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A Resource Based View of Productivity, Firm Growth and Technical Management Tools

- A case study of Swedish large-scale farms

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Abstract

The past and ongoing structural change in Swedish agriculture has led to an increasing number of large-scale farms. The biological factors associated with large-scale farming operations may cause increasing variability, risk and reduced yields due to sub-optimal timing and management of field operations. The theory of economies of scale suggests that large-scale production may benefit from lower costs due to scale efficiencies. Thus, large-scale farms may face cost reductions in terms of long term inputs factors, e.g. agricultural machinery. However, previous studies show that due to the complexity of farming operations including biological factors the timeliness costs may exceed the possible scale induced costs reductions in terms of machinery and labour.

The relationship between farm size and efficiency, profitability and productivity has been extensively researched. However, the previous literature is indecisive in terms of this relationship, presenting various results. Some authors argue that empirical findings supporting economic benefits, in terms of efficiency, for large-scale farming are rare. Furthermore previous literature raises management as an important factor when examining the productivity and efficiency of growth in agricultural firms. Moreover some authors claim that management has not been included in many studies and that management might be a more important factor than technical efficiency. This study examines the relationship between productivity and farm size. Furthermore, management in terms of firm growth is reviewed. Finally this thesis reviews the use of information technology and precision agriculture tools to aid farm management, and how this can be used in large-scale farming operations.

A mixed method case study is used in this thesis. The productivity is examined by the use of historical farm management data while interviews are conducted to gain a detailed understanding of management and the growth process of the case farms. The results are analysed with the resource-based view. This implies that the firms competitive advantages are reviewed based on the firms productive resource.

The study reveals that there tends to be a negative correlation between farm size and productivity for the case farms, suggesting that farm growth decreases productivity. Moreover, management, administrative work and the employees of the firm have been identified as an important factors for firm growth, where as, machinery and labour is not decisive for productivity. The study has found that the use of information technology and precision agriculture tools do not explain differences in either productivity or costs of management and administrative work.

Sammanfattning

Den tidigare och pågående strukturomvandlingen inom det Svenska jordbruket har resulterat i ett ökat antal storskaliga jordbruksföretag. De biologiska faktorer som är sammankopplade med storskaligt jordbruk kan öka variationer och risk samt leda till minskade skördar till följd av icke optimal tidsanpassning och styrning av fältarbete. Teorier om stordriftsfördelar föreslår att storskalig produktion kan producera till längre kostnader till följd av skaleffektivitet. Därför kan det finnas möjligheter för storskaliga jordbruk att minska kostnader för t.ex. jordbruksmaskiner. Dock visar tidigare forskning att till följd av komplexiteten med biologiska faktorer i jordbruksdrift så kan ökade kostnader till följd av bristande tidsanpassning och styrning överskrida möjliga besparingar rörande maskin- och arbetskostnader till följd av skaleffektivitet.

Förhållandet mellan gårdsstorlek och effektivitet, lönsamhet och produktivitet har omfattande undersökts i tidigare forskning. Dock presenterar litteraturen en kluven bild av dessa förhållanden. Somliga författare argumenterar att empiriska bevis för ekonomiska effektivitetsfördelar till följd av storskalig jordbruks drift är sällsynta. Vidare lyfter tidigare litteratur företagsledning och styrning som viktiga faktorer för att förklara effektivitet och produktivitet vid tillväxt i jordbruksföretag. Vissa författare hävdar att företagsledning inte har inkluderats i många studier och att det kan vara en viktigare faktor än tekniskt effektivitet. Den här uppsatsen undersöker förhållandet mellan produktivitet och gårdsstorlek, vidare inkluderas företagsledning och tillväxt i studien. Slutningen inkluderas användandet av informationsteknik och precisionsodlings verktyg som en resurs vid ledning och styrning av gårdsdriften, och hur det kan användas av storskaliga jordbruksföretag.

I denna uppsats utförs fallstudier med en blandad metodik. Produktivitet studeras med hjälp av historiska data från jordbruksdriften tillsammans med intervjuer som utgör grunden för att få detaljerad förståelse för företagsledningen och tillväxt processen i fallgårdarna. Ett resurs baserad synsätt används för att analysera resultaten från fallgårdarna. Detta innebär att företagens konkurrensfördelar analyseras baserat på företagens produktions resurser.

Uppsatsens resultat visar tendenser till en negativ korrelation mellan gårdsstorlek och produktivitet för fallgårdarna. Detta medför att gårdarnas tillväxt skulle minska produktiviteten. Företagsledning, administrativt arbete och företagets personal har identifierats som viktiga faktorer i tillväxtprocessen. Medan maskin- och personalkostnader inte är avgörande för företagens produktivitet. Uppsatsens resultat kan inte förklara att informationsteknik eller precisionsodling påverkar varken produktivitet eller kostnader för administrativt arbete och företagsledning.

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1 Introduction

The theory of economies of scale suggests that costs can be reduced if production operates at a larger scale. Scale economies has long been a subject for economic research, in many production settings since it emerged in the 19th century (Stigler, 1958). Adam Smith (1776) introduced the motive for profits within the firm. Pindyck and Rubinfeld (2009) define profit as the difference between revenues and costs. Thus, economies of scale may increase profits by reducing costs. The motive for profits is an accepted driving force for business firms and has been identified as an objective of firm growth.

Recent structural changes in the Swedish agricultural primary production reveal that farm operations have increased in terms of size. Since the early 1980's until now the number of farms operating areas larger than 100 hectares has more than doubled in Sweden. During the same period of time farms operating 50 to 100 hectares has decreased by similar proportions (www, SJV, 2015a). Furthermore prices for agricultural land and the rents paid for agricultural land has increased. During the last 30 years prices for arable land has more than doubled in Sweden (SJV, Swedish Board of Agriculture, 2012). Rents have increased by 65 per cent during the last 15 years (www, SJV, 2015b). Hence it is of utmost importance for farmers to remain or increase their productivity during the expansion.

Rapid machinery development paved way for the structural changes in agricultural primary goods production (Kislev and Peterson, 1982). More efficient machinery allows for large scale farming operations. However, the more efficient machinery technology is not available to small-scale farms (Stonehouse, 1991). The contemporary structure of agricultural primary production has to a great extent adopted new machinery technology. Cost for machinery and labour dominates all other direct input factors in agricultural production (Søgaard and Sørensen, 2004). Hence, there may be a possibility to distribute the cost for farm machinery and benefit from economies of scale by farm expansion.

While the number of farm businesses operating areas larger than 100 hectares has increased the yield development has displayed a stagnating pattern. During the late 1960's and the 1970's the wheat yield increase by 18% per decade, on average slightly less than 100 kilos per hectare each year (www, SJV, 2015c). Since 1995 the mean wheat yield in Sweden has showed no increase in parity to previous development. There are several recent research initiatives trying to explain this development, some times referred to as the wheat yield plateau. Knight et al. (2012) found that no single factor had a dominating effect on stagnating yields rather that; a more holistic approach to agronomy is needed. Elmquist and Arvidsson (2014) found that one of the most important factors for explaining why some farms obtain higher yields is management.

This study intends to examine the relationship between large-scale farming and productivity of agricultural firms operating in the primary sector that are subject to growth. Furthermore, the use of information technology tools to support various management tasks and handle the biological complexity of large-scale farm units is included in this study. In the next section of this chapter the academic problem and a background providing detailed insights in the issues concerning large-scale farming are presented.

1.1 Problem background

The aforementioned structural changes in Swedish agriculture involve increasing number of large-scale farm-units. This development may lead to an increasing number of agricultural firms, which may benefit from economies of scale or size. The possibility for firms to benefit from of economies of scale or size has long been a topic of interest to many researchers, both in agriculture as well as other industries. The complexity of agricultural production, which to a great extent depends on biological factors, may make it more difficult to evaluate possible size benefits. Previous research using case farm scenario modelling show that there are economic benefits to gain from large-scale production (Bailey et al., 1997; Kumm, 2008). However, Hallam (1991 p.168) concludes that only few economies of size have been found in empirical research.

A recent study by Rasmussen (2010), using an input distance-function approach for a large data set from a period of over 20 years, concludes that more than 95% of all Danish full-time farms operate in a segment where they benefit from increasing returns to scale. This indicates that a majority of the Danish farms operates below their optimal technical scale. However, for arable farms this may be an effect due to restrictions in acquiring enough land to fully benefit from the technological development. (Rasmussen, 2010). Hallam (1991) argues that structural changes may be due to other factors than economies of size, such as technological change, improvements in managerial techniques and information systems. This section will present biological and technical factors, which may be determinant for agricultural firms to benefit from increased production size, starting with the possibility to reduce machinery costs.

1.1.1 Machinery costs

The possibilities to utilise economies of scale in agricultural firms depends on the use of capital-intensive farm machinery. Large-scale farm units may utilise alternative systems, which are not affordable or applicable to small-scale farms. Stonehouse (1991) concludes that alternative tillage system suitable for large-scale farms may increase farm level net returns in long run terms. However, such alternative systems may affect crop yields negatively. Labour and machinery are important input factors dominating all other cost categories. Therefore it is important, if possible, to adapt the machinery and management system to the specific farm size (Poulsen and Jacobsen, 1997). Empirical findings show large variations in farm machinery costs for Danish farmers, in a range of more than 130% difference (Jacobsen, 2000; Søgaard and Sørensen, 2004). Given these findings it is evident that the possibility to reduce machinery costs due to economies of size is an important competitive advantage.

1.1.2 Timeliness costs

The ability to attain high yields in crop production depends on providing the most desirable biological conditions for the crops. This may include the performance of seedbed preparations, drilling and harvesting as well as fertilisation and pest control. For these specific operations there is always an optimal time, which will provide a maximum yield outcome (Witney, 1995). Yield reduction as an effect of mismanaged field operations is often referred to as the timeliness effect, which can be further assessed as an economic loss; timeliness cost. Timeliness costs is a time-related penalty that decreases the total revenue in crop production. The penalty is associated with risk and arises when an operation is preformed at a non-optimal time or with non-optimal capacity of the equipment, affecting the quality or quantity of a crop (Witney, 1995)

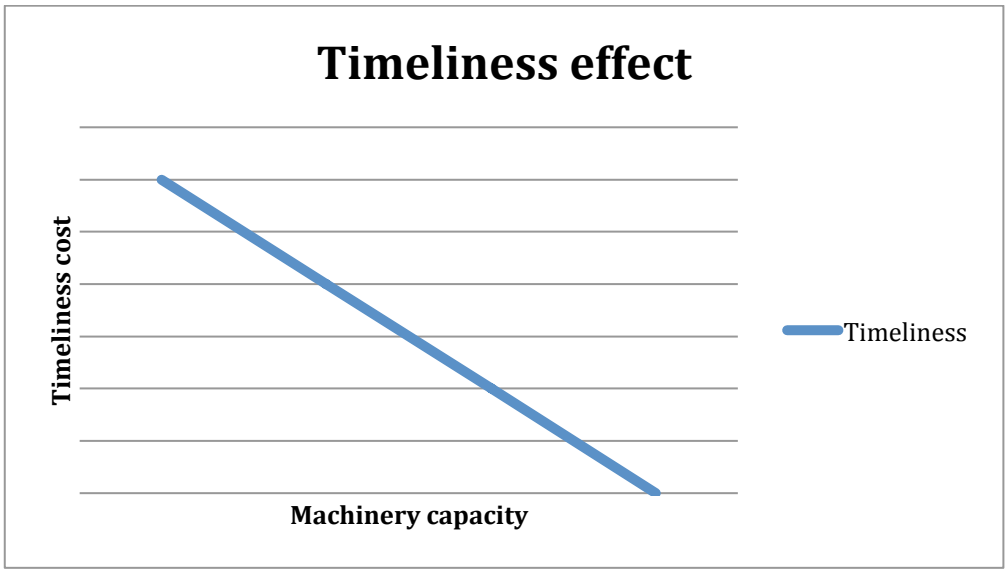

Figure 1: *The relationship between increasing machinery capacity and decreasing timeliness cost.*

The timeliness cost is related to machinery capacity, where increased machinery capacity will allow for more optimal timing of field operations, as illustrated in Figure 1 (Axenbom et al., 1988). However, agricultural machinery is capital intensive and the increase in machinery capacity will severely increase the capital costs. For large-scale farm-units it may be possible to replace conventional tillage equipment and invest in more productive machinery equipment, covering a larger acreage in the same amount of time, thus reducing labour costs (Stonehouse, 1991). However, timeliness costs arise in crop production since it is not technically feasible to operate all areas at one specific optimal time (Gunnarsson et al., 2005). Stonehouse (1991) examine minimum tillage machinery suitable for large-scale farm-units, which allows for considerable reduction of machinery costs. If adopted, cost reduction is obtained compared to conventional tillage methods. However the study shows that in the short run there are no major profit opportunities originating from investing in these machinery systems due to reduced yields.

De Toro (2005) confirms the results of the previously cited study in a Swedish case. De Toro reveals that even though large-scale farms may benefit from lower machinery costs they are prone to suffer from substantial timeliness costs. Considering labour, machinery and timeliness costs a study by de Toro (2005) reveals both greater variation in timeliness costs as well as higher average costs per hectare for a 600-hectare farm compared to a 200-hectare farm. Consequently the long run reduction in machinery costs predicted by Stonehouse (1991) may result in increased timeliness costs. Given the relationship presented in Axenbom et al. (1988) increased machinery capacity can reduce timeliness costs. However, this will affect any predicted size benefits from decreased machinery costs per hectare. The increased variability found in de Toro (2005) adds an additional aspect of this phenomenon, risk. Large machinery systems have, according to de Toro (2005), lower variable cost, due to lower risk. The ability to minimise machinery costs without a substantial increase in timeliness costs and variation is consequently dependent on management of the farm operations and scheduling. Even though increasing machinery capacity may supress the problem, the importance of the management task increases with a higher degree of labour and machinery coordination.

1.1.3 Farm management technology

The interest in the possibly to improve farm management with the support from decision tools has long been a topic of research. Öhlmér (1989, 1981) evaluated the interest and development of computerised management systems for farm use. However, since the publication of this research there has been major changes in technology available for farmers, shifting the nature of this problem. More recent reviews by Öhlmér (2007) define how computerized management tools may assist in farm management by providing functions for planning and forecasting consequences of decisions. Recent developments in precision agriculture tools may improve one of the critical issues with computerised management tools raised by Öhlmér (2007), time consuming data entry. According to Fountas et al. (2006) precision agriculture tools may provide farmers with the opportunity to cope with in-field variability and to efficiently handle and manage vast amounts of information. Hence, this facilitates reducing risks related to yield variability.

Precision agriculture is a management strategy that uses information technologies to bring data from multiple sources to support decisions associated with crop production (Batte and Arnholt, 2003). Precision agriculture technologies and associated management tools may provide necessary tools to maintain crop yields and profitability for large-scale farm-units facing challenges with machinery capacity and timeliness costs. More specifically the concept of precision farming has the possibility to aid farmers in their use of fertilisers and chemical crop protection for a more efficient use. Thereby, there is a possibility to increase crop yields and to reduce costs (Pedersen, 2003). Hence, the use of precision farming tools increases the potential to manage large farm-units in a precise manner with attention to specific details.

1.2 Problem

The main problem of this thesis is the past and on-going structural changes in the agricultural primary production sector in Sweden. As presented in the previous sections large-scale farm-units may benefit from economies of size due to decreasing machinery costs. However, large-scale farms may also suffer from an increasing timeliness costs due to biological sub-optimality as a result of timing and management of field operations. Several studies have been conducted where the relationship between farm size and productivity is examined. However, there is no clarity to be found from the studies reviewed. There are some empirical findings of an inverse relationship between farm size and profitability and production efficiency in developing countries (Carter, 1984; Herath, 1983). Yet this may be an effect of other enterprise and social factors restricting the possibilities to benefit from economies of size (Feder, 1985). Other more recent studies argue that there is no inverse relationship between farm size and productivity, and that any relationship between farm size and efficiency are subject to more complex relationships (Helfand and Levine, 2004; Townsend et al., 1998). Hall and LeVeen (1978) concludes that even though their study reveals a significant technical basis for economies of size other factors such as resource quality and management might be even more important factors for productivity.

