetermined pea price. In addition, the participants are slightly negative towards a pea price that to a greater extent is linked to grain prices. However, the pea producers' opinions of a pea price with a higher correlation to grain prices are uncertain and of low quality as the standard deviation for this statement is relatively high. A majority of the respondents indicate that they are not willing to take higher risks when producing peas, in order to realize a higher average payment. No questions or statements regarding alternative pricing models were included in the survey as it was assumed that those types of questions would be difficult to answer. It is difficult to relate to something that is unknown and it was considered that the pea producers therefore would not be able to have any opinions about alternative pricing models.

As the payment to the pea producers is independent of Findus' marketing possibilities to its customers, Findus bears all price risk (Bogetoft & Ballebye Olesen, 2004). Moreover, the production contract determines an exact price to be paid (Heifner *et. al.,* 1993; Harwood *et. al*., 1999). It can be assumed that Findus is the cheapest risk bearer in comparison to the Findus pea producers (Bogetoft & Ballebye Olesen, 2004). Hence, the contract should be designed in such a way that Findus assumes all risk except some element of the idiosyncratic risk as some risk must be borne by the farmers for incentive reasons. The Findus producers bear some idiosyncratic risk as their yield and thus payment is dependent on that the farmers perform plant protection etc. The general production risk in pea production is shared between the farmer and Findus. From the starting point of harvest, Findus takes all production risk as the payment to the farmers is independent on whether the processor can market the peas as green peas for human consumption or not.

The Findus pea producers are exposed to a relatively large share of the general production risk in the current contract as the farmers are paid in accordance with their performance in absolute terms, rather than in relative terms (Bogetoft & Ballebye Olesen, 2002). Findus bears some general production risk as the farmers are guaranteed a minimum payment of 58% of the average yearly payment. However, as the minimum payment is dependent on average payment and thus average yield, the pea producers are not completely protected against general production risk at very low yields. When comparing the annual historical average payments per hectare for all pea producers across all varieties with our calculated production cost, it is evident that the minimum payment is less than the production cost for some years. The results of our survey reveal that some respondents want the minimum payment to be increased. The pea producers' general production risk would be eliminated at very low yields if the minimum payment was fixed, i.e. independent of average yield. If risk is shifted from one contract party to the other party, the latter requires a larger share of the risk premium (Meuwissen *et. al*., 2001; Hedberg, 1996; Milgrom & Roberts, 1992). Hence, if Findus bears a larger share of the general production risk, the farmers must accept a lower expected profit. If the pea producers are guaranteed a minimum payment per hectare at very low yields, it is reasonable that the farmers refrain some profit at very high yields. This may be achieved by introducing a maximum payment per hectare.

6.2 How Do the Pricing Models Affect the Pea Producers' Risk and Return?

The optimal farm plan is identical in all pricing models. Thus, regardless of pricing model it is optimal to maximize the number of hectares of sugar beets, peas, rapeseed preceded by malting barley, winter wheat preceded by peas, malting barley and winter wheat preceded by rapeseed. The restrictions in *Table 2* make the optimal solution stable as the options between different farm activities are limited. According to the QRP model, the differences between the examined pricing models are very small both in terms of expected net farm income, expected farm utility and risk. This was expected as the pricing models were formulated so that the average payment across all varieties and pea producers for a t-value of 100 were the same for all pricing models.

The deferred pricing model's expected net farm income is 533 SEK higher than the expected net farm income of the current pricing model, see *Table 8*. Conversely, if risk is taken into account the current pricing model is preferable as it has the highest expected farm utility. The window 2 pricing model is according to the optimization model the third most beneficial alternative and preferred over the window 1 pricing model. The case farm's payment hits the ceiling price twice in the window 1 pricing model and three times in the window 2 pricing model; the floor price never becomes effective. As the ceiling price is effective, the average gross margin or cj-value per hectare is decreased, see *Table 9*. Thus, as shown in *Table 8* the expected net farm income and utility are somewhat lower for the window pricing models compared to the current pricing model and the deferred pricing model. As a result, the case farm would not benefit if a window pricing model was introduced. This is due to the fact that the case farm's yields for peas are high. However, if the case farm would have had average or low yields in relation to the average yield across the entire Findus pea production area, the pricing models' effect on the case farm's risk and return would have been different. A window pricing model is preferable for pea producers with low average yields as the floor price would kick in and increase their expected net farm income.

The concept of window pricing is to remove risk below the window floor in exchange for giving up gains above the window ceiling (Unterschultz et. al., 1998). This is achieved in the window 1 and window 2 pricing models. However, as the Findus pea price in the window 1 pricing model is related to grain prices, the overall risk of the optimal farm plan increases. Also when applying the window 2 pricing model, the overall risk of the optimal farm plan increases. This is due to that the ceiling price in the window 2 pricing model is effective during years when grain prices are low. Thus, the covariances between grain prices and the gross margins for Findus peas are increased compared to the current pricing model and thus the CV value increases, see *Appendix 1* and *Table 8*. Hence, the risk and therefore the variance in the total expected net farm income increases. The formulation of the window pricing models should be considered as rough schematic models and an alternative formulation would impact the result. An alternative would be to link the pea price to annual averages of spot and forward prices for grain instead of average prices at harvest.

