Risk and technology adoption: the case of the System of Rice Intensification in Andhra Pradesh, India

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Thesis report is part of the master 'International Development Studies' containing a research on the impact of risk perception and risk preferences among rice producing farmers in Andhra Pradesh, India, on the decision to adopt the System of Rice Intensification.

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ABSTRACT

This thesis examines the role of individual risk attitudes and risk perceptions in the decision to adopt the System of Rice Intensification (SRI) in Andhra Pradesh, India. I conducted a survey and a field experiment to elicit the risk preferences of Indian farmers, who faced the decision of adopting SRI, potentially being low in investment and high in rewards. The major risks in rice production are compared between SRI and conventional methods, and also the farmer's perceptions on risks and risk preferences are examined. I find that SRI is a less risky rice production method than the conventional method and that farmers also perceive SRI to be less risky. However, *dis- adopters* find SRI to be more risky than *adopters*, farmers that have performed SRI regularly in the past years. Risk preferences do not play a role.

Keywords: System of Rice Intensification, Technology Adoption, Risk Preferences, Risk Perception, Utility Theory, India

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1. INTRODUCTION

1.1. Background to the present study

After China, India is the leading rice producing country in the world with a production of 133.7 MT in 2009 (FAO stat). The leading states in rice cultivation are: Uttar Pradesh, West Bengal and Andhra Pradesh. Andhra Pradesh ranked third. In India, rice is an important ingredient of household food-basket. Yet its yield level is low, stagnant and uncertain. The operational holding- size is shrinking, and land and water resources are getting degraded. And therefore, evolution of innovative production practices is needed to meet the growing demand of rice. Under such a scenario, system of rice intensification (SRI) has emerged as an important technology for rice production, producing more food with less inputs (Barah 2009). Father Henri de Laulanié, a French Jesuit missionary who worked in Madagascar for 34 years, developed SRI during the 1980's in Madagascar. In November 1982 fateful events led to the 'accidental discovery' of SRI. Because of the late arrival of the seasonal rains, Laulanie and his students had a shorter time than normal to produce rice seedlings. If they were to generate enough seedlings to transplant into the paddy fields they had prepared, their small rice nursery would have to be used twice within 30 days. So, they decided to produce the rice seedlings in 15 days (instead of 30 days that were typical for that area), these plants grew much more than expected and the rice yield increased (de Laulanié 1992 in Berkhout & Glover, 2011). The transplanting of very young seedlings was one of the most distinctive features of de Laulanié's novel rice cultivation system, but it was not the only one. Other steps are (2) single, widely spaced transplants; (3) early and regular weeding; (4) carefully controlled water management; and (5) application of compost (Stoop *et al,* 2002). SRI claims to be an unusual innovation in several ways in that its methods can raise the productivity of the land, labour, water, and capital invested in irrigated rice production with no mandatory additional external inputs, reduction in levels of input use, flexibility, no substantial sunk-investments. Uphoff (2007) states that SRI crops are more resistant to most pests and diseases, and the use of SRI methods can reduce the agronomic and economic risks that farmers face.

SRI was 'invented' in Madagascar in the 1980's and since then SRI is reported to have spread to nearly fifty countries around the world (Berkhout and Glover, 2011); the spread varies from the major rice producers as China, India, Indonesia, The Philippines and Vietnam, to in lesser extent countries like Afghanistan, Costa Rica and Guyana. The spread has often been (financially) supported by big donor agency's like the World Bank, IFAD, WWF and also by governments, (International) NGO's and universities. Also in the area where this current study is being carried out, Andhra Pradesh, many attempts of popularizing SRI have been made. The Acharya N.G. Ranga Agricultural University (ANGRAU) in Hyderabad promoted SRI cultivation in the state, large scale on farm demonstrations were conducted and the Andhra Pradesh state government allocated Rs.4 crores (around US$700.000,-) for promoting SRI method among farming communities. Despite these great programs on the extension of SRI, favorable adoption conditions and the expansive spread around the world, the adoption rates somehow still remain quite low and the rates of dis- adoption have been high (Moser and Barrett 2003). A few studies have been carried out on the adoption process and adoption patterns of this technique, but they are limited to a number of countries and they have been quite small in scope (Anthofer, 2004; Namara *et al*., 2004; Noltze *et al*., 2012; Sita Devi *et al.,* 2009). Very little is known about the patterns and dynamics of SRI adoption and much remains to be learned. Understanding the dynamics of spread of SRI assumes much greater significance now as SRI is moving from just being a scientific curiosity to more of a larger development agenda.

It is in this light that two post- doctoral scientists at WUR initiated a study with the aim to investigate the spread and the effects of SRI. This project started in 2010 and is still running to the present day. The research is been carried out in four different states in India, in cooperation with four Indian PhD students. The main objective is to identify, measure and characterize the patterns of spread of SRI. These patterns will be captured in terms of farm plots (spatial), farmers and their characteristics, seasonality and changes in agronomic and resource management practices that SRI induces over time. One of the factors that might influence the adoption of SRI, and that the previous mentioned study does not address, is risk. In many studies (Lindner *et al.,* 1982; Lindner, 1987; Tsur *et al.,* 1990; Leathers and Smale, 1992; Feder and Umali, 1993) on technology adoption, risk is seen as a major factor reducing the rate of adoption of a new technology. Decisions by an individual about the optimal combination of actions or practices depend on the individual's perception of expected profit, perception of risk and attitude to risk (Ghadim 1999).

Concluding, a significant part of the rural population in Andhra Pradesh derives their livelihood from rice production (planting 28% of gross cropped area), where productivity is often low. SRI offers the opportunity to increase production and income substantially. Overall adoption rates are low. Knowing the constraints of adoption of SRI may result in (local) governments and development projects trying to remove some of the constraints. Risk, shown to be a big factor influencing farmer's decision to adopt a new technology, needs further research. No important research has been done on the topic of risk, uncertainty and risk preferences and the adoption of SRI before. This current study also perfectly fits within the 'big study' mentioned previously done by the two WUR researchers, it is complimentary in the sense that it investigates an extra factor that may explain SRI adoption patterns.

1.2. Structure of report

This thesis is organized into six chapters. Chapter 2 gives an overview of the current relevant literature on technology adoption and risk preferences. Following the literature review, Chapter 3 presents the research objective and research questions. Chapter 4 presents the methodology used, where an introduction to the research area is given and the sampling is explained; followed by a description of the data collection, data description and data analysis. The 5th Chapter gives the empirical results, where the first part presents the assessment of the risks and a comparison is made on the 'riskiness' of both methods. Also an overview is given on the risk perceptions of the farmers. The second part of Chapter 5 consists of the results regarding risk preferences; how household characteristics are related to risk preferences and how risk preferences influence SRI adoption. Chapter 6 presents the conclusion, the relationship between risks, risk perception and risk preferences is studied, followed by the general conclusion, discussion and recommendations.

2. THEORETICAL FRAMEWORK

Policy makers and interest groups have many questions about the use of improved technologies in developing country agriculture. These include the roles of policies, institutions, and infrastructure in the adoption of improved technologies and their impact on productivity welfare (Doss 2004). Over the years, many scholars have worked to answer the changing questions about agricultural technology adoption. The main determinants of technology found in the literature are wealth (Moser and Barrett 2003; Anthofer 2004; Croppenstedt et al. 2003; Sunding and Zilberman 2001), education (Aldana *et al.*, 2009; Foster and Rosenzweig 1996; Huffman 2001), learning spill over (Besley and Case 1993; Foster and Rosenzweig 1995; Munshi 2004) and access to information (Minten and Barrett 2008). Also risk is recognized by the theoretical model of technology adoption as an important factor (Feder 1980; Feder *et al.* 1985; Just and Zilberman 1985; Lindner *et al.*, 1982; Lindner 1987; Weisensel and Schoney, 1989).

Assuming, for now, that risk plays a role when adopting a new technology, the theories behind risk are examined. In a study done by Wilavsky and Dake (1990), where they try to explain why some people perceive certain things to be more dangerous than other people, the authors came up with three theories that can explain differences in risk perception. These theories are discussed in this chapter.

2.1. Knowledge theory

According to the ***knowledge theory***, people perceive technologies (and other things) to be dangerous because they (don't) know them to be dangerous. In this perspective risk perception is not permanent and it can be shaped if new information and/ or experiences are obtained. The perception of a decision- maker on a certain risk is specific to a particular technique, location and time.

Risk perception of SRI thus depends on the current decision environment, information availability, the experiences with SRI and the nature of SRI. Smale (1995) found that farmers with more experience in hybrid maize technology appear to have increased input allocation on the new technology. This result is consistent with the knowledge theory, that on the average, farmers that have been experimenting with the technology increase the area they sow as they become more confident with its performance on their fields. Smale (1995) concludes that farmers' perceptions of relative yield variance affects the allocation of inputs. Binswanger (1985) found that past experiences have a big impact on risk perception and that farmers, after a series of droughts, would be more reluctant to invest in a new technology, than they normally would on account of their own average risk aversion. During the mid-1990s an extension program was encouraging crop farmers in Australia to grow chickpeas. Evidence suggested that chickpeas were viewed by Australian farmers as being more risky than other available crops and that this was inhibiting their rate of adoption (Ghadim 2004). How farmers perceive certain risks regarding the new crop, whether it is based on knowledge, experience or information, these perceptions are proven to impact the decision on whether to adopt a new technology or not.

In order to know whether a perception is based on experience or not, a risk assessment will be done where the two methods, SRI and conventional method, will be compared in terms of riskiness; which is ranked as more or less risky, regardless of the definition one might want to adopt, just as Binswanger (1985) did in his study. Moser and Barett (2003), for example, found in their study that SRI increases yield risk due to the risk effects of early seedling transplanting and SRI's more sensitive water management regime. The risk assessment is done based on both objective and subjective assessments of the farmers (more information on the methodology in given in Chapter 4). The perceived subjective risk (independent variable) is used in the regression analysis and tries to explain technology adoption (dependent variable).

2.2. Personality theory

Another commonly held cause of risk perception follows from the ***personality theory***: some individuals love risk taking so they take many risks, while others are risk averse and seek to avoid as many risks as they can. In most literature, this theory is named as 'risk attitude' or 'risk preference'. Dillon and Hardaker (1993) define risk attitude as the extent to which a decision- maker seeks to avoid risk or is willing to face risk. It is seen as a characteristic of a human being (just like 'creativity' of 'intelligence') that doesn't change for a long period of time, it is permanent (permanent as in the sense that risk preferences can change in the long run, but not in the short run. In this study I assume that since the moment that a farmer was able to choose to adopt SRI, until the time the research was conducted, risk preferences have not changed). The implications of the personality theory for the adoption of a technology can be found in the *utility theory.* This theory says that farmers select among alternative practices or options by calculating the expected utility associated with each option and then choosing the one with the higher expected utility (Ellis 1988). The objective is to maximize personal 'welfare' or 'happiness'. Under risk, farmers who are maximizing expected utility will sometimes make choices that offer lower average incomes but less income variation. In Figure 1 you can see how this approach deals with risk. The risk situation, which is described, is about uncertainty about the weather. Only two events can happen: low (a bad year) and high (a good year) rainfall. The graph contains three output response curves to describe the two events:

1. TVP1= Total Value Product in a good year
2. TVP2= Total Value Product in a bad year
3. E (TVP)= Expected Total Value Product

In this example the farmer expects 3 years out of every 5 years to be 'good' and 2 years out of 5 years to be 'bad' and therefore E (TVP) =0.60 (TVP1)+ 0.40 (TVP2). The shapes of the curves reflect the impact of 'good' and 'bad' weather conditions on the response of output to varying levels of input. A year with bad weather results in the very poor output response depicted by TVP2. The TFC line represents the increase in total production costs as more input is purchased, the impact of risk on the efficiency calculation of the farmer can be examined. In Figure 1 you can see three operating positions, X1, X2 and XE, each one represents a farmer's subjective preference to risk.