This indicates that management is an important factor to review when examining the farm size and productivity relationship. Furthermore, there may be reasons to study the growth of the firm and how this affects the productivity as the size of the farm increases. Penrose (1959) studied the growth of the firm and in particular the role of management in the growth process. The results and view of management in previous studies within the topic is presented in table 1. Furthermore, the methods used in these studies are presented in Table 1.

Table 1: A summary of literature to provide a general understanding of relevant literature

Key References	Aspect 1: Farm Size productivity relationship	Aspect 2: Farm size and management relationship	Aspect 3: Method used to evaluate efficiency or productivity in relation to farm size
Penrose, 1959			Management is a limiting factor for firm growth.
Hall & Leveen, 1978	There are significant technical basis for economies of scale.	Management are even more important than the technical basis for economies of scale.	Calculation of cost frontier and comparing efficiency by valuing all inputs.
Hallam, 1991	There are no clear empirical evidence of economies of size in agriculture.	There are difficulties in correctly measuring size economies, other facts are important i.e. Management.	Estimation of cost function and linear programming is the most common method.
Hansson, 2008	The study does not examine farm size.		Management affects efficiency, personal aspects of the manager are more important than management systems.
Rasmussen, 2010	Farms operate at increasing returns to scale.	This study does not incorporate management in the model.	A quantitative model where calculations of scale efficiency using an input distance function is used.

Since the work of Penrose as well as the majority of studies conducted to examine the farm size and productivity relationship there has been substantial development in terms of information technology. Farm management tools and precision agriculture technology may aid decision-making and in preventing yield losses from rising management challenges on large-scale farm-units. Previous research have found that the increasing challenges associated with large-scale farm management and harvest logistics may have a significant influence on the expected efficiency of machinery and hence, the timelines costs (Gunnarsson et al., 2008, 2005).

On the basis of previous problem description this thesis attempts to investigate the fundamental factors that affect the economic outcome of some selected large-scale farms, which have experienced growth in their farm operation size in the past years. In addition this thesis will examine the use of precision agriculture technology and farm management decision aids and their affect on a successful firm growth.

1.3 Aim

The aim of this thesis is to analyse large-scale farms, which have experienced substantial growth and expansion. The main subject of analysis is productivity of land area. Furthermore, this study aims to examine the underlying reasons for firm expansion, if it has affected the productivity and how the case farms attempt to solve the problems presented in the problem background. By doing so, this study includes a review of the management and precision agriculture tools used on the case farms and how these tools aid the managers in their decision-making process concerning farm growth. Finally this study aims to identify key factors for successful firm growth in the agricultural primary production sector. Examining management and the role of management in the growth process enables us to identify possible limits to firm growth. To fulfil the aim of this study, one main- and several sub research questions are stated to be answered in this thesis.

Main research question:

- How does the relationship between productivity and farm size develop for agricultural primary production firms during a period of growth process?

Sub questions:

- What key-factors could be identified for agricultural firms in order to succeed in their growth process?

- How do the case farms work with farm management and precision agriculture tools to reduce the managerial problems facing large-scale farm operations?

The answer to the main- and sub research questions should be of relevance to farmers striving to develop and expand their farm business. The academic contribution and the novelty of this study is the use of a resource-based view in combination with information technology and precision agriculture to evaluate the managerial effect on firm growth in agricultural businesses. Furthermore the use of a historical perspective in this study provides an additional dimension to the problem. Lockett and Wild (2014, p. 384) "suggest that future resource-based view scholars have much to gain if they embrace the importance of history in shaping the nature of a firm's resource-base over time". This study examines the management systems of the case farms in detail to analyse the effect of management in farm expansion.

1.4 Delimitations

To retain relevance of this study some delimitations are made. The study incorporates farm management data from case farms. Hence, these farms constitute the basis for the analysis. As presented in the aim, this study examines the productivity of farms during the process of growth and the importance of management and technical decision aids.

The choices of case farms used in this study are based on the problem statement and aim of this study. The case farms should have experienced recent changes to the structure of their business in terms of growth. The farm management data used to analyse the productivity of the case farms is provided by LRF Konsult, hence the case farms must be a part of LRF Konsult business analysis program (LRF Konsults affärsanalys), which provides the raw data for this study. The case farms are all situated in the southern parts of Sweden. This region provides the best possible biological conditions for crop production in Sweden. Hence, the case farms may operate various enterprises including speciality crops such as vegetables, peas and sugar beets. Furthermore, there are several processing industries operating in this area, which allow for outstanding market conditions in this region. The favourable conditions for production of agricultural primary goods in southern parts of Sweden imply that the case farms are not restricted by the surroundings. Therefore, the choice of case farms in this thesis allows examining the cases with minimised attention to the surrounding factors.

The choice of time period of study in this thesis concerns the possibility to examine the farm in the light of firm growth. The previous decade has displayed a very volatile grain market, after years of relatively stable grain prices (SJV, 2014). The time period included in in this study intersects with that of volatile grain prices, however this study will not include the years prior to this period. This will hopefully reduce the risk of interference from market conditions when examining farm growth. Finally this study does not regard the ownership of land but focuses on comparing the farm operations irrespective of ownership conditions. However it should be noted that 43% of all arable land in Sweden is rented (SCB, 2013)

2 The theoretical framework

The theoretical framework of this thesis is based upon the micro economic theory of economies of scale and management theories. By comparing micro level profits in a historical perspective for the case study companies the economic outcome of structural changes in size of farm operations are evaluated. The comparison is executed using farm management data for the case companies during a period of time. Total factor productivity will be used when comparing the case companies as a relative measure.

2.1 Economies of size and scale

The economies of size and scale have been extensively researched in different areas of business. The fundamental concept or reasons to why a firm may benefit from economies of scale are described in detail in Pindyck and Rubinfeld (2009). By operating a large-scale production the average cost of producing one unit may decline as a result of the reasons presented below (Pindyck and Rubinfeld, 2009). Some of these reasons may be more or less applicable to an agricultural context.

1. Large-scale business operations may provide the opportunity for workers to specialise in certain activities of interest and expertise, which would increase the overall productivity.
2. The flexibility of operations may be enhanced as a result of scale. The possibility to vary the combination of inputs utilised to produce the output may provide managers with increasing possibilities to organise production in a more effective manner.
3. The firm may be able to acquire some production inputs at lower costs as a result of more favourable negotiation terms when buying large quantities.

These factors are, to some extent, applicable to large-scale farms. However, other organisations such as co-operatives may provide similar benefits to small-scale farmers. The relation between scale and increasing returns are likely to turn at some point, this may relate to the following reasons (Pindyck and Rubinfeld, 2009).

1. The increase of production may in the short run result in a shortage of long run inputs such as machinery, production facilities, which in the end may result in less effective production.
2. The tasks required by the manager will become increasingly advanced due to enhanced complexity of production. This will lead to more managerial duties, which may result in inefficient production due to insufficient management.
3. Potential advantages in buying large quantities of inputs may disappear after reaching a certain volume. At some point, the available supplies of key input factors may be limited, eventually increasing the cost of specific inputs.

The problem of this thesis is highly related to the first and second reasons for diseconomies of scale previously mentioned. The potential economies of scale may be re-evaluated at a certain farm operations size where additional machinery investments are required. Moreover the managerial duties associated with large-scale farm-units is an important factor to consider due to the possibility of substantial yield losses as a result of increasing timeliness costs (Debertin, 2012).

2.2 A micro economic approach

Debertin (2012) describes the economies of size and scale in an agricultural context. However, to some extent the agricultural context may prove to be slightly more complex due to a vast number of production factors, both technical and biological. Therefore, Debertin (2012) specifically raises the important difference of economies of *size* and *scale* in an agricultural context. The economies of size in an agricultural context may regard the acquisition of additional input factors such as land, for arable farms, or stable buildings, for livestock farms. In this thesis the increase of land area is of particular interest. The growth of farming operations, in terms of tillable land, will surely bring increases in direct input factors such as, seeds, fertilisers etc. However, it does not necessary result in increases in more fixed character inputs such as machinery or grain storage facilities in the short run. The economies of scale on the other hand presume an equal increase of all input factors, land, building, machinery and management. Raup (1969) argues that many studies regard management as a fixed factor. However, as farm size increases management becomes a critical item. In reality this is not approach is not feasible since most farm machinery, buildings or management, can only be increased or decreased in discrete quantities. The ability to increase one input factor, without adjusting other input factors implies a sub-optimality before the expansion. Rasmussen (2010) concludes that 95% of Danish full-time farmers operate at increasing returns to scale, thus, implying a sub-optimal production. The traditional micro economic approach of estimating the cost function or expansion path and technical efficiency is used in many previous studies (Hallam, 1991; Hansson, 2008; Rasmussen, 2010; Townsend et al., 1998).

Several studies using economic engineering or synthetic firms to examine economies of size in agriculture find that the long-run cost curve is L-shaped, showing that the production costs decline rapidly with initial increase in size followed by a slow decline (Hall and LeVeen, 1978). Hallam (1991) concludes that this L-shaped cost curve is not readily refuted by empirical evidence. Hall and LeVeen (1978) argue that the technological advantages of farms over 1300 hectares are relatively small compared to farms around 100 hectares. The large farms have production cost advantages of 0% to 15% compared to the ones around 100 hectare (Hall and LeVeen, 1978). Moreover Hall and LeVeen (1978, p. 599) conclude that even though there is a technical basis for economies of size in terms of declining production costs, other factors such as management, institutional structure and resource structure are even more important. Hansson (2008, p. 44) argues that due to its complexity managerial capacity has often been treated like a black box in previous studies, represented only by a few aspects.

With regard to previously presented understandings this thesis examines the basis for economies of size using a theoretical framework, which includes the management and resource structure of economies of size

2.3 The resource-based view

Most formal economic tools operate on the product-market side of strategy (Wernerfelt, 1984). In terms of applying a product-market theoretical framework to an agricultural primary production context this may cause problems due to the homogeneity of agricultural products. To determine competitive advantages of firms, which produce a very similar or sometimes identical product, may be difficult using a product-market side approach. However, the resource-based view may provide a tool for analysing a firm's competitive advantages from a resource position. The resourced-based view of the firm conceptualises the firm as unique

bundles of productive resources which managers utilise (Lockett and Wild, 2014) According to Wernerfelt (1984) the resource based approach views the firm as a historically determined collection of assets or resources which are tied semi-permanently to the firms management. The typical resource to include in such analyses are labour, capital and land. Penrose (1959) examines the firm with a perspective of resources in a broader sense. Wernerfelt (1984) argues that this approach is unpleasant for modelling purposes. For some resources such as technological skills, or in the context of this thesis agronomical skills, the mathematics use by economists typically require that the resources exhibit declining returns to scale, as in the traditional theory of factor demand (Wernerfelt, 1984).

Penrose (1959) defines the industrial firm with reference to its administrative framework within which industrial activities are co-ordinated. However, in reality the firm is more than an administrative unit, it is a collection of productive resources. These resources are at the disposal of the administrative unit. Hence these resources and the different use of them is determined by administrative decisions. The resources included in the firm may be both physical and human resources such as, in this specific agricultural context, tillable land, machinery, seeds, fertilisers, storage and grain drying facilities as well as, labour; machinery-operators, farm managers and farm owners. It is important, however, to recognize all of these resources, including managerial services, as resources for production input. Penrose (1959) argues that it is never the resources themselves that are the inputs in a production process, but only the services that the resources can render.

From the previously presented theoretical perspectives the business firm, as used in this study, will be defined as: a combination of both the administrative organisation and a collection of productive resources. Furthermore it is assumed that the general purpose of the firm is to organise the use of its own resources and combine them with other resources acquired from outside the firm to produce goods at a profit. The foundations for looking at firm growth in the perspective of the resource-based view of the firm were laid out by Penrose, working with strategy and business history (Lockett and Wild, 2014). The theory of the firms growth (Penrose, 1959) intends to explain the growth of firms by re-asserting the importance of economic principles and human motivation. Rugman and Verbeke (2004) introduce Penrose as one of the most influential economist of the twentieth century. Penrose (1959) discusses the role of resources in diversification and firm expansion in to new products or markets. It is agreed by more recent authors that the resource-based view may indeed by a useful tool in addressing this issue (Priem and Butler, 2001).

The theoretical framework of this thesis is illustrated in Figure 2. From the literature on the resource-based view and firm growth some prevalent elements usually discussed in the context of firm growth have been observed. These elements may relate to restrictions and motivation to growth and are further presented in this chapter. The resource-based view is used to analyse six case farms. Furthermore the use of precision agriculture and farm management tools is included in the theoretical model. Precision agriculture technologies where not developed when the resource-based view emerged. However, a strong relationship between the technology and several elements within the resource-base view can be identified. The use of precision agriculture and management tools can be seen as an enabler for large-scale farm operations. Thereby, creating the opportunity and motivation for growth. Furthermore, the use of precision agriculture as a management tool may increase the managerial services within the firm. Hence, affecting any managerial limits to growth. The possibility to organise data and document fieldwork with precision agriculture technology may create path dependency within management of field operations.

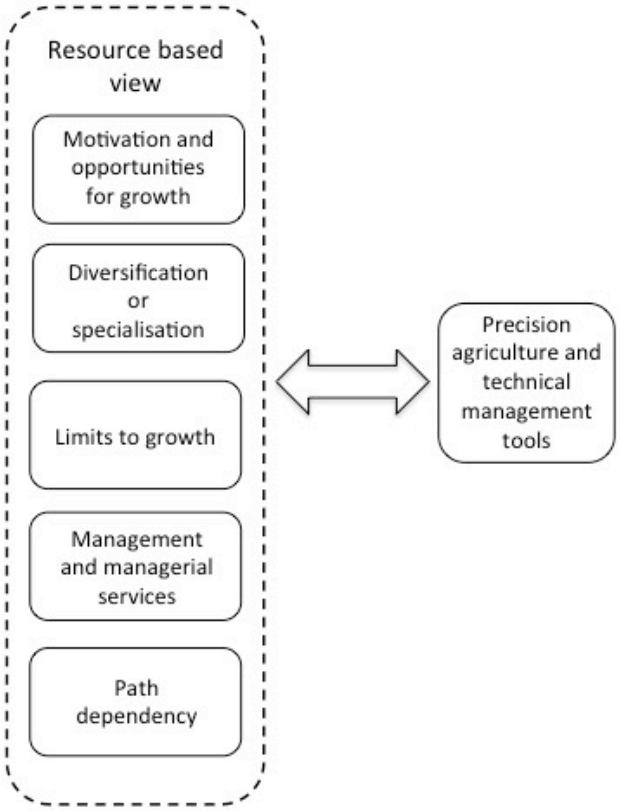

Figure 2: Model of theoretical framework

Motivation and opportunities for growth

Penrose (1959) assumes that the managers in a firm base their decisions in the light of some purpose. However, Penrose remarks that the true nature of this purpose is notoriously difficult to discover. It is usually assumed in economic theories, including Penrose (1959) that the main purpose of any firm investment or growth decision is to gain profits. However, from this point one may ask the question, why should a firm or its manager always strive to make profits? The profits of the firm create the means for firm owners dividend, which in turn may increase the personal income and wealth of the shareholders receiving the profits. To this argument Penrose (1959) add that employed managers, which have little or nothing to gain from paying out dividend may have more to gain from the profits being reinvested in the firm. Other alternative motivations to firm growth, a part from profits, may be personal prestige, long-term profitability or the will for handing over a sustainable business for coming generations.

The firm's current resource-base my affect the willingness of managers to seek firm growth. The potential services available from unused resources motivate managers to seek opportunities to expand as they want to put these resources to productive use and to exploit economies of scale or size (Thompson and Wright, 2005) Wiklund et al. (2003) examine the attitude towards growth among small business managers. Their conclusions state that the managers belief about the consequences of growth determine whether they shall expand their business or not. Furthermore, Wiklund et al. (2003) found that non-economic concerns such as the well being of their employees and the work atmosphere is more important than the possibility of personal economic gain or loss. Managers who believe that the work atmosphere will improve due to growth tend to have a positive attitude towards growth.