Figure 10 illustrates in accordance with Bogetoft & Ballebye Olesen (2004) the general production risk in the deferred pricing model and the window pricing models. The deferred pricing model can in this figure be compared to the current pricing model. In the deferred pricing model, the pea producers' minimum payment is not specified in monetary units. On the other hand, there is no upper limit for the hectare payment. Conversely, in the window pricing models the producers' are guaranteed a fixed floor price or minimum payment whilst there is a maximum payment per hectare.

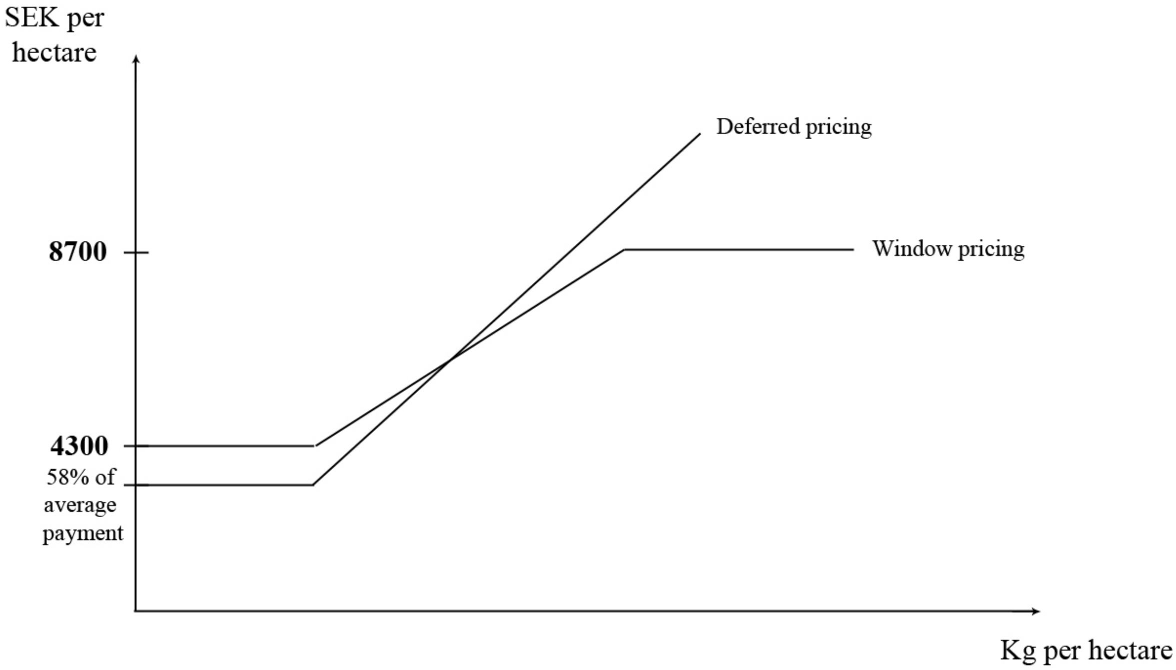

Figure 10. The pricing and general production risk of the alternative pricing models. Source: own modification.

It can be proposed that the current pricing model should be retained as the pea producers are relatively content with the current pricing model. In the current pricing model, the pea price is not linked to grain prices, which can be seen as both an advantage and a disadvantage. The current pricing model is favorable in terms of risk as the variance of the expected net farm income is minimized. An uncoupled pea price may be very advantageous for years when grain prices fall during the growing season. On the other hand, an uncoupled pea price may be a disadvantage for years when grain prices increase during the growing season. In this case, the received pea price may be a disappointment. It may be psychologically important for the pea producers to use a pricing model with a price more correlated with grain prices. If grain prices increase in relation to the pea price during the growing season the profitability of growing peas may be lower than the profitability of alternative crops. In this case, the farmers' reservation values are not obtained. Though, it may be disadvantageous for Findus to introduce a pricing model with a pea price correlating with grain prices to a greater extent than in the current pricing model. The grain market and the market for frozen vegetables are two completely separate markets in terms of price movements, supply and demand. Hence, it is difficult for Findus to transfer its increased costs associated with increased grain prices and thus the pea price to its customers.