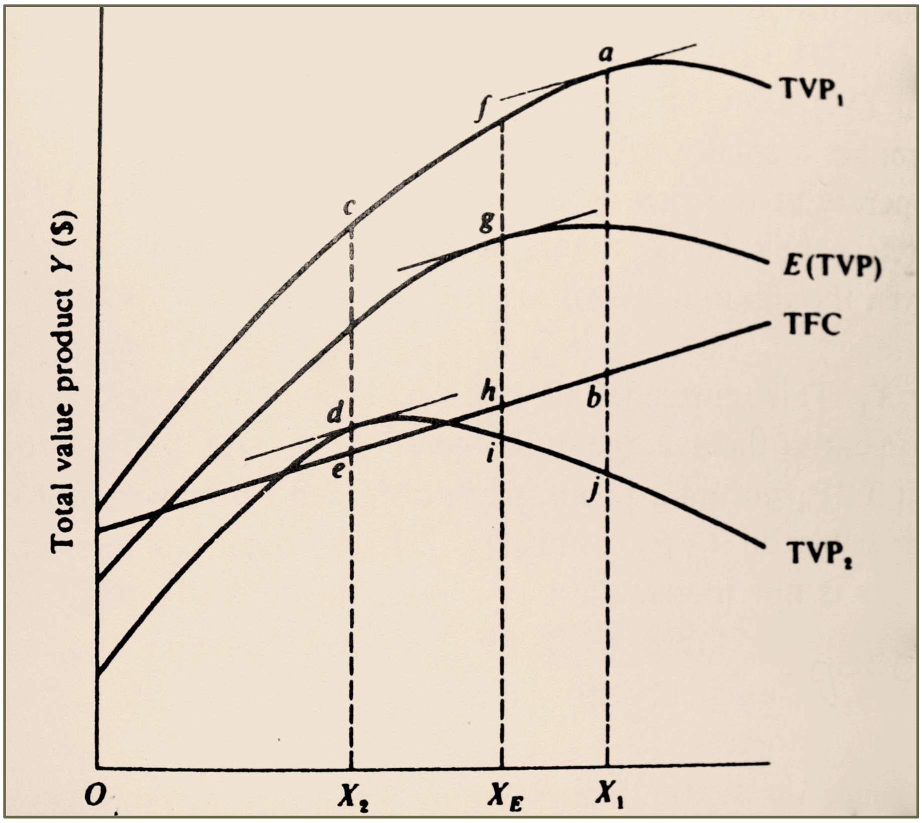

Figure 1. Income variance approach to risk. Source: Ellis (1988)

A farmer choosing to operate on position X1 is described as risk- taking, because the farmer prefers to take a chance at the largest possible profit (ab), than thinking about the potential loss (bj). A risk-averse farmer operates on position X2, he prefers to be 'safe' if the worst possible outcome will happen, even if he knows that the probability is only 0.40 and he misses a greater yield when a 'good' year occurs. Input use XE represents allocative efficiency consistent with a balanced assessment of the average outcome of 'good' and 'bad' seasons. The farmer chooses to not obtain the highest yield, but neither the biggest loss, such a farmer is risk- neutral. Risk- aversion occurs here as a matter of personal choice between several alternatives. According to the personality theory and utility theory I expect that risk- averse attitudes affect production and investment decisions. Risk- averse households will be less likely to adopt SRI. The risk preference variable (independent variable) will explain technology adoption (dependent variable) in a Multinomial Logistic Regression analysis. The reason behind the choice for a multinomial logistic regression is that 'adoption of SRI', in this thesis, is seen as a nomial choice, a farmer is seen as either, adopting, dis- adopting or not adopting SRI. A Multinomial Logistic regression is appropriate when the dependent variable in question is nominal (a set of categories which cannot be ordered in any meaningful way, also known as categorical) and consists of more than two categories. An example would be: 'Which major will a college student choose, given their grades, stated likes and dislikes?' In this research all farmers are classified into three categories: *adopter*, *dis- adopter* and *non-adopter* (more explanation on the classification in Chapter 4). These categories cannot be ordered in any meaningful way and therefore a multinomial logit is conducted with the following model:

$$A_y = \beta_0 + \beta_r R_y + \varepsilon_y \qquad (1)$$

In a second regression, household characteristics are included in the model (more explanation in Chapter 2.3), constructing the following regression:

$$A_y = \beta_2 + \beta_r R_y + \beta_x X_y + \varepsilon_y \qquad (2)$$

The **dependent** variable:

$A_y = SRI\ adoption$

A_y represents the likelihood of farmer *y* to (dis) adopt SRI. It is a nomial variable and can have the values of 1= non- adopter, 2= dis- adopter and 3= adopter. In section 4.1, explanation is given on the construction of this variable.

And the **independent** variables:

$R_y = risk\ preference$

The *R* is a regressor extracted from a factor analysis. It stands for the risk preference of farmer *y*; the higher the value, the more risk seeking the farmer tends to be. In Chapter 4.2.4 explanation is given on the construction of this variable.

$X_y = A\ set\ of\ household\ characteristics\ including$:

$Z_y = age$

Age of the head of the household *y*. In many studies (a.o. Binswanger, 1985) regarding risk preferences there is a negative correlation found between age and risk preferences. The older the farmer, the more risk averse. In order to find out if risk preferences are associated with household characteristics, age has to be included, it might influence risk preferences.

$G_y = gender$

Gender is added to the regression, as it may influence risk preference. In many empirical studies (Eckel & Grossman 2008, Byrnes, Miller & Schafer 1999) it is found that men are more risk seeking than women.

$W_y = wealth$

Wealth level of the household *y*. As well as age, wealth is often associated to be correlated with risk preferences. In many empirical studies positive correlations have been found between wealth and risk preferences. The more wealthy the subject, the more risk seeking he tends to be.

The variable 'wealth' is often difficult to measure and requires explanation on the measurement. The variable 'wealth' is constructed by asking one local person in the village to 'rank' all the participants according to the classification *very poor, poor, average* and *rich*. A researcher of the NGO WASSAN, mentioned that poor farmers tend to engage in casual labour; so in order to cross check the variable 'wealth', a question is incorporated asking whether the farmer himself is engaged in casual labour. Then I found a significant negative correlation, that means, the poorer the farmer, the more likely he is to participate in casual labour. From these results, I can trust that the variable 'wealth' is a good approximation of the actual wealth status of a farmer. In the regression, the higher the value for wealth, the higher the wealth of the subject.

$C_y = caste$

C_y stands for the caste farmer *y* belongs to. The caste system is still strongly incorporated in the everyday lives of the people in India and it might influence the decision making of a farmer. In general, the higher the caste, the more access the farmer has to labour and credit, and therefore the more risk he might take regarding farming. It is important to include this variable in the model. This variable was measured by asking the farmer to which caste he/she belongs. In the regression, the higher the value for caste, the higher the caste is where the subject belongs to.

$H_y = household\ size$

The number of household members that live in the same household *y*. Having more household members means having more labour available to farm the land, that can decrease the risk of not having enough labour and it can result in the farmer being able to take more risk and being less risk averse.

$L_y = land$

The total amount of land that farmer *y* owns or hires. This number is in hectares. The amount of land is sometimes seen as a proxy for wealth, the more land a farmer has/hires, the wealthier the farmer. And as mentioned before, I hypothesize, the wealthier the farmer, the more likely he is risk seeking.

$V_y = village$

With the village 'Timma Reddy Palli' as reference village.

The variable 'village' is included in the regression as risk preference may differ between villages. It is possible that risk preference is embedded in the 'culture' of the village, or that there are some characteristics at village level that influence risk preferences.

2.3. Economic theory

The third explanation follows ***economic theory***, which says that the rich are more willing to take risks stemming from technology because they benefit more and are somehow shielded from adverse consequences. Moser and Barrett (2003) find that poorer farmers with little land are much less able and likely to adopt the technology than richer farmers with more land. Also Rosenzweig and Binswanger (1993) find similar results. Eswaran and Kotwal (1990) have shown that given higher average returns to risky production activities, households less able to insure consumption (poorer households) are left in lower return activities and don't opt for the 'risky' technology. Morduch (1991) and Dercon (1996) for India and Tanzania respectively also provided insights into how households less able to smooth consumption (proxy for wealth) are less able to produce high- risk, high- return crops. Binswanger (1980), however, finds no correlation between wealth and risk aversion.

Berkhout and Glover (2011) performed a study on contemporary literature regarding SRI practices, during this study they encountered that SRI is often described as a cultivation system that is particularly appropriate for poor, resource- constrained farmers and households, because benefits can be gained through changes to management practices, without having to adopt expensive external inputs such as new seeds or chemical fertilizers. But who is actually adopting and who is not? In their study Berkhout and Glover (2011) found out that patterns in SRI adoption follows the typical pattern in technology adoption, which is that better endowed households are more likely to adopt new practices. Although there is discussion around whether wealth influences the decision to adopt a new technology or not, most studies show that there is certainly a relationship. In the same way that wealth can influence the adoption of SRI, so can other household characteristics. Therefore, other characteristics are taken into account when looking at technology adoption. Besides, it is shown that household characteristics not only influence technology adoption directly, but also indirectly through risk preferences. Gender for example, is found to influence risk preference. In many empirical studies (Eckel & Grossman 2008, Byrnes, Miller & Schafer 1999) it is found that men show more risk seeking behaviour than women. Which on its turn can influence technology adoption. Other characteristics are age, size of household, size of landholding, caste and village. In order to see whether household characteristics influence risk preferences an ordinary Least- Square Method (OLS) is performed:

$$R_y = \beta_1 + \beta_x X_y + \varepsilon_y \qquad (3)$$

With the **dependent** variables:

$R_y = Risk\ preference$

The *R* in this equation is the same *R* (as explanatory variable) as in the first equation and it is a regressor extracted from a factor analysis. It stands for the risk preference of farmer *y;* the higher the value, the more risk seeking the farmer tends to be. In Chapter 4.2.4 explanation is given on the construction of this variable.

And **independent** variables:

$X_y = A\ set\ of\ household\ characteristics.$

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Age of the head of the household *y*. In many studies (a.o. Binswanger, 1985) regarding risk preferences there is a negative correlation found between age and risk preferences. The older the farmer, the more risk averse. In order to find out if risk preferences are associated with household characteristics, age has to be included, it might influence risk preferences.

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The total amount of land that farmer *y* owns or hires. This number is in hectares. The amount of land is sometimes seen as a proxy for wealth, the more land a farmer has/hires, the wealthier the farmer. And as mentioned before, I hypothesize, the wealthier the farmer, the more likely he is risk seeking.

$V_y = village$

With the village 'Timma Reddy Palli' as reference village.

The variable 'village' is included in the regression as risk preference may differ between villages. It is possible that risk preference is embedded in the 'culture' of the village, or that there are some characteristics at village level that influence risk preferences.

2.4. Adoption

Within the theoretical framework, it is important to explain what is meant with *adoption* of SRI. Berkhout and Glover (2011) think it is a crucial thing to do, for everyone trying to quantify SRI practice. Who qualifies as an adopter of SRI? Most of the authors explaining SRI adoption apply a numerical principle, that a farmer should have adopted at least a certain number of SRI component practices in order to be considered an SRI adopter (Berkhout and Glover 2011). But this classification seems too 'hard' and dismisses many farmers that, maybe, in a way to mitigate risk, follow the flexible principles differently according to their circumstances. Different studies (Kabir and Uphoff 2007; Anthofer 2004; Resurreccion and Sajor 2008) done on the adoption of SRI, suggest that adoption of SRI is partial rather than complete in many regions. Anthofer (2004) for example, found in his study that SRI farmers, on average, transplant young seedlings at the age of 16.8 days at a rate of 1.3 seedlings per square, which in a strict definition of SRI adoption these farmers would not be seen as *adopters*, because the guidelines of SRI recommend to transplant seedlings between 8-12 days at a rate of 1 seedling per square. Palanisami (unpublished) finds that most farmers only adopt one or two SRI components out of five promoted. In this research the definition of Namara *et al*. (2004) is followed, which is that an SRI farmer is any farmer who states that he performs SRI, without specifying the actual number of components that has been tried. As SRI is a set of flexible principles that need to be adapted for particular settings, Glover (2011) says it is not strange to find diverse implementations of SRI methods in different settings.

Besides adoption, *dis- adoption* is included in the model. Studies on technology adoption (Suri 2011; Duflo, Kremer and Robinson 2008) find that many farmers switch between adopting and dis-adopting a new technology. And with SRI, some dis- adoption has been observed as well. The importance to differentiate between adoption and dis-adoption is because it can give some clarity on whether the decision to dis-adopt is based on bad experiences with the method (risk perception based on experience) or on other factors. An *adopter* as said before is any farmer who states that he performs SRI, besides that, he has to have performed SRI for at least 50% of the seasons since time of adoption. If he/she has performed less than 50% of the seasons, he is seen as a *dis-adopter*; this is explained and motivated in more detailed in Chapter 4.1.

