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Department of Economics

The Diffusion of Minimum Tillage in Agricultural China

- A study of the factors influencing the farmers' choice of tillage system

Jenny Andersson
Marcus Halvarsson

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Jenny Andersson
Marcus Halvarsson

Supervisor: Hans Andersson, Swedish University of Agricultural Sciences, Department of Economics

Examiner: Karin Hakelius, Swedish University of Agricultural Sciences, Department of Economics

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Jenny Andersson & Marcus Halvarsson

Summary

The Chinese government´s aim to be self-sufficient in food production in combination with the increased food consumption in China has put high pressure on the productivity within the Chinese agricultural sector (He j *et al*, 2010). In order to increase the productivity, modernization and adoption of new farming techniques are essential. The opportunity to adopt and import foreign technology has lately been possible in China, as more authority and decision rights have been given to the individual farmers and the country has opened up for foreign trade (Zheng, 2012 & Fan, 1991).

A more open Chinese market enables new opportunities for foreign agricultural companies to expand their businesses by introducing their products to Chinese farmers. But to succeed with this strategy the Chinese farmers must be willing to adopt these, for them new innovations. Minimum tillage is a tillage practice used worldwide that is suitable in northern China where drought and erosion are the main problems in the crop production (pers.com., Arvidsson, 2012).

Potential users' opinion of new innovations such as minimum tillage is closely related to adoption (Rogers, 2003). This study aims to increase the understanding of the diffusion of the minimum tillage practice, by examine the Chinese farmers' opinion of it.

The study is based on qualitative interviews conducted in the two provinces Heilongjiang and Inner Mongolia located in northern China. Interviews with eight farmers were held, where different aspects regarding the opinion of minimum tillage were examined.

This study reveals that there are big differences in how the minimum tillage practice is perceived. In the Heilongjiang Province, where the practice has been adopted the farmers find it to be a suitable solution to their existing problems and a general positive opinion of the practice is stated.

In the Inner Mongolia Province, where the practice has not been adopted, the farmers do not find the practice to be a suitable solution to their existing problems and in general they have a negative opinion of the practice.

The farmers in both areas perceive the external factors such as governmental support to be positive towards minimum tillage, and they find the practice possible to implement in their farm organisations. However, these factors are not found to explain the adoption decision exclusively. It is instead the perceived economic and biological benefits in tandem with the influences from neighbours that are found to affect the opinions to a large extent.

Sammanfattning

Den kinesiska statens mål att vara självförsörjande på livsmedel i kombination med landets ökade matkonsumtion har medfört en ökad press på produktiviteten inom landets jordbrukssektor (He j *et al*, 2010). För att kunna öka produktiviteten inom lantbruket krävs modernisering samt att de kinesiska lantbrukarna tar till sig ny utländsk teknik.

Möjligheten att importera och ta till sig utländsk jordbruksteknik har nyligen blivit möjlig i Kina, detta på grund av att enskilda lantbrukare fått en utökad beslutsfattanderätt och att Kina har öppnat upp för internationell handel (Zheng, 2012 & Fan, 1991). Ett öppnare Kina har skapat möjligheter för utländska maskintillverkare att expanderar genom att introducera sina produkter på den kinesiska marknaden. Men för att lyckas måste de kinesiska lantbrukarna vara villiga att ta till sig, de för dem nya teknikerna.

Reducerad jordbearbetning är ett odlingssystem som används världen över och är lämpligt att använda i områden som norra Kina, där torka och erosion är de största problemen inom spannmålsodlingen (pers.com., Arvidsson, 2012). Potentiella användares syn på den till ny teknik så som reducerad jordbearbetning är starkt relaterat till adoption (Rogers, 2003). Den här studien syftar till att öka förståelsen av spridningen av reducerad jordbearbetning i Kina genom att undersöka de kinesiska lantbrukarnas syn på reducerad jordbearbetning.

Studien är baserad på kvalitativa intervjuer, utförda i de två provinserna Heilongjiang och Inner Mongolia i norra Kina. Åtta lantbrukare intervjuades angående deras syn på reducerad jordbearbetning.

Studiens resultat visar att det fanns en stor skillnad i hur reducerad jordbearbetning uppfattas. I provinsen Heilongjiang där reducerad jordbearbetning redan nu används anser lantbrukarna att systemet är fördelaktigt och kan minska deras odlingsproblem. Lantbrukarna anses därför ha en positiv syn på reducerad jordbearbetning. I provinsen Inner Mongolia har inte reducerad jordbearbetning antagits av lantbrukarna, där anses inte systemet kunna lösa deras odlingsproblem vilket resulterar i en mer negativ syn på odlingssystemet.

Lantbrukarna i de båda områdena uppfattar externa faktorer så som statligt stöd till att vara positivt till reducerad jordbearbetning, samtliga lantbrukarna anser också att odlingssystemet är möjligt att implementera på deras gårdar. Dessa faktorer kunde dock inte själva förklara beslut att anta systemet eller inte. Istället är det till vilken grad lantbrukarna uppfattar de ekonomiska och biologiska fördelarna samt influens från grannar som påverkar lantbrukarnas syn på reducerad jordbearbetning i störst utsträckning.

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1 Introduction

This chapter provides the reader with an introduction of the agricultural situation in People´s Republic of China (from here after, China) as it is the target area of the study. Thereafter established theories about market development will be covered, to present incentive for companies to internationalise their businesses. The chapter ends with an overview of this study's problem and aim.

1.1 Agricultural China

As China is a large country the conditions for grain production vary considerably (Zang, 2011). In the northwest crops can hardly be grown due to the low amount of rainfall and in the southwest the mountains limit the arable acreage of land. The major share of agriculture is therefore concentrated to the eastern part of China (www, USDA, 1, 2012), see figure one.

Figure 1. Map of China and the country's different provinces (www, China tourist maps, 2012).

In the four provinces of Heilongjiang, Jilin, Liaoning and Inner Mongolia, the agriculture production is large-scale and conducted with sizeable modern machinery (pers. com., Qiao, 2012). In the provinces Henan, Jiangsu and Shangdon the farms are smaller and less mechanized, yet as the climate enables two harvests per year the annual production is high, close to 50% of the country´s total production (pers. com., Bei, 2012). The crop varieties that are grown in these areas differ depending on the geographical position and local conditions. In the southern more tropical provinces it is most common to grow sugarcane, coffee, rubber and palm oil. In the north and northeast where only one crop a year is grown crops such as soybeans, maize, rice and sorghum are most prevalent (www, FAO, 2, 2012).

The arable land in China is today owned by the state (Feder *et al*, 1992). To give farmers economic incentives while maintaining the public ownership a tenure system is enacted. Each household in rural China has according to the 1978 household reform the right to a leasing certificate that secures their right to cultivate an area of arable land free of charge (Westen,

2011). The arable land is distributed by village authorities and is allocated according to the number of people in the households (www, USDA, 2, 2012). Farms in China are therefore conventionally small, on average 0, 4-1, 2 ha and the profitability is low (Zang, 2011) & (Westen, 2011). The government therefore introduced a reform in 2008 that allowed trade of leasing certificates to a third party and increased the maximum leasing period from 30 years to 70 years (Mckinsey, 2009). The purpose of the reform was to increase the productivity and efficiency. By increasing the average farm size the plots should be more suitable for modern machinery, which will in turn increase the productivity. The long-term investment incentive should also increase, as the leasing certificate is longer. The reform is believed to be a step towards privatization of land in China.

Another method for the Chinese government to encourage modernization of agricultural machinery is to subsidize the investment. The subsidy is today 30% of the machinery purchase price, but as local provincial governments are allowed to add additional support the subsidy can be even higher for some types of agricultural machinery (www, MAO, 4, 2012).

Instead of trading the leasing contracts to other farmers to create bigger units, some small farms are pooled together to form cooperatives (www, USDA, 2, 2012). This is getting more and more common. There are 256,5 million farm households in China today and 13, 8% of them are a part of a farm cooperative (www, MAO, 1, 2012). The Chinese government encourages the farmers to organize themselves into bigger units in order to increase effectiveness and productivity. The government is therefore promoting farm cooperatives and other alternatives to increase the size of the units.

Besides these cooperatives another type of sizeable farm units exists in China, so called state farms (pers. com., Qiao, 2012). These are farms that the Chinese government operates and controls. The employees at these farms receive a salary from the government. As an effect of the government's goal to modernize the machinery in the agricultural sector these farms are very mechanized and are to a great extent operating with imported modern technologies and machinery. These farms often enable smaller farms in the area to rent machinery and have therefore a positive effect on the mechanization level in their surroundings. These state farms are mostly found in northern China where the population density is lower.

The Chinese grain purchase market was set free in 2004 when the former monopoly was abolished (www, MAO, 1, 2012). But in order to support the farmers and guarantee a price the government has introduced a floor-purchasing price for staple grains like wheat and maize.

1.2 Market entry –technology diffusion

Diffusion of innovations is how new innovations are spread through social systems. This process is therefore partly driven by how companies introduce products on new markets (Rogers, 2003). Companies are often trying to expand their businesses and there are different methods to accomplish this (Johnson *et al*, 2011). The first option is to increase the market share on the existing market by penetration. This method implies a low risk, as the company has high knowledge about the market and is recognized by the consumers. A second step is market development where existing products are introduced at new markets, such as new users or geographical areas. This is more risky and expensive as there are more unknown factors and less existing knowledge about the market.

New geographical markets do not need to be located in the home country, when a company chooses to internationalize the business it implies new high risks and new competitors but also new potential market shares.

According to the internationalization theory by Johnson *et al* (2011), there are four main incentives for companies to internationalize. These are:
• Market drives, which occur when similar customer needs can be identified in another market, and there is a potential demand for the company's products.
• Cost drives, which occur when lower cost of production can be attained by taking advantage of countries' specific differences, such as cheaper labour and energy or by economies of scale.
• Government drives, which occur when opportunities due to reforms or regulations exist, such as subsidies or patenting that cause a gain in production or sales.
• Competitive drives, which occur when a company needs to react to a competitor's move, or when a company wants to be able to cross subsidize their business in one market by using profit from another.
Often when a company internationalizes the decision is based on more than one drive, and the motives differ greatly between industries and companies.

When companies introduce products on new markets the customers have to adopt them in order for the introduction to be successful (Rogers, 2003). The spread of these products is often described with the diffusion of innovation- and consumer behaviour theory, which describe how products are introduced in new markets and adopted by the new consumers over time, but also the risks this implies.

In this study the farmers are the consumers of the new innovations and they are therefore the potential adopters. The theory implies that the consumers opinions of these new innovations greatly affect their adoption behaviour, which highlights the importance of this research area in terms of market expansion and consumer behaviour.

1.3 China background – how it became a global market

China has during the most recent decades grown into a central position in the global economy (Spence, 2011). It is the most populated country in the world with an estimated population of 1, 3 billion people and has a constantly increasing middle class. The country has in the last thirty years experienced a high sustainable growth, between the years 1978 to 2006 the country had an average economic growth of 9, 4 percent per year (Tsui *et al,* 2006). This high growth can be explained by a line of new reforms that the government started to introduce during the seventies, which have transformed the former plan-based economy into one that is more market-based (Spence, 2011). Prior to the reforms, China was a politically closed country with limited private business and international trade. The introduction of the liberal reforms became the foundation of China's economic growth, during which the government converted from a direct participating role to an increasingly indirect and regulating role (Chen & Duncan, 2008). This new system made it easier to start and run private businesses while also encouraging international and domestic trade (Fan, 1991).

The transformation of the Chinese economy has resulted in a rapid increase in living standard. The gross domestic product (GDP) per capita has increased from $400 to $3 500, which has exponentially expanded the middle class (Spence, 2011). This increase in welfare also included the rural areas where over 700 million people increased their purchasing power

parity (PPP) from below absolute poverty (which is considered less than US$1.25 per day) to over US$2 per day (Spence, 2011). The higher living standard in rural areas has created a significant increase in domestic demand for agricultural commodities. The government has been attempting to be food self-sufficient since the start of the reformation period (www, ministry of agriculture1, 2012). But with a population corresponding to 20% of the entire world population and only 9% of the world's arable land the agricultural productivity is subject to duress. Despite this lack of arable land, China is today food self-sufficient and a main actor in the world market for agricultural products. The country accounts for 3, 4% of the international trade of agricultural commodities and is therefore the world's fourth largest trader of agricultural goods.

The Chinese agricultural sector has had a big impact on the country's high financial growth. The productivity in agriculture started to increase significantly during eighties (Spence, 2011). The biggest reason for the increase in productivity was the reform made in 1979 called the Household Production Responsibility (Fan, 1991). Before this reform all cultivated land was collectively owned, and the government bought all the products from the farms and distributed the inputs. The revenue from the land was then divided between the commune members as a salary. Consequently the income was not based on their individual productivity. The reform 1979 decentralized authority and responsibility to family units and linked the income to work effort. Each household earned the right to lease a plot of land from the government. The households then had to supply a certain quota of crops, for which the government set the price. The households were allowed to sell and keep the profits of the remaining grain and were also allowed to buy the inputs themselves. This reform introduced a market system in the agricultural sector where the commodities could be bought and sold, which caused efficiency and productivity increase significantly. The farmers increased efforts, allocated resources more efficiently, and increased their output. Continuously until today additional reforms and actions have been issued to liberalise the market and improve the conditions of the farmers.
In 2001, the government opened the market to international trade and became a member in the World Trade Organization (WTO) (Spence, 2011). The WTO-entrance enforced changes in the Chinese agricultural policies and subsidies, as they were not consistent with the commitment that WTO demanded (Chen & Duncan, 2008). The result was reduced export subsidies, reduced import tariffs and removal of other trade barriers. This has increased the competition that the farmers in China face from foreign competitors but also increased the inflow and availability of new knowledge and technologies (Marchant *et al,* 2003).

1.4 Problem background

Much pressure has been placed on the agricultural production in China due to the government's aim to stay self-sufficient in food, the increasing living standard, the increasing food consumption, and the rapid urbanisation that decreases the amount of arable land (He j *et al,* 2010). To meet the increasing demand improved productivity is needed. The government has therefore worked actively to modernise the Chinese agricultural sector, as it has been out-dated using traditional farming techniques. New techniques have been considered to be an essential part of the solution to increase the productivity. The modernisation of farm technologies have therefore been encouraged by tax reductions, reforms that allows farm amalgamation, promotions of farm organisations, and reforms that have reduced the protectionism on domestic machinery and techniques (Chen & Duncan, 2008). These reforms have enabled an inflow of new innovative technology and machinery from foreign countries to China.

The decentralisation of authority and the increased autonomy of each farmer or farm manager incorporated with the institutional change that allows an inflow of new technology have altered the adoption decision of new technologies from the former authorities to the individual farmers (Zheng, 2012 & Fan, 1991). This has enabled the farmers to take advantage of new technology to solve local issues. As China is a big country the conditions differ between regions and therefore the needs do so as well (Tang & Zhang, 1994).

In the north and northeast part of the country the climate is dry with cold winters (Jin *et al*, 2010). In these areas only one farming cycle per year is possible and the main cropping systems are single or double cropping with mainly wheat, maize and soybeans. The farmers in these regions face major problems with drought and erosion and low levels of soil moisture in the spring, which have negative effects on the crop production. To reduce these problems minimum tillage systems have been locally developed and partly adopted since the mid-eighties. Studies have shown significant positive effects of these systems in terms of higher yields and reduced production costs as well as reduced erosion, increased water infiltration, and improved soil properties. The minimum tillage machinery that farmers in China have used in the past have been mostly domestically produced as the country was closed for foreign trade for a long time and inflow of new foreign technologies was not encouraged in the past. Today the Chinese market conditions enable other machinery companies outside the country to export their minimum tillage innovations to the Chinese market, which allows farmers to adapt these foreign technologies (www, ministry of agriculture1, 2012).

1.5 Problem

The use of the minimum tillage practice is spread worldwide and the number of adopters is constantly increasing (The World bank, 2010). In 2008 the minimum tillage practice was used on around 110 million hectares globally (Derpsch, 2008). The continents where the practice is used to a high extent are North and South America where around 40% respectively 45% of the arable land is cultivated with minimum tillage practices. The practice is less used in Europe but the adoption rate is slowly increasing. Even in Africa and Asia the adoption rate is low, but as these areas experience economic growth, the access to larger machinery necessary for the minimum tillage system increases, and therefore the adoption rate tends to increase as well.

Minimum tillage has been stated by earlier studies to be needed in China (Chen & Duncan, 2008). It has also been proven to have economic as well as biological benefits (Jin *et al*, 2010). Yet there is an uncertainty to what extent the Chinese farmers are willing to adopt this technology. No study exists that has examined the diffusion of minimum tillage amongst Chinese farmers and, more specifically, their opinions of it. If foreign machinery companies should export their products to China, the Chinese farmers need to adopt these new technologies if the introduction should be successful, which highlights the importance and interest of this research area.

To examine adoption decision and the adoption process the adoption theory is often used instead of an economic model (Leeuwis, 1993). Economic models are often used to explain logical relationship between different variables and to simplify the more complex reality. These models often fail to include the social dimensions of knowledge, communication, and rationality. When the social dimensions are not included a gap between the economic theory and the real behaviour is created (Leeuwis, 1993) (Rogers, 2003). Adoption theory is used to bridge the gap and to capture the complexity in behaviour and opinions. This implies that the

behaviour and opinions among the Chinese farmers towards new innovations are affected by more than just economic rationality, and these aspects need to be considered in order to understand their adoption decisions.