It may be advantageous for Findus to introduce a window pricing model with a maximum payment per hectare, i.e. a ceiling price per hectare, regardless of t-value. This would imply that the total maximum payment for all producers is known and fixed. Findus is at present owned by the British private equity firm Lion Capital. Creation of shareholder value is increasingly being used as a yardstick of performance in large companies (Srivastava et al., 1998). Shareholder value can be defined as the present value of future cash flows discounted by the risk-adjusted cost of capital. One way of increasing shareholder value is to reduce the risk associated with cash flows as a reduction in volatility of cash flows indirectly decreases the firm's cost of capital. Hence, more stable cash flows cause higher net present values and thus more shareholder value (Pennings, 2004). A window pricing model can be considered to result in more stable cash flows as the total payment cannot exceed the ceiling price per hectare times the number of producers. One the other hand, a window contract also implies the use of a price floor that transfers some of the production risk from the pea producers to Findus. Hence, if introducing a window contract Findus has to increase their total payments to their pea producers compared to the payment in the current contract during years when the pea production amongst all pea producers is low. On the contrary, years when the overall production amongst Findus pea producers is high, Findus will lower their total payment compared to what they would pay if using the pricing model in the current contract. Introducing a window pricing model therefore implies a reduction of price risk because of the fixed maximum payment but an increase in total payment relative to the payment in the current contract during years when the average yield is low amongst a large part of the Findus pea producers.

6.3 What is the Value of Incorporating Findus Peas in the Crop Rotation?

The results in *Table 6* show that the value of growing peas for Findus is considerably more profitable than producing rapeseed and malting barley. Nevertheless, both the survey results and the optimization results indicate that sugar beets is the most profitable crop in the case farm's crop rotation system. The difference in gross margin between $RAPE_{mb}$ and $RAPE_{peas}$ can be explained by the difference in preceding crop benefit, see *Table 1*. Even though the costs of nitrogen are lower for $RAPE_{peas}$, the yield is so much lower that the gross margin cannot compete with the gross margin for $RAPE_{mb}$. The costs of WW_{peas} are slightly lower than the costs of the other winter wheat activities as the nitrogen costs are somewhat lower. Despite that the yield and thus income is higher for WW_{rape}, the gross margin for WW_{peas} exceeds the gross margin for WW_{rape}. It is noticeable that peas grown on contract for Findus is the case farm's second most profitable crop after sugar beets, see *Table 6.* This can be explained by the fact that the costs of producing peas are low in comparison to the alternative crops. Pea production for Findus is associated with less working capital costs as costs for seed, harvest and fertilizers are eliminated or reduced. The machinery costs and thus maintenance and depreciation costs are substantially lower for peas as pea production for Findus is associated with less machinery utilization.

The high profitability of Findus peas observed in the gross margin calculations is not coherent with our telephone survey. First, the survey results suggest that the pea producers think that the value of producing sugar beets and rapeseed is higher than the value of growing peas whilst the value of growing malting barley is comparable to producing peas. This is not coherent with *Table 6,* in which the value of growing peas is higher than the value of growing rapeseed and malting barley. Second, the pea producers rank the economic value of producing peas as number three out of three alternatives. The main advantage is considered to be preceding crop benefits followed by convenience aspects such as positive time aspects. The survey result also indicates that the farmers are not satisfied with the financial compensation for growing peas. However, there are some issues that must be taken into account when considering the farmers' expressed dissatisfaction with the economic compensation. The answers may be biased as the participants may state that they are unsatisfied in order to avoid a price decrease or to encourage a price increase. *Table 6* shows that the income, note not the profit, per hectare of Findus peas is the lowest income per hectare compared to all other crops in the crop rotation. Farmers can easily calculate the received income per hectare for various crops whilst the actual gross margin per hectare for various crops is more vague and complicated to calculate.

The fact that the survey result differs to such an extent in relation to the QRP model result indicate that the pea producers underestimate the value of producing peas and/or overestimate the value of alternative crops. Hence, the substantially lower costs per hectare of Findus peas may not be considered when comparing the value of growing Findus peas with the value of producing alternative crops. This is also illustrated in *Appendix 6*. In the optimization model, it is assumed that no crops are stored at the farm. Thus, all output prices are based on prices at harvest, i.e. August to October. This may have affected the case farm's average income and thus gross margin for winter wheat, rapeseed and malting barley in a negative way as prices tend to be lower at harvest compared to prices at other points in time. Moreover, possible costs of soil compaction should be considered as about 11% of the respondents in the survey state that the risk of soil compaction at harvest is a major drawback of pea production for Findus. The possible cost of soil compaction is not considered when calculating the gross margin for Findus peas but should not be overlooked when comparing the gross margins of various crops.

If peas cannot be grown, the case farm's expected net farm income decreases with 151 559 SEK compared to producing peas under the current contract, which is an 8% decrease of the total expected net farm income. Instead of producing peas for Findus, more winter wheat will be grown according to the optimal farm plan derived in the QRP model. The value of incorporating Findus peas in the crop rotation for the case farm under the current pricing model is 439 SEK per hectare. This number is calculated in terms of the total acreage of the farm, i.e. 345 hectares.