Defining adoption and SRI is maybe as important as defining non- adoption and is seen as the conventional method. A *non- adopter* is a farmer who has never tried SRI and performs the conventional method. The conventional method is the method, which farmers have been performing for decades. In this research conventional means, any method of rice production that is <u>not</u> SRI.

2.5. Framework

Following the literature on risk and technology adoption, the main factors that are often recognized to influence technology adoption are risk perception and risk preferences. These two factors follow from the *knowledge theory* and the *personality theory.* Another factor that can certainly not be neglected according to the *economic theory,* is 'wealth', which has often been found to be positively correlated with technology adoption. Wealth, and also other household characteristics, is a 'special' case though. This is because household characteristics not only influence technology adoption directly, but also could influence risk preferences and therefore indirectly technology adoption. As seen in Figure 2, household characteristics may also influence risk perception (dotted line). In this research the link between household characteristics and risk perception is not taken into account. But it is important to keep in mind that there might be a link.

For a better understanding of the theoretical framework, the three researched factors and their conceptual relations are put graphically in figure 2.

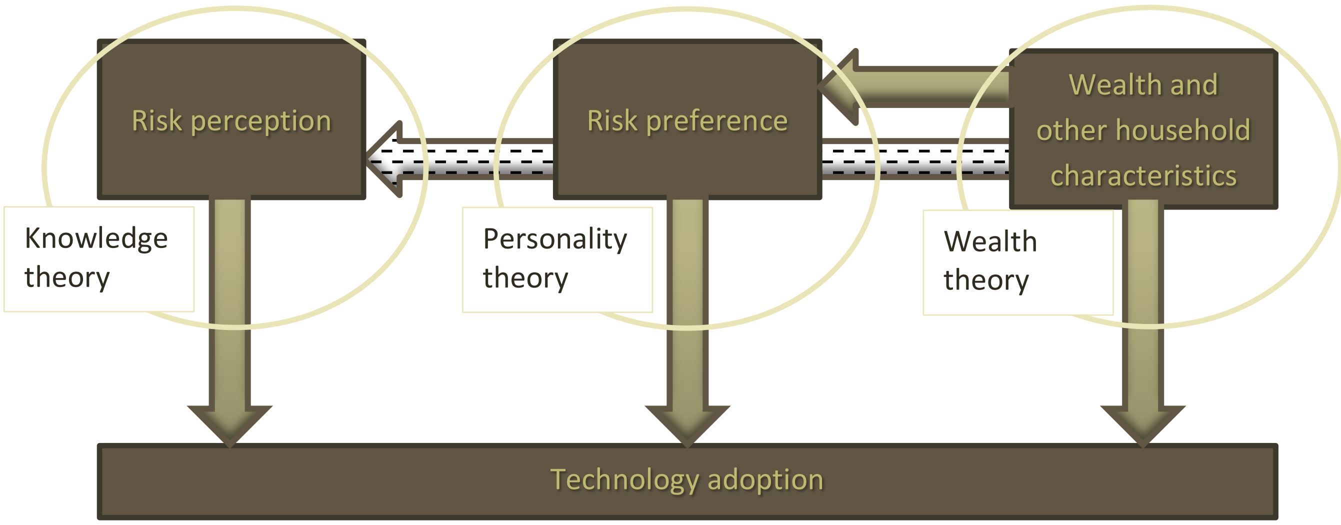

Figure 2. Theoretical framework. Source: constructed by author.

The **knowledge theory** says that one's perception of the risk of a new technology, whether based on information or experience, affects the decision to adopt a technology. Having a negative perception of a technology decreases the adoption of the technology and a positive perception increases the adoption of the technology. Therefore the next hypothesis is constructed:

(1) A negative perception of the risks SRI, whether it is based on experience or knowledge, decreases adoption of SRI.

The knowledge theory also states that the perception of a decision- maker on a certain risk is specific to a particular technique, location and time. It is possible, for example, that farmers perceive a technology differently after using it for some years, their risk perception may increase or decrease. Also, in many technology adoption studies, 'social learning' is taken into the model as one of the explanatory variables. Although time is an important aspect in risk perception, this variable is not taken into account in this research. The emphasis is different, furthermore, the subjects in this research are visited once, it was not possible to measure at different moments in time.

Risk preference comes from the **personality theory***,* which says that the risk preference of a person, risk avoiding or risk seeking, influences the adoption of a technology. The higher the aversion to risk, the less the person is likely to adopt a technology. The next hypothesis is constructed:

(2) A risk averse farmer is less likely to adopt SRI.

The last hypothesis comes from the last factor influencing technology adoption in this model. Wealth follows the **economic theory***,* which says that the rich are more willing to adopt a new technology because they benefit more and are somehow shielded from adverse consequences. As mentioned before, wealth, does not only affect technology adoption directly, but also indirectly through risk preferences. In many empirical studies it is found that wealth and risk seeking behaviour are positively correlated. Besides wealth, other household characteristics are taken into account. The last hypothesis follows the *economic theory* and reads:

(3) The higher the wealth level of a farmer the higher the chance to adopt SRI.

In the next chapter the research objectives and research questions are presented.

3. RESEARCH OBJECTIVE AND RESEARCH QUESTIONS

Following the literature review on technology adoption and risk aversion the following objectives and research questions are developed.

General research objective:
To find out whether risk perceptions and risk preferences influence SRI adoption.

Specific research objectives:

1. To make an assessment of the risks involved when using (a) the SRI method and when using (b) the conventional method
2. To make risk profiles of famers and find out whether risk preferences and risk perception affect SRI adoption

With the aim of accomplishing the proposed research objectives, the following research questions are proposed:

1. What are the major risks that rice producing farmers face in rice cultivation?
2. Is SRI a more 'risky' rice production method than the conventional method?
3. Do household characteristics, and specially wealth, affect risk preferences?
4. Do household characteristics, and specially wealth, affect SRI adoption?
5. Do risk perceptions, whether based on knowledge or information, affect SRI adoption?
6. Do risk preferences affect SRI adoption?

4. METHODOLOGY

This Chapter gives an outline on how the research is carried out, starting with the study area and sampling and followed by the data collection (design and procedures).

4.1. Study area and sampling

This research compares the risks of SRI and conventional rice fields in four villages (Timma Reddy Palli, Neetur, Anantapur Tanda and Metlakunta) of Mahabubnagar district of Andhra Pradesh (Figure). The data are from the 2011-2012 rabi (dry) season. In these villages, SRI has been promoted over the past 4 years (since 2008) by the Federations of SHGs (i.e., self-help groups) with support from the NGO WASSAN. From a list of farmers who are practicing SRI, in these four villages where the program is active, a random sample of 15 SRI- using farmers is drawn. Then an equal number of farmers cultivating the conventional method is selected. The village Anantapur Tanda 'misses' eight farmers, because there were not enough SRI- farmers found. Thus the complete data set consists of 112 farmers. In de dataset of these 112 farmers there are some missing values. Sometimes farmers did not answer all the questions. The data of the farmers are collected in July and August 2012, during the kharif season. Out of the 112 farmers, 19 farmers have never tried SRI; so the remaining 93 have used SRI at some moment in time. Some have only tried it once and dis-adopted the method and another group still uses it every season. I chose to classify the farmers in to three categories:

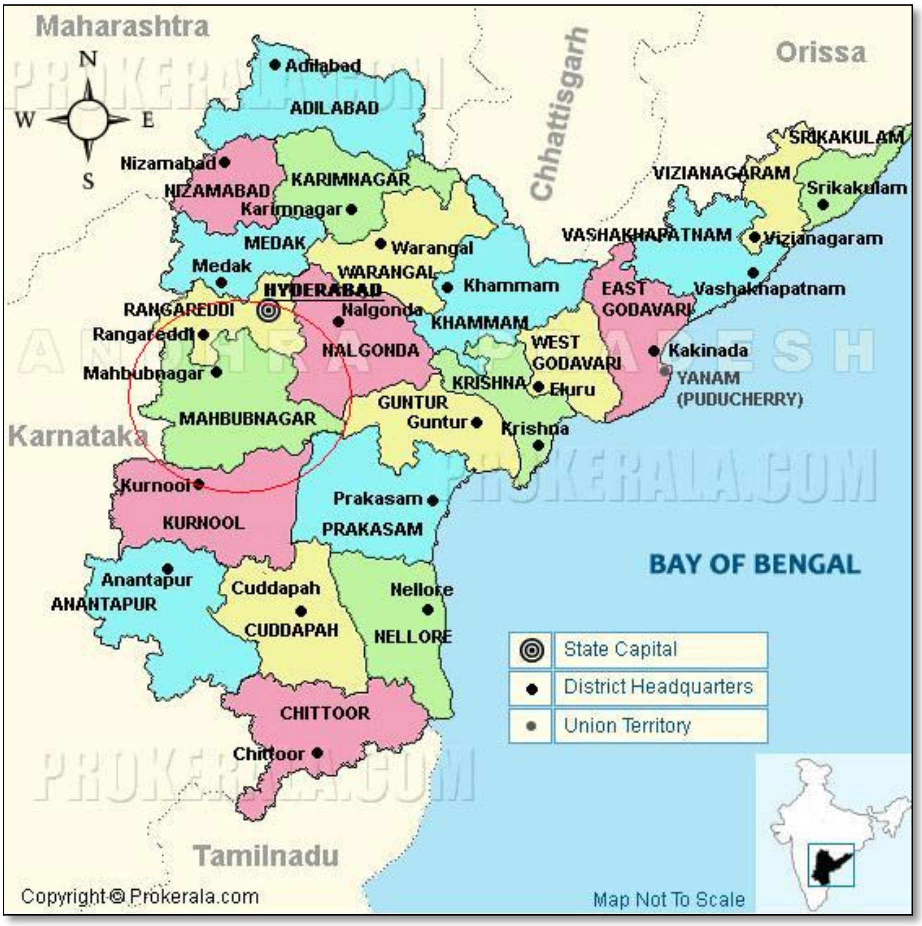

Figure 3. Map of Andhra Pradesh

a) *Non- adopter*. Farmer has never tried SRI (19 farmers/17%)

b) *Dis- adopter*. Farmer has tried SRI once or twice since time of adoption, but abandoned the method (28 farmers/26%))

c) *Adopter.* Farmer has tried SRI many times since time of adoption and can be seen as a SRI-farmer (62 farmers/57%)

The classification is done in the following way: I know in which year the farmer performed SRI for the first time and I also know how many seasons the farmer has performed SRI since the year of adoption. With these two variables I was able to classify the farmers. The first category *non- adopter* consist of 19 farmers and have never tried SRI. The line between the other two categories is in a degree somewhat subjective. In order to distinguish *adopters* from *dis- adopters*, the next rule is applied: if a farmer has performed SRI less than half the times he could have performed it since the year of adoption, then he is classified as a *dis-adopter*; if he has performed SRI half the times, or more, that he could have performed it, then he is classified as an *adopter*. Suppose there are two farmers that have performed SRI three times, but one started in 2006 and the other one in 2010. The farmer, which started in 2006, would be classified as a *dis-adopter*, since 2006 he has had 12 opportunities (2 seasons per year) to perform SRI, and he has only done 3, which means he cannot be seen as an SRI- farmer. The second farmer is classified as an *adopter*, since 2010 he has had 4 opportunities do perform SRI and he has done it 3 times, at this moment in time, he is seen as an SRI adopter. There are three missing values; these farmers did not answer the question.

The classification of *non- adopter, dis- adopter* and *adopter* is an important one for this research, but nevertheless a bit unusual. As said before by Berkhout and Glover (2011), it is very important to define what is meant with adoption and what is seen as an *adopter*. Classifications in researches are often subjective, in the end, it is the researcher that classifies, but in this research, once the 'classification method' is established, the classification is done in 'objective' way by quantifying the number of seasons of SRI and non- SRI performance. The classification of the farmers is often mentioned in this thesis, so when reading about the 'type of farmer', keep this classification in mind. In the rest of the chapter it is described how the data has been collected and analysed.