A common and relevant theory to describe and understand the spread of an innovation is the Diffusion of Innovations (Rogers, 2003). This theory describes how a new innovation spreads through different communication channels in diverse social systems over time. It also points out that unique characteristic among adopting individuals/organisations affect the adoption process, which consists of five general stages: *agenda- setting, matching, decision, restructuring, clarifying and routinizing*. In order to adopt new technologies farmers and farm organisations need to go through this adoption process. To be able to adopt an innovation knowledge and awareness about its existence is necessary, yet this is not enough, as individuals often know about innovations that they do not adopt. The decision about adopting an innovation is related to the individual's opinion, which is formed during the first stages and reflects the individual's view of the innovations use and relevance for him/her and the organisation's situation. When the individual has awareness, knowledge and have valued the influences from the environment about the innovation, he/she makes the decision to adopt it or not. It is therefore of great importance to examine and understand the Chinese farmers´ opinions of minimum tillage in order to be able to understand the diffusion of the technology in China.

1.6 Aim

Adoption of new innovations such as minimum tillage is driven by and dependent on the opinion of it among the potential users. The spread of the technology in China can therefore be studied by examine the Chinese farmers opinion of it, which can be used to understand what factors that influence the choice of tillage system.

This study's aim is the following and is based on the problem presented above:

The aim of this study is to increase the understanding of the diffusion of the minimum tillage practice in agricultural China.

As diffusion and opinion of minimum tillage are affected by how it is perceive by the farmers the following four research questions are used to reach the aim of this study.

1. Do the Chinese farmers find minimum tillage suitable in their crop production?

2. What characteristics do the Chinese farmers find important with the minimum tillage practice?

3. What environmental aspects affect the Chinese farmers' opinion of minimum tillage?

4. Is there a problem to implement the minimum tillage practice in the Chinese farm organizations?

Due to the scale of this study delimitations have been conducted, the extent of these as well as a discussion about how they have been considered can be found in section 3.9.

1.7 Outline

This section presents the outline of this thesis, followed by an illustration of it (see figure 2).

Chapter 1: Introduction
This chapter presents the subject and gives the reader an introduction to the problem and ends with this thesis' aim and research questions.

Chapter 2: Literature review and Theoretical perspective
This chapter provides the reader with earlier conducted studies related to this study area and the theoretical framework that is used to analyse the empirical data.

Chapter 3 Method
This chapter describes which method that is used to collect empirical data and argument to why it is chosen, furthermore the methods to analyse the data are explained. Methods that are deselected are also evaluated and the reasons to why they were abandoned are explained.

Chapter 4: Empirical study
This chapter presents the collected empirical data and ends with a summary of it.

Chapter 5: Analysis/Discussion
In this chapter, the empirical data is compared with earlier studies and analysed with the theoretical framework. Similarities and differences in the results are highlighted.

Chapter 6: Conclusion
This chapter includes the conclusion of the study presented by providing answers to the research questions stated in the aim. The chapter ends with recommendations for further research.

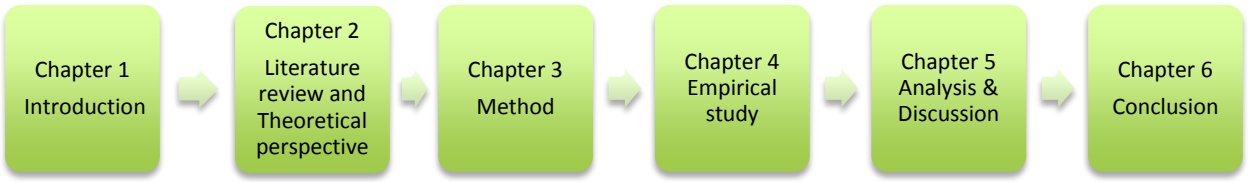

Figure 2. Outline of the thesis (own creation)

2 Literature review and theoretical perspective

Chapter two provides a literature review of adoption and diffusion processes of technology within and outside the agricultural sector. The theoretical framework used in this study is also presented followed by the developed hypotheses.

2.1 Course of action - Literature Review and Theoretical framework

In order to conduct an empirical study background material is needed and therefore a literature review was conducted. The literature review was used to gather background information about minimum tillage, China and its agricultural system as well as results from earlier studies about the adoption and diffusion processes of technology within organizations, within and outside the agricultural sector. The gathered information was also used to create a foundation of theories as well as the methodology that should be used in this study.

Information about China and its agricultural system was gathered from the Ministry of Agriculture in China, FAO, USDA and earlier studies conducted in China. It was important to find different sources of information, both from Chinese sources as well as international in order to ensure the validity. Literature from earlier studies was gathered using different databases at SLU such as Scopus and Web of knowledge. Google scholar was also used in order to find and follow up references in the literature. Keywords that were used to find literature is presented in the following table, see table three.

Table 1. Presentation of used keywords in the literature review (own creation)

Keyword	and	Keyword	and	Keyword
Adoption Adoption theory Diffussion Decision making Decision process		Agriculture Orgnisations Farm Farm structure Company China Rural Developing East Europe		Minumum tillage Conservation tillage Tratidional tillage Reduced tillage Farming system

After the literature review the theoretical framework was developed and seven hypothesises could be formed based upon it. The relation between the theory, literature and the created hypothesises are shown in an illustration to clarify the linkage between these in the end of this chapter, see figure three further down.

2.2 Literature Review

This chapter provides the reader with a review of earlier studies in the area and starts with an introduction of the concept of minimum tillage.

2.2.1 The definition of Minimum tillage practice

Minimum tillage is a farming system used worldwide and is one of the three basic farming systems (pers. comm., Arvidsson, 2012). These three systems are:

- No tillage system: a practice when the seed is directly planted in the field without any cultivation after the preceding crop. Between 30-100 percent of the surface is covered with crop residues after planting.
- Minimum tillage system: a practice that includes one or more passes of lighter tillage equipment without turning the soil before planting (also referred to as reduced tillage and conservation tillage).
- Traditional farm system: the practice where a plough is used to break and turn the soil.

There are two principal reasons to utilize the development of minimum tillage. The first reason is environmental and soil issues; wind/water erosion and other soil property problems have encouraged the development of the technology. The second reason is cost reduction, as the production costs can be decreased due to the fact that the need for inputs, such as machinery and labour, in some cases are lower with the minimum tillage practice.

2.2.2 The adoption process in organisations

Several studies have been conducted in order for further understanding of why some individuals or organisations adopt new technology more rapidly than others. The major focus on the literature in this field is what characterizes those who adopt versus those who do not and what factors affect the adoption decision among individuals and organisations.

One study about what affects adoption is Premkumar`s *et al* (1998) research conducted in the USA1998. It is based on interviews conducted with 78 organizations about their perspectives on new communication technologies. Ten variables in three areas that influence the likelihood of adoption were tested. These areas were the characteristics of the innovation, organization, and environment. Out of ten variables, five had a significant correlation with adoption of the communication technology. The only variable among the innovation characteristics that had a statistically significant influence on adoption was the innovations relative advantage according to the user. Among the organizational characteristics, top management support and organizational size were important in terms of adoption. Stronger management support and a larger size of the organization had a positive influence on innovation adoption. Among the environmental characteristics, external pressure and competitive pressure displayed a positive correlation with adoption. Organizations are more likely to adopt as competitive pressure increases. The study also found that organizations are more willing to adopt a technology if there is external support for implementation available. Characters that did not have a statistically significant influence on adoption were cost, complexity and comparability of the innovation with existing technology, and the need of expertise in the organization.

Similar results were found in another context when 1000 hospitals were examined by Moch & Morse (1977) in the USA. In this study the relationship between organizational structure and the adoption of innovation were examined. The result showed that the size of the organization had a positive correlation with adoption in line with the previous study. Another result was that more centralized organizations adopted new innovations to a lower extent than those that are decentralized. The reason for this was stated to be that in a more decentralized organizations decision makers were closer to the operating field and could therefore

distinguish compatible innovations from incompatible ones, which increased the level of adoption. The amount of hired external specialists also affected the adoption level. If the organization hired more specialists, the adoption rate increased as more external knowledge was available.

Lal's study also found compatibility to be a significant factor effecting the adoption of new technology (1998). The results in the study were based on a research of 59 Indian IT companies in which the adoption of information technology was examined. The study found that there was a relation between existing technology and the adoption of new products. If the new innovations were related to the existing products the companies used the tendency to adopt increased, as the companies then had better internal capabilities to adopt it. The study also concluded that knowledge about the new innovation and the benefits of it displayed a positive correlation with adoption.

Frambach *et al* study (2002) of organization's adoption of innovations agrees with earlier mentioned studies and concludes that the size of an organization usually has a positive correlation with adoption. This is explained by that larger companies work more actively to improve their performance than smaller firms. But the study also reveals that smaller organizations are more flexible and can therefore be more innovative and more effectively implement new innovations. These findings contradict each other suggesting that more factors such as structure are influencing the adoption decision by an organization. Firms that are more formalized and centralized are less likely to be aware of new innovations. However once they obtain sufficient knowledge about them they are better in realizing them. The opposite is found for highly specialized organizations. They are more aware of new innovation but more ineffective with implementing the new technology.

2.2.3 The adoption process in the agricultural sector world wide

Several studies have examined the adoption process among farmers in different areas with focus on varying innovations. Bryce and Gross (1943) created the foundation of diffusion of innovation in the agricultural sector by their study conducted in Iowa 1943 where 259 farmers were interviewed about their adoption of hybrid seeds. The conclusion of the study was that social structure and communication had significant influences on adoption. The majority of the farmers based their decision on adopting the seeds on what neighbours and other farmers told them. Only the early adopters based their decision to adopt the seeds on what the salesmen told them.

A study on farmer's adoption of new innovations conducted by Zepeda (1987) in California 1987 concluded that farmer´s characteristics influence their adoption decision. The study examined the dairy farmers' opinions of adopting the new milk production stimulator hormones, called bovine somatotropin (BST). 131 dairy farmers were telephoned and took part in the survey.
The farmers observed in the study were categorized into different groups. The first group was farmers who had not heard of the technology, and the second group was farmers with knowledge about the technology. The second group was divided into groups according to their opinions of the new technology. These three groups were farmers who were opposed to using the technology, farmers that were positive towards its use immediately and farmers who wanted to observe the result in neighbouring farms that had adopted it prior adaptation themselves.

The result of the study was that farmers who were characterized as being potential adopters had more cows, had more productive cows and were more likely to own multiple dairies. The farmers who said that they had not heard of the new technology were less educated, had smaller herds, a lower milk production and were less likely to own a computer.

A qualitative study in rural Vietnam by Chi & Yamada (2002) about farmers' adoption of new technology showed that farmers were more positive towards small investments than large scale. The reason to this was stated to be the increased risk exposure with a larger investment. Innovations with more secure benefits had a greater likelihood to be adopted than innovations with a less secure impact. The study also concluded that the two main reasons to reject an innovation with a positive image were lack of both capital and government support. Additional factors in line with other studies were that age had a negative correlation and education a positive correlation to adoption.

Another study conducted in a rural area is Abdulai & Huffman (2005) who examined the diffusion of crossbred cows in Tanzania. The study tested how knowledge, geographic location and household characteristics effected the adoption of the technology. An extra focus was on how credit constraints and the distance to the market affected the adoption decision. The reason for the study was that significant benefits with crossbred cows had been observed but the adoption level was still low. 406 farms in two regions answered a survey and the results were that adoption was more common on farms in areas where cows were more widespread. Experience of the technology and learning from other farmers were therefore stated to be correlated with adoption. The distance to the market was also correlated with adoption. Farms more proximate to the marked had adopted to a higher extent than farmers further away. The study also found the same conclusion as Zhou *et al* (2008) that education had a positive correlation with adoption. Age could not be statistically proven to be correlated to adoption, which some other studies have showed Smith *et al* (1992) & Korshing´s *et al* (1983). Another finding was that liquidity constraints had a negative correlation with adoption. Farms with more constraints adopted the technology to a lesser extent than farms with less liquidity constraints and as in several other studies farm size had a positive correlation with adoption.

Feder (1980) considered the choice between adoption of new innovations and older technology to be a portfolio problem, and that the adoption decision was affected by the individuals view on risk. A stochastic production function was used to examine essential factors to adoption. The farm size was found to have a positive correlation to adoption but the available capital was concluded to be the most important. It was therefore stated that to encourage investments and adoption of new innovations institutions that reduced capital constraints were crucial.

Diederen *et al* (2003) conducted a study among Dutch farmers about adoption of technology in general. 1075 farmers were interviewed to collect data for the study. The farmers were asked about financial information, personal characteristics and adoptions during the period 1995 to 1997. The study claims that the diffusion of innovations is driven by information. When the knowledge among farmers and the accessible information increased it had a positive effect on the adoption rate. Three fundamental factors to why adoption differs among farmers were stated. These were imperfect information and lack of transparency, personal characteristics and the range of benefits related to the innovation. Imperfect information and lack of transparency about the innovation were found to be an issue. It was not the lack of information about the existence of the innovations that was found to cause trouble. It was

instead the lack of information about the innovation´s operating performance, effects and risks as well as its characteristics that affected the adoption negatively. The study claimed that innovations would not be adopted on a large scale based on knowledge about their existence, but rather on experience of its performance. Personal characteristics affected the adoption decision, even if available information and experience were prevalent amongst all farmers, personal opinions of it affected the adoption decision. The structural characteristics related to each individual farm also affected the adoption, as the structure affects the magnitude of the economic benefits of the adopted technology.
Farms having a structure that make them more capable to capture the economic benefits of the technology will therefore respond more positive to adoption. Factors that affect the structure of the farms are for example farm size, market share, ownership and currently used technology. The result of the study was that the most common adoption during the study´s time period was adoption of processes, 80% of all new innovations were processes designed to reduce costs, and improve animal, human and environmental conditions. Another significant finding by the study was that farmers adopting innovations earlier searched external knowledge more actively and valued it higher than farmers who adopted later. Another conclusion in line with other literature was the negative correlation between age and adoption rate.

The importance of knowledge and experience of the performance of a new innovation have also been concluded by Giller *et al* (2009). The study concludes that with more complex innovations, such as minimum tillage, more evidence of the innovations´ benefits and performance is needed before adoption.

The farm structure also influences the ability to adopt new innovations and technologies, a study conducted by Mathijis *et al* (2001) compared converted large-scale state farms and family farms in former East Germany. The state farms were, during the study period converted into shareholder companies or private cooperatives. The study examined the difference in efficiency and technology adoption between the different farm types during the period 1991-1995. The data sample consisted of 729 family farms, 137 partnership farms and 301 shareholder companies. The study concludes that the former state farms had a lower technical efficiency and adoption rate than the family farms during the beginning of the transformation. But at the end of the transformation in 1995 there was no difference between the two different structures. The difference in efficiency was explained by principal agent problem at the former state farms, the workers were less efficient as their work effort was not linked to income whereas family farms tried to maximize their welfare and worked harder. The decreases in efficiency difference between the farm structures were explained by the transition of the state farms that removed bureaucratic controls and linked work effort to income.

2.2.4 The adoption process of minimum tillage in the agricultural sector world wide

Studies about the adoption of minimum tillage have been conducted worldwide to analyse the economic and biological effects and also what characterizes those who adopt the technology (Lexmon & Andersson, 1998). Korshing´s *et al* (1983) study in Iowa (USA) was based on 193 interviews and examined the adoption of minimum tillage while comparing it to traditional adoption of new innovations. According to the study, the adoption of minimum tillage followed the same pattern of adoption as other innovations, and the cumulative numbers of adopters followed an s-shaped as other innovations tend to do over time according to Rogers (2003). The study concluded seven statistically significant factors that divided

adopters and non-adopters from each other. Age had negative correlation with adoption. Farm size, involvement in organisations, gross farm income, amount of owned land, number of hired labour and the complexity of the farm had a positive correlation with adoption of minimum tillage.

Sheikh *et al (*2002) did a similar study in Pakistan of important factors that influence the adoption of minimum tillage among farms growing wheat, rice and cotton. 180 personal interviews with farmers were used to collect data. The result both correlated and opposed other research as the study showed that increased contact with advisors reduced the adoption rate even if the technology had been proven to have positive effects. The reason for this phenomenon was stated to be lack of trust between farmers and advisors. A second factor that the study concluded had a positive effect on the adoption, which is in line with other accessible literature is the availability of the technology. Farmers were less likely to adopt the technology if it not was available on farms and at suppliers in the area.

This result has also emerged in a study conducted by Smith *et al* (1992) in an erosion-affected area in Canada, the 176 farmers were asked question about use and opinion of minimum tillage and other conservation practices. One finding was that the farmer requested the opportunity to rent or try the equipment to get experience with it before adoption. This result was even more significant at smaller farms due to economic restrictions. A second factor that was found to be significantly related to a positive opinion and adoption was the evidence that showed that the equipment was cost efficient and economically beneficial. The economic benefits with the equipment were correlated with adoption, but the biological benefits of it could not be solely correlated to adoption. Productivity and short term economic benefits were therefore found to be correlated to adoption, whereas environmental improvements were not. Other factors that were shown to have significant correlation to adoption in line with similar literature were age, membership in farm organisations, farm size and knowledge about the erosion problem.

Lexmon & Andersson (1998) did a study about what factors influence the adoption of minimum tillage in the middle regions of Sweden. 415 surveys were used to examine different factors relation to adoption. Different soil types were found to be related to adoption, depending on the farm´s soil type the farmer was more or less willing to adopt the technology. Highest probability to adopt occurred at farms with medium clay and the lowest probability at farms with sandy loam. The study also concluded that economic incentives had a strong correlation to adoption whereas environmental biological effects did not, in line with Smith *et al* (1992). A finding that differs compared to Korshing´s *et al* (1983) and Smith *et al* (1992) was that no correlation between age and adoption could be found.