6.4 Generalizability

Can our results, which refer to the case farm used in our study, be generalized for Findus' entire pea production area? In this section the generalizability of the case farm's cost structure and the case farm's optimal farm plan are evaluated. Also, it is discussed if there are any differences in the pea producers' opinions of the value of growing peas depending on region. Lastly, the pea producers' derived coefficient of absolute risk aversion is discussed.

It would have been interesting to use more than one case farm as the generalizability for Findus entire production area would have been higher. However, if more case farms would have been included, the reliability of our study would have been reduced due to that data collected would not have been as detailed and extensive.

The case farm's high cj-value for Findus peas is somewhat surprising compared to the survey results. It is possible that the case farm tends to plant at a favorable time each year. If this happens to be the case, this affect the case farm's average pea yield positively and thus the gross margin. The cost estimations for depreciation of machinery and maintenance are in the enterprise budget calculations based on the case farm's actual crop rotation and the case farm's amount of arable land. The survey result indicates that the Findus pea producers on average farm 280 hectares, which is somewhat lower than the case farm's tillable acreage. This may suggest that the machinery costs are somewhat lower per hectare for the case farm than for the average pea producer as the machinery costs can be allocated on a larger production area i.e. more hectares. However, the case farm's cost structure in terms of machinery costs is assumed to be average compared to medium sized farms in south western Skåne (pers. comn., Yngvesson, 2012). The case farm has joint ownership for several of the machines used in the sugar beet production and some other machinery including the fertilizer spreader.

To test whether the result of the optimization model is generalizable or not, a comparison with farms with roughly the same conditions as the case farm is conducted. Hence, the result can only be compared to farms with similar crop rotation. The case farm's crop rotation is representative for the south western part of Skåne (pers. comn., Yngvesson, 2012; pers. comn., Nilsson, C, 2012). The south western part of Skåne is defined as yield survey districts 1211, 1212, 1213, 1214 and 1216, see *Appendix 4*. Thus, our results have been compared to the above defined region. Consequently, our results cannot be generalized for Findus' entire pea production area. By comparing the case farm's optimal farm plan with an optimal farm plan based on data for the above stated survey districts, it can be concluded if the case farm's results can be generalized for this area.

Historical yield data for winter wheat, rapeseed, malting barley and sugar beets for yield survey districts 1211, 1212, 1213, 1214 and 1216 were collected for the years 2002-2011. Thereafter, average yields per crop and year for all districts were compiled. Historical data for Findus peas was obtained from Findus. The data included payment per hectare of Findus peas and zip codes for all Findus pea producers during the time period 2007-2011. Payment per hectare was considered to be a superior measure compared to yield per hectare as variety and t-value differs between producers and years. By translating the zip codes into SCB's yield survey districts, selection of pea producers in the right area was enabled. Thereafter, an overall annual average payment per hectare for the districts 1211, 1212, 1213, 1214 and 1216 was calculated. Instead of the case farm's yield data, the collected SCB yield data and Findus data were applied in the QRP model. The same output prices for winter wheat, malting barley, rapeseed and sugar beets were used, see section *4.2.3 Gross Margin Calculations*. By adding the annual EU subsidy to the annual average payment per hectare of Findus peas, the annual income per hectare of Findus peas was obtained. The same costs as those used when deriving the case farm's optimal farm plan were used.

Table 11 illustrates the average gross margins, i.e. cj-values, used in the generalized QRP model. When comparing the case farm's average gross margins with the average gross margins of the south western part of Skåne, it is clear that the cj-values for south western Skåne are substantially lower than the case farm's cj-values. In spite of this, the results of the generalized optimization model show that the optimal farm plan is exactly the same as the case farm's optimal farm plan. *Table 11* shows that the most profitable crop in the crop rotation is sugar beets followed by Findus peas, which is coherent with the case farm's average gross margins shown in *Table 6*. Hence, as the case farm, the pea producers in the south western part of Skåne receive a payment from Findus that on average exceeds their reservation value. Accordingly, the results of this study are generalizable for the south western part of Skåne. However, the difference between the average gross margin for Findus peas in south western Skåne and the average gross margins for alternative crops is substantially lower than for the case farm. If Findus peas is excluded from the crop rotation in the generalized QRP model, the total expected net farm income decreases with about 91 000 SEK which is a 7% reduction and corresponds to a loss in expected net farm income of 264 SEK per hectare.

Table 11. Average gross margins per hectare (SEK), GM3, for the yield survey districts 1211, 1212, 1213, 1214 and 1216, i.e. south western parts of Skåne and for the case farm. All numbers in 2011 year's price level. Moreover, the percentage decrease in gross margins between the case farm and the south western part of Skåne is presented.