4.2. Data collection and analysis

In this research two data collection methods are used: a survey and an experiment. With the survey, household characteristics and production data are collected; the survey also includes questions about hypothetical situations, which partly measure risk preferences. The experiment is designed to measure risk preferences. In this section the methods of data collection are described, including the design and the procedure; Table 1 shows schematically the methods used for each section.

Table 1. Methods for data collection

		Risk assessment & household characteristics	A measure of risk perception	A measure of risk preferences
Survey	Production data	X	X	
	Hypothetical questions			X
	Self- diagnostic assessment			X
Experiment (gambling game)				X

The survey is tested and improved three times. With the final version, a typical interview took approximately one hour. First I started with the experiment, followed by the questions on hypothetical situations, ending with the farming production survey. The survey was held in Telugu, the local language in Andhra Pradesh, and were translated by the translator who participated in the project. This translator was introduced into the project at a very early stage and was trained for two weeks, visiting the villages, having informal conversations with the farmers, testing the surveys and finally conducting (half of) the actual surveys. In order to complete all the surveys in a period of one and a half month's two teams were created. The first team consisted of two local enumerators. These men were inhabitants of the villages were they conducted the surveys and had done some surveys in the past for WASSAN. They were trained for a period of four days, receiving information on the objectives of the research, how to implement the experiment, some interviewing techniques and what kind of answers was expected. They practiced on farmers not included in the sample. After one test round, they were able to perform the survey on the farmers from the sample. During the first five interviews they were still assisted by me and the translator and after that they were able to do it themselves. While these two enumerators were surveying the first two villages, myself and the translator (the second team), surveyed the other two villages.

4.2.1. Risk assessment

In order to know why farmers are adopting SRI, it is important to know how 'risky' this new technology is. Therefore an important part of this research consists of an assessment of the most important risks in rice production, risks specific for the research area in Andhra Pradesh. On the basis of this assessment, a comparison can be done between the risks that farmers face while performing SRI and while performing the conventional method; this comparison in its turn, can give insights into which kind of risks farmers find to be the most hazardous and, how farmers have developed certain tools to deal with these risks. Through the risk assessment, research questions 1 and 2 are answered. In the beginning stage of the research, the relevant risks in rice production that were going to be researched upon were established through an explorative study, which consisted of literature review, informal interviews with farmers and meetings with researchers, extension agents and colleagues from WASSAN. Subsequently the establishment of the most frequent and/or severe risks is made. The risks identified are:

a) Risks regarding labour, more specifically, (not) finding enough labour on time.
b) Risks regarding lack of water
c) Risks regarding pest and diseases
d) Risks associated with weeding
e) Risks associated with transplanting.

Risks that exist regarding labour are having lack of labour, not finding labour on time for doing a certain operation; Moser & Barett (2004) state that SRI requires more labour than other conventional methods, specially in the beginning; if a method requires more labour, but the labour is not there, it can form a risk for the production. The farmers see lack of water as the risk with the most severe impact, sometimes even leading to loss of a crop, and it can be caused by many sources, like failure of the pomp, power cuts and drying of the lake/well. Weeding itself is not seen as a risk, but there are some issues around weeding that can affect farmer's decision making. Some farmers for example, believe that SRI suffers more from weeds, when the water level is low, at that time there is more opportunity for the weeds to grow; more weeds causes more pests and diseases. Having a pest plague can ruin a crop; this is a serious risk with a big impact. Transplanting is one of the components of SRI that is done differently than in the conventional method. The most risky aspect is the transplanting of the very young seedlings (10 days old versus 30 days at the conventional method); the fact that these seedlings are so young can make them more vulnerable for lack of water, pests and diseases and transplanting itself. All these risks mentioned, are potentially risks that are there.

In this early stage of the research I also took other risks into consideration, like access to seed, fertilizers and markets. But quickly I discovered that those issues don't form a risk to farmers in Mahubnagar, access to both the input- and output market is there. By means of the survey I want to find out whether the risks mentioned above are more frequent and/or more severe for SRI or the conventional method. Some questions in the survey are quantitative and some qualitative. This combination of types of questions gives this research an extra dimension; it is not only possible to explain *what* is happening, but also *why*.

In order to compare the two methods with each other some 'standard' statistical tests are done. The program used for the analysis is SPSS and the tools used are crosstabs, t- tests, tables, frequencies, descriptives and correlations.

4.2.2. Household characteristics

As said before in the theoretical framework (Chapter 2), household characteristics are taken in to the model of technology adoption. The following research questions are being answered: 'Do household characteristics, and specifically wealth, affect SRI risk preferences?' And 'Do household characteristics, and specifically wealth, affect SRI adoption?' For the first research question a multiple regression (Ordinary Leas- Square Method) is performed. For the second question a multinomial logit.

4.2.3. A measure of risk perception

The role of risk perception in the adoption of SRI is being researched through research question 5: 'Do risk perceptions affect SRI adoption?' The measurement of risk perception is done in the following way: the survey is dived into different operations within rice production: transplanting, weeding, water management etc. For each operation I asked the farmer to rank both production methods, SRI and conventional, according to the next scale: not risky at all, little risky, risky and very risky, with each category getting the value 1,2,3 and 4 respectively. In that way I am able to compare the operations with each other and also the difference in 'riskiness' between SRI and Non- SRI. Moreover, after asking to rank the different operations, I also ask the farmer *why* he thinks that a certain method is more risky than another. This gives me insights whether the perception is based on experience or information. The program used for the analysis is SPSS and the tools used are crosstabs, t- tests, tables, frequencies and descriptives.

4.2.4. A measure of risk preference

Most empirical research on risk preferences is based on either the use of experimental lotteries, or on hypothetical questions. In this research both are used. Risk preference means into what extent a farmer likes or dislikes to take risk. Risk preference is not an observable variable and can therefore not be measured directly; in this research, three proxies are used to all measure the same: risk preferences. The following methods are used:

- A gambling game with chocolates (the experiment)
- A self-diagnostic assessment
- Eight hypothetical questions (Appendix A)

Within the use of experimental lotteries there is a great variety of designs. Binswanger (1980) is among the first studies to provide tests of risk aversion among farmers in a developing country. He proposes both hypothetical and real payoff lotteries to Indian farmers where the outcome probabilities are fixed, but the payoffs of the lotteries are varied. Holt and Laury (2002) ask their subjects to make ten choices between paired lotteries. A subjects' degree of risk aversion is inferred from the point at which he switches from preferring the low- risk lottery to preferring the high- risk lottery. This design produces a more defined estimate of the utility function parameters. However, this comes at a cost of increased complexity, which may lead to errors. Eckel and Grossman (2002) (similar to the approach of Binswanger) present subjects with five gambles and ask them to choose which of the five they wish to play. All decisions are outlined as simple gambles with two alternatives, equally probable, payoffs. In a study by Dave and Eckel (2010) where the designs of Holt and Laury (2002) and Eckel and Grossman (2002) are compared, they find out that the 'best' measurement method to use depends from the subjects you have to do with. The more complex the method, the better it's accuracy, but these complex methods are especially suited for subjects with higher levels of mathematical skills. For the less able subjects, care must be taken to design experiments that are easily accessed and comprehended. Based on this argument and the fact that most of the subjects in this research are farmers with low education and limited mathematical skills, a very simple experiment is chosen. This experiment is easy to implement, no writing and/or reading skills are needed and the experiment can be explained orally.

The experiment is based on a design used by Jakiela and Ozier (2011) in Kenya. Each subject (head of household) receives an initial endowment (four chocolates). This endowment they can (partly) invest in a risky, but profitable investment. The participant then receives four times the number that he chooses to invest with probability of 0,5; and there is also the probability of 0,5 that the payoff is zero. In the original design of Jakiela and Ozier (2011) the experiment is done with money. In the beginning of the design of the experiment, it was the intention to use money, but due to ethical considerations, it is decided not to. Instead of money, the endowment is provided as chocolate.

Besides the experiment, I have chosen to also ask questions regarding hypothetical farming cases. In the questions the farmer is asked 'how likely' he is to take certain decisions. These questions are all farming related. In a study done by the Dohmen *et al.* (2005) different methods to measure risk preferences are compared, an important outcome of the study is that the best predictor of behaviour in a given domain is typically the question incorporating context specific to that domain. For example, willingness to take risks on health matters is a better predictor of smoking than the hypothetical investment question, or the general risk question, or any other domain-specific question. Therefore, in this research all the hypothetical cases are farming related. Many studies that have measured risk preferences by using questions on hypothetical cases have used a 'blue print' of questions to ask. For this research the 'blue print' could not be used, as the context of the farmers differs greatly from the context of the subjects in the other studies, mainly done in Western countries. The questions in this research I developed in close consultation with local staff and researchers, since they know the best how the circumstances of the farmers are and in what way the farmers take risks in their daily lives.

The last proxy for risk preference is the 'self- diagnostic' question and asks the farmer to rank himself in one of the four options *very risk averse, risk averse, risk seeking* and *very risk seeking*. In the same study done by Dohmen *et al.* (2005), where 22.000 individuals did a survey with questions regarding hypothetical situations, 450 participants also participated in a game with real monetary payoff. The researchers found that the answer to the 'self- diagnostic' question is a good predictor of actual risk-taking behaviour in the experiment.

In order to see whether the proxies (experiment, self- diagnostic assessment and hypothetical questions) capture the same outcome (risk preference), a factor analysis is done. The goal of a factor analysis is to identify otherwise not- directly- observable factors on the basis of a set of observable variables. Factor analysis finds relationships where variables are maximally correlated with one another and minimally correlated with other variables, and then groups the variables accordingly. After this process has been done many times a pattern appears of relationships or factors that capture the essence of all of the data. In general you want your 'variance explained', that means the correlation of the variables, to be as high as possible. As seen in Table 2, the correlations between the proxy's are not very strong and most of them not even significant. This outcome implies that, at the end, the different proxy's do not adequately capture the same variable (risk preference).

Table 2. Correlation matrix: factor analysis with all variables

Correlation Matrix risk preference										
	Self diagnostic	Experim -ent	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Self diagnostic	1,000	-,017	,170**	,185**	,443**	,099	,305**	-,192**	-,064	-,077
Experiment	-,017	1,000	,158**	,129*	,059	-,200**	-,017	,105	-,275**	-,002
Q1	,170**	,158**	1,00**	,165**	-,072	-,090	-,015	,086	,094	-,251**
Q2	,185**	,129*	,165	1,000	,180**	-,218**	,166	-,164**	-,054	,116
Q3	,443**	,059	-,072	,180**	1,000	-,025	,091	-,131*	-,136*	,197**
Q4	,099	-,200**	-,090	-,218**	-,025	1,000	-,133*	-,013	,116	-,083
Q5	,305**	-,017	-,015	,166**	,091	-,133*	1,000	-,092	-,004	-,021
Q6	-,192**	,105	,086	-,164**	-,131*	-,013	-,092	1,000	-,172**	,004

Q7	-,064	-,275**	,094	-,054	-,136*	,116	-,004	-,172**	1,000	-,179**
Q8	-,077	-,002	-,251**	,116	,197**	-,083	-,021	,004	-,179**	1,000

The variables seen in the matrix (self-diagnostic, experiment and Q1.. Q8) represent the 'self- ranking question', the experiment with the chocolates and the eight questions on hypothetical cases respectively. This table shows how the different variables are correlated with one another.
*significant at the 0,10 level ** significant at the 0,05 level

As seen in Table 2, there are two variables, which seem to be correlated with many other variables and very strongly with each other: *Self-diagnostic* and the *hypothetical question number 3* (Q3). In Q3 the farmer is asked *how likely he is to bore a new well, after he has tried 3 times unsuccessfully*. Out of the eight hypothetical questions, although the correlation remains a bit weak, this variable is the best one to choose as it is designed by a local enumerator and is probably closest to actual farmer experiences. The self- diagnostic is, as mentioned in the literature, a good estimator of actual risk taking behaviour. Therefore it is not surprising that these two variables correlate highly with each other and may actually represent *risk preferences* fairly well.

The two variables (self- diagnostic and Q3) have a significant correlation of 0,443 (see Table 2); putting the two variables in a factor analysis; 72% of the variance is explained, which is pretty good. The factor analysis extracts a new variable, which in this research represents *risk preferences*, it is thus a combination of *self- diagnostic* and *Q3*. The higher the value, the more risk seeking the farmer tends to be.