2.2.4.1 The adoption process of minimum tillage in the agricultural sector in a biological perspective

In order to examine the economic and biological benefits of minimum tillage and other conservation practices in China the Chinese Ministry of Agriculture (MOA) has since 1992 promoted research within this area. The reasons for this are the widespread issues of wind and water erosion and poor soil properties. Ten test sites with focus on northern China have been continuously in use since 2002 to examine the effects of these practises. The results of this research were presented by He *et al* (2010), which revealed several significant findings. Traditional farming systems were compared to different kinds of conservation systems. The traditional farming systems were defined as usage of mouldboard ploughs, rotary hoes and

removal of crop residuals. The different kinds of conservation techniques used were zero or minimum tillage, kept crop residuals on the field, usage of cover crops, precision application of inputs and permanent wheel tracks. Traditional farming systems and conservation tillage practices were also compared in terms of level of wind and water erosion damages and soil properties. The new conservation practices were found to have positive effects in all areas, the wind erosion in terms of transport of soil and dust were tested in the five north located test sites where this problem is most common. A decrease in wind erosion of 12-70% was found depending on the site location. The study therefore concluded that the technology is an efficient method to reduce the wind erosion and protect the soil surface.

The water erosion was tested in two test sites located in central China, the water run of from the fields were measured, and the results showed that the conservation practices reduced water erosion. The difference between the systems was larger during heavy storm years but still statistically significant during normal years. The cumulative water erosion for the test period examined (2003-2007) was 40, 9% less for minimum/conservation tillage than traditional farming system.

The soil property effects of the different techniques were tested between the years 1992-2007, and the result was that the biotic activity and organic carbon pool increased with conservation tillage and improved soil structure. The study therefore concluded that minimum/conservation tillage improved the soil condition.

Soane *et al* (2010) did a study in Europe where the benefits and disadvantages of traditional and conservation systems were compared. Field studies from nine countries were used as data and complemented with recent literature. The study concluded that conservation tillage reduced problems with erosion as more mulch was left and protected the soil surface. These factors had also a negative effect, as more mulch was left on the surface it reduced the sun radiation, which reduced the soil temperature and delayed the spring planting.

The pressure from weeds was found to be higher with conservation tillage, one explanation was that the weed seeds that earlier were buried in the soil by the plough were now left close to the surface and became more abundant, consequently the need for pesticides increased. Another difference between the two systems was that the amount of worms increased with conservation tillage as the plough disrupts the survival of the worms. Worms have a positive effect on the soil structure and improve the biological decomposition.

2.2.4.2 The adoption process of minimum tillage in the agricultural sector in an economic perspective

He *et al* (2010) also examined the economic effects in the ten test sites, mentioned above, located in China. The effects of minimum tillage and other conservation practices showed lower production costs by reducing the input usage of seed, labour and machinery at the same time as the crop yield increased. This result encouraged MOA to support the spread of this technology with the goal to reach 22 million hectares of farmland using this system by 2015.

Soane *et al* (2010) also examined the economic difference between traditional ploughing and conservation tillage. The economic aspects that were found were mostly related to energy and machinery use. Ploughing was stated to have higher production costs as more labour and machinery hours were used, which increased the use of fuel. With conservation tillage, the use of labour and machinery were lower but the use of pesticides increased. The overall cost

was still lower with conservation tillage compared to traditional systems, which therefore provided a lower yield with the same economic result. The main reason for this is that the cost of fuel has increased relatively to other inputs/outputs. Another advantage with conservation tillage was that it increased the amount of land that could be planted during the fall, which had positive economic effects as winter crops in general are more profitable. The general finding was that conservation tillage was more economically beneficial, even if the yield in general was lower but it was compensated by even more reduced costs. This could not be stated everywhere due to different soil and climate factors.

2.2.5 The adoption process in the Chinese agricultural sector

Several studies have examined the Chinese farmers' adoption characteristics. In 2012 a study was made to examine the factors that affect the acceptance of new seeds among farmers in China (Zheng *et al*, 2012). The study was conducted in 22 provinces by face-to-face interviews with 341 farmers. The conclusion from the study was that factors affecting adoption of seeds among the farmers were farm location, farm size, the farmers' perception of dealers, and the information exchange among the farmers. The study also found that farmers with more knowledge about the seeds´ benefits and weaknesses adopted them to a higher extent than farmers with less knowledge.

A similar study was conducted 1991 based on 500 surveys in the Hunan province (Lin Yifu, 1991). This study examined the correlation between education and adoption of hybrid rice among farmers. Other variables were also tested to find other correlating factors besides education. The result of the study was that education, agricultural experience, and farm size had a positive correlation with adoption. The price of the technology being adopted, in this case the hybrid rice had a negative correlation with adoption.

A study conducted in the mountain regions in northwest China 2008 by Zhou *et al* (2008) examined different factors' correlation to adoption of water saving technology. 210 farmers were interviewed to find a relation between adoption and farm and farmer characteristics. The study found a complexity in the correlation between education and adoption, farmers with low and high level of education were more likely to adopt than farmers with middle level education. Therefore a positive correlation between education and adoption could not be showed. In line with other studies, the size of the farm, income, membership in organisations, and experience of the technology had a positive correlation with adoption. Off farm employment was found to have negative correlation with adoption, which is contradicted to Lexmon & Andersson´s (1998) result. Their study showed a positive correlation between off farm work and adoption among Swedish farmers. The type of the soil at the farm affected the magnitude of the problem; the study concluded that farms with soil with better water holding capacity adopted to a lesser extent than farms with soil that had lower water capacity. The benefits of the technology could therefore be stated to have a positive correlation to adoption.

2.2.6 Summary of the literature review

Here follows a summary of the literature review which enables a clear overview of the literature findings, see table two.

Table 2. Summary of the literature review (own arrangement)

Articles / Factors influencing adoption	Studies regarding adoption within organizations				Studies regarding adoption within the agricultural sector								Studies regarding Minimum Tillage						Studies conducted agricultural China		
	Premkamar *et al* (1998)	Moch & Morse (1977)	Lal (1998)	Frambach *et al* (2002)	Zepeda (1987)	Chi & Yamada (2002)	Abdulai & Huffman (2005)	Feder (1980)	Diederen *et al* (2003)	Gillet *et al* (2009)	Mathijis *et al* (2001)	Bryce and Gross (1943)	Lexmon & Andersson (1998)	Korsching´s *et al* (1983)	Sheikh *et al* (2002)	Smith *et al* (1992)	He *et al* (2010)	Soane *et al* (2010)	Zheng *et al* (2012)	Lin Yifu (1991)	Zhou *et al* (2008)
The innovation aspects																					
Relative advantage	x															x	x	x			
Economic benefits													x			x	x	x			x
Biological benefits																	x	x			
Cost						x														x	
Compatibility			x																		
Complexity										x											
Trialability																x					
The individual aspects																					
Education					x	x	x													x	
Age						x			x					x		x					
Search for new knowledge									x												
Awerness of problems the innovation can solve (erosion)																x					
Knowledge about the innovation			x						x	x									x		
Experiance of the innovation																					x
Off-farm work experiance													x								x
The organisational aspects																					
Top management support	x																				
Organisational size	x	x		x	x		x	x	x					x		x			x	x	x
Structure of the organization (centralised vs uncentralised) (stateown vs family owned)		x		x					x		x										
Number of hired external specialists		x												x							
Gross Income																					x
Liquidity						x	x	x								x					
Complexity of the organization														x							
The environmental aspects																					
External pressure	x																				
External support	x					x								x		x					x
Neighbours							x					x							x		
Distance to market							x														
Availability of the innovation															x						
Contact with advisors															x						
Contact with suppliers																			x		

The summary of the literature review illustrates what factors other studies have identified to affect adoption of new innovation inside and outside the agricultural sector. The factors can be arranged in four different aspects, which are the innovation-, individual-, organisational-, and environmental aspects.

2.3 Theoretical Perspective

This section provides the reader with the theoretical framework that is used in this study. The choice of theoretical framework is based on the literature review. The used theoretical framework is chosen as it is suitable to analyse the empirical data. The literature review which is summarized in table two reveals that several factors grouped into four aspects influence the adoption decision. In order to examine the Chinese farmers' opinion towards minimum tillage and their adoption decision, a theoretical framework of these aspects is needed and it is presented below.

2.3.1 Definition of adoption

The main focus of this study is the consumer/organisation adoption, it is therefore of great importance that the term adoption is defined. According to Kotler & Keller (2009, S.658):
"Is adoption an individual´s decision to become a regular user of a product"

Rogers (2003, S.473) have a similar definition, adoption is according to him:
"a decision to make full use of an innovation as the best course of action available"

While adoption has been defined, it is also important to understand the meaning of the *diffusion* of an innovation such as a product or service (Kotler & Keller, 2009). The diffusion of a product or service describes how it is spread on new markets, and can be measured by counting the accumulated number of adopters/users over time, from the first to the last. Rogers (2003, S.5) defines the diffusion as "*the process in which an innovation is communicated through certain channels over time among members in social systems"*.
If the cumulatively number of adopters is plotted over time an s-shaped curve tends to be formed (Rogers, 2003). One explanation is that the individual learning curve is s-shaped and therefore the whole population reflects the same pattern. The population learns slowly in the beginning as the knowledge and adoption rate increase more experience and knowledge in communicated, which increases the adoption rate. When the majority of the population has adopted the innovation the adoption rate slows down as it become more difficult spread the knowledge. A second reason is the adopter effect, If each new adopter communicate with two other individuals within the population the adoption process is expanding, this increase the speed of process exponentially until a point where the diffusion approaches saturation.

2.3.2 The Diffusion of innovations, an overview

Rogers (2003) definition of diffusion implies that it is created by four elements. These are: 1. the innovation, 2. communication, 3. time and 4. social systems. Each element is described below.

1. Innovation is a product, process or idea, which is perceived as new by an individual or another decision-making unit, the age of the innovation is therefore less important (Rogers, 2003). How desirable the innovation is to the person is closely related to the attributes of the potential adopter and what characterizes him/her. This aspect is covered in the section *individual aspects* further down. Knowledge of the innovation is very important as it affects the level of uncertainty towards the innovation and the adoption. The attributes of the innovation also affect the desire towards it, depending on what kind of innovation it is such as software or hardware different factors are important. Five important characteristics of the innovation have been stated to explain the rate of

adoption, these are: **relative advantage**, **compatibility**, **complexity**, **trialability** and **observability**. These factors will be covered in the section **innovation aspects** further down.

2. Communication was earlier stated to be the process when information is created and shared between persons to obtain a mutual understanding (Rogers, 2003). In terms of diffusion this communication consists of information about the innovation, which is shared from one person to another. Through this process the information and knowledge of the innovation is spread. This is also accomplished through specific communication channels, such as mass media. It has been stated by diffusion studies that the mode of communication channel that is used highly affects the adoption rate. It is also stated that communication interaction is gained if the individuals' attributes are more similar. These attributes can be education, age, and knowledge. If two individuals who communicate are more similar it will have a positive effect as they will share meanings and use the same kind of language.

3. The time element in the diffusion process is applied at both an individual and a social level (Rogers, 2003). On the individual level the time period is measured from when the individual first gains awareness about the innovation to his/hers adoption or rejection decision. This time period is the **innovation-decision process** and occurs when the individual or organisation goes through the steps having knowledge about the innovation, forms an opinion of it and makes a decision to adopt or reject it.

4. The last element in the diffusion process is the social system. It is defined to be *"a set of interrelated units that are engaged in joint problem solving to accomplish a common goal"* according to Rogers (2003, S. 23). These units can be individuals, organisations or groups. The size of the social system can differ from all farmers in the USA to young mothers in a village. The structure of the social system and the units in it is closely correlated with the diffusion, the structure includes factors such as norms, the decision process and culture. This will be covered in the **environmental aspects and social structure** section further down in the chapter.

2.3.3 The innovation aspects

This section focus on attributes and characteristics related to the innovation, which are related to the adoption rate. Five general attributes are presented (Rogers, 2003):

- **Relative advantage** is the extent to which the new innovation is considered to be better than the previous or available alternative. Depending on the use of the innovation different types of advantage are demanded. Adopters can be searching for different characteristics such as economic profitability or social prestige. Different individuals also demand different attributes from the innovation. One important factor that affects the adoption rate is the initial cost of the product. The relative advantage in term of profitability, low initial cost, social prestige, time and inputs savings are found to be the most important factors to adoption.
- **Compatibility** is to what extent the innovation is consistent with existing values, needs and experiences. If the innovation is more compatible the uncertainty related to it decreases. Cultural values can affect the adoption, if attributes of the innovation are not consistent with the existing values then the innovation is less likely to be adopted. Technical compatibility can affect the adoption if the innovation is not consistent with existing technology.

- **Complexity** is the extent to which the innovation is difficult to adopt and use. If the innovation is complex the need of knowledge increases and the uncertainty related to it increases as well. The complexity can therefore be a barrier to adoption, when the complexity increases the importance of a supporting social network increases as well.
- **Trialability** is what extent the innovation can be tested before adoption. If it is possible to test the innovation, the uncertainty can be reduced and the adoption rate tends to increase.
- **Observability** is to what extent the result and effects of the innovation are observable for other than the adopters and how simply these results can be communicated within the social system.

2.3.4 The individual aspects

The previous section pointed out factors that affect adoption related to the innovation, here the focus instead is on the individual. Different factors have been found to influence the innovativeness and time of adoption among individuals (Rogers, 2003). Five different groups have been distinguished depending on time of adoption and innovativeness, these are: innovators, early adopters, early majority, late majority and laggards. The difference between the individuals in these groups has been stated to be different personal characteristics such as education, knowledge, social status, resources, size of organization/unit and size of social network. These characteristics affect the opinion of new innovations and the time of adoption. Adoption by individuals is often driven by problem recognition, where the individual in the initial phase recognises a problem and searches for a solution.

2.3.5 The organisational aspects

There are some essential additional factors regarding adoption in organisations (Abrahamsson & Andersen, 2005). The main reason for this is that the decision is collective and hierarchy driven. More individuals are involved in the process, which results in that an increased number of objectives and goals affect the decision-making. This makes the innovation decision process in an organisation more complex and it is important to distinguish different kinds of innovation decisions, which affect each organisation differently. These decisions can be individual decisions that only affect one individual in the organisation, collective decisions that are made by a majority of the individuals which affect all parts of the organization and authority. Decisions which are made by a smaller number of individuals yet affect all parts of the organisation. In line with the earlier conclusion that each individual adopts innovations differently an organisations function comparably; organisations adopt innovations differently and are more or less innovative (Rogers, 2003).

Organisation theory describes different structures among organisations and how they affect the operational work and decision-making within in the organisation (Abrahamsson & Andersen, 2005). The structure of the organisation is therefore correlated with the responsibility of each person in the organisation and to what extent these people have the right to make decisions either contrary to or in accordance with the group. The structure of an organisation is divided in three parts, which are uniquely independent each having the same importance to determine the structure: specialization, formalization and centralization/ decentralization.

The structure of an organisation is therefore the form of it in terms of for example hierarchy, responsibilities and dispersion (Abrahamsson & Andersen, 2005). The structure affects the function and outcome of the organisation, but it is difficult to deduce any broader general

assumptions related to innovativeness and adoption decisions as it depends on how the organisation works rather than what kind of organisation it is (Rogers, 2003). Other general characteristics of organisations that have been observed to influence the innovativeness and adoption decisions are:

- Organisation size has a positive correlation to adoption of new technology due to several reasons. The size of the workforce is correlated to adoption as more knowledge and available time to adoption exists. This is defined as organisation slack, which is the unused efficiency and workforce that exist in the organisation and is ready to use. The size of the budget also has a positive correlation to adoption as it increases the financial strength and the resistance towards uncertainty. The organizational size also has a positive correlation to adoption of new technology as the R&D budget in general increases.
- The openness of the system is defined as the extent that the organisation is connected to other individuals and organisations outside their own organisation. Openness has a positive correlation to innovativeness and adoption of new technology.

2.3.6 The innovation decision processes in organisations

The innovation decision process in organisation describes how decisions are taken and consists of six stages, two before the adoption decision and three after it (Rogers, 2003 & renewed by Kotler & Keller, 2009). These are 1.**agenda- setting**, 2.**matching**, 3.**adoption decision**, 4.**restructuring**, 5.**clarifying** and 6.**routinizing**. The three last steps cannot be done before the two foremost ones have been accomplished, which are initiated by problem recognition.

1. **Agenda- setting.** During this initial phase a problem that occurs in the organization is prioritized, which creates a need for a solution. A search for an innovation that can solve the problem is therefore started.
2. **Matching.** The organization's problem is matched with an existing innovation/solution during this phase and different innovations feasibility are tested.
3. **Decision.** After the innovation has been tested, the decision whether to implement it or not is taken. If the decision to adopt the innovation is taken the implementation phase starts.
4. **Restructuring.** During this phase, the innovation that the organization chooses to adopt is adjusted in order to fit the specific situation. The structure of the organization is also modified to make the best use of the innovation. Some adoptions of innovations lead to formation of new departments while others do not demand any change at all. Innovations demanding more knowledge of the employees can be more complex to implement.
5. **Clarifying.** In this phase, the relationship between the organization and the innovation is clarified, the innovation is spread within the organization and more of its members become aware of it. Clear management is essential in this phase in order to quell misunderstanding or unwanted side effects, as many employees are involved and uncertainty exists.
6. **Routinizing.** This phase is the completing part of the innovation process. This occurs when the innovation has become a natural part of the organizations' operations and is a regular activity. The innovation is more sustainable if more of the organizations' members take part in the implementation.

As the organisation becomes bigger, the number of people that influence the innovation decision process increases (Kotler & Keller, 2009). Compared to a single person, who influences the decision in a smaller organisation, a bigger organization can have a committee consisting of for instance technical experts who focus on the compatibility and effectiveness,

as well as operational officers who focus on working conditions which together influence the decision.