The direction of growth – diversification or specialisation

Penrose (1959) argues that a firm is not confined to given products but the activity it moves into. These activities are usually related in some way to existing resources. Fundamentally, it is the resource-base of the firm which limits the choice of markets it may enter, and the levels of profits it may expect (Wernerfelt, 1989). The resource-based approach considers the limitations to diversified growth. The sources for growth may be internal development, mergers or acquisitions. In the context of this thesis this may relate to processing of products, increased collaboration with other firms/farms or acquisition of other farms. Furthermore, the resource-based view considers motivation for diversification (Mahoney and Pandian, 1992). Penrose (1985) argues that unused productive resources create a puzzle for balancing the production process. Excess capacity of production resources due to indivisibilities and cyclical demand or labour intensity to a large extent drives the diversification process (Mahoney and Pandian, 1992). Moreover, unused human expertise resource, in particular, may drive diversification (Farjoun, 1994). Excess physical capacity leads to related diversification, if the capacity is end product specific (Chatterjee and Wernerfelt, 1988). In the context of this thesis such physical capacity may be agricultural machinery, which may be specific to certain crops i.e. potatoes or sugar beet. Hansson et al. (2010) investigated diversification and specialisation of farm businesses in Sweden. They found that farms with significant seasonal variation in labour need, or production that is not intensive-labour are more diversified. Furthermore, larger farms are more diversified, which is explained by the high value of unused resources.

Limits to growth

The reasons and limits for growth of firms have long been discussed. In these discussions the difference between growth and size are determined. Penrose (1959, P. 1) that "size is but a by-product of the process of growth" and that "there is no optimum or even most profitable, size of firms". According to Penrose (1959) there are three possible explanations why there may be a limit to the growth of firms. Managerial abilities, production or factor markets and uncertainty and risk. The first represents limits within the firms where as the second refers to conditions outside the firm and the third is a combination of internal attitudes and external conditions. For agricultural primary producers the market limitations may be less of a problem, apart from some specialised production such as vegetables or production of crops affected by policy induced production quotas e.g. sugar beets.

Mahoney and Pandian (1992) raise several key-resource constraints, which may limit the growth of the firm; shortage of labour or physical inputs, shortage of finance, lack of suitable investment opportunities and lack of sufficient managerial capacity. Penrose (1959) argues that the long-run limits to firm growth are only affected by internal management resources. Since managerial services are necessary for firm expansion this determines the possibility for growth. Training of new managers may increase the managerial capacity of the firm. However, the training of managers and their integration into the work force occupy some of the existing managers time. Thus reducing managerial services available for expansion (Mahoney and Pandian, 1992). The managerial constraint to growth has been called the 'Penrose effect' (Marris, 1963) and suggest that firms growing fast in one period, tend to experience slower growth in the next period (Penrose, 1959). This theoretical argument by Penrose has been empirically tested in several papers using case studies (Penrose, 1960; Richardson, 1964), formal models (Slater, 1980; Uzawa, 1969) and econometric models (Shen, 1970), which all show support for the Penrose effect.

Management and managerial services
As previously described the manager's abilities and the availability of management services is an important resource to consider in the context of the resource-based view. Hutzschenreuter and Horstkotte (2013) argue that it is the role of the management to put the resources to use and decide on their combination. Hence, management and managerial services are significant to firm growth. Penrose (1959, p. 20) defines the firms managerial abilities as; the firm's ability to maintain sufficient administrative co-ordination, which set the limit to its size. In the process of growth where sufficient administrative co-ordination is not provided managerial diseconomies may arise. This may be prevalent in agricultural production due to the biological aspect in the production, which may cause considerable yield reductions in case of un-sufficient administrative co-ordination.

Penrose (1959) raises the question whether managerial diseconomies will cause long-run increasing costs. However, this would imply that management is regarded as a fixed input factor. Given previous definitions, the resource of a firm, which constitute the necessary means to produce a product, includes managerial services. Hence, management cannot be regarded as a fixed input factor to expect economies of scale. However, in agricultural firms, which often are operated as family businesses, the management may consist only of the owner of the firm. Thus it may be regarded as a fixed factor unless the manager or owner actively increases the managerial services to the firm resources in accordance with the growth of the firm. The management of resources and the services they can render is the key to competitive advantage (Kunc and Morecroft, 2010). The firms ability to render managerial services set the limit to firm expansion (Hutzschenreuter and Horstkotte, 2013).

Path dependency
The growth of firms is according to Penrose (1959) determined by the current and historical activities of the firm, which shape the firms future resources and knowledge. Hence, the firms resource base is unique and path dependent (Lockett and Wild, 2014). Penrose (1959, p. xiii) argues that history matters; "growth is essentially an evolutionary process and based on the cumulative growth of collective knowledge, in the context of a purposive firm". Lockett and Wild (2014, p. 373) claim that history is largely absent from much resource-based research, with path dependency rarely operationalised to any significant degree. Therefore, this study includes a historical perspective to firm growth. Path-dependent evolution should have strong consequences for firms in terms of creating unique opportunities and limiting others (Richardson, 1972). Penrose (1959) refers to this as the firms inherited resources, which is its accumulated experience and knowledge. This in turn constitutes the firms productive opportunities, which are shaped and limited by the ability to use the inherited abilities and resources. Hutzschenreuter and Horstkotte (2013) emphasise the importance of preparing for future growth by developing managerial services with in the firm. Since the firms resource bundle is unique the consequences of its past managerial decisions and subsequent experiences define the firms opportunity (Lockett and Thompson, 2001). Hansson et al. (2010) found that decisions regarding diversification or specialisation are path dependent and will effect future diversification or specialisation.

2.4 Use of precision agriculture and management tools

The use of management tools to aid farms decision-making has long been a topic of research. As previously mentioned Öhlmér (1989) reviewed the possible use of computerised systems to aid farmers decision-making. The development of, and access to, computers has reduced the issue in terms of technical barriers to such computerised systems. Precision agriculture is a general term for systems, which can be used to aid farmers in their crop management. It is an information technology system that allows the manager to tailor soil and crop management. Fountas et al. (2006) defines precision agriculture as the management of spatial and temporal variability at a sub-field level to improve economic returns and reduce environmental impact. De Toro (2005) shows that even though large-scale farms may reduce their machinery cost the scope of the field operations will induce larger yield variability, thus increasing timeliness costs. However both Aubert et al. (2012) and (Fountas et al. (2015) emphasise that precision agriculture technologies have provided a tool to cope with variation and to handle and manage vast amounts of information efficiently. Thereby possibly reducing the problems of large-scale farming posed by de Toro (2005). Furthermore Fountas et al. (2006) investigates the possibility to aid farm management strategies and decision-making by using precision agriculture data collection.

Sorensen et al. (2010) argues that the farmers decision-making process often induce decisions based on intuition rather than formalised planning tools, such as precision agriculture data organised in a farm management software. This in contrast to industry settings where there is long tradition for explicit planning comprising formalised documents passed down to the shop floor by the management (Chary, 2006). The use of precision agriculture may also reduce the administrative work needed. Sørensen et al. (2010) raise the possibility of using data collected by precision agriculture tools for several documentation purposes complying with requirements from both authorities and traders who value traceability.

Diederen et al. (2003) conducted a study of Dutch farmers adoption of new farming technology. They found that farm-size, market-position, solvency and age of the farmer were decisive. Previous studies more specific to precision agriculture technologies have presented to which extent farmers have adopted the technology and what characteristics define adopters. Khanna et al. (1999) state that precision agriculture tools are adopted by 20 % of farmers, and furthermore that large-scale farms and young farmers tend to have a higher rate of adoption. A more recent study by Aubert et al. (2012) shows that 32 % of farmers have adopted precision agriculture tools. However this study do not show any evidence supporting a relationship between farm size nor age and precision agriculture tools adoption. Aubert et al. (2012) presents several precision agriculture technologies. These constitute the basis for the interview questions regarding precision agriculture in this thesis.

This study focuses on a cross-sectional analysis of the relationship between a firm's resource-base and performance, some times described as the resource-performance relationship. Hence, the resource-based view is to be regarded as the main theoretical approach of this thesis. The analysis of the firms resources will be based on the previous presented possible explanations to the direction of and limits to growth. Furthermore the use of precision agriculture and management tools to increase the managerial services and the administrative resource base within the firm is examined. The method used in the thesis is further presented in the next chapter.

3 Method

This chapter defines and explain the method used in this thesis. Furthermore the methodological choices are motivated based on the literature.

3.1 Research approach

When considering the research approach there are traditionally two different alternatives; quantitative and qualitative (Robson, 2011). Robson describes these two different methodological approaches as fixed or flexible designs. The fixed or flexible design regards to how the data collection is planned and executed. In the fixed design the method for data collection is decided before the actual collection starts. The flexible design, on the other hand, is based on a preliminary plan for data collection but allows for changes as the process progresses. Both Eisenhardt (1989) and Robson (2011) emphasise that these two approaches shall not be regarded as opposites and furthermore that the combination of these two approaches to data collection can be highly synergistic. The objective of this thesis is to study the relationship between firm growth and productivity of agricultural primary producers in terms of the management of an increasing resource base and utilisation of precision agriculture tools. The outcome of this research is not previously decided; hence the use of a flexible approach is necessary.

Previous studies that examine the relationship between farm size and productivity (Hallam, 1991), as well as studies within strategy and the resourced based view of the firm (Lockett and Wild, 2014, p. 372) have focused on employing large-scale quantitative studies. The studies examining scale efficiency in agriculture has to a large extent used econometric methods to estimate the cost function of the firms. However, the results form these studies are indecisive, this is confirmed by Hallam (1991, p. 156). Binswanger et al. (1993, p. 49) concludes that most empirical work on the farm-size productivity relationship has been flawed by methodological shortcomings, and has failed to deal adequately with the complexity of the issues involved.

Gummesson (2006) addresses that complexity, context and persona in a subject suggests for a qualitative method. Furthermore he argues that certain properties in a research subject require a qualitative approach to accomplish genuine validity and relevance. The research field of management and business are characterised by complexity due to the vast number of variables in the reality of the business firm. Gummesson (2006) stresses that qualitative approaches, such as case study research entail efforts to address complexity, which can further be used to put variables in a context. Moreover Gummesson raises the concept of persona used to represent human aspects, individual personalities, collective consciousness and the research environment, which, are unavoidable in the research process. Since the qualitative research involves the creation and interpretation of data the persona can never be excluded.

Lockett and Wild (2014, p. 384) argue that the use of historical case studies of contemporary organisations is decidedly rare in the current resource based view literature. Furthermore they stress that future research within the resource based view have much to gain from embracing the importance of history. The possibilities to conduct a longitudinal case study are limited due to the duration of the study. However, the use of historical farm management data provides insights to the historical development of the case study companies. Robson (2011) describes the combination of a qualitative (case studies) and a quantitative (farm management

data) approach as a multi method strategy approach (mixed method). This strategy is suitable for research where there is a substantial amount of qualitative data collection as well as a substantial element of quantitative data collection within the same research project. The multi method approach is used when striving to compensate the weakness of one method with the strength of another method. The importance of this is emphasised by Ihantola and Kihn (2011). The objective of this study is to find if large-scale farms are more productive and to understand which characteristics within the firm, that affect productivity. To gain understanding of this problem the use of historical farm management data is essential, therefore a multi method strategy is used.

To conduct this study it was of great importance to gain access to historical farm management data. An agricultural business advisory service company, LRF Konsult in consent with the case companies, provided this data. Initially the objective and the research questions were presented to LRF Konsult, and after their approval the research proposal was also sent to the case companies for their approval.

3.1.1 Case study

To develop the research design Robson (2011) suggests the research questions and the purpose of the study as a starting point. The purpose of this study, previously presented, relates to the understanding of certain key factors for firm growth within the agricultural primary production sector. This thesis has conducted six company case studies of large-scale agricultural producers in order to gain understanding to key factors for successful firm growth. Yin (2009) stresses that the type of research questions given in the aim of the study should motivate the use of case studies. It is relevant to use case studies for explanatory research questions such as how questions (Rowley, 2002). Furthermore Yin (2009) advocate the use of historical studies to answer how and why questions. The historical approach is naturally not suitable for studying contemporary events. However, Yin (2009) stresses that case studies are preferred in examining contemporary events. The combination of these two sources of data should improve the explanatory power of this study. To define what the case is, Yin (2009) accentuates the importance of finding the unit of analysis.

The aim of this study is to find out if there are economies of size to be utilised for large-scale farms, and explain how and why there may be different outcome, in terms of utilising the economies of size for growing firms. The necessity to gain access to case companies with extensive historical farm management data from the past decade, and which had experienced substantial firm growth within that period limited the available firms to include in this study.

The farm management data is produced and provided by advisory company LRF Konsult, therefore their involvement in selecting the case companies were inevitable. Thus, the selection of case farms may have been biased by the involvement of LRF Konsult. Perry (1998) argues that representativeness is not the main criteria for case selection. Preferably the choice of each case should be made such that it either: predicts similar results for predictable reasons or produces contrary results for predictable reasons. Eisenhardt (1989, p. 537) state that the “random selection of cases is neither necessary, nor even preferable”. For qualitative research, such as, case study methodology the selection of cases is purposeful and involves using replication logic and largely depends on the conceptual framework developed from prior theory (Perry, 1998). The number of cases to be included in a case study is not defined in the methodological literature (Perry, 1998). However, Eisenhardt (1989, p. 545) suggest between four and ten cases where as Hedges (1985) propose the use of four to six cases.

3.1.2 Literature review and theoretical framework

As previously mentioned the choice of research question and unit of analysis are important steps in designing a feasible case study (Eisenhardt, 1989; Yin, 2009). However, the development of a preliminary theoretical understanding is also important. The theory should relate to the collected data. Therefore an early development of a theoretical framework is necessary prior to the data collection. Yin (2009) upholds the importance of early theory developments in order for the researcher to gain a deeper understanding of the problem in the research design process. For the case of this thesis it was important to develop an understanding of the problem from previous studies to enrich the empirical contribution and ensure the relevance of the interview questions. Therefore a literature review and a preliminary theoretical framework were developed prior to the empirical data collection.

The literature review is to a large extent based on academic journals within the field of management as well as agricultural economics. In addition some textbooks were used including Penrose 1959 the theory of the firms growth. The initial phase of the literature review attempted to comprehend the general understanding of previous research on scale efficiency in agriculture. These articles gave an indication of the general understanding within the topic as well as a significant enlightenment of the importance of management and the resource perspective. This, according to some authors (Hall and LeVeen, 1978; Raup, 1969), are more important than technical efficiency and has been neglected to some extent in other studies. Given these concerns the second phase of literature review focused on developing an understanding for the resource based view, combining fundamental papers such as (Barney, 1991; Wernerfelt, 1984) with more recent work within the subject. Simultaneously the current research on precision agriculture was reviewed to find possible tools for reducing management issues of large-scale farm units.

3.2 Data collection

Qualitative methods including case studies preferably use several sources of data (Eisenhardt, 1989; Yin, 2009). The use of multiple source of evidence supports the creation of validity of the case study (Riege, 2003). The mixed method used in this thesis may be regarded as a multiple source of evidence. According to Dellinger and Leech (2007) the use of two frameworks is complementary and the elements of mixed methods construct validity. Therefore the data collection follows the proposed planning and design previously described. However, this includes many choices and considerations. In this section the methods used for data collection in this thesis are presented including the consideration and procedures for ensuring data quality and ethical aspects of the study.

The data collection in this case study is based on two sources, historical farm management data and qualitative interviews. As previously mentioned the use of multiple sources and in this case even multiple methods for data collection is a way of increasing validity. According to Denscombe (2000) the use of more than one method when collecting data in one topic enables triangulation, which furthermore increases validity and in turn the quality of the research.

Triangulation provides the possibility to examine the problem from different perspectives, in this thesis a historical as well as a contemporary insight in the case firms. Lockett and Wild (2014) stress the need for research within the resource-based field with a historical perspective. In addition Perry (1998) argues that theories can be viewed as some additional

evidence, which can be used to triangulate on the external reality of the case study. Moreover, Perry (1998) emphasises the importance of triangulation in case studies since they might be complex and hard to grasp without the use of several sources of data.

3.2.1 Interviews

To conduct interviews is a method commonly associated with qualitative research designs (Denscombe, 2000). However, interviews are also a suitable method when using a mixed method approach, such as this thesis (Robson, 2011). Ihantola and Kihn (2011) agues that there are several possible threats to validity when conducing interviews using a mixed method approach such as; inaccurate and unsystematic interview questions, inaccurate transcriptions and failure to record or take notes of the interviews. Hence, all interviews in this research project were recorded and transcribed. There are many different types of interview methods to choose from, however it is important that the interview method matches the overall design of the project (Yin, 2009). The interviews in this study followed a semi-structured design. The semi-structured interview includes an outline of topics to be covered, with suggested questions (Kvale and Brinkmann, 2009). Furthermore, additional questions may be added by the interviewer during the course of the interview (Robson, 2011). The interview guide used in this thesis can be found in appendix 1. The interviews conducted in this study are mainly personal interviews, but in one occasion a group interview. The organisation of the interviews conducted is presented in Table 2.