5. RESULTS AND DISCUSSION

This chapter presents the results of this study and consists of four parts. The first part (5.1) is a data description of the sample, where basic information is shown. The second part (5.2) shows the main risks that farmers face during paddy production, how the risks differ between SRI farming and conventional farming and what action the farmers take to mitigate those risks. In part three (5.3) the results regarding risk perception are presented, followed by risk preferences (5.4).

5.1. Data description

Table 3 shows the summary statistics for the household characteristics of the survey. The average farmer in the sample is about 46 years old. In India, the farmers sometimes own land and sometimes the farmer hires it from a landlord. The average amount of land a farmer has for cultivating crops is 5, 5 hectare, from which 2 hectare is used for paddy and 1, 2 hectare for SRI cultivation. Other crops grown are sorghum, cotton, chickpeas and millets. The 'caste' variable is incorporated into the research to see whether being part from a particular cast influences wealth levels and no significant correlations were found.

The highest caste is the 'Forward Caste' (FC) and makes up about 35% of the population. The second highest caste is the 'Backward Caste' (BC) and makes up 50% of the population, followed by the 'Scheduled Caste' (SC) (10%) and 'Scheduled Tribe' (ST) (5%). People from the Forward caste are mainly landlords and priests. The people from the Backward caste are predominantly artisans, small-scale farmers and traders; this caste is classified as backward due to its financial, educational and/or political depression. The people of this caste benefit from specific government policies to help uplift their status. The Schedule Cast is predominantly engaged in unskilled and manual labour and the Scheduled Tribe are engaged in hunting and gathering, the primitive type of agriculture known as shifting or slash-and-burn cultivation. In this sample most of the farmers belong to the Backward Caste, except in the village 'Anantapur Tanda', where most of the farmers belong to the 'Scheduled Tribe' (St) caste.

Table 3. Farm household characteristics

	The village where the farmer lives				
	Timma Reddy Palli	Neetur	Ananth apur Tanda	Metlakunt a	Total
	N=30	N=30	N=22	N=30	N=11 2
Age of the head of the household (mean)	50,8	37,7	47,3	46,8	45.7
Number of years of experience in rice farming (mean)	28,7	16,7	28,8	28,4	25.7
Total	6,1	4,9	7,1	6,9	6.3

Household size (mean)	Working*	3,5	2,8	3,9	4,3	3.6
	Not working	2,6	2,0	3,2	2,4	2.6
Farm size (mean)	Total	4,5	4,5	6,1	6,4	5.4
	Paddy	1,1	1,2	2,8	3,3	2.1
	SRI	, 5	1,1	, 9	2,5	1.3
Wealth level of the household (in % per village)**	Very poor	23%	0%	0%	3%	6%
	Poor	50%	10%	19%	7%	22%
	Average	27%	90%	40%	63%	55%
	Rich	0%	0%	40%	13%	13%
The caste to which the farmer belongs (in % per village)	St (lowest)	0%	0%	59%	10%	17%
	Sc	13%	10%	9%	10%	11%
	Bc	87%	63%	27%	70%	62%
	Fc (highest)	0%	27%	4%	10%	10%
Number of seasons the farmer has performed SRI (absolute numbers)	0	15	0	4	0	5
	1-2	4	26	4	1	9
	3-4	6	2	7	5	5
	5-6	2	1	2	7	3
	7 and more	2	1	4	16	5
Type of farmer***	Non- adopter	15	0	4	0	19
	Dis- adopter	0	22	6	0	28
	Adopter	14	8	11	24	62
Risk preference (mean)****		0,0516	-0,8956	0,2713	0,6381	0,016 4

*Working household members are those who work on- or off- farm.
**Wealth measured by classification by a village member.
***Type of farmer, according to the classification done in section 4.1
****Risk preference extracted from factor analysis. The higher the value, the more risk seeking the subject

5.2. Risk assessment

This part is structured according to the five main risks of paddy production (labour, lack of water, risks concerning weeding, pest and diseases and transplanting) mentioned before in Chapter 4. Within each sub-division (risk), it is discussed how the risks differ between SRI farming and conventional farming and what action the farmers take to mitigate those risks. To have these sub-divisions in this way, makes it easier to discuss and analyse the risks found in the field with the risks discussed in the literature. One input, labour, requires special attention and is discussed at first in this chapter. Labour is an input that affects many operations in rice production, and can cause a risk for the farmers. You will notice that the issue 'labour' in mentioned often in other risks.

In this first section of the chapter (5.2) the following research questions are answered:

What are the major risks that rice producing farmers face in rice cultivation?
Is SRI a more 'risky' rice production method than the conventional method?

5.2.1. Labour

In previous research, scholars have stated that SRI requires more labour than the conventional methods. The need of more labour can be a risk if there is not enough labour available. Table 4 describes the total hours spent in the field during nursery, transplanting and weeding. The number of hours mentioned in the table, is the sum of the quantity of labourers (family and hired labour) times the hours worked per labourer, per acre. The comparison is done through an independent t-test.

Table 4. A comparison between SRI and conventional method regarding labour requirements

	Production Component		
	Nursery	Transplanting	Weeding
SRI	14,0**	71,7**	60,3**
Conventional	19,5**	89,0**	6,3**

SRI includes the answers of dis- *adopters* and *adopters* (N= 90) and are regarding SRI. Conventional are all farmers (N=112) and answers are regarding the conventional method. Hours per acre. The data come from questions 12,13, 38, 39 83 and 84 of the survey found in Appendix A. It refers to the amount of labour used for the rabi season (dry) 2011-2012.
Independent t- test.
** Difference in mean is significant at the 5% significance level

These results are partly in line with previous literature on the labour requirements of SRI. Previous research has found that SRI requires more labour than the conventional method; for example, during the transplanting stage, the general impression is that SRI requires more labour because greater care and effort are required in transplanting young seedlings (Moser and Barett 2003). But this is not the case in this research, an average of 72 hours per hectare for SRI is estimated and an average of 89 hours per hectare for conventional methods. The same applies to transplanting of the young seedlings. For weeding though, SRI requires a lot more labour with 60 hours per acre vs 6 hours in the conventional method. A first explanation for this difference is the fact that SRI requires 3 weedings in stead of 1 or 2 in the conventional method. Secondly, many SRI farmers first weed with a rotary weeder and after that manually; so the work, and therefore the labour requirement, is doubled per operation (more on weeding in Chapter 5. 2.4).

Not finding enough labour on time is a big fear for farmers. And they are more afraid not to find enough labour for SRI than they are for the conventional method. And although SRI in totality requires more labour than the conventional method, it is not the case for the nursery stage and transplanting of the young seedlings. And even in those operations, they feel more frightened. An explanation for the 'feeling' of needing more labour for SRI, might come from the fact that farmers, which perform SRI, need qualified labour. The labourers working on SRI need to have had a little training on how to do the transplanting and the weeding, which are the components that are done different than the conventional method. The numbers of qualified labour available is less than 'regular' labour. Another reason why farmers have the feeling that SRI requires more labour could be because SRI requires more 'time management'. SRI requires that some components are performed 'on time'. For example, the guidelines for SRI say that transplanting should be done between the 8 and 14 days after planting the seeds; within this timeframe of six days, the transplantation 'should' be done. Transplanting a day later can have serious consequences for the seedlings and the performance of the plants. In such circumstances, it makes finding labour more precise and stressful. A farmer needs to plan ahead and have his activities scheduled. This can be experienced as SRI requiring more labour.

Besides comparing SRI with the conventional method, a comparison is made between *adopters* and *dis- adopters*. Table 5 is structured according to the three groups of farmers. Farmers that have performed SRI in the past, or are still performing SRI at current time, are the only ones that can share their experiences regarding SRI, so *non- adopters* don't have these experiences and cannot give answer to this question. That is why there is an empty space at the *non- adopters*. For non- SRI, all farmers are able to give answer.

Table 5. A comparison regarding labor requirements: *adopters* vs. *dis- adopters*

	Production Component		
	Nursery	Transplanting	Weeding
Non- adopters	-	-	-
Dis- adopters	8,6**	64,1**	54,3**
Adopters	16,8**	76,9**	60,1**

Hours per acre used for SRI farming for *dis- adopters* (N=28) and *adopters (N=68).* The data come from questions 12, 38 and 83 of the survey found in Appendix A. It refers to the amount of labour used for the rabi season (dry) 2011-2012.
** Difference in mean is significant at the 5% significance level

An interesting outcome is the fact that *adopters* seem to use more labour than *dis- adopters*. Why? A reason could be, that *adopters* have more access to labour and therefore use more labour. Access to labour consists of own labour (family) and hired labour. To see whether access to labour plays a role in the observed difference, I compared *adopters* and *dis- adopters* regarding the amount of family- and hired labour that they use. Household size could be a good indicator for 'family labour' and I looked whether there is a relationship between household size and the quantity of hours worked, but there is not significant relationship found. That means that household size does not play a role. I also looked whether the *adopters* use more hired labour than the *dis- adopters* and that again, is not the case. So, the quantity of labour used does not depend on the quantity of labourers used, also there is no difference found between family and hired labour. The difference why *adopters* have a higher usage of labour is because they work (or hire) for a longer period of time. That could mean that they can afford to hire personnel for a longer period of time and/or that they can afford to use own labour and sacrificing the opportunity of working elsewhere for a wage.

Independently of the access to labour issue, the fact that *adopters* use more labour could have other causes and these causes are difficult to overtake. An example of another possible cause is that *adopters* do all the operations with much more attention for details than the *dis- adopters* have ever done. But these kind of conclusions are dangerous to make.
Concluding the 'labour' chapter, in its totality the SRI method does require more labour than the conventional method. But the data show that this is due to the weeding. For nursery and transplantation SRI requires less labour. Furthermore, the farmers perceive SRI to be more labour intensive. Finally, *adopters* use more labour than *dis- adopters,* but the reasons therefor are not clear.

5.2.2. Lack of water

From many conversations with farmers it became clear that having a lack of water is one of the most influential factors for agricultural decision-making. Farmers have expressed that sometimes they are not able to plant their most profit- making crop (paddy) because of lack of water; they are forced to plant a crop, which needs less water, like groundnut and sorghum. Andhra Pradesh has a semi- arid climate (semi- arid regions receive low amounts of rainfall and tend to have scrubby vegetation and are prone to droughts); there are two important climatic seasons in which paddy can be produced: Kharif, the monsoon season, from June till September and Rabi season, from December till February. Because of the wet weather during monsoon season, it makes it favourable to produce rice, but even then, the rainfall is not enough, farmers need an extra source of water. That is why all the 112 farmers in this sample have a tube well.

The main reasons for having lack of water are insufficient rainfall, burning of the motor, a dry tube well/lake/pond and power cuts. Burning of a motor means that the motor, which is used to pump out the water of the well, is burned/broken. When the motor is broken, no water can be pumped out and the crop stays without water until the motor is repaired or until there falls some rain. Power cuts happen often in rural areas; if there is a power cut, it means that the motor of the well cannot function and no water can be gained from the wells.

The farmers are asked how many times they have had incidents of lack of water in the past ten years, due to a) burning of the motor and b) a dry well. The data (Table 6) is divided according to the type of farmer (*non- adopter, dis- adopter* and *adopter*). The incidents are the relative number of incidents, so the average number of incidents per farmer.

Table 6. Incidents of lack of water in the past 10 years

Type farmer		Due to burning motor	Due to drying up well	Total
Non- adopter (N=19)	Incidents	1.6	1.7	3.3
	% of crop loss	30%	84%	58%
Dis-adopter (N= 28)	Incidents	3.5	2	5.5

	% of crop loss	66%	68%	67%
Adopter (N= 62)	Incidents	6.2	1.7	7.9
	% of crop loss	27%	67%	35%
Total	Incidents	11.3	5.4	16.7
	% of crop loss	35%	70%	44%

All farmers in this table refer to their fields, either SRI, conventional or both. An 'incident' is the average incident per farmer. So, an *adopter* has had an average of 6.2 incidents of lack of water due to burning of motor in the past 10 years. Loss means the percentage of those incidents that have led to loss of the crop.

It is interesting to see that the drying up of the bore well, has much more impact (70% leads to loss of crop) than burning of a motor (35% leads to loss of crop). It makes sense as repairing the motor is easier and costs less time than wait till the well fills up with water. The damage that a broken motor causes is for a smaller period of time and therefore less severe than an empty bore well.