2.3.7 The innovation and decision model

Öhlmér *et al* (1998) created a similar decision model as Rogers (2003) but with one essential difference that must be highlighted. Roger´s (2003) model follows a linear approach in which the steps follow each other. Öhlmérs *et al* (1998) model also includes four phases but these do not follow a linear pattern. Instead the model focuses on the processes in each phase, which can be repeated several times during the same decision process. These phases are: *problem detection, problem definition, analysis and choice* and *implementation*. Depending on factors such as the situation, the individual and the type of decision these phases are more or less expanded. The extent of these phases depends on four different sub processes, which can be found in each phase. These are; *searching and paying attention, planning, evaluating and choosing, bearing responsibility*. These sub processes increase the knowledge and understanding of the problem and situation. This can result in that the individual have to go back in the model and restart the decision process, which confirm that the model is not linear. In terms of adoption this model is also essential as it indicates that a decision process to accept or reject an innovation can be restarted if the individual, for instance, obtains more knowledge of if or the situation is changing.

2.3.8 The environmental aspects and social structure

Two persons or organisations that have the same characteristics might adopt innovations differently, this can be explained in that they live in different cultures and with different norms (Rogers, 2003). Norms serve as a guide of expected behaviour and form a pattern of behaviour within a social system. Norms within a culture can be an obstacle for change and can be the reason to not adopt new innovations. These norms can be cultural or religious and can operate on a national as well as local village level.

Decisions to adopt an innovation can be made differently, it could either be taken by an individual, by a group of individuals or by authority (Rogers, 2003).
A single individual can naturally influence a decision more if he/she is taking it alone. But even in these situations the individuals' decisions are influenced by the culture's norms and by communication.

Studies have concluded that the majority of individuals often hear about an innovation from a salesman but that they base their decision of adoption on opinions from neighbours and friends. Only early adopters find the salesmans' arguments more important than neighbours'. The process of diffusion is therefore stated to be as following, early adopters hear about the innovation from the salesmen and adopt it. The majority thereafter ask the early adopters about the opinions of the former and base their decision on these. This phenomenon is called a social snowball, once the adoption starts it will lead to more people adopting it. There is therefore no doubt that individuals adoption decision can affect others. Therefore the base in innovation diffusion can be perceived as interpersonal communication. Diffusion of innovations is therefore defined as a social process where norms and culture affects the adoption rate.

2.4 Hypotheses

A hypothesis is a guessing/assumption or a claim with a clear relation between the independent and dependent variable (Denscombe, 2009). In this case, the dependent variable is the respondent's opinion of minimum tillage, and the independent variables are based on the literature review and the theoretical framework.

2.4.1Theoretical relation and hypotheses

To clarify the relation between the theory of the adoption process and the affecting factors, a model has been created to illustrate the connections between the theory and the hypotheses, see figure three. The H:x in brackets refers to the hypotheses used in this study found in the next section.

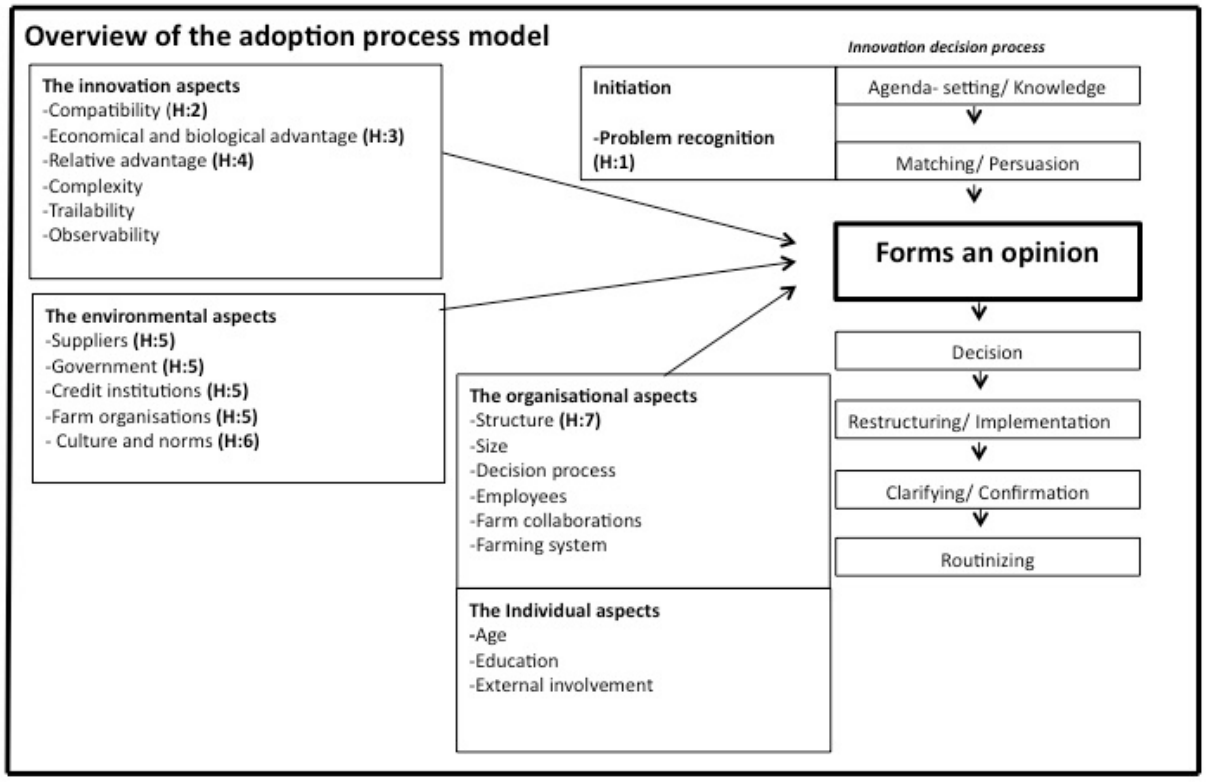

Figure 3. Illustration of the relation between the theory and hypotheses (Kotler & Keller, 2009 & Rogers, 2003 & Öhlmér et al, 1998, Own creation)

The presented model demonstrates the relation between the used theories, the presented literature and the created hypotheses in this study. The model illustrates how the innovation decision process starts with problem recognition, which results in that the individual/ organisation starts to search for knowledge and available solutions (Rogers, 2003). When an innovation to solve the issue is found the individual-, innovation-, environment- and organisation aspects affect the opinion of it. The opinion affects the decision to accept or reject the innovation and is therefore related to what extent innovations are spread throughout social systems.

2.4.2 Hypothesis

H:1. *Adoption of innovation is related to interests of solving existing problems (Rogers, 2003). To recognize a problem and matching it with an innovation solution is essential for the adoption process.*
Farmers who are interested and aware of existing problems and find minimum tillage to be part of the solutions to them will therefore have a more positive opinion of it (Diederen *et al*, 2003 & Zheng *et al*, 2012).

H:2. Innovations that are more compatible with the existing system are easier to implement on the farms (Rogers, 2003).
Farmers who perceive minimum tillage compatible with their existing farming system will therefore be more positive towards it (Lal, 1998).

H:3. *The perceived economic and biological factors of the innovation affect the opinion of it (Rogers, 2003*).
Farmers who find minimum tillage more economically and biologically beneficial will be more positive towards it (Lal, 1998 & Smith *et al* 1992 & Soane *et al*, 2010).

H:4. Relative advantage is to what extent the innovation is perceived to be better than other available alternatives (Rogers, 2003). An innovation with a perceived relative advantage has a higher rate of adoption.
Farmers who find minimum tillage to have a relative advantage will therefore be more positive towards it (Premkumar *et al*, 1998).

H:5. External support is to what extent the innovation is supported by external sources such as governments, credit institutions, partners and suppliers (Rogers, 2003). External support has a positive correlation with adoption.
Farmers that find more external support to minimum tillage will therefore be more positive towards it (Chi & Yamada, 2002 & Feder, 1980 & Premkumar *et al*, 1998 & Sheikh *et al*, 2002).

H:6. Culture, norms and communication influence the adoption of new innovations (Rogers, 2003).
Farmers who have neighbours or friends using minimum tillage system will be more positive to adopt it (Bryce & Gross, 1943 & Sheikh *et al*, 2002).

H:7. The existing structure of the organisation affects the implementation of the innovation (Abrahamsson & Andersen, 2005). If the implementation is perceived to be difficult it reduces the adoption rate.
Farmers that perceive the implementation of minimum tillage to be difficult will therefore be more negative towards it (Diederen *et al*, 2003 & Frambach *et al*, 2002 & Moch & Morse, 1977 & Premkumar *et al*, 1998).

3 Method

This chapter presents the methods used in this study and provides the reader with the work process of this thesis.

3.1 Research Approach

In this study a qualitative research approach was used to collect empirical data to be able to test the study´s hypotheses. The empirical data was gathered by personal interviews with farmers operating in two provinces in northern China, having decision-making position of machinery purchase. Similar interviews were held with suppliers of machinery in the same area to validate the data. The study was conducted in China after interest from the Swedish agriculture manufacturing company Väderstad-verken, which supported and financed the field study.

There are many different methods to collect empirical data. It can be conducted by either qualitative or quantitative approach (Brinkman & Kvale, 2009), see figure four further down. Qualitative research is based on a smaller sample and does not seek to obtain quantitative data that can describe general opinions (Brinkman & Kvale, 2009). Instead the purpose of a qualitative research is to find specific explanations which describe complex situations. The questions in a qualitative survey are more open in order to enable a deeper understanding about feelings, opinions and beliefs of the respondents. Quantitative research is based on a bigger sample of data to create a more general understanding (Churchill & Lacobucci, 2005). In quantitative research the questionnaires are more standardized and the questions are more structured.

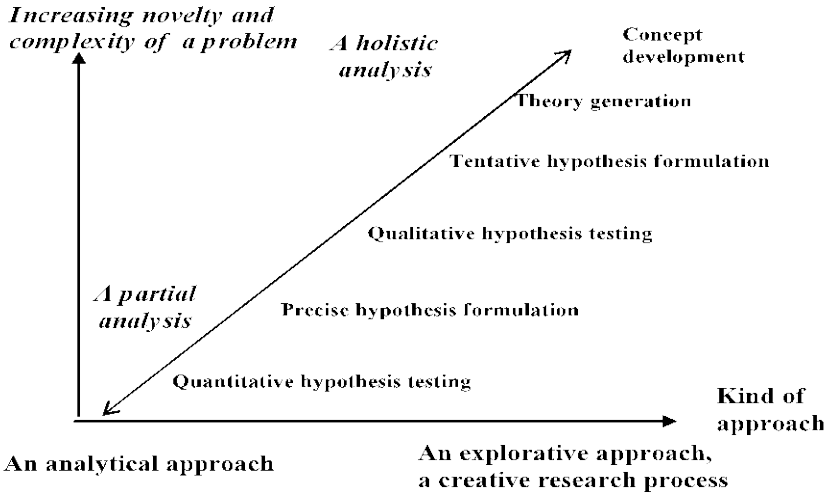

Figure 4. Illustration of how the complexity of the subject affects the research approach (Nyström in Mark-Herbert, 2002, S.17).

The different approaches are more or less suitable depending on the study´s purpose and the type of data being collected, which is highlighted in figure four (Denscombe, 2009 & Nyström in Mark-Herbert, 2002). A qualitative research is more suitable when the research approach is more complex and explorative. As this study aims to understand the diffusion of minimum tillage which is a complex phenomenon, a qualitative approach was chosen.

3.2 Data collection and Questionnaire

In this study personal interviews were chosen to be the method to collect data. There are other methods that could have been used such as a mail survey. There are several advantages with a mail survey, it can reach a large number of respondents that are spread out in vast geographical area, and the respondents can answer a mailed survey alone at home in their own pace, which makes them feel more comfortable (Ejlertsson, 1996). The disadvantage of using a survey is that the respondents do not have a chance to ask questions, and the risk of misunderstanding increases (Ejlertsson, 1996). If the respondents do not understand a question in the survey they can chose to not answer it so the risk of receiving unanswered questions increases. The person can also answer questions without understanding them, which would lower the reliability and the quality of the study. Another disadvantage with a survey is that the interviewer cannot ask further questions in order to get a deeper understanding and is therefore unable to capture the complexity of situations.

The survey methodology was abandoned due to several reasons. Earlier surveys conducted in China have got an extremely low response, as personal contact is of great importance in the Chinese culture. Some surveys have got as low as 0, 1% answer response (Fang, 2005). It is therefore important to meet the respondents in real person in order to get answers and to get reliable data. Another obstacle with a survey in this case is time. A survey should not take more than 30 minutes to answer and as the farmers' knowledge of the study´s subject is uncertain and the study´s purpose unknown, much time is needed to clarify and describe the project (Ejlertsson, 1996). A longer time than 30 minutes is needed in order to describe the project as well as inform the respondents about how the collected data will be used which is important in order to increase the credibility.

By conducting personal interviews, detailed questions and follow up questions can be asked which strengthen the validity of the data (Denscombe, 2009). Personal interviews are a central method to obtain deeper information about more complex phenomenon. Obstacles with personal interviews are that they are more cost and time consuming per respondent, which decreases the total number of possible interviews. Another essential obstacle with interviews is the interviewer effect, which is the phenomenon that people tend to answer questions differently dependent on how they perceive the interviewer (Denscombe, 2009). Preconceptions that the respondents have therefore affect the outcome from the interview and this has to be included in the validity of the data.

3.3 Interview guides

The next step was to formulate questionnaires that were based on the hypotheses and the perception of the amount of data needed to be able to answer all the research questions and reach the stated aim. 51 questions were created and arranged in a structured order, see questionnaires in appendix one and two. As the study aims to capture explanations and understanding of the diffusion of minimum tillage and the Chinese farmers opinion of it, a semi-structured interview approach was chosen. This was done as it was stated to be the most preferable methodology to obtain a deeper and complex understanding of the respondents beliefs and opinions without losing all structure according to Denscombe (2009) and Brinkman & Kvale (2009). Effort was put in to determine the content of each individual question. Several aspects were considered such, as is this question needed? Should this question be split into two? Will the respondent be willing to provide this information? The wording of the questions was also considered. The questions used simple and as few farm

specific words as a translator would be used and as little misunderstanding as possible should occur. It was also of great importance to test the interview guide before the field study to ensure that they could be used in the Chinese culture and with an interpreter in order to ensure the validity of the data.

The first test of the interview guide was made by testing it on two Swedish farmers in order to get experience and enable the possibility to change some observed issues with the interviews guides. The answers were checked to make sure that the data needed in order to accept or reject the study's hypotheses and answer the study´s research questions was gathered.

The second test sent the interview guides to a Chinese interpreter who checked them in order to avoid culturally offensive questions in China, which could decrease the validity of the data collected. The interview guides were also tested on one Chinese farmer. As there was no misinterpretation and necessary answers for the study were gathered, no adjustments were made and the interview could therefore be included in the study as Trost (1997) recommends.

3.4 Sites

The study was based in the cities Hailun in the Heilongjiang province and Hohhot in the Inner Mongolia province. To gather information about where to collect the data for the study the Swedish Embassy, the Swedish Trade council in Beijing, SIDA, Chinese Agricultural Universities as well as companies working within the Chinese agriculture sector were contacted. Their common advice was to conduct the study in the northern part of China as the farms there are larger and are more mechanized than in other parts of the country. The provinces Heilongjiang and Inner Mongolia were therefore suitable regions to conduct a study of modern agriculture machinery and technologies (pers. com., Mahon, 2012).
An additional essential reason for conducting the study in these two regions is that erosion and drought are large problems there, which make the areas suitable for the minimum tillage practice (Jin *et al,* 2010).

3.5 Selection of respondents

The choice of respondents can be both random and individually selected depending on specific characteristics of the respondents (Denscombe, 2009). The optimal number of interviews differs between studies but is usually between 5 and 25 performed interviews (Brinkman & (Brinkman & Kvale, 2009). The sample of respondents in a qualitative study is in many scenarios better when small (Trost, 1997). The analysis of a small sample of interviews is clearer than a large sample as too many aspects and details can become unmanageable.

In this study the population of interest is farmers who operate a big enough farm to have modern technology and have a farming system, which is in need of tillage systems. To select farmers, local universities and political authorities were contacted. They organized visits to different farms that suited the characteristics for the study. Suppliers of farm machinery were also interviewed in the same areas to validate the data from the farmers.
The weakness with this approach is that as the universities and political authorities selected the units of analysis, which can affect the mixture of them. Personal relations, hidden agendas and other unknown factors could have affected their choice, which should be included in the validity of the presented data.

3.6 Interviews structure

The interviews were conducted with assistance of an interpreter. The interpreter was given information about the study's purpose and aim before the interviews were conducted in order to ensure that the questions were asked in a manner that provided data needed to answer the study´s aim. The interpreter was also consulted to give reflection on the questions in order to not conflict with the Chinese culture and to structure the interview so that it was suitable for the situation. The weakness with the approach with an interpreter is that the respondents' answers had to pass via an additional person, which can increase the risk of misunderstandings, reduce clarity in communication producing loss of data.

The interviews were conducted in person at the farms where the farmers were operating and with suppliers at their offices. This was suitable as the farmers could show their operation instead of only having to explain it by words, which decreased the risk of misunderstandings. This was advantageous with the machinery dealers as well as they could show the machinery in reality, which decreased the risk of misunderstanding. Another advantage to conduct the interviews in the natural place for the respondent is that they felt more comfortable, which improved the quality of interview (Brinkman & Kvale, 2009).