	WW_{peas}	WW_{rape}	WW_{mb}	WW_{ww}	$RAPE_{mb}$	$RAPE_{peas}$	MB	SB	PEAS
SW Skåne	3027	2985	1909	1506	1997	1231	2980	8190	3591
Case farm	3680	3638	2562	2159	3737	2971	3656	11076	6584
% Difference	-18%	-18%	-25%	-30%	-47%	-59%	-18%	-26%	-45%

To examine whether there are any differences in the pea producers' opinions of the value of growing peas depending on region, chi-square tests on some of the survey result were conducted (Wahlin, 2011). The survey statements included in the chi-square tests were 16-19 and 20, see *Appendix 2*. The respondents were divided into two groups; producers situated in the south western part of Skåne, in accordance with the above stated definition, were sorted into one group and the remaining producers into another group. The procedure of the chi-square tests is described in *Appendix 7*. The chi-square tests show that there is a statistically significant difference between the answer distribution of questions 16, 17, 19 and 20. Hence, the producers in the south western part of Skåne tend to value peas in relation to winter wheat, rapeseed and sugar beets somewhat lower than producers in the remaining Findus pea production area. There is no statistically significant difference between the groups regarding their perception of the value of growing malting barley in relation to Findus peas. Moreover, according to the chi-square test of statement 20, producers in south western Skåne are slightly less satisfied with the financial compensation they receive for growing peas than other producers. Consequently, the pea producers not situated in the south western part of Skåne, perceive that the gross margin for Findus peas to a greater extent is comparable to the gross margin of alternative crops.

The optimal solution for each pricing model is the farm plan with the maximum expected net farm income. This holds despite the fact that the Findus pea producers are considered to be relatively risk averse. In accordance with the survey results and classification made by Hardaker *et. al.,* (1997) the pea producers' coefficient of relative risk aversion ($r_r(w)$) is estimated to 2.0. The result of the QRP model indicates that the case farm's optimal farm plan only changes at a relative risk aversion substantially higher than 4.0. According to theory, a relative risk aversion of 4.0 denotes an extremely risk averse individual (Hardaker *et. al.*, 1997). Consequently, our optimal farm plan holds for all plausible degrees of risk aversion. The Findus pea producers' absolute coefficient of risk aversion is derived by *Equation 8*. It is also possible to derive r_a by the use of *Equation 7*. The case farm's expected net farm income equals 20% of a wealth measure, *w*. The wealth measure refers to Swedish grain farmers estimated equity, i.e. assets reduced by debt. The equity estimation is based on SCB's report "*The 2010 Farm Economic Survey*" (Statistiska centralbyrån, 2010). However, the optimal farm plan would have been the same even if *Equation 7* would have been used. The only difference would have been that the tangents to each efficient frontier would have had a less steep slope, i.e. the pea producers would have been less risk averse.

7 Conclusions

The aim of this study is to examine, from the producer's viewpoint, the current production contract between Findus and the pea producers and whether there are alternative pea pricing models that are more effective, for both contract parties, given volatile agricultural commodity markets.

The current pricing model functions well based on theory, the result of the QRP model and the survey. The pea producers have incentives to maximize the integrated profit and Findus bears a relatively large share of the risk as the processor bears the price risk and a share of the general production risk. Nevertheless, it might be preferable to shift more of the general production risk to the cheaper risk bearer Findus through a window pricing model. The alternative pricing models formulated in this study have a rather limited effect on the Findus pea producers' risk and return. However, the models were formulated so that the producers' average pea price under the alternative pricing models is equal to the average price under the current pricing model.

The alternative pricing models are not proven to increase the pea producers' expected utility. The models can therefore, according to the QRP results for the case farm, not be regarded as more effective on volatile agricultural commodity markets than the current pricing model. The window pricing models are not preferred by the case farm as this would reduce the case farm's average payment per hectare. However, a window pricing model may be preferable for pea producers with a lower average payment per hectare. The formulation of the window pricing models, especially the design of the price windows must be more carefully examined by someone with full access to Findus historical yield and payment data.

According to our analysis, the value of incorporating Findus peas in the crop rotation is considered to be high. The performed gross margin calculations for the case farm and south western Skåne, reveal that the average gross margin of Findus peas is the second most profitable crop in the crop rotation. In addition, there are other values of growing peas such as preceding crop benefits and less working capital employed. This result is not entirely consistent with the result of the survey, which indicates that the gross margin for Findus peas are lower than the gross margins for rapeseed and malting barley. The estimated cost structure of the case farm has been verified by agricultural professionals and is considered to be generalizable for the south western part of Skåne. The pea production cost per hectare is considerably lower than the production costs for alternative crops. This implies that the gross margin for Findus peas is high despite the fact that the income per hectare is lower than for other crops in the crop rotation. Accordingly, the pea producers participating in the survey are considered to either underestimate the value of producing peas and/or overestimate the value of alternative crops.

7.1 Further Research

There are a number of areas that would be interesting to further examine. It would be interesting to study how the variety, planting time, geographical area and the farmers' skills affect the pea producers' risk and return. Moreover, it would be ideal to have access to historical yields and payment data for all Findus pea producers over a number of years.

If Findus and the Pea Grower Association decide to introduce a new pricing model in the production contract, further development and analysis of the alternative pricing models examined in this study are necessary.