As seen in Table 6, *adopters* have experienced the most incidents of lack of water (average of 7.9 times per farmer in the last 10 years), but the percentage of those incidents that have led to a loss of the crop is much lower than compared to the other two groups, with the *dis- adopters* having the highest rate of crop loss. Under the conventional method (non- *adopters* all perform the conventional method), it is usual that 58% of times that there is an incidence of lack of water, the water unavailability leads to a loss of the crop. This may imply that SRI, which has been performed by *adopters* regularly for the past four years, is less vulnerable for lack of water. I also asked the farmers what they think are the main reasons for one method to be more risky than another, the question asked in order to obtain these results was a) 'which method is more risky regarding water unavailability?' and b) 'why?' 66% of farmers find the conventional method to be more risky, against 26% that find SRI to be more risky and eight percent find both to be equally risky. In general, farmers that find the conventional method to be more risky, is because they think the method is less resistant to water scarcity. The fact that farmers themselves find the conventional method to be less resistant to water scarcity and that the rate of crop loss is higher for *non- adopters* and *dis- adopters*, there can be concluded that SRI is more resistant against drought and therefore less risky regarding lack of water.

Concluding remarks are that SRI doesn't seem to be more risky than the conventional method regarding having lack of water. It is even the other way around. The conventional method seems to be more risky; it requires more water than SRI and seems more vulnerable to drought than SRI.

5.2.3. Pest and diseases

Pests and diseases can be a great risk for a crop, some methods, or some crops are better resistant to pests and diseases and this decreases the risks for the farmers of losing their cultivation. The farmers were asked to indicate 'how much the crop (SRI and non- SRI) suffers from pest and diseases', they had to answer this question on the basis of a four- point- scale (very little, little, a lot, very much). Of the SRI farmers (*adopters* and dis- *adopters*) 86% find that the SRI method has *little* pest and diseases (not in a table). This is in contrast with the conventional method whereby 72% of the farmers (all farmers) experience to have *a lot* incidents of pest and diseases. Moreover, giving the farmers to choose which method has more incidences of diseases, 90% indicate the conventional method. The reason why farmers find SRI to have less incidents of pests and diseases is because there is less chance of infection. Farmers think that is due to the fact that they weed more often on SRI plots, which reduces the risks of infections.

5.2.4. Risks associated with weeds

The risks associated with weeds vary greatly. It can be that the quantity of weeds that grow is bigger in one method than the other. Regarding this connotation, the experiences of the farmers are divided; some experience SRI to have more weeds, alternate wetting and drying gives the opportunity to weeds to grow when the water level is low. On the other hand, some farmers believe that constant inundation of the field, as is the case with the conventional method, increases the growth of weeds. Also it is possible that one weeding method (manually vs. with the use of a weeder) is more efficient than the other; or that it is more difficult to get labour for a certain type of weeding method. So, in this Chapter with the words 'risks associated with weeding' I mean all this different connotations.

Weeding schedule

According to the guidelines of SRI, to control weeds, the use of a rotary weeder is recommended. This mixes up the soil surface and buries young weeds. Weeding should start 10–12 days after transplanting, to early limit weed growth and to aerate and fertilize the soil (Uphoff 2011). An important aspect of SRI is that weeding should be done early, around 10 days after transplanting; for the conventional method the first weeding is done around the 25th day after transplantation. For SRI, the average, at which the first weeding is done is 16 days after transplanting, with only 20% transplanting 'on time' (at 10 days). A reason of this 'delay' is that many farmers believe that 10 days is too early, at that time the plants are not strong enough and can be damaged by the weeding, moreover, there are not enough weeds to extract. So, if weeding is done later, it can be done more efficiently. Planting at a later stage can also be seen as a way of facing risk. If weeding is done at an early stage, there is the risk of damaging the plants; so, if weeding is done later, the risk of damaging the young plants is smaller.

As mentioned before, the guidelines of SRI recommend the use of a rotary weeder. As seen in Table 7, very few farmers use restrictively the rotary weeder, most farmers performing SRI use a combination of rotary weeder and manual labour. Although many farmers are very positive about the rotary weeder, they say that the weeder works only on big strokes of land and it cannot get to the plant stem, the stem is then surrounded by weeds, the weeds close to the stems need to be cut by hand. Making use of manually labour is for SRI farmers, a way to reduce the risk of having too much weeds on their land. Another standard recommendation for SRI is to perform three weeding's (for the conventional method two weeding's) before harvesting. As seen in Table 7, most farmers don't perform the third weeding. Farmers believe two weeding's is enough.

Table 7. Weeding schedule

	Adoption	Manually	Rotary weeder	Combination	No weeding at all	Total
1st weeding	SRI	37%	3%	60%	0%	100%
	Conventional	100%	0%	0%	0%	100%
2nd weeding	SRI	34%	3%	60%	3%	100%
	Conventional	88%	0%	0%	12%	100%
3rd weeding	SRI	1%	3%	16%	80%	100%
	Conventional	1%	0%	0%	99%	100%

Per weeding (row) the farmer is asked to indicate which type of weeding he performs, manual labor, rotary weeder or both (column). SRI includes the answers of dis- *adopters* and *adopters* (N= 90). Conventional are all farmers (N=112).

The rotary weeder

In some casual conversations with farmers I heard some 'complaints' regarding the rotary weeder; the first complaint is that it is very difficult to find labour for the rotary weeder. The second complaint is that the weeder requires a lot of effort and sometimes- especially with muddy fields- it is difficult to handle the weeder; another complaint is that using the weeder causes pain in the shoulders and in the back. Lastly, due to the great effort and difficulty many women cannot manage the weeder. So, there has been a shift in gender regarding the weeding. And some farmers see this as problematic because female labour is cheaper than male labour. Taking these conversations into account, I included the question 'do you face any problems regarding weeding?' in the questionnaire (results not presented in table). Thirty percent find labour to be the most difficult issue; finding labour *on time* is seen as a problem and also finding *qualified* labour can be problematic. Another thirty percent has difficulty managing the rotary weeder and the rest has no problems at all. The difficulties that farmers face finding (qualified) labour- is in contrast with some 'access to the labour market' results we got. We asked the farmers, for each which 'type' of weeding, how difficult it is to get. Farmers could choose from a four- point scale: very easy, easy, difficult and very difficult. Against all expectations, labour for the weeder is easier to find. 60% of the farmers think it is 'very easy' and 'easy' to find labour to operate the weeder. And 24% think it is 'very easy' and 'easy' to find labour to remove the weeds manually. Although finding labour is seen as an important issue within SRI, for weeding, after all, finding labour doesn't seem to be a bigger problem than for the conventional method.

Concluding, risks regarding weeding are not more frequent or have a bigger impact for SRI than for Non SRI. Farmers have developed skills and knowledge on how to prevent possible risks.

5.2.5. Risks associated with transplanting of young seedlings

One of the most important elements of SRI is transplanting the seedlings when they are young, according to the guidelines 8 to 15 days. In the conventional method farmers transplant the seedlings after 20- 30 days. In Table 8 a comparison is made between SRI and the conventional method regarding the transplantation practices.

Table 8. Comparison transplanting practices

	Age of seedlings Average	Seedlings per hill Average	Planting Average
SRI	14.14 days	1.60 seedling	37% does square planting
	36% of the farmers transplants according to guidelines (8>15)	45% of the farmers transplants according to guidelines (1 seedling)	42% of the farmers transplants according to the guidelines (square). The rest 58%) does row planting.
Conventional	24,3 days	3,4 seedling	100% random planting

SRI includes the answers of dis- *adopters* and *adopters* (N= 90). Conventional are all farmers (N=112).

Age of seedlings

What the data reveal is that no farmer transplants his seedlings at age eight, neither nine nor ten days. The earliest is eleven days. As seen in Table 8 one third of the farmers (36%) transplant their seedlings according to what the guidelines suggest regarding how many days after transplantation one should transplant the seedlings. Reasons for why farmers choose to transplant later differ. The most common reason is that farmers believe the seedling is not strong and tall enough when they are young, followed by the perception that transplanting seedlings at a later stage will give them more tillers and therefore more yield. Farmers, who transplant according to the guidelines, do it, mainly because they believe it gives them higher yields. Overall, the most important reason for farmers to transplant their seedlings at a certain time is that the farmers believe that at that time, the seedlings are at their healthiest/strongest and tallest point.

Seedlings per hill

According to the guidelines of SRI, seedlings are transplanted singularly. Out of the farmers who use SRI, 45% plant only one seedling. More than half of the farmers plant more seedlings. Out of this group, the most important reason to plant more seedlings is to cope with the risk of a seedling dying. In Table 9 we can see the distribution of the number of seedlings planted and the reasons for that.

Table 9. Reasons for planting a certain number of seedlings per hill

Reasons for planting a certain number of seedlings per square	Number of SRI seedlings planted per hill			
	1	2	3	Total
High yield	5%	11%	0%	6%
According to the SRI guidelines	18%	23%	0%	16%
1 seedling is sufficient, provided that it is strong enough	62%	9%	5%	20%
To cope with the risk of a seedling dying	0%	23%	85%	25%
More tillers	7%	29%	0%	13%
Other	9%	6%	10%	8%
Total	100%	100%	100%	100%

This table contains data from SRI farmers, both dis- *adopters* and *adopters* (N=90). Farmers are divided according to the number of seedlings they plant (columns).

The main reason why the farmers plant one seedling is because they believe one seedling is enough, provided that it is strong enough. And the reason for planting more than one seedling is mainly that the farmers want to cope with the risk of one seedling dying. If they plant more, at least one or two seedlings survive. Also they believe that planting more seedlings give them more tillers.

Within the SRI 'group' of farmers, there are some differences between *adopters* and *dis- adopters*. In Table 10 it is shown that *dis- adopters* plant one seedling per hole and *adopters* plant almost two seedlings per hole. This difference may imply that *adopters* deviate from the guidelines in order to reduce the risks. All the risks regarding transplanting can be foreseen by 'playing' with the guidelines. By transplanting two seedlings instead of one, a farmer avoids the risk of ending up with zero seedling.

Table 10. A comparison between *dis- adopters* and *adopters* regarding transplanting practices

	Age of seedlings	Seedlings per hole	Planting
	Average	Average	Average
SRI			
Dis- adopters	14.4 days	1.25 seedling	21% does square planting
Adopters	14.02 days	1.95 seedling	51% does square planting

SRI farmers are divided according to their category with *dis-adopters* (N=28) and *adopters* (N= 62).

When dis- *adopters* and *adopters* refer to SRI, they might be referring to a different 'SRI'. So, *adopters* and dis- *adopters* might have different frames in mind. To clarify, dis- *adopters* might have been performing SRI on their own way, for example, planting 1.25 seedling per hill (as shown in Table 10) in contrast with *adopters*, who plant 2 seedlings per hill. There is no wrong or right, it is just important to keep in mind that the two groups do things differently and when they refer to SRI, they might be having different frames in mind.

5.3. Own risk perception

In this section, the risk perceptions of the farmers are analysed and thereby the following research questions is being answered:

Do risk perceptions, whether based on knowledge or information, affect SRI adoption?

As seen in Table 11, where the means of both methods are compared through an independent t-test, the conventional method is, significantly, seen as more risky than SRI (2,7 and 2,2 respectively). This outcome corresponds to the results found previously, that SRI is not found to be a more risky method than the conventional method.

Table 11. Riskiness perception of the farmer per operation stage

	Production stage					
	Nursery	Trans-plantation	Weeding	Water supply	Pest and diseases	Total
SRI	1,8**	1,7**	2,0**	2,8**	1,6**	2,2**
Non- SRI	2,1**	2,1**	2,5**	2,7**	2,7**	2,7**

SRI includes the answers of dis- *adopters* and *adopters* (N= 90) and are regarding SRI. Conventional are all farmers (N=112) and answers are regarding the conventional method. Riskiness ranks from 1 to 4. The higher the number, the riskier the farmer finds the method to be.
** significant at the 5% significance level

5.3.1. Risk perception and the nursery stage

Reasons why farmers find Non- SRI to be more risky than SRI differ among farmers and amongst different production stages. Table 12 summarizes the reasons that farmers give why one method is more risky than another during the *nursery* stage. We can see that the farmers that find SRI to be more risky than Non-SRI during the *nursery* stage, think that is because they cannot find enough labour on time. On the other hand, Non- SRI is seen as more risky by most farmers, but in that case because of water unavailability. Farmers that think Non- SRI to be more risky, say that Non- SRI requires much more water than SRI and if the water is not available- due to lack of rainfall, burn of motor, power crisis- the loss will be greater for Non- SRI. Striking is too see that most of the farmers ‘think’ that the risk of SRI is largely due to difficulties in finding labour, but if you go back to Table 4, of the requirements of labour, we see that SRI needs less labour than the conventional method, except for weeding. Al in all, Non- SRI is found to be a more risky method regarding the nursery stage and that has mainly to do with the risk of not having enough water for the young seedlings.