The interviews started with a presentation of the study and the authors, see fact sheet appendix three. The purpose of the study was clarified as it was an undisguised research, and a presentation of the interview procedure was given (Gilbert *et al* 2005). A factsheet with the same information in Chinese was distributed to the respondents in order to make it clear.

Before the questioning was started information about ethics was given to clarify that the interview was anonymous and completely confidential. This can result in some difficulties in presenting the result as personal describing information had to be removed which decreased the possibility for further research, as it is impossible to reproduce the study (Denscombe, 2009). But there is also a benefit with this approach, as the interviewed person remains anonymous it is more likely that he/she is truthful and the quality of the data increases as he/she does not have to worry about who would take notice of his/here answers.

The interview guides used in this study were structured into sections, based on the theory. The interview guides are presented in appendix one and two. The first section was labeled *Description of the Farmer and the Farm*. It contained specific but simple questions, as Trost (1997) recommended in order to make the respondent feel comfortable in answering and increase the quality of the study. The farmers were asked about their present farming system. The purpose of these questions was to receive a general understanding about the farming situation and the currently used farming system. The next section was labeled *initiation*. It contained questions about the farmers' awareness and problems recognition concerning tillage systems. These questions were asked in order to gather data that could be used to reject or accept hypothesis number one. After the questions about problem awareness had been asked, a short movie of different tillage practices were shown. This was done in order to clarify and define the minimum tillage system. The next section was labeled *the innovation aspects.* In this section questions were asked about the how the farmers perceived the characteristics of the minimum tillage practice, such as its complexity, compatibility, economic and biologic benefits and relative advantage. These questions were necessary in order to reject or accept hypotheses number two to four. The following section was labeled *the environmental aspect*. In this section questions were asked about the external support given to the minimum tillage system in terms of subsidies, information, credibility and service. These questions were used

to answer hypotheses number five and six. The section after was labeled *the organizational aspects.* It contained questions about the organization's/ farm's structure and its decision process. These questions were needed to answer hypothesis number seven. The last section of the questionnaires was labeled *general conclusions*. The questions in this section were more universal about the farmers' general opinions of the minimum tillage system, their thoughts about the future as well as their opinions of foreign technology. The purpose of these questions was to capture the farmers' general opinion towards minimum tillage and new technology but also to enable repetition of unclear questions and to summarize the interview. All sections ended with a gradation were the farmers graded minimum tillage for each aspect on a scale from one to five. After all questions had been asked the respondent was asked if he/she had any questions. This was done to increase the quality of the study. The interviews with the suppliers were conducted with the same structure but with another questionnaire, see appendix two.

3.7 Transcription

After the interviews were conducted, they were transferred from oral to written language. A well-transferred interview reveals the same result as the oral interview, it is therefore important to capture other influences than solely the spoken words (Brinkman & Kvale, 2009). The transcription should be done as fast as possible to avoid losses of data. Written summaries of the interviews were therefore done direct after the interviews had been conducted. The written summary of the interviews were checked and confirmed by the interpreter who translated during the interviews, in order to avoid misunderstanding and increase the validity of the data. No names of the respondents were written in the paper as confidentially was promised.

3.8 Analysis

The method to analyse the empirical data was determined before the data was gathered as it determines the design of the interview guide, the interview process and the transcription of the interviews (Brinkman & Kvale, 2009). To be able to analyse the empirical data it is presented in the four sections based on the theoretical framework. The sections are as mention earlier; initiation, innovation aspects, environment aspects and organizational aspects. Each section is summarized with a grade. The farmers graded the sections with a 1-5 scale in order to ease the comparison and analysis of the empirical data.

3.9 Delimitations

Due to the scale of this study delimitations have been made, both actively by the authors and enforced by external factors. These delimitations are theoretical, empirical and methodological, and are described in the following sections.

3.9.1 Theoretical Delimitations

The theoretical model chosen is based on adoption theory by Rogers, which is supported by theories describing consumer/organisation behaviour and organisation structure. These were chosen due to several reasons. The first one is that adoption theory by Rogers is the main theory in terms of how new innovations are spread and the decision making process. Other authors have described this phenomenon after Rogers, but his original work is the foundation.

The weakness with this theory is that it can be difficult to apply and understand which increases the importance of an adequate description and usage of it (Straub, 2009).
There are other theoretical frameworks that could have been used. Production functions could have been used to analyse the effects of minimum tillage among Chinese farmers and estimations could have been done to observe how different farming systems affected the outcome (Feder, 1980). Property rights theory, which explains to what extent the owner of a property has the right to use it and the level of its utility, could also have been used in this study (Mathijis *et al,* 2001). As it in China is the government and not the farmers who own the land, this framework would have been useful in the study as it affects the use of the land. But these two approaches were abandoned as it was considered to be too difficult to find farmers who would reveal their opinion about government intervention in China and also reveal economic data required for a deeper numerical analysis. These other theories were also abounded as they failed to capture the farmers' opinion of minimum tillage, which was essential in the study´s aim.

3.9.2 Empirical Delimitations

This study focuses on the farmer's opinion of minimum tillage. The study could have included other perspectives as well, such as the government's view of minimum tillage as they are highly involved in the agricultural sector and its development. This approach was abandoned due to two reasons. The first was because it is difficult to get contact with the political individuals that would have given useful and needed information. The second reason was that the aim of the study was more related to the farmers' opinion as they are in the operative position and their view is based on the practical aspects of the minimum tillage system. Other sources of information from China could also have been used, such as academician and domestic producers of machinery. These sources were abandoned to maintain the focus in the study and due to lack of contacts.

3.9.3 Methodological Delimitations

This study is limited by the fact that the empirical data was gathered during three weeks in China, which limited the number of interviews and contacts. As the authors were stationed in the cities Hohhot and Hailun the geographical area was limited to the regions that could be covered during a one-day drive from the cities. Another limitation of this study was that all interviews had to be conducted with an interpreter, which reduced the author's ability to communicate in person and capture all personal opinions. An additional weakness was that the authors were unfamiliar with the Chinese culture, which could lead to misunderstandings and that the interviewed persons might have withheld some information due to lack of trust or comfort.

4 The empirical study

This chapter presents the empirical data collected in this study. The data is presented according to the aspects identified as influencing adoption by the literature and the theory. These are the initiation-, innovation-, environmental- and organisational aspects. The empirical data is based on interviews with eight farmers, see table three.

Table 3. Illustration of the respondents in this study (own arrangement)

Respondents	Area	Farm size (ha)	Organisation	Usage of minimum tillage
Farmer 1	Heilongjiang	9 866	State farm	Yes
Farmer 2	Heilongjiang	20 000	State farm	Yes
Farmer 3	Heilongjiang	20 080	State farm	Yes
Farmer 4	Inner Mongolia	1 065	Private farm	No
Farmer 5	Inner Mongolia	500	Private farm	No
Farmer 6	Inner Mongolia	55	Private farm	No
Farmer 7	Inner Mongolia	133	Private farm	No
Farmer 8	Inner Mongolia	15	Private farm	No

The interviewed farmers were operating in two areas, Heilongjiang and Inner Mongolia. The farm sizes differed from 15 to 20 080 hectares and three state farms which all used minimum tillage and four private farms that did not use the practice were included in the study to be able to distinguish adopters from none adopters and what factors that affect their opinion of the practice.

4.1 Qualitative interviews Farmers

4.1.1 Farmer 1 Heilongjiang

The respondent is 50 years old, he/she went to high school and has studied two years in agriculture machinery school. He/she is the farm's agricultural machinery manager. According to the respondent the farm operates 9 866ha of farmland and has 3 100 employees. The main crops on the farm are maize, soybeans, sorghum. The 25 tractors at the farm range in size from 185-310 horsepower and are from Case, New Holland and John Deere. The tillage machinery is from Case and Kverneland and are 4m wide. The farm uses five Great Plain drills with a width of 6,6m. The plough has not been used at the farm since 2004, and all machinery at the farm is equipped with GPS.

Initiation

Drought and erosion are problems on the farm according to the respondent. But he/she explained that planting trees around the fields and along the roads have solved the erosion problem. The respondent is at the moment searching for machinery that can handle the maize stocks left at the field after harvest more effectively than the current machinery.

The Innovation aspects

The respondent considers minimum tillage to be a better tillage system than ploughing, both in terms of drought and erosion. He/she also states that it is a more effective practice than the plough as it is less time consuming. According to the respondent, minimum tillage also has biological benefits as it is better for the organic matter in the soil and protects the "animals" in it, which has led to an increase in yield. He/she claims that a new tractor was bought at the

same time as the minimum tillage equipment, which resulted in no compatibility problems. Minimum tillage is also according to the respondent easy to understand and use. He/she thinks that the only disadvantage is that it less effective when there is a lot of biomass left on the field, especially after maize has been grown.

The Environmental aspects

According to the respondent suppliers of agricultural machinery promote minimum tillage and arrange presentations of the machinery. He/she also perceives that the Chinese government supports the use of minimum tillage. Government agencies arrange annual training sessions and support the purchase of the new machinery more than the ordinary 30% as the farmers were sceptical to the new practice in the beginning. The traditional use of the plough is, according to the respondent, "deep in the heart" and the farmers were hard to convince. The respondent explained that the farmers thought that the soil looked "ugly" after cultivation as the straws were not totally covered. The government therefore paid 100% of the initial cost of the new machinery and let the farmers pay their share (70%) after 2 years when they had tried the machinery. The respondent also said that it is possible for farmers to obtain a loan from the banks to pay the machinery.

The Organisational aspects

The respondent explained that this state farm is a part of a three steps chain. The state farm is the operative unit and they report information and their opinion of the farm machinery to a local sub-office. The local sub-office then reports to the central governance that has the executive power. The respondent claimed that she/he could try to influence the decision making but that the final decision on what kind of farm machinery that should be used is taken at a central level. The decision in 2004 to introduce minimum tillage at the farm was therefore made by the central authorities. There were no problems according to the respondent with implementing the system as training sessions of the machinery for the drivers were arranged.

4.1.2 Farmer 2 Heilongjiang

The respondent is 30 years old and has a master degree in farming systems. He/she is the manager of the technology department at the farm. The farm operates 20 000ha and is a home to 12 000 people, 6000 of these people are agricultural workers and 400 are professional drivers who are certificated to drive the new machinery. The main crops at the farm are soybeans, maize and rice. The farm mostly uses large modern machinery. The 36 tractors at the farm vary in size from 210 to 530 horsepower and are from Case and John Deere. The farm uses 6m drills from Great Plains and 6m cultivators from Case. A GPS system is used during all field operations and the plough has, according to the respondent, not been used since 2007.

Initiation

Water and wind erosion are big issues at the farm. According to the respondent drought is not a problem as the farm has a lot of black soil that contains 7-9% organic matter, which captures the moisture. The level of water is instead too high during the spring when all snow melts. A way to handle these issues is to alter the planting direction at the fields between years, (north to south or west to east). The respondent is searching for tillage equipment that efficiently handles the biomass left after harvest of maize. The currently used machinery leaves too much biomass on the surface, which according to him/her has increased the amount of weed. It is also a problem that the biomass becomes "jammed" in the cultivators.

The Innovation aspects

The respondent stated that minimum tillage is favourable compared to a traditional farming system. He/she thinks that it saves time and has positive effects on erosion. He/she also said that the implementation of the system was easy five years ago as the tractors and tillage equipment were purchased at the same time. A disadvantage is that the problem with weed has increased after the system was introduced and therefore necessitated an increase in pesticide use. The minimum tillage machinery is also more expensive to purchase than ploughs as the ploughs are domestic produced while the tillage machinery is from foreign brands. The respondent added that the most essential component of crop production is the yield, and it has increased on this farm since the minimum tillage system was implemented.

The Environmental aspects

Suppliers in the area have, according to the respondent, spread information about minimum tillage. They have arranged field presentations to show how the practice works and provide introduction classes when a machine has been purchased. The government also supports the practice and has in some areas called land reclamation, forbidden the use of ploughing as the areas have been heavily affected by erosion. The government has also enforced the use of minimum tillage on many state farms, like the farm he/she works at. As the plough has been used for a long time the respondent did not believe that the minimum tillage would have spread in the same extent as it has, if the government had not supported it and in some cases enforced it. According to the respondent banks enable loans to finance the purchase of farm machinery.

The Organisational aspects

The respondent believes that he/she has good knowledge about different tillage practices as he/she wrote his master thesis on the subject. But he/she claims that his knowledge is not important in the decision making process as the decision is made at a central level without his/hers participation. According to the respondent, the central governance has their own experts and conducts their own studies to be able to implement the most beneficial machinery. He/she thinks that the implementation of the minimum tillage practice at the farm was easy, and as the drivers took classes on how the machinery is used, there was no problem at all.

4.1.3 Farmer 3 Heilongjiang

The respondent is 43 years old and has a masters degree in agricultural science. His/hers position at the farm is agriculture machinery manager. The farm he works on is a state farm and operates 20 080ha. The population of the farm is approximately 15 000 people, 3 000 of them work actively at the farm, and there are 300 professional drivers. The crops that are grown at the farm are maize, soybeans and rice. The respondent state that ploughing has not been conducted at the farm since 2000. The tractors used are from John Deere and Case and are in sizes 180-485 horse power. The drills are 6.6m from Great Plains, and the cultivators are 5,3m wide from Case.

Initiation

The respondent considers the biggest crop production issue at the farm to be the dry conditions during the spring as it makes it difficult for the seeds to germinate. Soil erosion is present in the area but is, according to the respondent, not the main issue. He/she thinks that weed is an issue at the farm but that its impact has been reduced as more effective pesticides now are used. The respondent is now searching for machinery that can protect the soil moisture and efficiently cultivate the maize stubble.

The Innovation aspects

The respondent believes that minimum tillage is a very good practice as it saves time and is easy to use and understand. As the cultivation machinery and drills were purchased at the same time as the tractors there was no problem to start using them. The most important benefits with no/minimum tillage is, according to the respondent, that the soil moisture is better captured and that the soil gets "rich" as the soil nutrition is kept.

The only disadvantage compared to traditional ploughing is that the machinery in the minimum tillage system is more expensive and that the maize straws need to be cut before cultivation. The farm's productivity has, according to the respondent, increased since they converted to minimum tillage, but this can also be explained by the fact that the seeds and pesticides have improved.

The Environmental aspects

According to the respondent the government encourages the use of the minimum tillage. The government subsidizes the machinery purchase, and the additional cost can be financed by loans from the bank. Ploughs are now rare in the area. Since the state farm adopted it, minimum tillage has spread to the smaller farm units. The general opinion is that it is favourable compare to other existing systems. The respondent stated that there are suppliers in the area that deliver the machinery to the farm, and that it is easy to find service parts. When the no/minimum tillage machinery were purchased the seller showed the workers how they work.

The Organisational aspects

The implementation of minimum tillage at the farm was easy, as much knowledge already existed in the organization and both machinery and tractors were purchased at the same time. As the farm is a state farm the central authority has to give their permission for bigger decisions at the farm level. The decision to adopt minimum tillage in 2000 was conducted by the respondent office. All nine persons involved in the decision process were positive towards it, and as the government also was positive the adoption was possible.

4.1.4 Farmer 4 Inner Mongolia

The respondent is 62 years old and went to elementary school. He/she is the leader of the village, which consists of 2 000people and 1065ha. The main crops are, according to the respondent, maize and millet. The families in the village each individually rent the land from the government, but the village has, during the last years, tried to coordinate the production. The farm village uses the families owned machinery. The respondent therefore does not know the exact number of machinery used, but they are small and many. The tractors are in sizes of 25-50 horsepower, and the cultivators that are used are 2-3m, and the ploughs 2-3 furrows.

Initiation

The main problem at this farm according to the respondent is wind erosion and drought. The area is very windy and the respondent explained that the wind "takes away the land". According to the respondent the wind erosion is the reason to why the plough is used in the spring instead of the fall.

The Innovation aspects

The respondent stated that the farm could not afford minimum tillage equipment, as they are too expensive. According to the respondent minimum tillage is a good practice as it saves time, but according to other farmers in the area the practice decreases the yields. The problem

with erosion can, according to the respondent, be reduced with the minimum tillage practice, but he/she does not think that the village ever will be able to buy the machinery. If the practice should be implemented on the farm in the future the machinery will be rented from other farms in the area.

The Environmental aspects

The respondent answered that the government supports the practice of minimum tillage and has a test field in the area to show how it works and the result of it. The respondent claims that banks do not enable any loans for machinery purchase but that the government supports 30% of the total amount. The respondent is not aware of any suppliers in the area nearby the farm that supply minimum tillage equipment. According to him/her the general opinion among farmers in the area is that the minimum tillage equipment is expensive and that there is no increase in productivity with the practice.

The Organisational aspects

The respondent claimed that to be able to purchase bigger and more modern machinery the village needs to be more united, as all families need to purchase the machinery together. According to the respondent the village is currently trying to become more united, but it is taking time. There are other villages in the area according to him/her that have been more successful. But the respondent does not think that there will be any problem to implement new machinery in the future if it is proven to be beneficial. Right now funding is the biggest obstacle to purchase new machinery.

4.1.5 Farmer 5 Inner Mongolia

The respondent is one of two owners of the farm and is 60 years old. His/her education background is elementary school and three years at the agricultural university. The farm focuses on potato production and is in total 500 ha, most of the land is rented from other farmers. There are in total 23 employees working at the farm. According to the respondent the farm has six tractors with sizes of 80-120hp. According to the respondent the plough with 5 furrows is always used to till the land after harvest.

Initiation

According to the respondent drought is the main problem on the farm, and it is therefore important to use the existing moisture in the soil. Due to lack of rain water erosion is not a problem, but wind erosion is. Another significant issue with the potato production is the high input costs in terms of fertilizers and pesticides. According to the respondent his focus is on minimizing the costs and maximizing the yield when he/she chooses which tillage system to use.