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Appendix 1: Variance-covariance Matrix

	WW_{peas}	WW_{rape}	WW_{mb}	WW_{ww}	$RAPE_{mb}$	$RAPE_{peas}$	MB	SB	Current	Deferred	Window 1	Window 2
WW_{peas}	5788458	5900559	5363518	5162128	4475699	3817041	4611504	-215658	**-1354440**	**1497604**	**-2534005**	**-777855**
WW_{rape}	5900559	6015363	5466811	5261104	4543322	3869104	4704712	-241811	**-1409787**	**1508841**	**-2594002**	**-812196**
WW_{mb}	5363518	5466811	4980045	4797508	4146496	3544991	4199028	-118567	**-1271811**	**1360846**	**-2364502**	**-721903**
WW_{ww}	5162128	5261104	4797508	4623660	3997686	3423449	4009397	-72350	**-1220070**	**1305349**	**-2278439**	**-688043**
$RAPE_{mb}$	4475699	4543322	4146496	3997686	6570854	6094366	1707456	228492	**-326551**	**640363**	**-2451244**	**-324900**
$RAPE_{peas}$	3817041	3869104	3544991	3423449	6094366	5736861	1237447	646567	**-135707**	**531329**	**-1920341**	**-199591**
MB	4611504	4704712	4199028	4009397	1707456	1237447	6545301	226088	**-1039028**	**2352282**	**-459137**	**-692726**
SB	-215658	-241811	-118567	-72350	228492	646567	226088	24593694	**-5209180**	**-2742342**	**48812**	**-3192207**
Current	**-1829289**	**-1895124**	**-1701669**	**-162913**	**-658935**	**-379071**	**-1466931**	**-5209180**	**4198928**			
Deferred	**1497604**	**1508841**	**1360846**	**1305349**	**640363**	**531329**	**2352282**	**-2742342**		**2736643**		
Window 1	**-2534005**	**-2594002**	**-2364502**	**-2278439**	**-2451244**	**-1920341**	**-459137**	**48812**			**2808375**	
Window 2	**-777855**	**-812196**	**-721903**	**-688043**	**-324900**	**-199591**	**-692726**	**-3192207**				**2193427**

Appendix 2: Questionnaire, Telephone Survey

1. How old are you?
2. How many hectares do you farm?
3. How many of these hectares are on average peas?
4. For how many years have you grown peas for Findus during the past ten years?
5. In your opinion, how is the production risk divided between the farmer and Findus? (percent)
6. In your opinion, how is the price risk divided between the farmer and Findus? (percent)

Next, a series of statements will be presented. Specify your level of agreement with the following statements on the scale:
1: Strongly disagree, 2: Agrees to a small extent, 3: Neutral, 4: Degree to a high extent,
5: Strongly agree.

Part 1: Risk attitude

Degree of market orientation

7. I keep myself updated about the market prices of the products that I produce.
   (1) (2) (3) (4) (5)
8. I adapt to changes in the grain market.
   (1) (2) (3) (4) (5)

Risk preference

9. I consider the grain market as risky.
   (1) (2) (3) (4) (5)
10. I am able to predict grain spot prices.
   (1) (2) (3) (4) (5)

Innovativeness

11. I buy new products before my colleagues buy them.
   (1) (2) (3) (4) (5)
12. I like experimenting with new ways of doing things in my enterprise.
   (1) (2) (3) (4) (5)

Risk attitude scale

13. I am more concerned about making a large loss than to forgo a significant profit.
    (1) (2) (3) (4) (5)
14. I would rather be safe than sorry.
    (1) (2) (3) (4) (5)
15. I am willing to take higher financial risks when selling my grain, in order to realize higher average yields.
    (1) (2) (3) (4) (5)

<u>Part 2: Opinions about the current pea production contract</u>

The pea producers' motivation for producing peas

16. The economic value of producing peas in comparison to rapeseed is high.
    (1) (2) (3) (4) (5)
17. The economic value of producing peas in comparison to winter wheat is high.
    (1) (2) (3) (4) (5)
18. The economic value of producing peas in comparison to malting barley is high.
    (1) (2) (3) (4) (5)
19. The economic value of producing peas in comparison to sugar beets is high.
    (1) (2) (3) (4) (5)

Opinion about the pricing model

20. I am satisfied with the financial compensation I receive from Findus for producing peas.
    (1) (2) (3) (4) (5)
21. I think it is good that the pea price is specified when the contract is signed.
    (1) (2) (3) (4) (5)
22. I would prefer if the pea price follows grain prices to a greater extent.
    (1) (2) (3) (4) (5)
23. I am willing to take higher financial risks when producing peas, in order to realize a higher average payment.
    (1) (2) (3) (4) (5)

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24. What are the benefits of producing peas? Rank the following options, start with the option that you believe is most advantageous.
    _______Preceding crop benefits and crop rotation
    _______Economically beneficial crop
    _______Easy crop to grow as it results in reduced work load, etc.