Table 2: Interviews conducted in this study.

	Interviewee	Interview date
Farm A	Farm manager	2015-03-09
Farm B	Owner and Farm manager	2015-03-05
Farm C	Owner	2015-03-11
Farm D	Owner	2015-03-10
Farm E	Owner	2015-03-12
Farm F	Owner	2015-03-11

As previously mentioned Perry (1998) argues that representativeness is not a criteria when selecting cases. Denscombe (2000) states that the selection of respondents in qualitative research rarely is based on probability or objectivity. In this study the choice of interviewees were largely based on two factors, first that the farm management data was available for the company and second that the firm had experienced changes to their operations, which include firm growth and expansion. The choice of interviewees were made such that the study could include a cross case analysis to find certain factors affecting the growth process and productivity of the firm. Hence, the interviewees and case studies were chosen with the objective of providing the necessary data. The case farms were selected upon the suggestions from the agricultural business advisor Kenneth Olsson at LRF Konsult. Therefore, the selection cannot be regarded as fully unbiased.

The interviewees consist of farm owners and farm managers. The farm owners were asked if they would like their farm managers to participate. As presented in Table 2, the majority of the interviews were conducted with solely the farm owner participating, apart from Farm A were the manager was interviewed and farm B were both the owner and manager were interviewed in a group interview. It should also be recognised that all of the farm owners do not employ a manager. All of the interviewees were contacted in advance about their

participation, initially when agreeing to participate in the project and later to confirm the interview schedule. During the second point of contact the interviewees were further presented with the contents of the interview. However, they were not presented with the actual interview questions beforehand. Perry (1998) suggests that even though some probe questions must be prepared before the interview, the interview should be started with an unstructured part, where the interviewer only presents the topic. This gives the interviewee a chance to answer the questions before they are asked, preventing the interviewee from being biased by the question at hand. The interview guide was tested on two farm owners, which had experience substantial firm growth, to ensure that the questions where not misinterpreted by the interviewees. The preparations of interview questions provide a reliable framework for cross-case analysis of data (Perry, 1998; Yin, 2009). During the course of the interview the statements of the interviewees were orally validated. Summaries of the interviews were later sent to the interviewees for validation.

3.2.2 Farm management data

The farm management data collected in this study is based on an annual business analysis (LRF Konsults affärsanalys). The business analysis is preformed by a farm business advisor, in this case Kenneth Olsson, at the beginning of each year and is preformed as a budget at completion. The budget is based on actual costs and includes a complete presentation of all cost items as well as yields and final prices for each product. Furthermore the budget presents a complete distribution of production, i.e. number of hectares for each crop and number of unit produces for livestock. In the budget material all common costs such as administration is also accounted for. The historical farm management data is produced as a service by the advisory company LRF Konsult. The material was exclusively summarised for this study when the case farms where decided up on (pers. Comm, Olsson, K., 2015)

3.2.3 Ethical considerations

There are several ethical considerations involved when collecting data for a research project (Oliver, 2010). Qualitative methods often involves different ethical issues regarding confidentiality which are not found when using questionnaires (Kvale and Brinkmann, 2009). In this project there are two main areas, which are strongly considered in terms of ethical considerations. First, the purpose of the research project should be known to the persons and organisations involved in the project. Second, the confidentiality of sensitive information revealed by the case farms and anonymity of the case farms and interviewees.

When preparing for the project the topic and problem was communicated to Kenneth Olsson at LRF Konsult in order to make the intentions of the project clear and to receive valuable information on how this thesis could contribute to their work. Furthermore the dialog was clear regarding the handling of sensitive data from the case farms.

3.3 Data analysis

This study uses mixed methods with both qualitative interviews and qualitative data, which entail a rather large amount of data. The process of handling this data actually started when designing the data collection method and choosing the case farms. This is a process, which involves several choices related to maintaining the focus of the study to answer the research questions. Robson (2011) suggests structuring the interview data by using thematic coding in order to keep the information manageable. The coding involves a process where several

measures are taken to divide and define the data according to its actual content and meaning. The analysis of the collected data in this study started with the identification of codes or themes relevant to the aim of this study. The decided themes are based on the theoretical framework in a combination with the actual collected data. The determination of themes made the data analysis manageable to be conducted in a structured way focusing on each theme individually.

The thematic coding represents one way of structuring the analysis. However, Robson (2011) emphasise that it is important to be aware of the impact the researcher as analyst can have on the analysis. The researcher may be inconsistent and overlooking some facts or its reliability. Thematic coding makes it easier to structure data hence minimising the impact of the researcher being biased. Figure 3 illustrates the model of analysis used in this thesis.

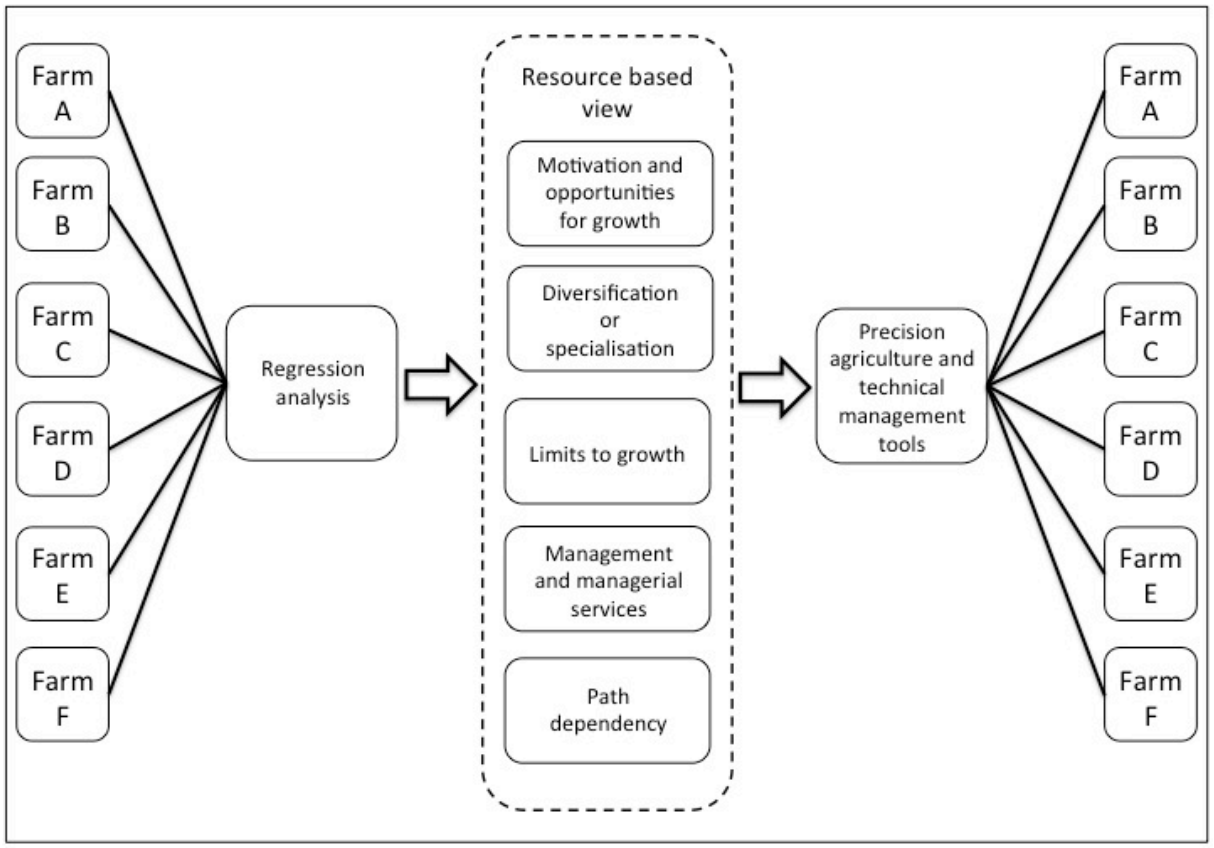

Figure 3: Model of analysis

The quantitative farm management data is statistically analysed. The results from the statistical analysis are used to support the analysis of qualitative data using the theoretical framework of this thesis. The perspectives of the resource-based view are related to the use of precision agriculture and technical farm management tools. Finally this two methodological frameworks are brought together in a cross case analysis.

3.3.1 Farm level productivity

To determine the productivity for each case company a total factor productivity (TFP) index is used in this study. The factor productivity measures the ratio between all outputs and all inputs in the firm to asses the productivity. If the TFP equals 1 the output equals the costs, if the TFP measurement is less than one implies that a business is operating at loss where as a measurements greater than one imply that the production is profitable. The productivity measurement used in this thesis is based on a modified concept of the Malmquist input based productivity index presented by Caves et al. (1982). The productivity is calculated using equation (1).

$$TFP = \frac{\sum_{j=1}^{J} p_j^t x_j^t}{\sum_{i=1}^{I} p_i^t x_i^t} \qquad \textit{Equation (1)}$$

The total factor production measurement in equation (1) consist of all outputs of the firm, i.e. price p_j times quantity for all products x_j divided by price p_i times quantity for all production inputs x_i . In this case the price for land, rented or owned is excluded from the input side according to the delimitations of this study. The TFP-ratio is calculated for each year *t* and each case farm. The TFP measurement has previously been used in several studies aiming to compare productivity within the agricultural sector (Coelli, 1996; Coelli and Rao, 2005; Lissitsa and Odening, 2005; Manevska-Tasevska and Rabinowicz, 2014; Rasmussen, 2010). In this study the TFP index is used for two purposes. First, to preform a comparison between case farms, and secondly, as a comparison over time possibly correlated to operated land area.

Manevska-Tasevska and Rabinowicz (2014) use the TFP to measure competitiveness of Swedish agriculture. Their comparison is based on farm accounting data provided by the European commission farm accountancy data network (FADN). The revenue and cost items used to calculate TFP in this thesis follow the method used by Manevska-Tasevska and Rabinowicz (2014). The cost of land is excluded in accordance with the delimitations of this study. This study does not intent to measure productivity based on land ownership structure.

The FADN data is adjusted to neither inflation nor any other cost index. The use of the method used by Manevska-Tasevska and Rabinowicz (2014) enables a comparison of the results from Manevska-Tasevska and Rabinowicz to the empirical finding of this study. Therefore, the farm management data in this study is not adjusted to either inflation or any other cost index. The inflation in Sweden during the period of study in this thesis has been very low in a historical perspective, some years has be characterised by deflation. The average annual inflation during the period included in the study is 1,18 % (www, SCB, 2015).

The possibility to use previous studies of Swedish agriculture in general to compare the producitivy of the large-scale farms included in this study may provide some remedy for the fact that this study does not include a control group since Manevska-Tasevska and Rabinowicz (2014) presents a general picture of the productivity of Swedish agriculture

3.3.2 Regression analysis

The farm management data is analysed using a multiple regression analysis. This method provides an additional tool to explain the growth of the case farms and possibly create an understanding of the complex relationships involved in the problem of this thesis. The results may indicate which costs items that are determinant for farm productivity. This can be used further to relate to the interview results. A multiple regression is suitable when aiming to predict or explain the behaviour of the response variable, in this case TFP, base on the relationship between several independent variables (Freund and Wilson, 2006). The multiple regression analysis is based on equation (2)

$$Y_{ft} = \beta_0 + \beta_{0f} + \beta_1 x_{f1} + \beta_2 x_{f2} \ldots \beta_m x_{fm} + \varepsilon_{ft} \qquad \textit{Equation (2)}$$

Where

Y_{ft} is the dependent variable for each farm *f* and time *t*

$x_j, j = 1, 2, \ldots, m$, represent *m* different independent variables

β_{0f} = the intercept for each case farm (value when all the independent variables are 0)

$\beta_j, j = 1, 2, \ldots, m,$ represent the corresponding *m* regression coefficients

ε_{ft} = the random error, assumed to be normally distributed with mean zero and variance σ^2

The independent variables x_j used in the regression preformed in this thesis are land area, machinery costs, labour costs, administrative costs and common costs. Furthermore the regression in this thesis uses a categorical background variable for each farm. Thus, allowing performing a multiple regression with several linear regression equations. The slopes of the linear regression equations are the same for all farms, however the intercept point β_{0f} of the Y-axle is different. This provides a measurement of the TFP for each farm where all independent variable are zero, which can function as a relative productivity measurement between the case farms. There are several ways to use order categorical repressor variables (Anderson, 1984). In this study the data is ordered based on the categorical farm variables.

The regression analysis can be quite sensitive to the appearance of outliers or influential data points (Stevens, 1984). Therefore it is important to address how possible outliers are to be detected and handled in this thesis. Stevens (1984) suggests a graphical diagnostic procedure for outliers on the y-axle i.e. the dependent variable. These can be identified using a histogram of the studentized residuals. This procedure reveals which residuals differ from the rest and therefore corresponds to possible outliers on Y_{ft}.

Stevens (1984) argue that the results of a regression analysis can be seriously affected by just one or two errant data point. Therefore it may be necessary to isolate such points. If an outlier or influential data point is identified the reasons behind the outlier value must be investigated (Freund and Wilson, 2006). Outliers may be simple recording errors or miscalculations. This will be the first approach to find a remedy to errors in the data. However, if the observation is correct and a natural part of the sample it may need to be left untouched (Freund and Wilson, 2006). Stevens (1984) suggests that a remedy for natural outliers may be to preform two regression analyses, one where the influential data points are omitted and one where they are included. This approach can also emphasise the impact of the outliers.

4 The empirical study

This chapter presents the empirical findings from the analysis of qualitative and quantitative data. Initially the case farms are presented followed by the empirical results from the qualitative interviews with respect to several factors possibly related to firm growth. Thereafter the empirical findings based on the farm management data are presented. The changes to productivity and inputs costs are summarised. Finally the results from the statistical analysis are presented.

4.1 Introduction to case farms

In this section a brief overview of the case farms is provided.

Farm A
Case farm A operates around 2000 hectares of tillable land dominated by grain production with elements of sugar beets and specialised production of dill and spinach. This farm has experienced a 10 % reduction of tillable land during the period of study in this thesis. This reduction mainly relates to a discontinued rental contract as the rented farm was sold. However, they have increased their speciality crops to compensate loss of income.

Farm B
Case farm B has experienced major changes since the 1990's. After ending their dairy production they decided to put their main focus on cash crops and seed production in particular. Today they are operating more than 1000 hectares primarily growing cereals and grass seeds, oil seed rape and peas. Originally the farm operated about 400 hectares but has increased its farming operation by collaboration and different forms of rental and share farming arrangements. Farm B was an early adopter of machinery collaboration with neighbours.

Farm C
Farm C runs a very diversified farm business with crop production, breeding pigs production as well as lamb production. Furthermore they market their products directly to consumers, restaurants and specialised grocery stores. Today they operate somewhat more than 500 hectares. However, this has been subject to changes during the years of study in this thesis, peaking at just over 700 hectares. The crop production has long been operated through machinery collaboration with a neighbouring farm.

Farm D
Case farm D operates specialised potato production in combination with cereals and oil seed crops. The farm manages the potato distribution from field to grocery stores, with storage, washing and packaging. Farm D has based their acreage expansion through mainly rental contracts where they rent specific fields one year in the crop rotation for potatoes. Furthermore, farm D has recently signed a major rental contract, increasing their tillable land from around 800 hectares to 1200 hectares. This has led to major machinery investments on the farm. Farm D has increased their specialised production by growing some 20 hectares of leek as well as pumpkins for Halloween.

Farm E
Farm E operates specialised potato production as well as cereals and oil seed rape at a total area of 800 hectares. Furthermore farm E produces asparagus on a couple of hectares. As of last year farm E increased their agricultural land by 100 % from 400 hectare to 800 hectares. This has led to substantial machinery investments during the past years.

Farm F
The agricultural production at farm F consists of crop production and finishing pigs. The crop production is based on 800 hectares of tillable land where cereals, oil seed rape, peas, grass seeds and sugar beets are grown. The operated land area has increased by 10 % during the period of study in this thesis. Furthermore farm F is part owner in a biogas production plant, where the farm uses the residues as fertiliser to the crops.