The Innovation aspects

According to the respondent the minimum tillage practice is not possible to use at the farm, as it will increase the impact of weed, which is already high and causes high input costs in terms of pesticides. The soil in the area is also very hard due to the high clay content, and it needs to be aerated in order to produce potatoes. Because of this the plough is the only alternative. The dry weather conditions in the area make the plough even more beneficial as it, according to the respondent, captures the moisture in the soil better. An additional disadvantage with the practice is, according to the respondent, the high cost of the machinery. According to the respondent the minimum tillage practice has some benefits in other areas such as decreasing the amount of needed labour, but it is not, due to the earlier mentioned conditions, possible to

implement on this farm even if it would not be problem to use with his tractors and employees.

The Environmental aspects

According to the respondent the government has had test fields of minimum tillage in the area during the past 12 years. The result has been bad, decreased yield and increased levels of weeds. But the government still encourages the use of minimum tillage. Today the machinery bought that can be used in a minimum tillage system is supported to 50% by the government instead of 30% as all other machinery. According to the respondent it is possible to borrow money from the bank to finance machinery purchase. There are suppliers in the area that provide minimum tillage equipment, but it can be necessary to wait for delivery as all "special" equipment is not in stock. According to the respondent minimum tillage is not used at any other farms in the area, and the farmer's knowledge level of the practices is low. The use of plough is perceived as a more reliable practice.

The Organisational aspects

The respondent does not find any obstacles to implement the practice in the organization. It is only the farms location and its soil conditions that are not suitable for the practice. The respondent stated that he/she shares the ownership with one other, which makes the decision process very uncomplicated. If the minimum tillage practice was proven to be economically beneficial it could and would be implemented immediately at the farm.

4.1.6 Farmer 6 Inner Mongolia

The respondent is the owner of the farm and is 50 years old. The respondent education background is nine years in elementary school. The farm is 55ha and produces potatoes and wheat. During the busy times the farm has up to eight employees. The farm has one tractor with 90 horse powers, which is used to the 3m wide driller, tillage equipment and the 4 furrows plough. The respondent uses the traditional tillage system and claims that the plough is needed and always is used after harvest.

Initiation

According to the respondent his crop production has two main issues, the first is that the land is dry and the second is that the land is very hard with high clay continent and needs to be aerated. These two problems are, according to him/her reduced by using the plough, which helps the potatoes to get enough moisture in the spring as the plough goes deep enough to aerate the soil and breaks it. In the potato production weed is also a major problem. This issue is reduced with the plough as well in combination with usage of pesticides. The respondent claims that he/she knows about the minimum tillage systems, but that the current farming system used on the farm works better than minimum tillage in all terms.

The Innovation aspects

According to the respondent no/minimum tillage are not possible to use on his farm or at other farms in the area. This is because the soil is too hard and dry, and the impact of weed would increase if the plough was not used. Even if his tractor and driller can be used in a no tillage system he/she would not convert to it as it is not suitable and the machinery cost is too high. According to the respondent a traditional farming system is better and more reliable and also gives higher yields than the new systems. There are according to him no obvious benefits with using a minimum tillage system.

The Environmental aspects

The respondent revealed that the government supports the adoption of no/minimum tillage. He/she explained that instead of the standard support of machinery purchased at 30% the government supports minimum tillage machinery at 50% in the area. The respondent said that he/she knows about the government´s test sites in the area where they test no and minimum tillage, but according to him/her the result of the tests are not good. According to the respondent there are suppliers in the area, which provide minimum tillage machinery, but he/she said that no one promotes the practice. The respondent claims that no farmers in the area use the no/minimum tillage practice and that the average knowledge level about it is low. The farmers in the area find the traditional system good in this area and cannot see any reason to convert to another system.

The Organisational aspects

The respondent said that as he/she is the only owner of the farm he/she decides what machinery to purchase and what farming practice should be conducted. According to the respondent the only reason to why minimum tillage has not been adopted on his/her farm is that he/she finds it unsuitable. The only obstacle he/she finds to implementation of new machinery is lack of funds as new machinery is expensive.

4.1.7 Farmer 7 Inner Mongolia

Farmer seven is 47 years old and has 9 years of elementary school education. The respondent operates 133ha of farmland, most of which is rented from other farmers. The respondent revealed that the only crop he/she plants is maize. The people working at the farm are the respondent, the respondent spouse and one employee during the harvest. The respondent owns three tractors in sizes 20-90 horsepower, two types of 3 meter cultivators and a 5 furrow plough. A traditional tillage system is used at the farm, and the respondent explained that the maize stock is baled and sold to dairy companies in the area.

Initiation

According to the respondent the main problem at the farm is drought. He/she said that this problem is solved with usage of an irrigation system. Another issue at the farm is the impact of weeds. He/she said that this problem is reduces with pesticides and usage of the plough. The soil is also hard with high clay content according to the respondent and therefore has to be irrigated in order for producing maize.

The Innovation aspects

According to farmer seven the minimum tillage practice is not possible to use at the farm due to several reasons. The soil in the area is too hard and includes too much clay, which make the minimum tillage practice not work properly. There are also already issues with weeds and the use of minimum tillage practice would increase these problems. According to farmer 7 the soil at the farm needs to be aerated to enable the growth of maize, and the best way according to him/her to do this is to use the plough. He/she also said that as the farm only produces maize, which leaves lots of biomass at the field after harvest. The plough is a suitable tool to turn down these nutritions into the soil to make the most use of them. Ploughing also enables good planting conditions as it leaves less biomass at the surface. Another disadvantage with the minimum tillage according to the respondent is the high investment required. He/she concludes that minimum tillage has no obvious benefits and is not suitable in this area.

The Environmental aspects

According to the respondent the government supports minimum tillage practice, they support machinery purchases for no/minimum tillage use with 50% of the costs, and the rest can, according to the respondent, be financed by loans from the banks. He/she also said that there are suppliers in the area that provide machinery for minimum tillage to a limited extent. But, according to the respondent, the suppliers promote the traditional tillage and the use of the plough. According to the respondent no other farmers in the area use the minimum tillage practice, and the knowledge about it is limited. He/she thinks that most farmers do not know what minimum tillage is.

The Organisational aspects

According to the respondent there are no problems to implement the minimum tillage practice if it is proven to be more beneficial than the plough. As farmer seven is the owner of the farm he /she decides what machinery should be bought and used. The respondent thinks that he/she needs more knowledge about the practice and evidence that it is beneficial in order to implement it.

4.1.8 Farmer 8 Inner Mongolia

The respondent is 60 years old and has 9 years of primary school education. He/she owns the farm and operated together with his son. The farm is 15ha, and the only crop that is planted is maize. The only people working at the farm are according to the respondent are the three family members. The respondent together with his son owns two tractors with 90 and 30 horsepower, a 2,6m rotary tiller and a 4 furrow plough. The plough is always used to till the soil after harvest.

Initiation

According to the respondent there are two main issues in the farm´s maize production, the first is the dry climate and the second is the high abundance of insects and pests. The drought is, according to farmer 8, reduced with the irrigation system, while the insects and pests are reduced with pesticides and use of the plough. Erosion was also considered to be an issue in the area, but the respondent said that few actions are taken to reduce it. According to the respondent he/she has knowledge about minimum tillage and how the practice works but he/she does not think it is applicable in the area.

The Innovation aspects

The respondent said that the minimum tillage practice is not as good as the plough in many aspects. According to him/her the plough turns down the maize stock into the soil better and as it circulates the soil, the nutrients from the deep soil reach the seeds at the surface. The respondent explained that if the minimum tillage practice was used, these nutrients in the deep soil would not reach the seeds, and the maize stock would be left at the surface. He/she added that the plough also improves the soil structure as it aerates it. Another big difference between the plough and the minimum tillage practice according to the respondent is that the plough decreases the amount of weed whereas the minimum tillage practice instead would increase it. The yield would therefore, according to the respondent, decrease if minimum tillage was implemented at the farm. Another disadvantage with the minimum tillage system is according to the respondent the high machinery cost. Minimum tillage has, according to farmer eight, no benefits.

The Environmental aspects

The respondent said that the government supports the practice and has some test fields in the area, which show the result of the practice. But according to farmer 8 the results after using minimum tillage are poor, the maize is shorter and the maize cobs are smaller.
According to farmer 8 it is possible to find minimum tillage machinery at local dealers, but traditional machinery, like the plough, is much more common and promoted by the dealers. No other farmers in the area use the minimum tillage practice, and the general opinion about it is that it does not work in this area. According to farmer 8 famers in the area do not like to change the farming system as they have used the traditional one for a long time and know that it works.

The Organisational aspects

According to farmer 8 all the three family members decide together what kind of machinery to purchase and use. If the minimum tillage system was proven to be beneficial there would be no impediments to implement it at the farm. The existing tractor can also, according to the respondent, be used with the minimum tillage machinery.

4.2 Summary of interviews

In the following illustration are the answers from the eight interviewed farmers summarized to capture the most notable trends and facilitate the following analysis, see table four.

4.2.1Overview of farmers answers

Table 4.Summary of the empirical data. (own arrangement)

Theoretical relation	**Initiation**	**The Innovation Aspects**	**The Environmental Aspects**	**The Organisational Aspects**
Hypothesis/Farmer	**1. Agenda setting- Interest -Problem recognition- matching**	**2. Compatibility** **3. Economical & Biological factors** **4. Relative advantage/disadvantage**	**5. External support** **6. Social system**	**7.Implementation**
Farmer 1 Heilongjiang Age: 50 Education: High school and two years of adult agriculture machinery school Title: Agriculture machinery manager Farm size: 9 866ha Use minimum tillage	The main problems in the crop production is: • Erosion • Drought • The maize stock Searching for better machinery	Minimum tillage is: • Good in terms of drought and erosion • Less time consuming than the plough • Good for the biological activity in the soil • Increasing the yield and is more reliable • Easy to use and understand • Less effective towards the maize stock compared with the plough	• Suppliers and the government support the practice. • The bank enables loan for machinery purchase • Farmers in the area use and value the practice	• The decision to use minimum tillage was made at a central level. • No problem to introduce the practice, as enough knowledge exists in the organisation.
Farmer 2 Heilongjiang Age: 30 Education: Master degree in farming systems Title: Manager of the technology department Farm size: 20 000ha Use minimum tillage	The main issues in the crop production is: • Erosion • Water from melting snow • The maize stock Searching for new better machinery	Minimum tillage: • Is effective towards erosion • Saves time • Is easy to use • Has increased the issues with weeds • The machinery are expensive	• Suppliers and the government are positive towards the practice. • The bank enables loan. • Farmers in the area are used to the plough, but are starting to use and value minimum tillage.	• The practice was easy to implement, enough knowledge existed in the organisation. • Offered classes to the drivers

Farmer 3 Heilongjiang Age: 43 Education: Master degree in agricultural science Title: Agriculture machinery manager Farm size: 20 080ha Use minimum tillage	The main problems in the crop production is: • Drought • Erosion • Weeds Searching for new better machinery	Minimum tillage: • Saves time • Easy to use and understand • Keeps the soil moisture • Keeps the nutrition in the soil • Has increased the productivity	• The government and suppliers encourage the use of minimum tillage • Farmers in the area find the practice better then other alternatives • The bank enables loan	• The practice was easy to implement, enough knowledge existed. • Tractors and machinery was bought at the same time.
Farmer 4 Inner Mongolia Age: 62 Education: Elementary school Title: Village leader Farm size: 1 065ha Do not use minimum tillage	The main problems in the crop production is: • Drought • Erosion	Minimum tillage: • Machinery is too expensive • Saves time and reduce erosion • Reduces the yield"	• The government supports the practice. • Suppliers don't provide minimum tillage machinery • The banks don't enable loans on machinery purchase • Farmers in the area find the practice expensive and not profitable	• The organisation is not united enough to purchase minimum tillage machinery • The practice could be used if funds was available
Farmer 5 Inner Mongolia Age: 60 Education: Elementary school ad three years at agricultural university Title: Farm owner Farm size: 500ha Do not use minimum tillage	The main problems in the crop production is: • Drought • Erosion • Weeds • High input costs	Minimum tillage: • Increases the amount of weed • Increases the input costs and reduces the yield • Doesn't aerate the soil enough • Saves time • Can be used but is not beneficial	• The government support the practice. • Banks enable loan on machinery. • Suppliers provide minimum tillage machinery. • Farmers in the area don't use the practice.	• There are no obstacles in the organisation to implement the practice.
Farmer 6 Inner Mongolia Age: 50 Education: Elementary school Title: Farm owner Farm size: 55ha Do not use minimum tillage	The main problems in the crop production is: • Drought • Hard soil, need to be aerated • Weeds	Minimum tillage: • Can not be used as the soil is to hard and dry • Issues with weeds increase with the practice • Is not that reliable as traditional farming systems • The plough is always more beneficial • The machinery is to expensive	• The government support the practice. • Suppliers provide minimum tillage machinery, but don't promote it. • No farmer in the area use minimum tillage.	No problems to implement the practice in the organisation.
Farmer 7 Inner Mongolia Age: 47 Education: Elementary school Title: Farm owner Farm size: 133ha Do not use minimum tillage	The main problems in the crop production is: • Drought • Hard soil • Weeds	Minimum tillage is not possible to use because: • The soil is to hard and need to be aerated with a plough. • The clay in the soil degrades the result of the practice. • Issues with weeds increase with the practice. • The yield is to low • It leaves too much biomass on the surface after growing maize.	• The government support the practice. • Suppliers provide minimum tillage machinery, but don't promote it. • No farmer in the area use the minimum tillage practice. • The knowledge about the practice is in general low.	If the practice was beneficial it would not be any problems to implement it in the organisation, but more knowledge is needed.
Farmer 8 Inner Mongolia Age: 60 Education: Elementary school Title: Farm owner Farm size: 15ha Do not use minimum tillage	The main problems in the crop production is: • Drought • Weeds and insects	Minimum tillage do not work on his farm because: • It doesn't turn down the stubble enough. • It don't turn up the nutrition in the soil • It increase the amount of weed Which decrease the yield	• The government support the practice. • Some suppliers may provide minimum tillage machinery, but no one promotes it. • The farmers in the area don't like the practice and don't use it.	There are no problems to implement the practice in the organisation.

4.2.2 Summary interviews Farmers

In this chapter a summary of the empirical result will be presented to highlight the most important data from the interviews. The farmers' opinion of minimum tillage are based on the four different aspects; initiation, innovation- , environmental- and organisational aspects and these are linked to the hypotheses presented earlier. These four aspects have been graded on a scale from one to five, where five is very good and one is not good. The farmers have been able to rate minimum tillage within these aspects. The result of this measurement can be observed in the following graph, see figure five.

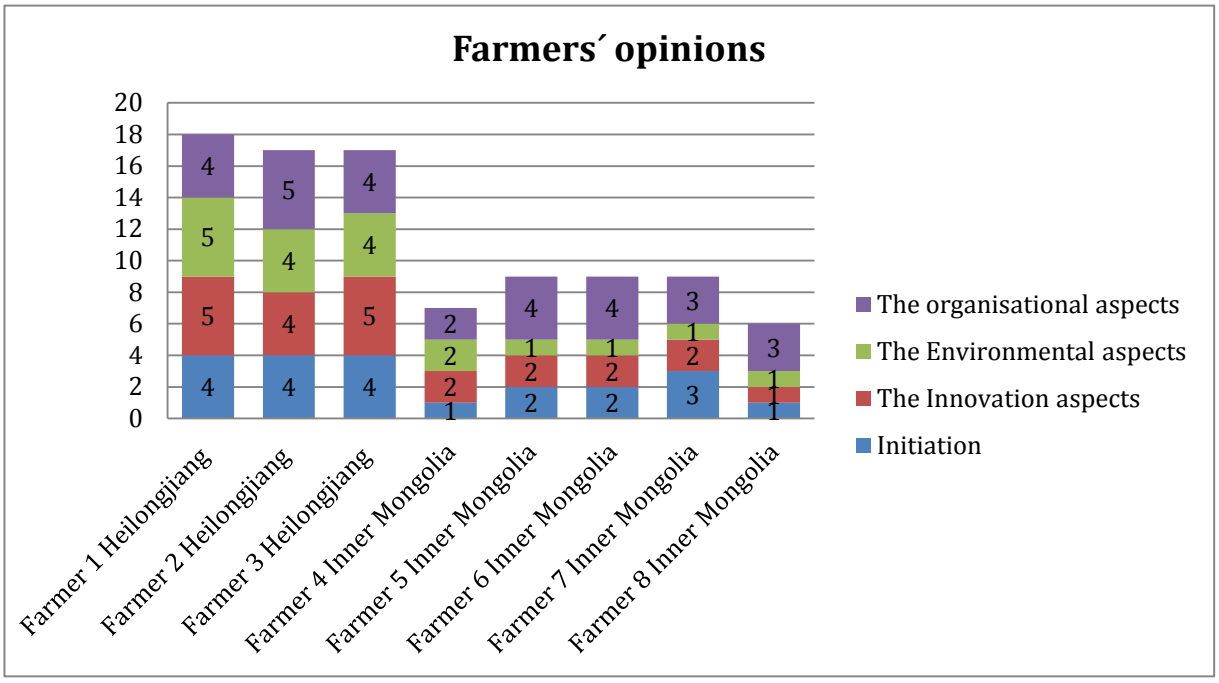

Figure 5. The graph summarizes the farmers' opinion of minimum tillage. Each farmer has rated the practice on a scale from 1 to 5, with focus on the four different aspect presented earlier. Own arrangement

The graph reveals that there tends to be a difference between the farmers in the two areas in terms of opinion of minimum tillage. The farmers in Heilongjiang found minimum tillage to be the solution to the existing problems in the crop production to a high extent, which can be observed in the initiation sector in the graph. The Heilongjiang farmers also found the practice beneficial in terms of innovation aspects, which include economic and biological factors, compatibility and relative advantage in relation to other alternatives. These farmers also found the practice suitable in their organisations and perceived a positive view of the practice in the surrounding environment. A generally positive opinion among the interviewed farmers in Heilongjiang towards minimum tillage can therefore be stated.