25. Is there anything in the pea contract that you would like to change?

____

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Appendix 3: Introduction Letter

Can Findus' pea production contract be improved with respect to the pricing model?

You are one of 80 randomly selected pea producers who signed Findus pea production contract for the growing season 2012. We are two agribusiness students from the Swedish University of Agricultural Sciences in Uppsala who are writing our master thesis in collaboration with Findus. We have received your contact information from Findus and you have been contacted since we are interested in your opinions regarding the pricing model currently used in the Findus pea production contract.

The purpose of this study is to examine, from the perspective of the pea producers, whether there are alternative pricing models that would be perceived as an improvement to the current pea production contract. We are also interested in your perceptions about the risk of growing peas in relation to the compensation you receive.

We will contact you to confirm that you are interested in participating in a telephone interview. If you confirm that you are interested in participating, we will also schedule for an appointment for the interview. The interview is expected to take 10 minutes and will be conducted during week 13, 15, 16 and 17 (19/3 to 29/4). The interview mainly consists of a series of statements that you are asked to answer by selecting one of the following options:

1) *Strongly disagree,* ***2)*** *Agrees to a small extent,* ***3)*** *Neutral,* ***4)*** *Degree to a high extent,* ***5)*** *Strongly agree*

Your answers will be treated confidentially. It will not be possible to connect your answers to you as a person and the results will be presented in a summarized report. Both Findus and The Pea Grower Association are interested in improving the contract and are therefore interested in your opinion. **Your opinions** are important and may affect the future pricing model of the contract.

Thanks in advance for your participation!

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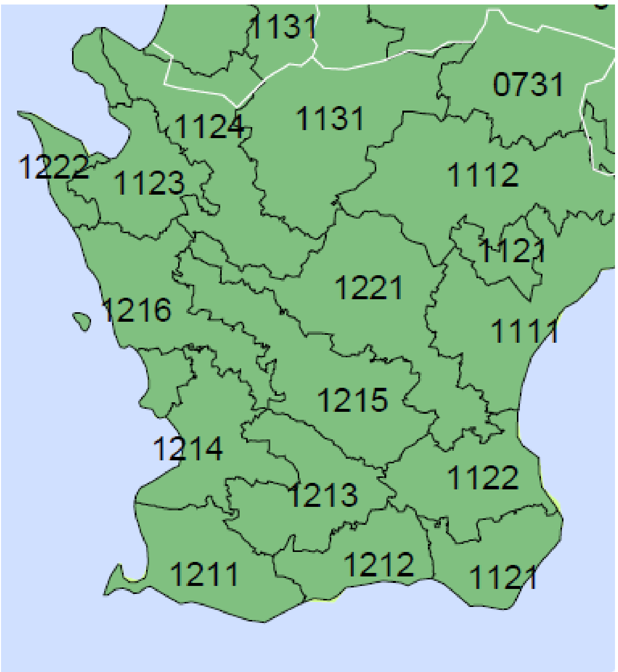
Appendix 4: SCB's Yield Survey Districts, Skåne



Source: Statistiska centralbyrån, 2011

Appendix 5: Overview Enterprise Budget Method

Incomes and seperable costs per ha			
	Quantity	Price	SUM
INCOMES			
Sales	kg	SEK	SUM
EU subsidy	no	SEK	SUM
SUM INCOMES			**SUM**
SEPERABLE COSTS			
Seed	kg	SEK	SUM
Fertilizer nitrogen (N)	kg	SEK	SUM
Fertilizer phosphor (P)	kg	SEK	SUM
Fertilizer potass (K)	h	SEK	SUM
Fuel, tractor	h	SEK	SUM
Fuel, combine	kg	SEK	SUM
Fuel, loader	h	SEK	SUM
Herbicides	no	SEK	SUM
Insecticides	no	SEK	SUM
Fungicides	no	SEK	SUM
Transport	dt	SEK	SUM
Grain drying	dt	SEK	SUM
Analysis of grain	no	SEK	SUM
SUM SEPERABLE COSTS 1			**SUM**
Maintenance, machinery	h	SEK	SUM
Working capital	kr	%	SUM
SUM SEPERABLE COSTS 2			**SUM**
Real net user cost of capital and depreciation costs of assets	h	SEK	SUM
Labor	h	SEK	SUM
SUM SEPERABLE COSTS 3			**SUM**
GROSS MARGIN			
GM 1 = INCOMES - SEPERABLE COSTS 1			SUM
GM 2 = INCOMES - SEPERABLE COSTS 2			SUM
GM 3 = INCOMES - SEPARABLE COSTS 3			SUM

Appendix 6: Enterprise Budgets for Findus Peas and Winter Wheat Preceded by Rapeseed, 2011