4.2 The growth of agricultural firms

In this section the empirical findings from the qualitative interviews are presented. The presentation of empirical data follows the presentation of the theoretical framework.

4.2.1 Motivation and opportunities for growth

First of all the empirical findings related to the motivation and opportunities, which initiate firm growth are presented. In Table 3 the case farms main purposes for firm growth and land area expansion are summarised. Farm B and F state that their motivation for growth is to increase profitability, which is also indicated by farm E. However they all have different purposes for increasing the profitability of their farms. Farm F states that they wish to be able to generate profits in the firm irrespectively of subsidy levels. Farm D and E which operate similar enterprises states that their main purpose for land expansion is to secure tillable land for their potato production, thereby securing long-term production and business relationships. Farm A has decreased their land area due to a terminated rental contract. However the manager of farm A states that the have tried to compensate for the loss in tillable land by producing high value speciality crops. Farm C has a more philosophical way of expressing the purpose for their expansion, “we believe in our business”, if you do not expand you are moving backwards in reality.

The interviewed farm owners and managers were asked if they had any additional purposes for expanding the business, other than previously presented, and how they consider the long- or short-term aspect of the firm growth. The answers are summarised in Table 3. Farm B, C, D and E all stated that one reason for expanding the business was the employees in one way or another. For instance creating motivation for employees as well as attracting more skilled labour and to keep the employed competence within the firm. Other reasons for expansion are to gain competitive advantages as a result of increased size from e.g. decreasing machinery costs per hectare (Farm A & D) and increased productivity (Farm F). The owner of Farm C states several other reasons for firm expansion and it is possible to perceive that the expansion may not always be completely rational, since the interviewee claims that a partial reason for expanding is the amusement of buying new farms. Further more Farm C raises an important perspective in terms of long-run reasons. The owner wishes his children to inherit a profitable and sustainable business. Farm D states that all their investments are made with a long-term perspective where as Farm E states that the investments should be profitable from year one, thereby hinting at a more short-term perspective.

Table 3: Purpose and motivation for firm growth

The main purpose of recent changes and growth					
Farm A	**Farm B**	**Farm C**	**Farm D**	**Farm E**	**Farm F**
The recent changes in tillable land area at Farm A are involuntary as one of the rented farms where sold.	Increased profitability to summarize.	"We believe in our business", if you do not expand you're moving backwards in reality, the surroundings forces growth.	To secure tillable land for the potato production	The purpose of growth is mainly to secure land for the potato production, which leads to -secure long term production -increased investment horizon furthermore the objective is to receive high profitability from employed capital.	The firm should be profitable without relying on subsidies by increasing yields and monitoring costs.
Other purposes for expansion					
Farm A	**Farm B**	**Farm C**	**Farm D**	**Farm E**	**Farm F**
Farm A wishes to increase their land area. Mainly by collaboration with other farms or rental contracts. The purpose of this is to attain competitive advantages by decreasing machinery costs.	Motivation for employees with moderne machinery equipment, makes it easier to attract competent employees.	Other factors are: -"pleasure account" it's fun to buy new farms. Preparing for the succession of generations. Attract competent employees by being an interesting employer. to compensate for the development of increasing costs.	Everything in this business is done with a long term perspective. Other purposes are: -Complete control of the crop rotation -To even out the work load during the year to occupy the employees on an annual basis, and thus retain the competence within the firm. -Hopefully increase efficiency and reduce costs due to large fields and by utilising one single irrigation system	Likes to work with employees rather than on his own. The investment must be profitable from year one.	The bio gas plant provides cost-efficient slurry fertiliser. Due to the variable phosphorus contents on their soils they wish to increase the production by adding bio gas residue fertiliser.
Motivation and opportunity for expansion					
Farm A	**Farm B**	**Farm C**	**Farm D**	**Farm E**	**Farm F**
We did not choose, it was an involuntary reduction of tillable land.	The first expansion was based on an old collaboration, which we increased the extent of. An analysis of the invested capital per hectare in the firm and how to decrease it led to further expansion. In the 90's farm B started collaborating with other farms resulting in a 50% reduction of tractors. After the diary production was discontinued they decided to develop their crop production. The opportunities to expand has come since they have been searching for additional land, but also from neighbouring farms which have approached them, whishing to rent out their land.	Farm C has a strategy: -make an inventory of available resource: they had high equity in the balance sheet and a favourable position in terms of mortgage. -they had a profitable firm, which can generate capital and survive increasing interest payments. -Market assessment: "Passion, you have to love what you're doing, and we did."	We had the opportunity to rent additional land, these opportunities are difficult to plan for. Previously other farmers has approached Farm D to rent out a year in their crop rotation for potatoes. To some extent the owner of farm D has been searching for suitable land to rent.	It is the opportunity, it is very difficult to plan any land expansions in agriculture, "it is out of my control". But one can work actively to acquire property or rent land, which the owner of Farm E has done by making sure his closest neighbours are aware of his expansion plans.	The expansion in finishing pig production was a coincident, a stable was acquired when purchasing a farm. The bio gas plant investment was done since the slurry from the pig production is not sufficient for the arable production. Opportunities with a bio gas investment partner made the investment possible. The bio gas plant provides low cost fertiliser which will provide a competitive advantage, hopefully increasing the productivity in the crop production.

This study also intends to answer why a firm chooses to expand at a particular moment. Thus aiming to find if the expansion is a result of coincidence and opportunities or in fact a result of a predefined plan. The results are summarised in Table 3. Farm D, E and F emphasise that it is the opportunities that you are provided that determine the expansion. However, it is possible to have a plan and to actively search for expansion opportunities but it is not possible to control when it will happen. For farm D and E it is simply a matter of rental contacts that have become available. For farm F the opportunities for growth consist of a farm, which has been acquired and the biogas plant investment. The farm added to the production included a pig barn, which first were used to increase the existing finishing pig production. However, the additional pig barn were recently taken out of production for financial reasons. Regarding the biogas plant the owner of farm F claims that it created an opportunity for producing low cost fertiliser, creating a competitive advantage. However, he states that this investment was based on the opportunities he when meeting with his business associates in the biogas plant. The involuntary loss of tillable land for farm A could also be counted for as an uncontrollable event of opportunities. Farm B and C states that they sought the opportunities them selves by analysing their surroundings, finding a suitable situation for firm expansion. Farm B took the opportunity to invest in a grain dryer and storage facility during a period when cereal producers experienced a relatively low profitability. Hence, there was a market opportunity to lower the cost of the investments in a grain handling facility at farm B.

4.2.2 Direction of growth – diversification or specialization

To examine how the resource base of the firm determines the diversification or the specialisation strategies of the firm the interviewees where asked about how they perceive that their business growth caused the production to be more diversified or specialised. Initially Table 4 presents the case farms view on why they sought to expand their business through additional land or not. There are some uniform answers, Farm A and F state that they already operate several business included in the farm, such as forestry, rental properties and energy. Farm A states that they try to maintain focus on all of their businesses but that they wish to expand further in the crop production. However, a diversified company creates stability according to the manager of farm A. At the moment farm A is considering to develop more rental properties.

Farm B states that in order to attract and build certain competence within the firm the scope of the business must reach a certain level. Farm C operates a relatively diversified business. The owner states that he prefers this type of business because he enjoys being a leader and to gain success though others. Furthermore he emphasises that he likes to develop businesses. The business of farm C has expanded by 10- 15 % the last years. The diversification is a way of spreading risk states the owner of farm C. Farm D has diversified their production by producing other vegetables along with potato production. Farm E who operates a similar enterprise as farm D, claims that his interest in the existing business operation leads to a specialised production of potatoes. However, farm E has also started growing other vegetables, which can be regarded as means of diversification.

Furthermore, the interviewees were asked about their opinion whether land expansion leads to specialisation or diversification. The answers are summarised in Table 4. Farm A has diversified their crop rotation by growing more specialised production crops such as increased area of grass seeds, carrots, dill and spinach. The manager of farm A emphasises the importance of attaining contracts for growing vegetables to increase the farm revenues through specialised production. Farm B claims to have specialised production in order to

reach a certain level of knowledge within the firm. The owner of farm C argues that, "diversification and specialisation are not necessary opposites". Farm C hopes to add one more specialised production to their rather diversified business by starting up vegetable production. The owner of farm C states that it is important to maintain quality in the production and of their products during the firm expansion process.

The owner of farm D argues that it is difficult to tell if the business is diversified or specialised due the expansion. Their purpose was to specialise in potato production, but this implies managing large areas of cereal production. Farm E provides similar answers as farm B that it is necessary to specialise to attain certain competence within the firm. Furthermore farm E states that specialisation provides increased machinery efficiency; the farm owner argues, "the volume needs to increase in order to make money". The owner of farm F has a different view of specialisation compared to the other interviewees. He argues that it is about developing a clear risk profile, and to make sure the business is able to handle future events of a weak economic situation. This is why he does not wish to specialise his production since large investments in markets where there are few players may lead to a situation of dependence. Moreover the owner of farm F argues that possible side-line business projects that may render profits to finance interest payments for investments in specialised production.

4.2.3 Limits to growth and managerial services

One of the main limits to growth according to Penrose (1959) is management, which even may result in managerial diseconomies. All the interviewees agree that the management and administrative work task grows as the scope of the firm grows. However, some claim to have solved the problems by developing routines for; delegating, keeping the flow of information to employees and outsourcing administrative work tasks, which are time consuming. In Table 4 the case farms perceptions regarding the change of administrative work are summarised.

Farm A and F reveal that the administrative work with regards to handling authorities increases. Farm B claims to have solved the problem of increasing administrative work by utilising the appropriate management tools. Farm C has another approach; to make sure to choose the most important work tasks based on the competence as a manager and to employ others to do other tasks. Farm D and E state in a similar way that one key to manage the increased administrative work task is to delegate operational responsibilities to the employees. Farm F states clearly that they have increase the managerial services in the firm. The owner of farm F has engaged a chairman of the board to bring perspective from outside the agricultural sector to their business. This has led to the development of management tools such as a accounting control documents where the responsibilities for all involved parties are clearly defined. The owner of farm F states that he is thinking of developing a similar control document for the crop production.

Furthermore the use of advisory services can be regarded as an increase in the managerial capacity of the business. Table 4 summarise the use of advisory service for each case farm. Farm A, D, and F has increased or changed their advisory services where as farm B states that it is the same as before or slightly less. Farm C and E do not claim that the changes in land area has led to any change. However these two farmers have quite different approaches to advisory services. Farm C tries to use suppliers to provide free advise. Farm E has always used advisors intensively. Now they try to use advisors for specialised advise in the potato production. However, they use a general agronomist and a business advisor. Moreover, they have recently concentrated the business advisory services towards a more specialised services.

Table 4: The direction of growth - diversification or specialisation

The direction of growth, why land?					
Farm A	**Farm B**	**Farm C**	**Farm D**	**Farm E**	**Farm F**
We already operate in several business areas -Forestry -Shooting -Property -Wind-power	The size of the farm operations must be large enough to attract and build knowledge within the firm	We have a very diversified business -I'm a creative person -I like to be an employer -I like to develop businesses -Risk spreading	We have started producing vegetables along side with the potation production e.g. Leek and pumpkins	I'm interested in the existing business operations, it has always provided good profits. I try to stick to the business which have proven to be successful for us.	Farm F has made minor increase to their operated land area. They already operate within several areas of business -Forestry -Biogas -Shooting -Farm events
Do expansion lead to a more diversified or specialised business					
Farm A	**Farm B**	**Farm C**	**Farm D**	**Farm E**	**Farm F**
We have diversified the crop rotation, now we are growing; -More grass seeds -More carrots -We have dill and spinach	We have specialised our business to crop production to increase our knowledge within this particular production.	We recently bought a farm were we hope to start growing vegetables, which lead to a specialisation but in general this diversifies our business further	It is hard to tell, we have specialised in our potato production, but we have increased our cereal production to similar proportions	The owner of farm E believes that specialisation is necessary, in order to gain competence about the production and to increase machinery efficiency.	The owner of farm F do not wish to specialise to much since this will tie down large amounts of capital in investments. He claims that the side businesses are important
Do expansion increase the managerial and administrative work					
Farm A	**Farm B**	**Farm C**	**Farm D**	**Farm E**	**Farm F**
Yes, we use more time for handling authorities -the work load connected to administrative tasks grow continuously	We solved this by applying the necessary tools for large-scale farming -It is important to delegate work -Keep the right information flow -We have no problem with administrating the business, since we made sure to acquire the necessary tools beforehand	Yes, but you need to choose what to do, and do the work where you have the competence. My competence is as: -Inspirator, seller and leader Then I outsource other tasks as: -Accounting services	Yes, but I delegate to operational managers. There is no problem now as a result of competent employees, the employees is a key factor.	Yes, it was a part of the purpose, to "get away from the tractor". Competent employees helps, I have a crop production manager. To grow you need to be able to delegate. However, to manage the personnel requires more planning.	Yes, the administrative task increases, the demands from authorities increase. -It is important to receive clear guidelines from the board.
Has the expansion lead do increased used of advisory services					
Farm A	**Farm B**	**Farm C**	**Farm D**	**Farm E**	**Farm F**
Yes, we have hired a new agronomist and stoped using advisory services from suppliers. We hire business advisory and accounting services.	Same as before, or slightly less due increased knowledge within the firm as a result of specialisation.	Use the suppliers to provide advise. -Makes a crop rotation plan with a sales person from Lantmännen -Pig production advise from the breeding organisations and buyers -Increases knowledge buy doing machinery trials on the farm in a collaboration with a machinery manufacturer	We have increase the use of agronomist services and business advisory services. Much of the increase related to the fact that the bank requires more budget work.	No great changes, we have always used extensive advisory services, both agronomist and business advise. However we have started doing a business analysis.	We have engaged a chairman of our board. We have increased and changed the agronomist services, trying to increase our yields.

4.2.4 Path dependency

This section presents the interview results, which relate to, first; the planning of growth in the case study firms and secondly; how previous experiences associated with expansion have shaped the future firm growth, summarised in Table 5. As stated in the theoretical framework, chapter two, the resource base of the firm is determined by the current and historical activities of the firm, which shape the future resource of the firm (Penrose, 1959). The firms resource base is path dependent and unique (Lockett and Wild, 2014), this should have strong consequences for the firms ability to create unique opportunities (Richardson, 1972).

One of the initial interview questions was if the manager or owner of the farm had a plan for the firm expansion beforehand. Four out of six claim they had some sort of plan. Farm A states that they did not have a specific plan but now they have a plan for the future. Farm B had a plan where they in the initial stages identified the necessary management tools for operating a large-scale farm. Hutzschenreuter and Horstkotte (2013) emphasise the importance of preparing for future growth by developing managerial services within the firm.

Farm C states that in the initial step of expansion one believes that it is possible to manage 50 additional hectares without increasing machinery capacity. However, the owner of farm C argues that every time new machinery is bought the capacity is increased, which creates an upwards spiral of growth. The owner of farm C summarise: “plan the dive, dive the plan”, however, you need to be flexible when and if attractive opportunities to acquire land should arise. Farm D states he had no plan prior to the expansion. Furthermore the owner of farm D reveals that when he has acquired new rental contracts for land some employees has been included in the rental contracts, which makes it easier to start farming the new land. The owner of farm E emphasise that you need to be able to buy land and sell it if other opportunities arise. He puts it this way, “land is not something you marry”. The owner speculates that this way of operating is related to the fact that he bought his farm some twenty years ago and is not affected by any pressure from his relatives to maintain the farm as an estate. The owner of farm F reveals that he has a continuous theme for the business, to increase available crop nutrition on his soils. The biogas plant investment is a step in this plan. He states “if we had not made the biogas investment I would have rented out the land”.

Furthermore the case farms were asked how they have followed through with their plans. The answers are summarised in Table 5. Four out of six claim they have not followed their initial plan. Both farm A and F argues that they have not followed their plan since the surroundings constantly change. Thus, they emphasise the importance of adapting once conditions change. However, they both express, in their own ways, the need for having a plan despite expected changes in the surroundings. Farm B and C claim that they have more or less developed their businesses according to the plan. The owner of farm E states that he has not followed any plan, simply because he did not have a predefined plan, merely a thought on how to expand the business. Farm D did not follow the plan; to grow only potatoes.