Table 12. Reasons why farmers find one method to be more risky than another during nursery

Reason	Most risky method		
	SRI more risky	Non-SRI more risky	Both equally risky
Wild pigs	0%	5%	0%
Infections	18%	7%	0%
Water deficit	14%	70%	18%
Labour	60%	4%	0%
Other	10%	11%	82%
Total	100%	100%	100%

Only farmers able to compare both methods (dis- adopters and adopters) gave answer to this question (N=90). They chose which method they thought it was more risky, or equally risky.

5.3.2. Risk perception and transplanting

Regarding *transplanting*, only 13% (no table) of the farmers find SRI to be more risky than the conventional method. Reasons for this are mainly labour unavailability and improper planting of the seedlings. 54% finds the conventional method to be more risky and 33% say both methods are equally risky. The main reason why the conventional method is found to be more risky is water unavailability. People that believe both are equally risky, say it is because finding labour is very difficult, regardless of the method.

5.3.3. Risk perception and water

As regards *water supply* (Table 13), the farmers that find SRI to be more risky, state it is due to the alternate wetting and drying. Those farmers (80%) find it difficult to manage the water supply, which in the case of alternate wetting and drying includes good time management. Farmers that find the conventional method to be more risky think it is because of water scarcity, many farmers believe that the conventional method is more vulnerable to lack of water, so if water is not there, the loss for the conventional method will be greater than for SRI crops.

Table 13. Reasons for 'risky' perception water management

Reason	Most risky method		
	SRI more risky	Non-SRI more risky	Both equally risky
Water scarcity	20%	53%	100%
Method more vulnerable for lack of water	0%	38%	0%

Alternate wetting and drying	80%	6%	0%
Other	0%	1%	0%
Total	100%	100%	100%

Only farmers able to compare both methods (dis- adopters and adopters) gave answer to this question (N=90). They chose which method they thought it was more risky, or equally risky.

5.3.4. Risk perception and weeding

Regarding *weeding,* the conventional method is seen as much more risky than SRI. For SRI 74% think weeding is not risky at all or just a little risky. In contrast with the conventional method where 56% finds weeding to be risky and very risky. Many farmers say that SRI is less risky because it is easier to remove the weeds; they experience the space between the plantlets to give them the space they need to remove the weeds properly. Moreover, some farmers experience the rotary weeder to be more effective than weeding manually. It is remarkably that SRI 'suffers' more from weeds, but that it is not seen as a more risky method in this aspect. There are two explanations for this. The first is that, as mentioned above, farmers experience that it is effective to weed with the rotary weeder than by hand; so even if there are more weeds, they are removed easily anyway. Another reason is the access to labour. In the measurement of the overall risk perception regarding *pests and diseases*, 92% of the farmers think SRI is not so risky 8% find it risky. For the conventional method, 30% find it to be not so risky and 70% find it risky.

5.3.5. Risk perceptions ranked

To put some things into perspective, I asked the farmers to order the eight most important operations (main field preparation, nursery, transplanting, weeding, finding labour, water management, pests & diseases and time management) according to their perception on 'riskiness' of the certain operation. They had to do this for both SRI and Non- SRI. The idea behind this exercise is to see which operation/component of paddy production they find to be more risky and to see whether SRI is different from Non- SRI. Through an independent t-test, both methods are compared. In Table 14 the results are presented. The least risky operation is *nursery* with a low score of 2,7 for SRI and 2, 9 for conventional. For both methods water and water management is seen as the most risky aspect in rice production and scores with a mean of 6,3 for SRI and 6 for conventional. The perceptions of the farmers regarding SRI and conventional method don't seem very different on the first sight. Nevertheless, the test shows that there are some differences in how farmers perceive different operations. *Time management* is significantly more risky for SRI than for conventional method; *pests and diseases* is significantly more risky for the conventional method than for SRI and *land preparation* is significantly found to be less risky for SRI than conventional method. The other operations are not significantly different from each other.

Table 14. Components of paddy production ranked according to 'riskiness'

	Method SRI (N=93)	Mean	Method Conventional (N=103)	Mean
Less risky	1. Nursery	2,7	1. Nursery	2,9
	2. Land Preparation	3,0*	2. Land Preparation	3,5
	3. Transplanting	4,0	3. Transplanting	3,9
	4. Pests and diseases	4,4**	4. Time management	4,2
	5. Weeding	4,8	5. Weeding	4,7
	6.Time management	5,1**	6. Pests and diseases	5,2
	7.Finding labour	5,7	7.Finding labour	5,4
Risky	8. Water and water management	6,3	8. Water and water management	6,0

Test: Independent paired The mean in this table is constructed by asking all the farmers to arrange the eight operations from not risky (1) to very risky (8). The higher the number the more risky the operation is perceived. Three operations (land preparation, pests and diseases and time management) are significantly different from each other regarding the risk that farmers perceive.
* significant at the 0,10 level **significant at the 0,05 level

In section 5.2.1 on 'labour', it wasn't really straightforward whether SRI required more labour than the conventional method. In its totality SRI required more labour, but without taking weeding into account it required less labour. Nevertheless, farmers believe- have the feeling- that SRI requires more labour, in Table 14 the data show that farmers perceive SRI to be more risky regarding finding labour on time, but it is not significant different from the conventional method. One of the reasons proposed for the perception that SRI requires more labour is that SRI requires better time management. As seen in Table 14 there is a significant difference in how farmers perceive time management throughout the methods. SRI is seen as more risky regarding time management; asking further on this issue, farmers have mentioned that they find it more difficult to plan activities according to the guidelines and the management consumes more time than in the conventional method.

5.3.6. Risk perception: *dis- adopters* vs. *adopters*

As said before, a significant difference in risk perception of the farmers is found between SRI and the conventional method. The farmers find the conventional method to be more risky than SRI. Next to this finding, a difference is found within 'SRI farmers'. *Dis- adopters* find SRI to be more risky than *adopters* with values of 2,3 and 1,8 respectively, where the higher the value, the riskier the perception (see Table 15). A remarkable finding from Table 15 is the fact that within SRI, there is a big difference in risk perception between *dis- adopters* and *adopters*. In general *adopters* find SRI to be less risky.

Table 15. Risk perception: difference between adopters and dis- adopters

	Nursery	Transplantation	Weeding	Water supply	Pests and diseases	Total
Dis- adopter (N= 28)	2,5**	2,4**	2,3	2,5	1,7**	2,3**

Adopter (N=62)	1,5**	1,8**	1,9	2,0	1,8**	1,8**

The numbers represent the riskiness perceived by the farmers. Farmers could rank from 1 (not risky) to 4 (very risky); the higher the number, the higher the risk is perceived.
**significant at the 0,05 level

The crucial issue here is to know where this difference in perception comes from. Connecting previous findings of the research, with the difference in perception, one can see certain relationships, but it is not certain that the relationship is causal. An example of such a relationship is the one where dis- *adopters* have had bad experiences with SRI and therefore perceive the method to be more risky. In Table 6, it is shown that *dis-adopters* have suffered 67% of crop loss due to lack of water, *adopters* only 35%. Following the *knowledge theory* in Chapter 2, perceptions can be constructed based on information or experience. In this case it would be the last one.

Another possible explanation for the difference between *adopters* and dis- *adopters* is that *adopters* might have adjusted better to SRI than *dis- adopters*. In some way or another they are more familiar with the method and have found ways to cope with the risks. This explanation can be found in Table 10 (Chapter 5.2.5). In the table it is shown that *adopters* plant on average more seedlings per hole than *dis- adopters* do, the main reason given by farmers for 'deviating' from the guidelines is to cope with the risk of a seedling dying.

Also important to keep in mind is that *dis- adopters* and *adopters* might have a different frame in their minds when they think about SRI. Other explanations are different to give. It is not possible to make conclusions with this data set. Maybe SRI is not suitable for the *dis- adopters*, for example because their land is not adequate for SRI, or because *dis- adopters* have not had the same training of SRI as the *adopters*. There are many variables that are not measured in this research. And the explanation can be in one of them.

Most of the farmers that have adopted, or dis- adopted, SRI have performed SRI on a certain part of their land (see Table 3), very few farmers are producing rice with the SRI method on all of their land. In order to get more insights into the reasoning's of the farmers to (partly) adopt SRI, a question regarding the reasons for adoption is asked. The main issues mentioned for not having more plots with SRI are: 'water unavailability', 'improper power supply' and 'finding labour'. One farmer mentioned that he doesn't want all his plots with SRI because SRI produces less straw than the conventional method and this straw he uses as animal feed. Another farmer mentioned that he doesn't like performing SRI, it is way too structured and planned, he prefers to do the conventional method, as it is more straightforward and just something he is used to. Remarkably is though, that many farmers don't want to perform SRI on more land because of water unavailability, but at the same time, if you ask them why they started with SRI in the first place, they answer because of higher yields and because SRI requires less water. On the one hand farmers are performing SRI because it requires less water, but on the other hand, they cannot expand because of lack of water. A reason for this finding might be that the farmers don't have irrigation on all of their plots.

Reasons why *non- adopters* have not adopted SRI are mainly because they have never heard of it, they have no knowledge on the technology and don't know it exists. Two farmers have heard of SRI before, but don't want to get started with it, because they believe that the alternate wetting and drying is too risky.

Concluding Chapters 5.2 and 5.3, farmers adopt SRI in the first place because they believe it gives them higher yields, reasons for not to cover all their land with SRI are 'water unavailability', 'improper power supply' and 'finding labour'. Lack of knowledge and information on SRI is the main reason why *non- adopters* have not adopted SRI. From the risk- assessment it can be concluded that SRI is not more risky than the conventional method in any respect. Regarding labour, weeding in SRI requires a tenfold of the labour that the conventional method requires; for the other two operations measured, SRI requires significantly less labour than the conventional method. It is difficult to say which method is more risky with regards to labour; nevertheless, farmers do perceive that SRI requires more labour. On the other hand, although SRI might require more labour, SRI is not significantly perceived as more risky than the conventional method (Table 14).

Furthermore, SRI suffers to a less extent from pests and diseases; it requires less water than the conventional method and it is seen as more resistant to drought; and at last, the method of transplanting in SRI doesn't seem to be a more risky activity than in the conventional method. It is actually the other way around, the conventional method seems to be more risky than SRI, especially regarding lack of water. A remarkably finding is done on the issue of transplanting. It is observed that *dis- adopters* 'follow' the guidelines more strictly regarding the quantity of seedlings to plant. *adopters* plant almost two seedlings and this goes against to what the guidelines suggest. A reason for not following the guidelines very precisely could be that *adopters* have managed to make the SRI method their own and have learned how to deal with risks. In one way or another they have adjusted to the method. Important to keep in mind, is that farmers might have a different frame of SRI in their minds.

5.4. Risk preferences

In this section the role of risk preferences on SRI adoption is examined. Household characteristics are also taken into account. With the regressions and the analysis done in this section an attempt is made to answer the following questions:

Do household characteristics, and specially wealth, affect risk preferences?
Do household characteristics, and specially wealth, affect SRI adoption?
Do risk preferences affect SRI adoption?