In Inner Mongolia the graph reveals that the farmers do not perceive minimum tillage to be the solution to existing problems in the crop production as the initiation staple is low. In terms of the innovation aspects the farmers did not find minimum tillage to be advantageous, instead was it perceived to be less beneficial than other alternatives. The graph also reveals that the Inner Mongolian farmers perceive a negative view of minimum tillage in the environment among, for example neighbours and suppliers. The only section with a tendency of a more positive opinion among the Inner Mongolian farmers is the organisational aspects where the bars are noticeably higher compared to the other aspects. This implies that these

farmers do not find minimum tillage difficult to implement in their current organisation structure. Despite this, a general negative opinion of minimum tillage among the interviewed farmers in Inner Mongolia can be stated.

4.3 Qualitative interviews suppliers – validity

Similar interviews were conducted with four suppliers in the two areas to validate the data from the interviewed farmers. These suppliers were asked similar questions about minimum tillage as the farmers in terms of initiation, innovation-, and environmental aspects, but not about the organisational aspects as the study did not focus on the suppliers organisations, see interview guides in appendix two. The suppliers rated the three aspects from one to five like the farmers, where one was not good and five was very good. Below follows a summary of these interviews to be able to validate the farmers' answers, see figure six.

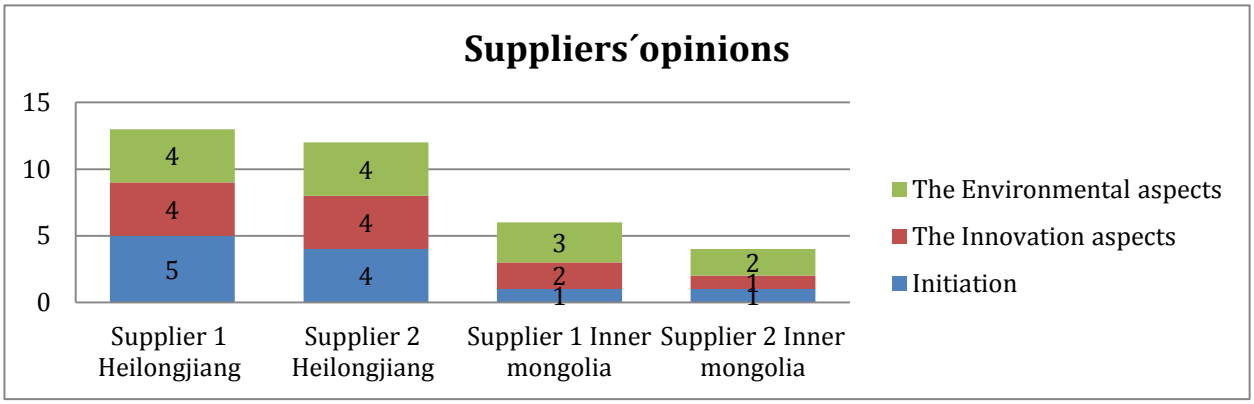

Figure 6. The graph summarizes the suppliers´ opinion of minimum tillage. Each supplier has rated minimum tillage on a scale from 1 to 5, with focus on the three different aspects presented earlier. Own arrangement

The data in the graph reveals that the interviewed suppliers' opinions were well in line with the interviewed farmers´. The suppliers in Heilongjiang rated the minimum tillage practice high in all three aspects likewise the interviewed farmers in that area did. Meanwhile the suppliers in the Inner Mongolia province rated as the farmers in that area and ranked minimum tillage low in terms of initiation, innovation and environmental aspects. The outcome of this is that a similar tendency can be observed among the farmers and suppliers in each of the two areas respectively, which strengthens the validity of the study.

Another important factor in terms of validity in this study is the geographical distance between the two study areas, which displays that the available information and experience of the practice can differ to a high extent in relatively condensed area. The opinions can therefore differ due to an uneven dispersion of knowledge. The geographical distance and differences in local conditions between the two areas also affect the used farming systems, culture and traditions. These factors can affect the general opinion of new innovations such as minimum tillage and can explain some of the differences between the two areas and should be included in the validity of the data.

4.4 Reliability and Validity

This last part of the chapter describes the concerns and actions taken against reliability and validity in this study.

4.4.1 Reliability

The reliability is considering the data consistency, trustworthiness and external influences (Brinkman & Kvale, 2009). This is important in two aspects, the first one is that the interviews should be conducted equally to enable the same situation for all the respondents and reduce the interviewer effect, where the interviewer is influencing the respondent´s answers. The second aspect is that the performance should be able to be repeated by another research and give the same result. In this study interview guides were used to conduct the interviews equally with each respondent. As the interviews were conducted with an interpreter it was important to practice the interviews so that they were performed in a proper way and that the respondents' entire answers and opinions were in fully transferred and interpreted. The interviews were also transcribed as fast as possible and were checked by the interpreter in order to reduce the risk to loss of data. The respondents participated confidentially in this study, which makes it impossible to redo the study with the same individuals. The positive effect with this approach is that it increases the possibility that the respondents answer the questions truthfully (Brinkman & Kvale, 2009).

4.4.2 Validity

Validity is a measurement on how well the study´s approach is consistent with its outcome and conclusion (Brinkman & Kvale, 2009). A valid outcome is based on all parts of the study. Validly should be thought of when the theoretical framework, method, empirical data and analysis are chosen to make the outcome defensible and convincing. Design of the interview guide also reflects validity. If it is well suited with the study's aim and purpose, the validity increases.

The theoretical framework in this study was carefully chosen in order to create a solid foundation for the analysis of the empirical data. As the data was collected in an unfamiliar country and culture for the authors, the method had to be carefully chosen. An interpreter was used to reduce language barriers, and the questions were constructed to reduce misunderstandings and avoid being culturally offensive. In the end of each interview an oral summary was also conducted to confirm the main findings and the interviews were written as fast as possible in order to reduce the loss of data and increase the validity.

To increase the validity different sources were asked about the same issues as it is considered a good method to validate the answers (Brinkman & Kvale, 2009). The triangulation was conducted by asking both farmers and suppliers of agriculture machinery the same questions to observe any differences, in order to validate and cross-reference the data. To increase the validity even more, discussions were held with faculty at the Inner Mongolian Agricultural University.

5 Analysis and Discussion

This chapter aims to analyse and discuss the result from the empirical data in chapter five. The data is analysed with the theory and literature presented in chapter two, and is structured on the hypotheses presented in chapter two. These hypotheses intend to be accepted or rejected, but as the empirical data is based on qualitative data in which no statistical tools have been used, no statistical significant conclusions can be drawn. The decision to accept or reject the hypotheses is therefore only based on the eight interviewed farmers, and no wider general conclusion will be made.

5.1 Initiation

H:1. *Adoption of innovation is related to interests of solving existing problems (Rogers, 2003). To recognize a problem and matching it with an innovation solution is essential for the adoption process.* Farmers who are interested and aware of existing problems and find minimum tillage to be part of the solutions to them will therefore have a more positive opinion of it (Diederen *et al*, 2003 & Zheng *et al*, 2012).

Rogers (2003) claims that interest and problem recognition are essential in the adoption process. This leads to the assumption that if minimum tillage is seen as a solution to existing problems the farmers would have a more positive opinion of it. These theories were also captured by Diederen *et al* (2003), who claimed that if farmers have knowledge about problems and how different innovations can reduce these, the adoption rate increases. Even Zheng *et al* (2003) highlighted that knowledge about an innovations advantages and disadvantages has a positive influence on adoption of new seeds in China.
This tendency can be confirmed with the empirical data, all the interviewed farmers in the Heilongjiang province find the minimum tillage practice suitable regarding the local issues with drought, erosion and time consumption in the crop production. These farmers also have a positive opinion of the practice, even if the practice is not the solution to all their issues, see figure five. In the Inner Mongolia province the farmers do not find the practice to be a suitable solution to the problems in their crop production. It is instead considered to reduce the productivity and increase problems with weed and drought. Hence the farmers have a more negative opinion of the minimum tillage practice, see figure five. Farmers in both areas show interest in the problems and obstacles related to the crop production and available solutions to these have been evaluated. The empirical data confirms what the theory and hypothesis one imply that the opinion of the practice is affected by its perceived ability to solve existing problems. Hypothesis one is therefore accepted.

5.2 The innovation aspects

H:2. Innovations that are more compatible with the existing system are easier to implement on the farms (Rogers, 2003). Farmers who perceive minimum tillage compatible with their existing farming system will therefore have a more positive opinion of it (Lal, 1998).

According to Rogers (2003) the compatibility of an innovation affects the adoption of it. The compatibility of the minimum tillage practice with the farms presently used farming system will therefore affect the farmer´s opinion of it. If the farmer has to conduct large changes to introduce the practice, it would affect his/her opinion negatively. Lal (1998) concluded that there often are similarities between the previously used technologies and the newly adopted, as the already existing capabilities decrease the implementation issues.

This phenomenon is difficult to observe in the empirical data as all the interviewed farmers find the minimum tillage practice possible to introduce and use at their farms. The farmers in the Heilongjiang province who use the practice have bought the tractors at the same time as the minimum tillage equipment and have therefore no problems with the compatibility. The Inner Mongolian farmers who do not use the practice claim that their choice to not use the practice is based on other factors than compatibility and that the practice is possible to use at their farms. The empirical data can therefore not confirm nor reject what the theory and hypothesis two imply, as the famers in the study do not indicate that compatibility would affect their opinion of minimum tillage. When the farmers are asked about the compatibility of the system, all interviewed farmers claim that the tractors presently in use at their farms can be used in a minimum tillage system. This highlights the fact that the farmers find the tractors to be the most important factor in terms of compatibility and the biggest obstacle to implement minimum tillage. This finding is in line with Premkumar´s *et al* (1998) study, which also examined the innovation compatibility effect on adoption but did not find any statistical correlation. Hypothesis two can therefore neither be accepted nor rejected.

H:3. *The perceived economic and biological factors of the innovation affect the opinion of it (Rogers, 2003*). Farmers who find minimum tillage more economically and biologically beneficial will have a more positive opinion of it (Lal, 1998 & Smith *et al* 1992 & Soane *et al*, 2010).

H:4. Relative advantage is to what extent the innovation is perceived to be better than other available alternatives (Rogers, 2003). An innovation with a perceived relative advantage has a higher rate of adoption. Farmers who find minimum tillage to have a relative advantage will therefore have a more positive opinion of it (Premkumar *et al*, 1998).

Rogers (2003) claims that how the farmers perceive the benefits of an innovation affect their opinions of it. In these terms the economic and biological benefits that the farmers perceive will affect their opinions of the minimum tillage practice. Smith *et al* (1992) concluded that economic benefits with minimum tillage affect the adoption rate to a high extent. The study also claimed that biological benefits affect the opinion of it, but not by themselves, in order to have an effect on the farmers opinions, an economic benefit as a result of the biological effect was needed. This result was also found in Lexmon & Andersson (1998) study, which concluded that economic incentive had a strong correlation with adoption whereas biological had not.

It can be observed in the empirical data that both economic and biological factors affect the choice of tillage system to a high extent, but no factor can be identified to be more dominant, as erosion, drought, clay content, time consumption, aeration, biological activity, initial cost and yield are mentioned by the farmers as important factors in their choice of tillage system. The empirical data instead tend to confirm what the Premkumar *et al* (1998) study claimed that the practice´s relative advantage affects the opinion of it and the choice of adoption. Even Rogers (2003) claimed that the practice´s relative advantage is important in the decision process and that different individuals perceive relative advantage differently, depending on personal attributes and values.

In the Heilongjiang province where the practice is in use, biological factors such as erosion and drought, but also economic factors like initial cost and time consumption, are said to be essential in the decision process of tillage system. In this area the farmers find the plough to be beneficial to issues such as cultivation of maize stubble, but the farmers still chose to use

the minimum tillage practice as it, according to them, has more benefits and therefore has a relative advantage. In the Inner Mongolia province the plough is instead found to be more beneficial than the minimum tillage system with biological factors such as drought, erosion and aeration and economic factors such as initial cost. Minimum tillage is therefore not considered to have a relative advantage in this area even if the farmers point out that the practice has some benefits such as reduced time consumption.

Chi & Yamada´s (2002) study concludes that farmers were more positive towards investment with low initial cost as it decreases their risk exposure. A similar tendency could be observed in the empirical data as seven out of the eight interviewed farmers expressed that the machinery used in the minimum tillage practice has a high initial cost and that this could be an obstacle for adopting it. The organization's liquidity is stated to affect its ability to adopt new innovations as higher liquidity encourages and enables new investments (Abudulai & Hoffman, 2005) (Feder, 1980). The empirical data does not reveal any information on liquidity, but it can be observed that larger organizations have adopted the practice to a higher extent, which can be correlated with liquidity and improved availability of credit.

With the gathered empirical data, Hypothesis three can with the empirical data be accepted as both the economic and biological factors tend to be considered in the decision of tillage system among the interviewed farmers. However no single specific factor appears to affect the decision more than another, as the Smith *et al* (1992) study stated that the economic factors influence the adoption of minimum tillage more than the biological. What the empirical data instead reveals is hypothesis four´s implication that the relative advantage of an innovation is important and determines its potential adoption. The minimum tillage practice is adopted at farms where it is consider to be the best tillage system available and is abandoned at farms where other systems are consider to be better.

5.3 The environmental aspects

H:5. External support is to what extent the innovation is supported by external sources such as governments, credit institutions, partners and suppliers (Rogers, 2003). External support has a positive correlation with adoption. Farmers that find more external support to minimum tillage will therefore have a more positive opinion of it (Chi & Yamada, 2002 & Feder, 1980 & Premkumar *et al*, 1998 & Sheikh *et al*, 2002).

H:6. Culture, norms and communication influence the adoption of new innovations (Rogers, 2003). Farmers who have neighbours or friends using minimum tillage system will be more positive to adopt it (Bryce & Gross, 1943 & Sheikh *et al*, 2002).

Roger (2003) states that external support affects the opinions of innovations. A farmer will therefore be more positive towards the minimum tillage practice if he/she perceives the institutions in his/her surrounding area to be supportive to the practice. Premkumar *et al* (1998) claims organisations that perceive external support for implementation are more likely to adopt innovations. This implies that if the farmers perceive that the government subsidies and bank loans support the practise, they will be more positive towards adopting it. Feder (1980) also concludes that credit institutions are important in order to reduce capital constrains and encourage the adoption process.

All the interviewed farmers in the two areas perceive the government and banks to be supportive of the practice and that suppliers can supply them with the needed machinery. But even though the farmers agree on the positive external support, only farmers in the

Heilongjiang province perceive and rate the environmental view towards minimum tillage high, see figure five. The difference between the farmers can instead be described with what Bryce and Gross (1943) state, that the culture and social structure among neighbours affect the opinion and adoption decision of those around them. In the Heilongjiang province where the practice is in use the farmers perceive a positive view of minimum tillage among their neighbours who also use the practice. The farmers in the Inner Mongolia province who do not use the practice instead perceive that their neighbours have a negative opinion of the minimum tillage practice and so they do not use it.

Diederen *et al* (2003) concluded that opinions and the adoption decision is not based on the knowledge about the innovations existence, it is instead the experience of its performance that has the greatest influence. All the interviewed farmers have an opinion about the performance of the minimum tillage practice and have knowledge about its existence. A difference between those farmers in Heilongjiang who have adopted it and the farmers in Inner Mongolia who have not is their experience about the practice performance. Farmers in Heilongjiang have positive experience of the practice´s performance from the area meanwhile the farmers in Inner Mongolia have a limited experience and find the practice less effective. This is in line with Giller *et al* (2009), who claimed that a more complex innovation such as minimum tillage need more practical evidence before adoption. Even Sheikh *et al* (2002) claimed that the availability in the area of an innovation increases the adoption rate. This is also confirmed by Smith *et al* (1992), who claimed that the possibility to try the minimum tillage practice before the adoption decision increases the adoption rate. More practical evidence and experience of the practice in Heilongjiang tend to have affected the adoption rate positively.

The empirical data in this study therefore shows the tendency that neighbours affect the interviewed farmers' opinions to a higher extent than the institutions do. Hypothesis five can therefore be rejected, as institutions such as banks and governments do not tend to affect the adoption among these farmers. The empirical data instead confirms what hypothesis six implies, that farmers base their adoption decision on experience and knowledge from neighbours. Hypothesis six is therefore accepted.

5.4 The organizational aspects

H:7. The existing structure of the organisation affects the implementation of the innovation (Abrahamsson & Andersen, 2005). If the implementation is perceived to be difficult it reduces the adoption rate. Farmers that perceive the implementation of minimum tillage to be difficult will therefore have a more negative opinion of it (Diederen *et al*, 2003 & Frambach *et al*, 2002 & Moch & Morse, 1977 & Premkumar *et al*, 1998).

Rogers (2003) claimed that the structure of an organization affects the opinon and adoption of an innovation to a high extent. If the organization perceives the implementation of an innovation to be difficult, it affects the adoption rate negatively. This implies that farmers who perceive the implementation of the minimum tillage to be difficult would have a more negative opinion of it. The empirical data reveals that the interviewed farmers are most positive towards minimum tillage in terms of the organizational aspects see figure five, as the organizational aspect had the highest average rates among the interviewed farmers in the two areas.