The concept of path dependency includes the firms inherited resources, which includes accumulated experience and knowledge (Penrose, 1959). In the interviews the case farms were asked to reflect on if their previous experiences from firm expansion makes it easier to expand the business further. The answers are summarised in Table 5. The answers are quite uniform, all case farms agree that you learn from the past. However, the manager of farm A emphasises that it is never easy to start farming new land. He claims that as a manager it is of utmost importance to be at the front line to support the employees when farming new land.

Table 5: Path dependency and planning of growth

Is there a plan for the growth					
Farm A	**Farm B**	**Farm C**	**Farm D**	**Farm E**	**Farm F**
No, not a specific plan, but the plan now is expansion in order to: -Maintain the costs for staff and machinery -To be able to handle 700-800 hectare more without any problem	Yes, we made a plan and identified the necessary tools for operating a large scale farm.	Yes, the plan is to buy 50 hectares additional land each year. -Make sure to have sufficient capacity in terms of machinery and labour -You need to be flexible when attractive opportunities to acquire land arise	No, we did not have a plan.	Yes, maybe not a plan but I have thought about expanding in the way I run my business: -I have let my neighbours know I'm looking to buy or rent land -You do not need to buy land as a life time investment, if a more attractive farm close by becomes available, sell the first one and buy that.	Yes, I have a theme for the business, to increase added fertiliser
Did your follow your plan?					
Farm A	**Farm B**	**Farm C**	**Farm D**	**Farm E**	**Farm F**
No, the situations constantly change and so must we. -It is important to adapt -But of course there needs to be a plan to start with	Yes, it has developed according to plan, and we have followed our plan -To end the dairy production was one of the best decisions	Yes, a part from trying to produce and market horse feed. -I learnt a lot from the horse feed project -You should not do things, which you do not take interest in	No -The plan was only to grow potatoes -When renting additional land we had to grow cereals	No, I did not have a plan in that way, I just knew, from the beginning, that I wanted to develop the business, but not how. -Coincidences has led to increase land area -It was easier to develop the business where I had the competence	No, thing changes, you just have to adapt -It is important not to loose the theme -EU regulations create new conditions
Do the previous experience from growth make it easier to continue expanding?					
Farm A	**Farm B**	**Farm C**	**Farm D**	**Farm E**	**Farm F**
I think you learn during the process, but: -You always start from scratch with new land -New land creates uncertainty -It is never easy to expand land area, new lands are always outside of your comfort zone	Yes, absolutely	Yes, I've learnt several lessons e.g. -Choose your suppliers carefully -Do an extra turn with the employees to get their perspective and opinions on the expansion -Learn to determine what information is important	Yes, you become blinded to see limitations -Once you have tried the knowledge of the problems, which may arise increases	Yes, you learn some -Grow slowly with small steps	Yes, to some extent you learn where the traps are and where to put the focus.
A chance to go back, would you do the same?					
Farm A	**Farm B**	**Farm C**	**Farm D**	**Farm E**	**Farm F**
There is no shame it loosing land, if you're not willing to pay the price, you should leave it be.	Yes, no great differences	Yes, I'm driven by passion	I would never do it again if I hade the chance to make it all over again. My new business goal is to be able to take some time off	Yes, of course it you had all the right answers from the beginning it would save some adjustments	Yes, but there are always things which can be handled different.

4.3 The use of precision agriculture management technology

In this section the empirical findings regarding management and precision agriculture tools used by the case farms are presented. A summary of the precision agriculture tools adopted by the case farms is presented in Table 6. Furthermore the case farms perception of their use of precision agriculture tools to aid the management work is presented in this section. All of the case farms use auto-steer technology for their tractors and combines to some extent. However this varies in terms of number of machines equipped with the technology and the positioning accuracy used. The way the case farms use soil mapping technology to aid their decisions are first of all dependent on their mapping update frequency. According to Hatfield et al. (1998) soil sampling should be conducted every 5th year to update the soil map. The Swedish board of agriculture (SJV, 2010) on the other hand recommends a ten year interval for soil sampling. However this should be decreased to 7-9 years for specialised vegetable production. Two out of six case farms included in this study update their soil map at a five year frequency where as two follow a ten year cycle and two do not conduct soil mapping. Yield mapping is conducted by farm A, B, C and E for cereals, and the specialised potato producers document the potato yield per field. Farm F does not use any yield mapping technology.

Five out of six farms use section control technology for their crop protection sprayer, a technology, which is beneficial in terms of both economic and environmental efficiency by reducing pesticide use and emissions. Finally the summary presents the use of variable rate technology to ensure in field site-specific optimality for fertilisers and seed inputs. Four out of six farms use variable rate for nitrogen. There is no case farm, which applies phosphorus on a variable rate and only one out of six, which use variable rate for potassium. None of the case farms use variable seed rate technology. To determine the total adoption of precision agriculture technologies the total number of these technologies used at each case farm is presented. Farm E uses seven out of nine technologies where as farm F use only one out of nine.

The organisation and use of data collected from precision agriculture tools are equally important as the tools them selves. The way the case farms organise and use their collected data in terms of farm management procedures is summarised in Table 6. Five out of six case farms use computerised farm management software to organise and analyse the data collected from precision agriculture tools. However, several of them point out that due to different technical deficiencies they do not use the software according to its full potential.

A majority of the case farms state that the use the precision agriculture data in the decisions and planning of the farm operations. However, to what extent they use the data is unclear. Farm A states that they use it to some extent, “but it is also based on intuition”. Farm C claims that their business advisor uses the data to analyse the profitability of each crop. Farm D state that their main use of the farm management software is to document the crop protection applications. The owner of farm F hopes that precision agriculture data can be further used in the future on their farm.

Finally the case farms where asked about the importance of precision agriculture techniques to reduce timeliness costs. They all agree that precision agriculture provide helpful tools. The manager of farm B states that it is of great importance, however, it does not help to cope with weather variations. Farm E says that it is a tool for efficient input allocation, “you can put the inputs where they are needed”, and that it will help to increase quality of the crops produced.

Table 6: Use of precision agriculture techniques

Implementation of precision agriculture						
	Farm A	**Farm B**	**Farm C**	**Farm D**	**Farm E**	**Farm F**
Auto-steer (GPS)	Yes	Yes	Yes	Yes	Yes	Yes
Soil mapping, update frequency?	No, only for sugar beets	Yes, every 5th year and more often if it is subsidised	Yes, every 10th year	Yes, Every 10th year	Yes, every 5th year and more often random samples in heterogeneous fields	No, but it is coming
Yield mapping	Yes, for cereals	Yes, since 1992	Yes	No, documentation of number of pallets per field	Yes, for cereals, and potatoes pallets per field	No
Crop protection sprayer section control	Yes	Yes	Yes	Yes	Yes	No
Variable rates of:						
N	Yes	Yes	Yes	No, we have only tried a bit	Yes	No
P	No	No	No	No	No	No
K	No	No	No	No	Yes	No
Lime	Yes, but we only apply lime if it is subsidised	Yes	No	No	Yes	No
Seed rate	No	No	No	No	No	No
Total PA adoption*	5 out of 9	6 out of 9	5 out of 9	3 out of 9	7 out of 9	1 out of 9
Organisation of collected PA data						
	Farm A	**Farm B**	**Farm C**	**Farm D**	**Farm E**	**Farm F**
	Farm A uses folders where all field work conducted is documented. This material is used by the agronomist and is to some extent a base for future decisions - "but it is also based on intuition"	Farm B uses a computerised farm management software, which they use to create application maps, create job orders for all filed work which require direct inputs e.g. drilling and pest control. They use collected data to base their decisions upon e.g. they apply lime based on soil map pH values.	Farm C uses a computerised farm management software. The data collected in this program is used by both agronomy and business advisors. This information is used to analyse profitability for each crop and field.	Farm D uses a computerised farm management software to organise their production, the geographic information for each new field is collected and stored in the program. The data collected from previous years is not prevalent in the crop planning decisions. We use the software to document the crop protection applications	Farm B uses a computerised farm management software, which they use to create application maps, create job orders for all filed work which require direct inputs e.g. drilling and pest control. They use collected data to base their decisions upon e.g. they apply lime based on soil map pH values.	Farm F uses a computerised farm management software. However this is only used to some extent but will hopefully be used more in the future.
Does precision agriculture technologies help to reduce timeliness costs						
	Farm A	**Farm B**	**Farm C**	**Farm D**	**Farm E**	**Farm F**
	The manager believes it help, we should use the technology we've got. Auto-steer increases the capacity, makes it possible to drive faster e.g. when spraying and keeps the machinery operators focused.	The manager claims it is of great importance, however, it does not help cope with weather variations. The machinery is more developed now, and we use an N-sensor, it is hard to tell what makes it better now.	It is necessary, and very helpful. Helps to keep things in order.	It is important, we are considering to start using application maps again. We suspect we are using to much potassium.	It is mainly a cost saver, you can put the inputs where they are needed. E.g. for lime, this increases quality leading to increased revenues.	-

*Number of precision agriculture technologies adopted out of the nine technologies regarded in this thesis

Finally this study intends to presents certain key factors for successful firm growth. The interviewees were asked if they have been able to identify any key factors to succeed with firm growth. Furthermore, they were asked if they have experienced any difficulties where the expansion did not go as planed. The results are summarised in Table 7. Farm A, B, D and E all mention the role of employees in one way or another. The ability to maintain a high flow of information to the employees as well as the ability to delegate responsibility in the business is brought up as important factors to succeed in the expansion process. Farm C emphasises the attention to detail and to "do the homework twice". Furthermore, the owner of farm C states that it is important to work where your passion is. Farm B also emphasises the importance of keeping attention to details. The owner of farm B claims he has got the answer that "the last hectare needs as much tender, love and care as the first". Some farmers (F and E) raise the involvement of risk in firm growth. Farm E claims that you cannot be afraid of taking risk when you expand. The other farm (F) states that it is important not to expand in a manner which leads to a locked in situation where the firm is dependent e.g. to one buyer of the products produced.

The case farms where asked of they have any plans for expansion at the moment. 50 percent of the case farms reveal that they are looking for opportunities to expand the business in some ways where as the other half claim that they do not have any expansion plans at the moment. However, farm E and F do not intend to increase their tillable land area. On the contrary, they both seem quite keen to expand their vegetable production.

Table 7: Key factors for successful firm growth

Success factors					
Farm A	**Farm B**	**Farm C**	**Farm D**	**Farm E**	**Farm F**
The main key factor is to maintain the flow of information to the employees. They need to be involved, even if it is small thing such as investing a new machinery, the employees need to have there say in things. It is the employees which lifts the business.	-"The last hectare need as much tender love and care as the first". -To keep things in order, finish the work you've started. -It's a team work, everybody need to be on the team. -The flow of information to employees.	Keep attention to details. -Check your suppliers. -Choose to do what's your passion. -Do the homework twice, preparation is important, once you get started it is to late.	The expansion is more costly than what you first think. -Competent employees is very important -It takes time to get the employees on the expansion train, but the need to be consulted before new investments	Delegate, it is not possible to growth if you can't delegate. -Don't be afraid of taking chances. -You cannot be risk averse. -The work load may be to much, then stop producing crops which takes time and focus from the main production, in this case potatoes. -Business partners such as banks etc.	Be careful to end up in an economic situation which prevents you from thinking clearly and rational. -Use competent advisors. -Investigate thing by yourself, don't use only advisors, talk to others which have conducted similar investment. -Don't build the business based on the growth of your firm solely, what is the advantage for you and your business group?
Do you have any plans for growth now?					
Farm A	**Farm B**	**Farm C**	**Farm D**	**Farm E**	**Farm F**
We like to start collaborating with other farms	No plans at the moment, but we do not hesitate if the right opportunities turn up.	Yes, we are diversifying out business with new products	No more land for now. But we are looking in to increase the vegetable production.	No, just to adjust the existing business to increase profitability. Maybe some investments in the packaging and handling chain.	Yes to some extent, if a piece of land turn up are we interested.

4.4 Productivity, machinery and size

This section presents the results from a comparison of farm management data with respect to productivity, farm size, machinery, labour and administrative costs.

4.4.1 Productivity and size relationship

The relationship between total factor productivity and land area is compared in this study. The operated land area for each farm is presented in Figure 4. All of the case farms display changes to their operated area of land. Farm A has decreased the area slightly, where as farm C has first increased and then decreased its land area. Farms B, E and F have increased their land area. Farm B by one third and farm E by 100 %. Farm D has not increased the land area within the time period of farm management data collection. However, they made substantial increases of the tillable land before the data collection started and as of this year they have increase their land by one third.

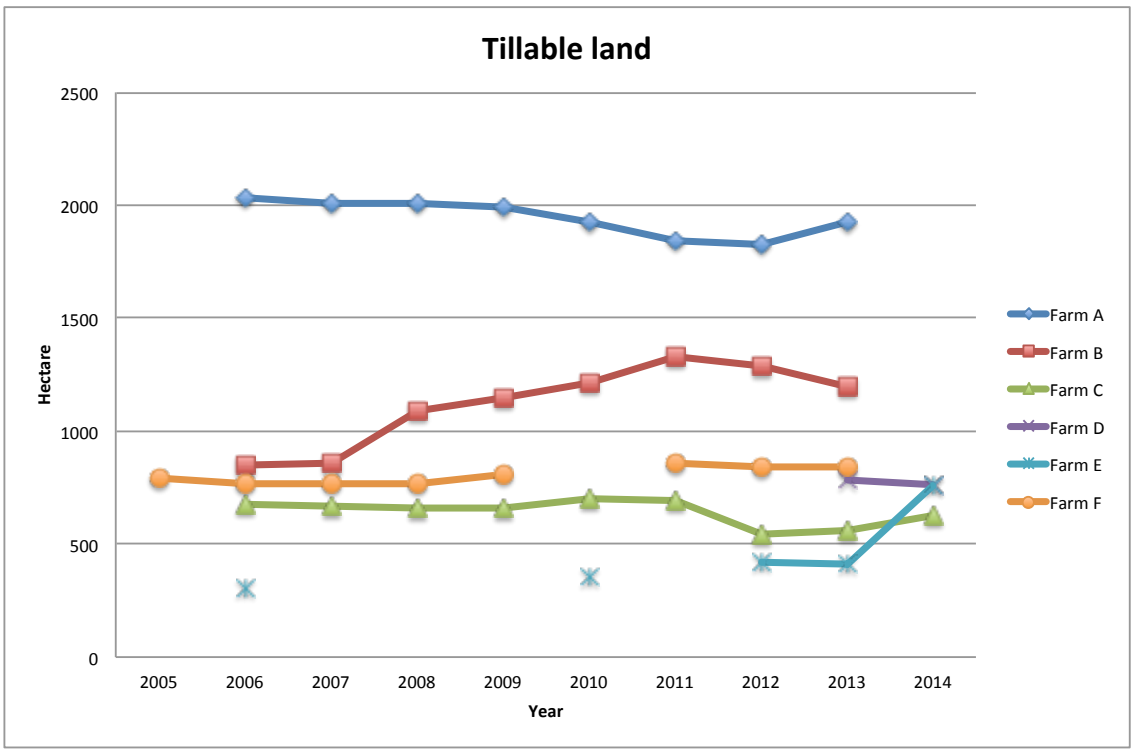

Figure 4: Annual development of tillable land for each case farm

The total factor productivity for each farm is presented in Figure 5, based on equation (1). The two first years of observation (2006 and 2007) for farm A display great divergence due to very poor yields in 2006 combined with low grain prices and good yields in 2007 in combination with high grain prices. The grain price for winter wheat varied by almost 100 % for farm A in 2006 and 2007. Farm E has managed to increase the total factor productivity by 10 % between 2013 and 2014, during this period farm E almost doubled the operated land area.