		FINDUS PEAS			**WINTER WHEAT**		
INCOMES					**GROWN AFTER RAPESEED**		
		Quantity	Price	SUM	Quantity	Price	SUM
Sales	kg	6 905	1,28	8 831	7 968	1,66	13 231
EU subsidy	SEK	1,0	2 291,00	2 291	1,0	2 291,00	2 291
SUM INCOMES				**11 122**			**15 522**
SEPERABLE COSTS							
		Quantity	Price	SUM	Quantity	Price	SUM
Seed	kg	0	0,00	0	180	3,63	653
Fertilizer nitrogen (N)	kg	0	0,00	0	173	10,33	1 787
Fertilizer phosphor (P)	kg	24	6,01	145	24	27,50	660
Fertilizer potass (K)	kg	7,5	48,10	360	7,5	38,00	285
Fuel, tractor	h	3,0	150,00	450	3,5	150,00	525
Fuel, combine	h	0,0	0,00	0	0,4	256,00	102
Fuel, loader	h	0,2	124,00	25	0,5	124	62
Herbicides	no	1,0	485,00	485	2,0	222,50	445
Insecticides	no	1,0	220,00	220	0,5	64,00	32
Fungicides	no	0,0	0,00	0	2,0	245,00	490
Transport	dt	0	0,00	0	96	4,40	422
Grain drying	dt	0	0,00	0	96,00	9,50	912
Analysis of grain	no	0,00	0,00	0	0	195,00	53
SUM SEPERABLE COSTS 1				**1 685**			**6 428**
Maintenance, machinery	h	1,0	419,00	419	1,0	54,00	988
Working capital	SEK	981	7%	69	3 386	0,07	237
SUM SEPERABLE COSTS 2				**2 173**			**7 653**
Real net user cost of capital and depreciation costs of assets	SEK		1 449,00	1 449		3 773,00	2 264
Labor	h	3,2	225,00	720	4	225,00	990
SUM SEPERABLE COSTS 3				**4 342**			**10 907**
GROSS MARGIN							
GM1 = INCOMES-SEPERABLE COSTS 1				9 437			9 094
GM2 = INCOMES-SEPERABLE COSTS 2				8 949			7 869
GM3 = INCOMES-SEPERABLE COSTS 3				6 780			4 615

Appendix 7: Chi-square (X^2) Test

This appendix exemplifies the chi-square calculations for statement 9. Calculations for statement 10, 11, 12 and 20 are performed in the same way. A contingency table is produced by cross tabulation from the multivariable frequency distribution of statement 9, see *Table 12*.

Table 12. Contingency table of statement 9.

Answer distribution	South western Skåne	Remaining production area	Row total
1	11	2	13
2	11	6	17
3	9	13	22
4	2	8	10
5	1	0	1
Column total	34	29	63

The first step is to formulate two hypotheses, H_0 and H_1 (Wahlin, 2011):

H_0: There are no differences in the distribution between groups.
H_1: There are differences in the distribution between groups.

The hypotheses are tested by the test variable formulated as (Wahlin, 2011):

$$x^2 = \sum_{i=1}^{W} \frac{(O_i - E_i)^2}{E_i} \qquad (14)$$

W = Number of cells in the contingency table
O_i = Observed frequency, read out from the contingency table
Ei= Expected frequency

If there are no differences between the groups, i.e. the null hypothesis is true, the expected frequency should be the same between the groups (Wahlin, 2011). In the second step, the observed frequencies between the two groups are compared with the expected frequencies if the null hypothesis is true. The expected frequencies can be defined as:

$$E_i = \frac{Row\ total * Column\ total}{Total\ number\ of\ counts\ in\ the\ table} \qquad (15)$$

Table 13. Expected frequencies of statement 9.

Answer distribution	South western Skåne	Remaining production area	Row total
1	13*34/63	13*29/63	13
2	17*34/63	17*29/63	17
3	22*34/63	22*29/63	22
4	10*34/63	10*29/63	10
5	1*34/63	1*29/63	1
Column total	34	29	63

The third step is to subtract the observed frequencies from the expected frequencies, shown in *Table 13*, square the difference and then divide by the expected frequency (Wahlin, 2011).

Thereafter the values from each cell are summed. The procedure follows *Equation 14* as shown in *Table 14*.

Table 14. Chi-Square values for statement 9.

Answer distribution	South western Skåne	Remaining production area	Row total
1	$(11-7.02)^2/7.02$	$(2-5.98)^2/5.98$	13
2	$(11-9.17)^2/9.17$	$(6-7.83)^2/7.83$	17
3	$(9-11.87)^2/11.87$	$(13-10.13)^2/10.13$	22
4	$(2-5.40)^2/5.40$	$(8-4.60)^2/4.60$	10
5	$(1-0.54)^2/0.54$	$(0-0.46)^2/0.46$	1
Column total	34	29	63

The chi-square values in T*able 14* are compared with a critical value obtained from the chi-square table (Wahlin, 2011). In this study, a significance level of 5% is chosen and the degree of freedom is equal to 4. In order for the null hypothesis to be rejected the calculated chi-square value must be equal to or larger than the critical value.