Abrahamsson & Andersen (2005) claim that larger organisations adopt innovations faster as they have access to more knowledge and experience as well as available resources such as

time. Frambach *et al* (2002) adds that larger organizations work more actively to improve their performance and therefore adopt new innovations faster, which also was supported by Korshing *et al* (1983) who found organizational size to be positively correlated to adoption. The empirical data indicates that both the large and small farms find the practice suitable in the organizations. But it is only the larger sized farms in the Heilongjiang province who have adopted the practice. The tendency among the interviewed farmers is therefore that farm size has a positive effect on adoption, which is in line with the studies by Abrahamsson & Andersen (2005) and Frambach *et al* (2002) findings. Zepeda's (1987) study concluded that both size and productivity had a positive correlation to adoption. Farmers who had a higher production were more positive towards new innovations, which also is in line with the tendency in the empirical data as the productivity is higher at the Heilongjiang farms where the practice is in use.

Moch & Morse (1977) concluded that the structure of an organization affects the adoption of innovations and that more centralized organizations adopt innovations in a lower rate than decentralized. An explanation to this is that the distance between the decision maker and the operational field is larger. This tendency cannot be observed in the empirical data as the more centralized state farms in the Heilongjiang province have adopted the practice, and the decentralized family farms in the Inner Mongolia province have not. The empirical data can therefore not confirm Moch and Morse´s (1977) conclusion. Mathijjis *et al* (2001) also examined the difference between state farms and family farms. The study concluded that the state farms had a lower adoption rate of innovations than the family farms, due to the weaker link between work effort and the workers income in these organizations. The adoption rate was higher at the family farms as the innovations benefits were more obvious for the individual workers. The empirical data in this study shows the opposite tendency, as it is instead the state farms that have adopted the new innovations rather than the family farms. But it was also observed that the family farms located nearby the state farms in many cases had adopted the minimum tillage practice and also used the possibility to rent machinery from the state farms. This indicates that organization structure affects the decision process, but that other factors are more determined such as, influences from the surrounding environment and the possibility to get experience of the technology without having to invest in the machinery.

Hypothesis seven cannot be accepted or rejected as all the farmers find the practice feasible in their organizations. The only tendency that can be observed in terms of the organizational aspects is that the farms that have adopted the practice are bigger farms with a centralized authority.

6 Conclusions

This chapter aims to draw conclusions based on this study to address the aim and research questions stated in chapter one.

The aim of this study is to increase the understanding of the diffusion of the minimum tillage practice in agricultural China.

6.1 Research questions

This study´s aim will be reached by answering the following four research questions:

6.1.1 Do the Chinese farmers find minimum tillage suitable in their crop production?

The study reveals that the minimum tillage practice is perceived to be a suitable practice to reduce problems in the crop production according to the interviewed farmers operating in the Heilongjiang Province. The analysis indicates that there is an interest in solving existing problems among these farmers, such as erosion and drought, to which they perceive minimum tillage can be a solution. Even economic benefits such as lower input costs and increased yields are found to affect the decision to adoption. In the Inner Mongolia province the interviewed farmers have an interest of solving problems in the crop production as well, but the analysis shows that minimum tillage is not perceived to be the solution to their main issues such as drought, needed aeration and the high clay content. The plough is considered to handle these issues more capably and the farmers do not have any good experience of minimum tillage conducted in the area. The conclusion is therefore that the crop production in northern China faces similar problems but that the farmers´ perception of minimum tillage as being a solution to these problems differs in different locations. The main differences between the two provinces in this study are the scale of production and the educational level. This study therefore indicates that these two factors are affecting the farmers' view of minimum tillage. Even the production rate was found to influence the farmers opinion of the practice. In Heilongjiang where the productivity was higher the general opinion of minimum tillage was found to be more positive compared to Inner Mongolia where the productivity was lower.

6.1.2 What characteristics do the Chinese farmers find important with the minimum tillage practice?

The analysis shows that the interviewed Chinese farmers base their opinion of minimum tillage and their choice of tillage system on both economic and biological factors. The difference between the farmers who have adopted the practice and those who have not, is to what extent the farmers perceive the economic and biological benefits with the different systems. The Inner Mongolian farmers found the high clay content and the drought to be the main disadvantages for the minimum tillage practice. The smaller family farms in Inner Mongolia also pointed out financial constrains to be an obstacle to implementation of minimum tillage as the equipment is expensive. In Heilongjiang where the practise is in use important characteristics with minimum tillage were reduced time consumption, decreased need of inputs and suitability in the farming system. As both areas primarily produces maize the practise compatibility with that crop is important. This study therefore identifies financial strength of the farms, the farmers perceptions of the economic and biological benefits and the practice suitability in the farming system as factors that affect the diffusion and implementation of minimum tillage in China besides the characteristics of the practice.

The farmers base their decision on adoption by comparing the practice´s relative advantage to other systems. In the decision process, both the biological and the economic factors are considered critical. A tendency observed in the empirical data is that biological factors are impacting the decision to a higher extent if they are associated with economic benefits. Factors regarding how compatible the practise is with the existing system cannot be stated to affect the choice of tillage system, as all the farmers find the minimum tillage practice possible to use on their farms without any problems with the currently used machinery that affect their decision

6.1.3 What external factors affect the Chinese farmers' opinion of minimum tillage?

All the interviewed farmers reveal that the government and credit institutions support minimum tillage, but the analysis showed that it is mainly the neighbours from surrounding farms who affect the decision to adopt minimum tillage. The conclusion based on this study is therefore that the interviewed farmers base their opinion and decision of adoption more on personal relations with other farmers and practical experience from neighbours then on connections with and influence from institutions.

6.1.4 Is there a problem to implement the minimum tillage practice in the Chinese farm organizations?

In the empirical data the farmers state that organisational factors have a low impact on their opinion of the minimum tillage practice, and no organisational factors are stated to influence the implementation. The analysis reveals that the opinions and adoption rate among the interviewed farmers are improved by a more centralized structure as the state farms in the Heilongjiang province have adopted minimum tillage, whereas the decentralized family farms in the Inner Mongolia province have not. This leads to the conclusion that there is no problem to implement the minimum tillage practice among the interviewed farm organisations, but that the central decision structure among the state farms has encouraged the decision of adoption. This might be explained by the government's encouragement of the transformation to more modern technology in recent decades and its encouragement of practices that improve economical and biological outcomes. As the government is controlling the state farms, the adoption of new technology may have accelerated due to several reasons such as added financial strength and more educated staff. In Inner Mongolia where the farms were smaller the farm organisations was affecting the use of tillage system in a limited scale, other obstacles at the farm level such as tradition and knowledge in the organisations were found to affect the use of tillage system more.

6.2 Implication for market entry -technology diffusion

As described in chapter one market entry is driven by different initiatives for companies to expand their businesses into new markets. This study reveals that the diffusion of the minimum tillage practice is ongoing in northern China. As the knowledge of the practice is spreading the number of adopters increases. This process increases the demand of new machinery. This creates opportunities and potential markets for foreign producers of this kind of machinery and also related machinery, such as tractors, that are needed in the farming system in general. The diffusion of minimum tillage in China therefore enables and encourages foreign machinery companies to expand their business to China.

The diffusion of minimum tillage is ongoing in the northern parts of China, and the knowledge and experience of it is spread through social networks primary, with secondary influence from institutions. Knowledge and demand of the practice can over time diffuse across the country and over borders entering new countries around China with similar conditions and need of new more advanced technology in the agricultural sector.

6.3 Future research

This study uses a qualitative approach to capture the interviewed farmers' opinions of the minimum tillage practice. This approach does not enable the possibility to draw general conclusions, which open for future opportunities. To increase the understanding of the diffusion of minimum tillage in China, a more quantitative study could be conducted. This would enable more general conclusions and a deeper understanding of the stated problem. Another interesting angel of this research area would be to study the Chinese farmers attitude towards the minimum tillage practice.

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Jeff Mahon
Canada- China business ambassador
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Johan Arvidssson
Professor soil and environment, SLU
Personal Meeting 2012-06-21

Robert Dykes
Consultant, Exportrådet / Swedish Trade Council
Email 2012-06-25

Sun Bei
Director European and African Affairs Division Jiangsu Provincial Foreign Affairs Office
Email 2012-06-25

Trent Meyer
Director of International Sales, Seed Hawk Inc.
Personal meeting 2012-04-26

Appendix 1: Interview guide farmers

Date; No;

Province; Area;

Description of farmer

1. What is your position on the farm/ in the organisation?

2. How old are you?

3. What is your school background?
- How many years in school?
- University experience?
- Agricultural education?

4. Do you have a job or have any former job experience outside the farm?

If yes: what type of job and for how long time?

5. Are you a member of any agriculture organization?

Description of the Farm

6. How large is the farm in ha/mu?

7. What are the main operation fields?

8. What crops do you grow at the farm?

9. How big on average is the harvest yield per ha/mu for the different crops?

Crops	Yield/ha or Yield/mu

10. How large area ha/mu is planted during the fall/ spring?

11. How many employees are there on the farm?

12. What machinery are used at the farm?
- Tractors

Tractor/equipment	Age	Size	Brand

- Equipment
  - Type
  - Size (meters)
  - Domestic/ International

13. Can you describe the tillage system?
- Ploughing?
- Minimum/no tillage?
- How many passes?
- What kind of tillage machines?

14. How does a normal cropping year look like, describe the practices that are used?

Practice	Time of the year	Passes

Initiation

15. Are you aware of any problems concerning tillage system on the farm?

16. What are the biggest issues for the crop production on this farm?
- Soil erosion?
- Drought?

- Use of fossil fuels?
- Field operations time consumption?
- Inputs cost?
- Weed?

17. Do you make any effort to handle these issues?

18. What issues/problems affect your choice of tillage system?

19. Do you search for new technology that can solve existing problems?

20. To what extent do you consider the minimum tillage practice to be a solution to the existing problems at your farm, on a scale 1-5 (5= a perfect solution, 1= no solution)

1 2 3 4 5
No solution A perfect solution

FILM! Tillage systems
Do you use minimum tillage on the farm?
Yes: Y
No: N

The Innovation Aspects

21.
N: Do you think that minimum tillage system is possible to use on your farm today?
Y: How do you perceive the use of minimum tillage on the farm?

22.
N: What changes do you need to do in order to adopt minimum tillage?
Y: What changes did you need to do?
- Machinery, labour, routines

23.
N: What are the obstacles for implementation?
Y: What were the obstacles for implementation?

24. What economic factors do you find important with minimum tillage?
- Initial cost?
- Input costs?

25. What biological factors do you find important with minimum tillage?
- Soil condition?
- Erosion?

26. Do you consider minimum tillage to be a solution to some of the problems, mentioned earlier, that exists on this farm?

27. Do you think that traditional farming systems (ploughing) is more reliable than new technology?

28. Do you find the minimum tillage system difficult to use and understand?

29. What do you consider the advantages of minimum tillage to be?

30. What do you consider the disadvantages of minimum tillage to be?

31. Do you find any risks related to minimum tillage?

32. What do you think of minimum tillage compared to other systems?

33. How suitable do you considered the minimum tillage practice to be on this farm keeping the questions 21-32 in mind? (1=not good, 5=very good)

1 2 3 4 5
Not good Very good

The Environmental Aspects

34. Is there any external support for adopting minimum tillage?

35. Is the government supporting the technology?
- Subsidies (list of machinery)
- Information

36. Does credit institutions enable financial support of the technology?
37. Is there a supplier in the area that offers support, service and purchase of the technology?

38. Do any of your neighbours use minimum tillage systems?

39. What is the general opinion towards minimum tillage among farmers in the surrounding area?

40. Do you consider yourself to have enough information about minimum tillage?
- From where do you get the information?

41. How do you perceive the general opinion towards minimum tillage in the area, keeping questions 34-41 in mind? (1=not good, 5=very good)

1 2 3 4 5
Not good Very good

The Organizational Aspects

42. N: Do you find it possible to implement the technology in the organisation/at the farm?
Y: How did you find the implementation of the technology?

43. N: What are the obstacles for implementation?
Y: What were the obstacles with the implementation?

44.
N: Do you consider that you have enough knowledge at the farm/in the organization in order to implement minimum tillage?
Y: Did you have enough knowledge at the farm/in the organization in order to implement minimum tillage?

45. How many people are involved in the decision-making process?

46. Is it difficult to convince the decision makers/ the rest of the organisation about adopting minimum tillage?
- Why

47. How feasible do you perceive the minimum tillage practice to be in this organisation with question 42-46 in mind? (1=not good, 5=very good)

1 2 3 4 5
Not good Very good

General Conclusion

48. What is your general opinion about minimum tillage?

49. If you don't use minimum tillage today, Will you consider minimum tillage systems in the future?

50. What is your opinion about of new foreign technology?

51. Do you have something to add that you find important for the study

Appendix 2: Interview guide suppliers

Area **Date**

General Facts about the area

1. How large on average are the farms in this area?

2. What crops are mostly grown here?

3. What are the main operation fields?
- Dairy
- Grain
- Beef

4. What types of machinery do farmers in the area wish to buy?
- brand, size, age, foreign/domestic produced

5. What is the farming system that farmers in general use in this area?
- Plough
- Minimum tillage

Y: Has minimum tillage been used for a long time?
N: Do you think farmers will use minimum tillage more in the future?

Provided services

6. What machinery do you sell?
- Tractors
- Equipment
  - Minimum tillage?
  - No tillage seeders?
  - Foreign technology?

7. Do you provide services if a machine break down?

8. Do you provide credit on machinery purchases?

9. In what currency is the deals done in?

Initiation

10. What are the biggest issues for the crop production in the area?
- Soil erosion?
- Drought?
- Use of fossil fuels?
- Field operations time consumption?
- Inputs cost?
- Weed?

11. Are you aware of any problems concerning the tillage system in this area?

12. To what extent do you consider the minimum tillage practice to be a solution to the existing problems in this area, on a scale 1-5 (5= a perfect solution, 1= no solution)

1 2 3 4 5
No solution A perfect solution

The innovation Aspects

13. Do you consider minimum tillage to be a solution to some of the problems existing on these farms described earlier?

14. Do you think that traditional farming systems (ploughing) is more reliable than new technology?

15. Do you find the minimum tillage system difficult to use and understand?

16. Do you think that minimum tillage systems are difficult for the farmers to adopt?

17. What do you consider the advantages of minimum tillage to be?

18. What do you consider the disadvantages of minimum tillage to be?

19. What do you think of minimum tillage compared to other systems?

20. What economic factors do you find important with minimum tillage?
- Initial cost?
- Input costs?

21. What biological factors do you find important with minimum tillage?
- Soil condition?
- Erosion?

22. How suitable do you considered the minimum tillage practice to be in this area keeping the questions 13-21 in mind? (1=not good, 5=very good)

1 2 3 4 5
Not good Very good

The Environmental Aspects

23. Is the government supporting the technology?
- Subsidies (list of machinery)
- Information

24. Does credit institutions enable financial support of the technology?

25. What is the general opinion towards minimum tillage among farmers in the surrounding area?

26. Do you consider yourself to have enough information about minimum tillage?

27. Is there any external support for adopting minimum tillage?

28. How do you perceive the general opinion towards minimum tillage in the area, keeping questions 23-27 in mind? (1=not good, 5=very good)

1 2 3 4 5
Not good Very good

Farmer connection

29. Do you talk to your clients regularly?
- Is personal relation important

30. Do you conduct farm visits?

31. Do you do presentations of new equipment?

32. Do you let the famers try the equipment?

33. How does this firm promote minimum tillage?

General Conclusion

34. What is your general opinion about minimum tillage?

35. What is your opinion about of new foreign technology?

36. Do you have something to add that you find important for the study?

Appendix 3: Fact sheet

Dear Sir

Our names are Marcus Halvarsson and Jenny Andersson and we are studying to become agronomists at the Swedish University of Agricultural Sciences in Uppsala (SLU). We are at the final stage of our education and have started our master thesis. Our thesis is about Chinese farmers opinions of adoption of new farming technologies and more specific minimum tillage.

The thesis is a co-operation between the Department of Economics at Swedish University of Agricultural Sciences in Uppsala and a Swedish farm equipment manufacturing company called Väderstad-Verken.

Fact about Väderstad-Verken
Väderstad-verken is a farm machinery manufactory situated in Väderstad, Sweden. The company produces flexible machinery for drilling and tillage operations. These are designed to minimize tillage and passes by conducting several operations simultaneously. The positive effects are: reduced planting time and energy use, decreased erosion, and less soil compaction. In order to improve and stay modern, Väderstad-verken is constantly developing new technology. Väderstad-verken has today 900 employees, 700 of them work in Sweden and 200 at their twelve different subsidiaries located in Europe, Russia and Canada.

Fact about Swedish University of Agricultural Sciences
Swedish University of Agricultural Sciences is situated in Uppsala, Sweden. The university's focus is environmental sciences such as agriculture, forestry and animal health and in 2011 the university had 2 920 full-time staff 4 102 full-time students.

The purpose of the project is to increase our understanding of the agriculture and the diffusion of minimum tillage in China. What we are interested in is; the use of minimum tillage today, what the general opinion towards the technology is and what the benefits/disadvantages with the technology are.

To be able to answer these questions we would like to interview you. Your participation in this study is of course:

Optional But we would really appreciate if you could take some time to answer our questions.

Confidential Your answers will not be official and your name will not be presented at all. When the thesis is completed it will not be possible to distinguish an individuals answer.

The interview will not take longer than one hour to complete. We would appreciate it if you wanted to participate in this interview, which will be of great help to us in this thesis.

Thank You for Your co-operation!

/Marcus Halvarsson and Jenny Andersson