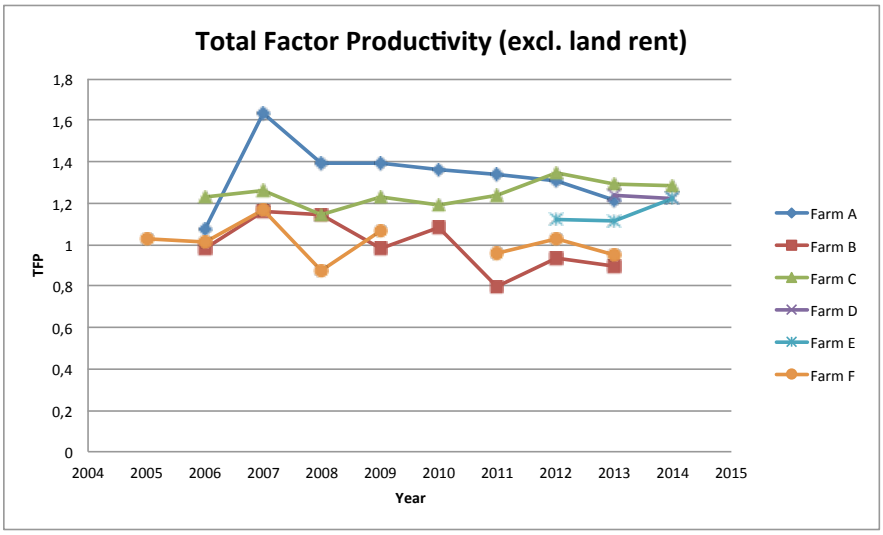

Figure 5: Annual development of total factor productivity for each case farm

The land area and total factor productivity relationship data also were used for a statistical analysis. The data show a negative correlation between productivity and size for three out of four of the cereal production farms (C, E and F). The statistical analysis is presented further in section 5.2.4.

4.4.2. Machinery costs

The annual development for total machinery and labour costs per hectare is presented in Figure 6. The farms which major production is cereals display relatively similar costs, where farm B is slightly lower and farm A is at the top of the three. The average cost of machinery and labour during the period for farm A, B and F is 3942, 3348 and 3716 SEK per hectare for the farms respectively. Farm D and E display higher machinery and labour costs due to specialised production. Farm C displays increasing machinery and labour costs per hectare during the period.

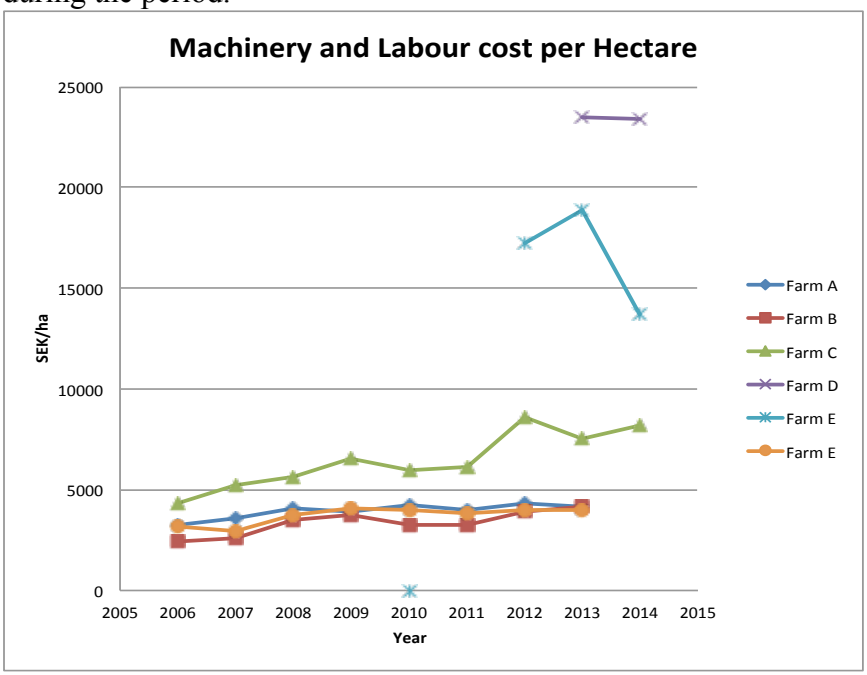

Figure 6: Machinery and labour cost per hectare for case farms

4.4.3. Administrative and common costs

The development of administrative and management costs for each case farm is presented in Figure 7. Farm A and B present relatively low costs, in the first years around 500 SEK and less per hectare. However, eventually the costs increase to around 800 SEK per hectare for farm A and B. Farm C faces decreasing costs for management and administrative work during the period. Farm F display increasing costs during the period. The costs at farm D remain at a relatively stable level; similar to the costs at farm F. The costs for Farm E are surprisingly volatile.

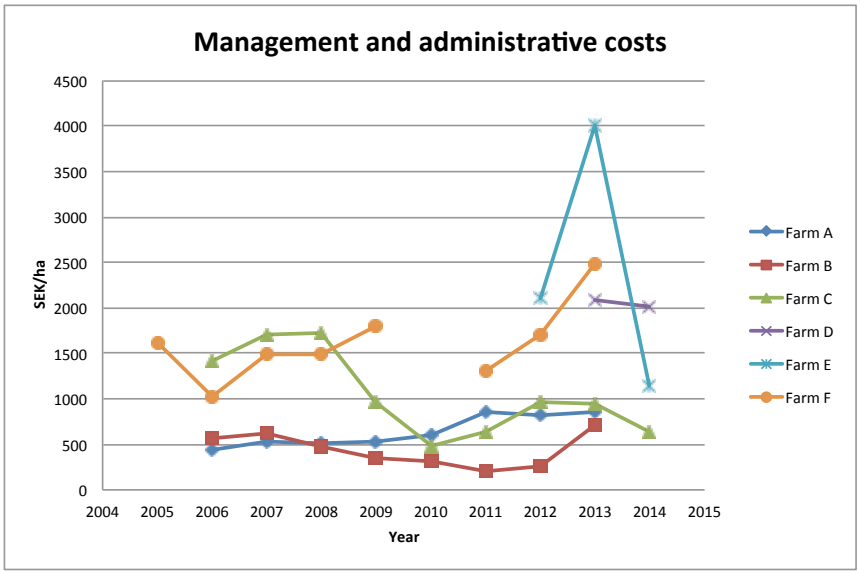

Figure 7: Development of management and administrative costs per hectare for each case

The development of common costs per hectare for the case farms is presented in Figure 8. The common costs displayed by the case farms are in general rather volatile. However, farm B reveals a quite noticeable trend towards increasing common costs. Hence, this result implies that an increase in common costs as the land area increases.

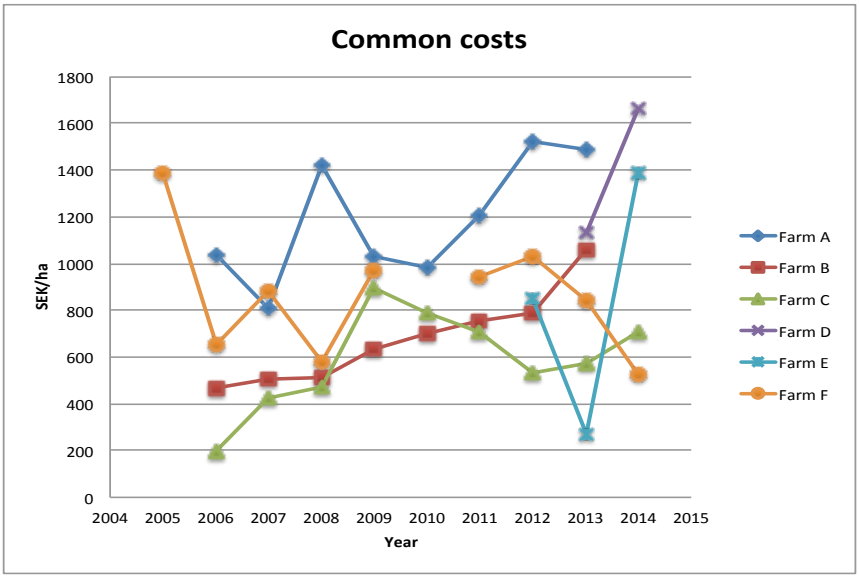

Figure 8: Development of common costs per hectare for each case farm

4.4.4. Statistical analysis

A multiple regression analysis was preformed in order to obtain additional understandings of the relationship between farm-size and productivity. The regression is based on the farm management data, which is used to determine what input factors affect the total factor productivity of the case farms.

Initially two influential data points where observed in the response variables on the regression line, this is illustrated in the histogram presented in Figure 9. These outliers are found in two extreme years in terms of yields and grain prices for farm A, as previously described. These two observations have a strong impact on the estimates. Freund and Wilson (2006) argue that outliers may be omitted from the data on some occasions. For example outliers may be omitted if they are strongly affected by a factor, which is not included in the model. In this case neither weather nor grain price is included as predictors in the model. Therefore the result of the regression is presented both with and without the two outliers omitted.

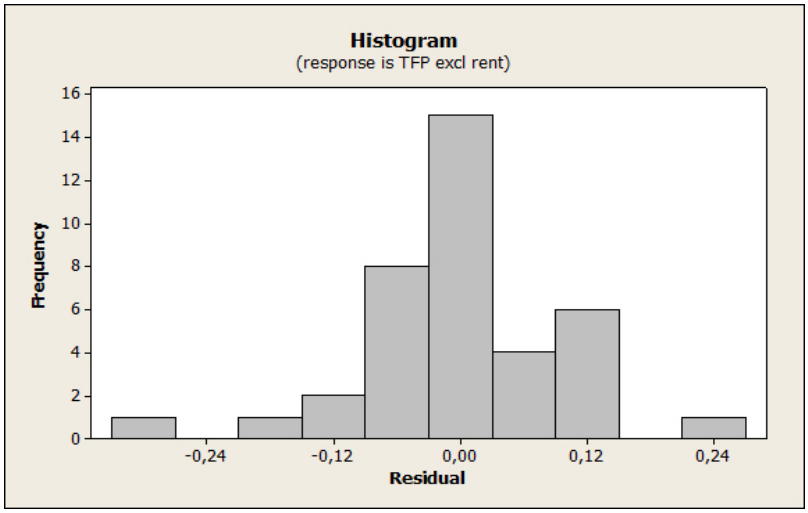

Figure 9: Histogram of residuals where outliers are included

The histogram, Figure 10, shows the distribution of the residuals after the outliers are omitted. This histogram presents a more desirable normal distribution with the two outliers omitted.

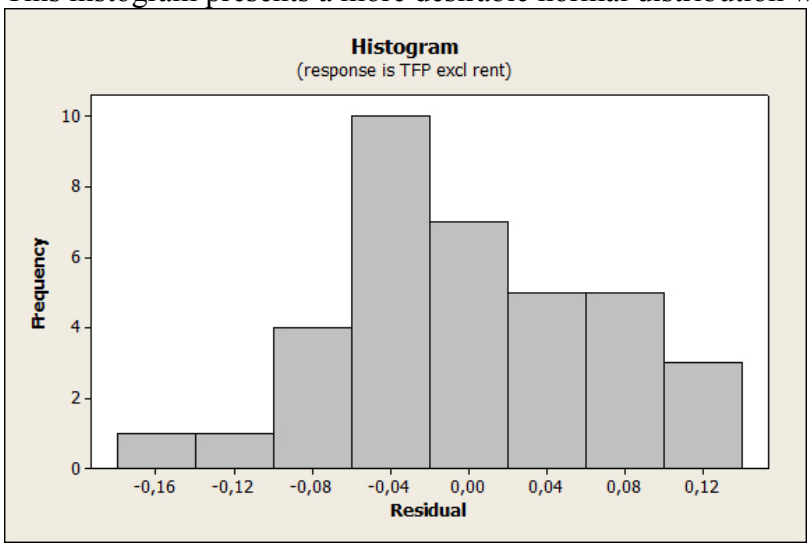

Figure 10: Histogram of residuals where outliers are omitted

The regression coefficients are presented in Table 8 and 9. Initially land area, machinery costs per hectare, labour costs per hectare, management and administrative costs per hectare and common costs per hectare where used as predictors to explain the dependent variable total factor productivity. Machinery and labour costs where not observed as significant for explaining the productivity. Therefore these predictors where omitted. The first regression where the outliers where included, Table 8, display a negative coefficient for land area at P-value 15,5 %. Furthermore, management and administrative costs display a negative coefficient at 3,2 % P-value. Common costs also show a negative coefficient, at P-value 5,4%.

Table 8: Regression coefficients where outliers are included in the model

Term	Coef	SE Coef	T	P
Constant	1,71183	0,216301	7,9141	0,0000
Land Area	-0,00026	0,000177	-1,46033	0,155
Management and admin/ha	-0,00011	0,000049	-2,2459	0,032
Common costs	-0,00016	0,000082	-2,01254	0,054

S = 0,101371	R-Sq = 73,06%	R-Sq(adj) = 65,62%

When the two outliers are omitted the regression displayed a higher level of significance for land area as a predicator for productivity. The coefficients from this regression are presented in Table 9. Land area shows a negative coefficient of -0,00024 at a 9 % P-value. The R-square value of the model display an increase to 81,81 % when the outliers are omitted. Hence the fit of the regression line is improved which allows the model to provide a higher level of explanation.

Table 9: Regression coefficients where outliers are omitted from the model

Term	Coef	SE Coef	T	P
Constant	1,67378	0,163714	10,2238	0,0000
Land Area	-0,00024	0,000139	-1,7534	0,091
Management and admin/ha	-0,00011	0,000039	-2,7075	0,012
Common costs	-0,00014	0,00007	-2,0645	0,049

S = 0,0763541	R-Sq = 81,81%	R-Sq(adj) = 76,42%

Management and administrative costs are statistically significant predictors for the farm productivity. Management and administrative costs per hectare display at negative coefficient of -0,00011 at 1,2 % P-value. This implies that if management costs are increase by 100 SEK per hectare the over all farm productivity decreases by 1,1 percentage points. The common costs of the farm also prove to be a significant predictor of farm productivity in the regression. The coefficient of the common costs is -0,00014 at P-value 4,9 %.

Table 10: Coefficients of categorical predictors

	Coef
Farm A	0,38798
Farm B	-0,25967
Farm C	-0,07549
Farm D	0,16205
Farm F	-0,03523
Farm E	-0,17963

Table 10 presents the coefficients for each farm as a categorical variable. The coefficient represents the deviation from the coefficient of the constant presented in Table 9, which is the average of the intersect points for each case farm. The intersect point for each farm represents the productivity of the farm where all other variables equal zero. The coefficients for each farm can be used as a relative measure for the farms productivity compared to the average of all six case farms. Hence, farm A and D display higher productivity than the average and B, C, F and E display lower than the average. The model predicts farm A, B and D to follow this relationship at P-values less than 5%. Farm F, which displays a coefficient slightly less than the average for the farms shows a high probability, 60 % P-value, to deviate from the prediction. Hence, it can be concluded that farm F preforms on average amongst the case farms.

The next chapter of this thesis presents an analysis of the empirical findings. The analysis will be preformed as a cross case analysis where the farm management data and the interview results are used to analyse the research questions presented in chapter 1.3.

5 Analysis and discussion

This chapter presents an analysis of the empirical findings based on the research questions posed in chapter one and the theoretical framework presented in chapter two. Moreover this analysis provides an interlink between the quantitative and qualitative data in this mixed method research project as well as a cross case comparison. The analysis is structured to provide a reunification with the problem statement and the objectives of this study. First the productivity and farm size relationship is discussed. Furthermore, this relationship are explored and explained with regard to management and technical management and precision agriculture tools. Finally this analysis presents possible key factors for successful growth in agricultural production firms and a discussion on the generalizability and quality of the empirical findings of this study.

5.1 Productivity and farm size

The statistical analysis preformed in this study show a negative correlation between productivity and farm size. Thus, suggesting when land area increase, productivity decreases and vice versa. The coefficient of -0,00024 would imply a 2,4 percentage points productivity reduction if land is increased by 100 hectares or a 5,2 percentage points increase if land is decrease by 200 hectares. This result support previous studies showing an inverse relationship between farm size and productivity (Carter, 1984; Herath, 1983). During the period of the study farm B has increased their operated land area by approximately 450 hectares. For farm B, the regression would imply a productivity decrease by 10,8 percentage points. In year 2011 when farm B reaches its maximum operated land area during the period the productivity has decreased by 18,6 percentage points and in the finial year of data collection, 2013, the area has decreased by around 100 hectares, which result in a 8,6 percentage points reduction of productivity from the first year of observation compared to the last year.

The interview results show that the main objective of firm expansion for three out of six case farms, B, E and F, is to increase profitability. This goes in line with the profit motivation for growth presented by Penrose (1959). Farm B states straight forward that their main objective with expanding is to increase profitability. However, the regression analysis shows a relative negative coefficient for farm B. Thus, implying that the regression line Y-axle point of intersect, if all independent factors equals zero, display a lower value in comparison to the other case farms. The owner of farm C argues that growth is inevitable for him, “if you don’t expand you’re moving backwards in reality”. Even though firm expansion has been identified as an important driver of a firm’s value creation (Koller, 2010). The results from this study show that firm expansion in terms of tillable land tends to decrease farm productivity. However, compared to a general analysis of total factor productivity for Swedish agriculture presented by Manevska-Tasevska and Rabinowicz (2014) the case farms in this study are in general more productive than the average Swedish farm. The majority of the cases farms included in this study are revealing total factor productivity above 1, which indicates that the business generates profits. However, these Figures are 10 to 15 percentage points above the general picture of Swedish agriculture presented by Manevska-Tasevska and Rabinowicz (2014).

The manager of farm A states that they wish to increase their land area, since “it is only the large ones that remain”. Furthermore the manager states that they desire to increase their land area in order to gain competitive advantages by decreasing machinery costs when operating a

larger area. Rasmussen (2010, p. 357) concludes productivity has increased for Danish crop farmers. However, technical efficiency has only contributed marginally to recent changes in productivity. The statistical analysis in this study shows that machinery costs are not statistically significant for farm productivity. It should also be recognised that farm B, which operates approximately 600 hectares less than farm A has a 15 % lower cost for machinery and labour per hectare. Farm F that operates more than 1000 hectares less than farm A display machinery and labour cost per hectare slightly lower than farm A. Thus, these results show that increasing land area for farm A would not necessary result in decreased machinery costs.

The statistical analysis shows that the common costs of the case farms are a statistically significant predictor of farm productivity. Hence, suggesting that the common costs of the farm must be kept relatively similar during the expansion process. However, Farm B has experienced increasing common costs when the operated land area has increased. Thus, implying that the common costs are neither constant nor possible to distribute to more production units by expansion. Hallam (1991) argues that constant costs have been identified as source for economies of size in agriculture; however, he concludes that many empirical studies are flawed regarding the constant costs. Previous studies have tried to explain the relationships between productivity, efficiency and farm size. Hall and LeVeen (1978) suggest that management should be reviewed as important factor when looking at economies of size in agriculture.

5.2 Management, administrative work and PA tools

In this study management is regarded as one explanatory factor for the previously presented productivity and farm size relationship. The theoretical framework of this study and in particular the resource based view provides a tool for analysing the managerial and administrative efforts to utilise resources within a firm in order to create competitive advantages and thus, profitability and productivity. Furthermore, the results in this study includes the use of management and precision agriculture technical tools.

5.2.1 Managerial limits to growth

The majority of the case farms state the their administrative work tasks have increased substantially since the business has expanded. Needless to say, farm B claims that their administrative tasks are more or less the same. According to the owner of farm B this is due to the fact that they extensively make use of management tools. Aubert et al. (2012) argue that precision agriculture tools provide opportunities for creating significant efficiencies in farming operations. Farm B has the second highest adoption of precision agriculture of the case farms in this study. The estimation of the regression show, that the cost of administrative work and management is significant to determine the productivity. The results show a negative coefficient, suggesting that as the cost for administrative work and management increase the productivity decreases. This implies that in order to maintain productivity the cost of management and administrative work must remain relatively constant. Raup (1969) emphasises that as farm size increases, management becomes a critical cost item. According the empirical findings of this study, five out of six case farms state that firm expansion requires more administrative work. This is illustrated in Figure 11.

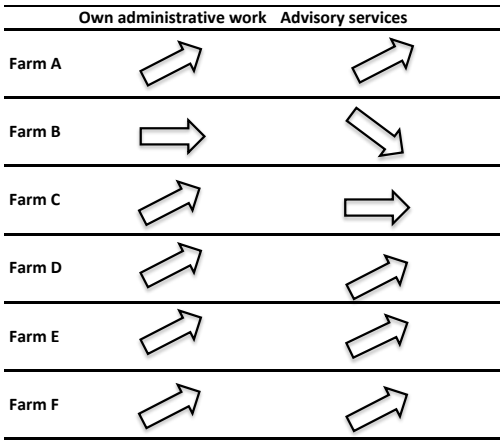

Figure 11: Relative changes to own administrative work and the use of advisory services

Raup (1969) early raised the importance of including management in the farm growth process, in his seminal paper regarding economies and diseconomies of large-scale agriculture. He emphasises that management cannot be regarded as fixed factor when examining farm growth. Hutzschenreuter and Horstkotte (2013, p.147) conclude that when preparing for future growth the development of managers is important. The case farms have different approaches to increasing managerial capacity. The owner of farm F has recruited a chairman of the board, where as farm D and E has trained operational managers. However, in small businesses such as agricultural firms, the fact that the owner is generally working in the business may affect the possibility to increase managerial resources within the firm. If the owner operates as the manager, this may result in the fact that management, to some extent, has to be regarded as a fix factor.

Penrose (1959) emphasises that firm growth requires additional management resources. The lack of sufficient management resources may cause managerial diseconomies. To account for the overall managerial services in the firm, advisory services are included. Four out of six case farms state that they have increased the advisory services they use. On the contrary, farm B says that they have reduced the need for advisory services, in particular agronomist services due to the specialisation of their business, which result in increased knowledge within the firm. Thereby they are able to increase the managerial resource-base. The coefficients of categorical predictors, presented in the statistical analysis, show great differences between farm A and B, suggesting that farm B preforms lower than the average of the farms included in the study, where as farm A preforms better than average. Farm B and A operates a relatively similar production. However, according to Figure 11, they have experienced different development in terms of development of management. This fact may explain differences displayed in the statistical analysis.

An important part of the resource-based view is the discussion on how to utilise the firms resources in diversification or specialisation of the firm. Farm A has a specialised crop production, however, the manager of farm A states that a diversified business creates stability. Farm A has diversified their business to utilise the available resources in the firm, e.g. by developing rental properties in an attractive area situated on the estate. According to Hansson et al. (2010) farm size and type of production appear to influence choices of specialisation or diversification. Farm D and E both operate specialised potato production. They have diversified their business into specialised vegetable crops. Thus, they are able to utilise existing resources such as cool storage facilities, irrigation systems, distribution logistics, marketing and sales network. Farm B states that it is necessary to specialise in order to attain

an adequate level of competence within the firm. Penrose (1959) raise market limitations as a possible limit to growth. In specialised vegetable production this is an important factor to ensure a buyer for the products produced. Farm A state that the wish to increase their specialised production, however, first they need to acquire production contracts.
Farm C is exceedingly aware of that they operate a diversified business; and one may argue that this is a part of their business strategy. The motivation for diversifying the business is based on the competence of the farm owner, thus the resource-base of the firm. The owner claims he is a creative person who enjoys developing businesses. Furthermore he argues that diversification is a part of the firms risk profile.

5.2.2 Use of management and precision agriculture tools.

This study aims to investigate if the case farms use management and precision agriculture tools and how this affects the managerial capacity of the firm. The empirical findings of this study present the adoption rate of precision agriculture on the case farms. Sørensen et al. (2010) argue that precision agriculture can aid farmers in their decision-making process and collect information to provide necessary documentation. Thus, precision agriculture may reduce administrative costs. However, the results of this study cannot provide any support for this. By comparing administrative and management costs and the use of precision agriculture there is no clear evidence to be found.

Farm A and B use five and six out of nine precision agriculture technologies respectively and are characterised by low administrative costs per hectare. However, farm E, which has the highest adoption rate of precision agriculture tools has high administrative and management costs. Farm F which have only adopted one out of nine precision agriculture technologies display high costs for administrative and management work, yet their costs are lower than both farm D and E per hectare. Batte and Arnholt (2003, p.139) conclude that it is clear that precision agriculture is not a turn-key technology There are many complex relationships that must be understood before the system can be introduced successfully. This may prove to be an explanatory factor for the results of this study. The case farms may not have the knowledge to fully utilise the adopted precision agriculture tools. Farm A does not use any farm management software, as the other farms do, yet their management and administrative costs are amongst the lower compared to all six case farms. Hansson (2010) concludes that personal aspects of the manager are more important for improvement in farm efficiency than the management system aspects.

5.3 Key success factors

The case farms were asked if they were able to identify any key factors to succeed with firm growth in agriculture. Four factors where prevalent amongst the answers:

- The employees.
- Flow of information to employees.
- The manager’s ability to delegate.
- Attention to detail.

The majority of the case farms emphasis the employees as a vital resource during the growth process where as farm F claims that the firm examines investments opportunities where no additional employees are needed. Canals (2001) argue that growth is important in terms of increasing the attractiveness of the firm when recruiting and retaining talented personnel in

the firm. Farm D also argues that one of their objectives of growth is to be able to provide employment for competent personnel. Wiklund et al. (2003) emphasis that small firm growth is the most important source of new jobs. It is agreed up on by several of the case farms that the flow of information to the employees is important to maintain the quality of production during intensive periods. Furthermore, it is important to discuss and include the personnel in future expansion plans in order to prepare them for new tasks and to make sure they are a part of the expansion.

The manager's ability to delegate as well as the manager's attention to detail suggests that a key factor to succeed with farm expansion is the manager. Hutzschenreuter and Horstkotte (2013, p. 139) argue that a firm's ability to grow depends on the managerial services available for expansion. Farm B states that they have maintained the level of administrative work and that they have decreased the need of advisory services. This is confirmed by their decreasing management and administrative cost per hectare. However, the statistical analysis reveals that farm B displays a more significant negative coefficient between productivity and farm size compared to the other case farms.

Furthermore, it should be recognised that different farms may relate differently to the meaning of success. The owner of farm C states clearly states that one of the purposes for firm growth is that it is fun to buy new farms. Hence, his view of success might regard the level of amusement created during the expansion process.

5.4 Generalizability and quality of data

The possibility to achieve statistical generalizability from case studies is limited (Perry, 1998). However, this study uses some measures of statistical analysis to support the qualitative case studies. Rowley (2002, p.20) argues that the method of generalization for cases studies is not statistical generalizability, but analytical generalization in which a previously developed theory is used as a template with which to compare the empirical results of the case study.

In this study the use of additional cases may increase the generalizability of the results. The cases used in this study are mainly large-scale farms. The use of some small or medium scale farms may broaden the generalizability of the results from this study. Furthermore, the time period examined in this study is relatively short, for two case farms only a couple of years. A longer time period may increase the quality of the study. Rasmussen (2010) use a 20 years data period. However, this material is randomly collected. Hence, it is not necessarily the same farms which appear in the comparison. This approach increases the extent of the comparison, however, other factors such as management may override the farm size factor in the comparison in this approach. The use of cases studies in this thesis examines the farms during the growth process. This method may provide a deeper understanding of the firms growth and the farm size and productivity relationship.

The farm management data used in the statistical analysis in this study was provided by LRF Konsult. Hence, the possibility to control the accuracy and quality of the data was limited. LRF Konsult in their turn bases the data on figures provided by the farms. However the data set use in thesis is unique in terms of accessibility to farms and management data. The generalizability of the results of this study is limited to firms similar to the case farms. In the next chapter of this thesis the conclusions from this study are presented. The conclusions are based on the research questions and the analysis.

6 Conclusions

The aim of this study is to examine the relationship between farm-size and profitability for some case farms, which have experienced a substantial firm growth and expansion. In this chapter the research questions are answered given the empirical findings and the analysis in this study. The research questions this study intends to answer, presented in chapter 1.3, are:

- How does the relationship between productivity and farm size develop for agricultural primary production firms during a period of growth process?

- What key-factors could be identified for agricultural firms in order to succeed in their growth process?

- How do the case farms work with farm management and precision agriculture tools to reduce the managerial problems facing large-scale farm operations?

The empirical findings in this study showed that:

- The relationship between farm productivity and farm-size is affected by growth. The results show a negative correlation between productivity and farm-size.

- Management and administrative work is the single most important factor for firm growth, this is confirmed by the statistical analysis as well as interviews and the theoretical framework. Furthermore the case farms emphasise the employees as an important factor to succeed with farm expansion.

- All case farms have adopted some precision agriculture tools. However the result of this study reveals no definite conclusion of the importance of these tools for neither farm expansion nor productivity.

The study shows that the productivity of the case farms in this study respond negatively to increases in operated land areas. However, the productivity of the case farms is somewhat higher than the productivity for Swedish agriculture in general (Manevska-Tasevska and Rabinowicz, 2014). The technical as well as biological conditions for the case farms are quite similar. However, they show substantial differences in productivity. Thus, the differences may be explained by the differences in farm management and the way the management utilise the available resource-base of the firm.

6.1 Future research

It is evident that more research is needed within this topic. Future research may include projects with more case farms or longitudinal case studies in order to gain deeper understandings and generalizability. Furthermore, future studies may develop the understandings of precision agriculture tools to aid the farmer's decision process and how these tools can be used in the growth process. Future research may benefit from using the theoretical approach of this study to further examine the importance of management during the growth process.

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Personal messages

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Appendix 1: Questionnaire

Allmänt om företaget

Vilken verksamhet bedrivs idag?

Vad har hänt i företaget den senaste tiden?

1a; Fråga: Vad var syftet med att ni förändrade arealen?

1 b; Följdfråga: Finns andra mål utöver det? Lång-/kortsiktiga.

2 a; Fråga: Vad gjorde att ni valde att växta vid just detta tillfället?

2 b; Följdfråga: Hade ni en utarbetad plan för tillväxt?

3 a; Fråga: Varför valde ni att öka areal istället för att utöka företaget med annan verksamhet?
3 b; Följdfråga: Tycker ni själva att ni har specialiserat er verksamhet genom att utöka arealen? Fröodling är ett exempel på att specialisera men ändå diversifiera.

4 a; Fråga: Har ni känt ett förändrat behov av administrativt arbete/företagsledning på gården i samband med att verksamhetens omfattning har förändrats?

4 b; Följdfråga: Har ni förändrat användningen av rådgivnings tjänster i samband verksamhetens omfattning har förändrats?

Maskiner och skörd.
5 a; Fråga: Har ni förändrat maskinkapaciteten? Generellt- Ökad, minskad, eller samma maskin kapacitet? Specifika förändringar i samband med ökningen?

5 b; Följdfråga: Har ni upplevt tydlig brist på maskinkapacitet vid vissa tidpunkter?

5 c; Plan för maskiner? Överkapacitet? In lejd maskin kapacitet?

5 d; Förändrades maskinkapaciteten för att vara tillräcklig för arealen eller förändrades arealen för att matcha maskinerna? Var det någon special maskin som motiverade förändrad areal?

6 a; Fråga: Skördeförändring Upp/Ner?

6 b; Följdfråga: vad beror det på? Plan för att hålla skördar uppe?

Teknik, management redskap och planering
7 ;Fråga: Använder ni er av nån särskild teknik för att underlätta arbetet när verksamhetens omfattning ökar?

8; Fråga: Har förändringen i areal inneburit förändringar i planeringen av växtodlingen? T.ex. Tidiga och sena grödor, frö vallar etc.

9 a; Fråga: Precisionsodling - I vilken utsträckning använder ni:

Autostyrning (GPS)

Uppdatering av markkartering

Skördekarting

Sektionsavstänging på spruta

Variabel giva av:
N

P

K

Kalk

Utsäde

9 b; Hur organiserar ni insamlad data? I vilken utsträckning ligger den till grund för beslut? Används den av rådgivare? Växtodlingsprogram?

10; Fråga: Använder ni planeringsverktyg för styrning av arbete? Schemaläggning av fältarbete och transporter?

11; Fråga: I vilken utsträckning tror ni det hjälper er att minska läglighetskostnader? Jämnare skörd? Högre skörd?

Intäkter
12 a; Fråga: Har ni någon plan för att behålla lönsamheten när verksamhetens omfattning förändras?

12 b; Fråga: Har ni utvecklat er strategi för att sälja era produkter i samband med att verksamhetens omfattning har förändrats? T.ex. Fröodling, prisförhandlingar, odlings kontrakt?

Uppföljning, med facit i hand.

13 a; Fråga: Har ni följt era förutbestämda strategier eller har ni ändrat dem med tiden?

13 b; Fråga: Har ni lyckats identifiera några nyckelfaktorer för att växta med framgång eller fällor att undvika? Var det något som inte lyckades i tillväxtfasen?

13 c; Fråga: Om ni skulle genomgå samma utveckling igen, skulle ni göra likadant?

14; Fråga: Har era lärdomar från tidigare tillväxt i företaget gjort att ni har lättare att förändra verksamheten?

Fråga: har ni tillväxt planer just nu?