5.4.1. Household characteristics and risk preferences

In order to know if there are any factors that influence risk preferences, a regression (OLS) is done with household characteristics as explanatory variables and 'risk preference' as dependent variable. In Table 16 you can see that there are three variables that play a significant role at the 5% significance level. First of all there is a significant negative relationship between age and risk preference. That means that the older the subject, the less risk seeking he is, and thus more risk averse. There is also a significant positive relationship between 'wealth' and risk preference. That means that the richer the farmer, the more risk seeking he is, the more risks he dares to take. The fact that there is a significant relationship between age and wealth with risk preference is not strange. This relationship has been described in many other empirical studies. Also interesting is the fact that farmers from the village 'Neetur' are significantly more risk averse than their colleagues in the other villages. Going back to Table 3, on household characteristics, it shows that Neetur differs greatly from the other three villages in three aspects: a) The farmers are much younger, b) household size is much smaller and c) it has the biggest share of *dis- adopters*. Household size although not expected, does not play a role when looking at risk preferences. Regarding wealth and age, Neetur has wealthier and younger farmers, so one would expect to see more risk seeking farmers, but the contrary is the case. Reasons why farmers in Neetur are more risk averse than farmers in other villages cannot be addressed, there may be other factors that remain unobserved, that may play a role.

Table 16. Household characteristics and risk preferences

		Risk preference[1]	
		Coefficient	Std. Error
Age of the head of the household		-,02**	,01
Gender		,04	,32
Wealth		,37**	,12
Caste		,01	,12
Household size		,01	,03
Farm size		,02	,02
	Neetur	-1,49**	,26
Village	Anantapur Tanda	-,35	,31
	Metlakunta	,13	,23

1. Ordinary Least Squares (OLS): Dependent Variable: Risk preferences. R Squared: 0,45. The higher the value for a variable, the higher the correlation with risk seeking behaviour; and a lower value means risk avoiding.
* significant at the 0,10 level **significant at the 0,05 level ***significant at the 0,01 level
A minus sign means that there is a negative correlation between a certain variable and risk preference (ex. Age: the older the subject, the less risk seeking he is).

5.4.2. Risk preferences and SRI adoption

Do risk preferences influence SRI adoption? This question is being answered through a multinomial logit regression. In Table 17 the output of this regression is shown. In the first column a regression is done with 'SRI adoption' as dependent variable and 'risk preference' as independent variable. A multinomial logit is always done with one category as a reference category, in this case the *non-adopters,* so *dis- adopters* and *adopters* are compared to *non- adopters*. From the first regression I find a significant positive correlation between risk preferences and adoption; this means that if the risk preference increases (becomes more risk- seeking) it is more likely that the farmer will be a dis-adopter and adopter, compared to non- adopter (reference category).

In the second column, the same regression is done as in column one, but with the inclusion of control variables. Control variables are variables that could affect the dependent variable, in this case SRI adoption, while incorporating control variables, I am keeping them constant to see whether there is a 'true' relationship between risk preferences and SRI adoption. With adding control variables, risk preference doesn't seem to play a significant role any more for the adoption of SRI.

Table 17. Household characteristics, risk preference and SRI adoption

Model		SRI adoption¹		SRI adoption²	
		Dis- *adopters*	*Adopters*	Dis- *adopters*	*Adopters*
Age of the head of the household		-	-	,92	,96
Gender		-	-	,56	25780683,28
Wealth		-	-	2,67	,204*
Caste		-	-	,43	,38
Household size		-	-	,65*	,90
Farm size		-	-	1,03	1,41
	Neetur	-	-	35010811232171988	574671632,12
Village	Anantapur Tanda	-	-	3212272113,53	96,55**
	Metlakunta	-	-	629617576,70	3288587531,72
Risk preference		,37***	1,68*	,38	1,42

Reference category: *non- adopters.* Exp (B) used.
1. First Multinomial Logit : Dependent Variable: Adoption. Regression without control variables.
2. Second Multinomial Logit : Dependent Variable: Adoption. Regression with control variables.

* significant at the 0,10 level **significant at the 0,05 level ***significant at the 0,01 level
Interpretation: for example household size *dis- adopters:* if a household were to increase her size by one person, the odds for being a *dis- adopter* above a *non- adopter* (reference category) increases by 0,65 given the other variables in the model are held constant.

In the last regression done, three variables seem to play a significant role when adopting SRI. The first is wealth; this outcome is interpreted as follows: the wealthier the farmer, the more likely he is to be an adopter. Regarding household size, the bigger the household (the higher the quantity of household members), the more likely the farmer is a dis- adopter. The other way around, it could be said that dis- *adopters* tend to have larger household sizes. The village Anantapur Tanda is also significant different, here residents from this village are more likely to adopt SRI. That farmers from Anantapur Tanda are more likely to adopt SRI, might be related to the wealth factor. This village inhabits the highest quantity of rich farmers (see Table 3), and as seen in the Logit Regression, wealth influences SRI adoption.

6. CONCLUSION AND DISCUSSION

Through this research I have given answers to various questions regarding SRI adoption and risk. In this chapter I will answer the research questions stated in Chapter 3.

1. *What are the major risks that rice producing farmers face in rice cultivation?*

In section 5.2 the main risks that farmers face during paddy production have been assessed. Through a literature research and intensive collaboration with farmers, researchers and extension workers I made a short list of risks that farmers face in rice production. The main risks affecting paddy production are: risks regarding labour, weeding, transplanting, pests and diseases and lack of water. Then these risks were compared through a risk assessment (Chapter 5.2), the results are summarized in the following question.

2. *Is SRI a more 'risky' rice production method than the conventional method?*

Yes and no. The results in the risk assessment show that SRI is not a more risky method than the conventional method regarding all operations, except labour. SRI has shown to suffer to a less extent from pests and diseases; it requires less water than the conventional method and it is seen as more resistant to drought; and at last, the method of transplanting in SRI doesn't seem to be a more risky activity than in the conventional method. Nevertheless, labour remains a questionable issue. In two operations (nursery and transplantation), SRI requires less labour than the conventional method. Regarding weeding, SRI requires significantly more labour than the conventional method. Requiring more labour could be a risk if farmers don't find it on time. Although farmers perceive that SRI requires more labour, their perception on the risk of not finding labour in time is not significant different from the conventional method.

3. *Do household characteristics, and specially wealth, affect risk preferences?*

Yes. Age and wealth do affect risk preferences. The data show that age has a negative impact on risk seeking behaviour, which means that the older the subject the less risk seeking he tends to be. Regarding wealth, the contrary is observed, there is a positive relationship, which means that the wealthier the subject, the more risk seeking he tends to be. Also the village 'Neetur' shows a significant negative correlation with risk preference. This means that in that village, farmers tend to be more risk averse, compared with their colleagues in the other villages.

4. *Do household characteristics, and specially wealth, affect SRI adoption?*

Yes. The data show that wealth influences SRI adoption. There is a significant positive correlation found between wealth and SRI adoption. This means that *adopters* tend to be wealthier than *dis-adopters* and *non- adopters.* Although there is a significant correlation between *adopters* and wealth, it can not be stated that wealthier farmers are more likely to adopt SRI. This is because both *dis- adopters* and *adopters* have adopted SRI at one moment or another. Then, also a significant positive correlation between *dis- adopters* and wealth should be expected and that is not the case. Reasons behind the wealth differences between *dis- adopters* and *adopters* vary and it is difficult to exactly grasp what is going on. In the literature on technology adoption the conventional explanation is that poorer farmers are less able to smooth their consumption and therefore opt to produce low- risk, low- return crops. Another explanation often mentioned is that wealthier farmers often have better access to markets and information, which makes them more likely to adopt a new technology. However, in the preliminary phase of this research I made a list of any possible risks that farmers could face in rice production; access to market and inputs was not seen as a risk by neither researches, agricultural extension workers nor farmers themselves. In this light, I discard that access to market could be an explanation for why *adopters* seem to be wealthier.

Besides the factors already mentioned, a factor that could play a role, but that I did not measure is schooling. It is often seen that schooling is associated with wealth levels, the wealthier the subject, the more schooling he has enjoyed (or the other way around). A higher educational level could provide higher ability to take in information, to adapt to new circumstances, to learn better and therefore also to adopt a new technology.

In India, the caste system is still very much present in society. Before hand, I would have expected that the higher castes would have higher wealth levels. However this is not the case, no correlations were found between caste and wealth. Caste do not give an explanation for why *adopters* seem to be wealthier.

Reasons behind the relationship between wealth levels and adoption remain unclear and at this moment, only speculations can be made. Therefore I suggest that more research is done on this matter, perhaps by linking wealth to other household characteristics and adoption.

5. How do risk perceptions, whether based on knowledge or information, affect SRI adoption?

As discussed many times before, both *dis- adopters* and *adopters* perceive SRI to be less risky than the conventional method. So, at first glance, it seems that a positive perception of SRI increases the adoption of SRI. Nevertheless, a significant difference is found between *adopters* and *dis- adopters* regarding SRI farming. *Dis- adopters*, compared with *adopters,* perceive SRI to be móre risky. In the next paragraph I will discuss some reasons behind this difference, but first I want to mention the following. In this research all the farmers were only visited once (July-August 2012). In that regard, the risk perception of the farmer concerning SRI (and conventional method) is bound to time. Farmers have given answers on their perception of thát particular moment. If farmers would have been asked about their risk perception *before* starting with SRI, they might have given different answers.

So, reasons for the difference in perception between *adopters* and *dis- adopters* could be that *dis- adopters* have had bad experiences with SRI. In Table 6, it is shown how often farmers suffer from crop losses due to lack of water, the data reveal that *dis- adopters* have experienced crop losses more often than *adopters*, that could be a reason to dis- adopt a certain method. Another reason why *dis- adopters* find SRI to be more risky, could be attributed to certain (unobserved) household- or farm characteristics. It is said, for example, that SRI is best done on saturated soil conditions (DeDatta 1981 in Uphoff *et al*. 2007), this variable, for example, I did not take into account in this research, and so are many unobserved variables that may play a role.

In this research the data have shown that *dis- adopters* and *adopters* perceive risks of SRI differently, a more elaborated research could be done on the matter of risk perception to see what the reasons are behind the difference in risk perception.

Coming back to the question, this research has shown that there is a relationship between risk perception and SRI adoption, however, the causality remains unknown.

6. Do risk preferences affect SRI adoption?

No. No significant correlation has been found between risk preferences and SRI adoption.

In offering these insights, it is important to mention the limitations of this research. One of the limitations is that the experiment with the chocolates, meant to measure risk preferences, did not work out properly. In this experiments farmers could bet a certain amount of chocolates that they wanted to put a risk. Almost all farmers bet the maximum quantity of chocolates and therefore not enough variance in the answers was seen; the reason for the lack of variance can be that chocolates are not seen as something of value for the farmers. Although, the risk preference variable (extracted from a factor analysis) in this research is well constructed, a well- performed- experiment with real monetary pay offs could be of extra value in the sense that such an experiment is represents actual behaviour to a greater extent.

Another limitation is that three different teams of enumerators conduct the survey. Two villages were surveyed by two different enumerators and the last two villages were surveyed by myself and a translator. An ideal situation would have been to have performed all the surveys myself, but due to time pressure it was not possible. This might have caused a bias in the answers. Sometimes, after receiving the forms, I could see that farmers from one village were inclined to give the same answers on for example reasons for having lack of water. Sometimes it was difficult to see whether the answers where the same due to village characteristics or due to bias.

An issue to think about is the specification of the concept of adoption. In this study adoption is seen as a binary choice, a farmer either adopts SRI or he doesn't. The precisely quantity of components that he/she is adopting (whether he is following the guidelines) are not taken into consideration, neither is the intensity of adoption, that is the total area over which a farmer practices SRI. A difference in specification of the concept of adoption can have dramatic consequences in the results. For example, if in this research, if I had categorized the farmers according to the quantity of components that they are adopting, I would have had a different categorization. Take a farmer that in my research is seen as an adopter, he has performed SRI regularly in the past four years but he doesn't follow all the guidelines by the rule, he transplants the young seedlings a couple of days later than what the guidelines say and he plants two seedlings instead of one. In a research with a categorization according to the adoption of different components, he probably would have not be seen as a full adopter. In this research, the fact that he is doing a bit differently than what the guidelines say does not mean he is not an adopter, in this research this farmer has proved to have adapted to the new technology and he is probably dealing with risk, the risk of a young plant dying. With this statement I don't think one specification of risk is better than another, the main message here is that the specification of adoption does play a large role and it can 'colour' the results. It is something to keep in mind in further research.

The main objective of this research was to see whether risk perceptions and risk preferences influence the adoption of SRI. Summarizing the results, one can say that risk preferences do not play a role when adopting SRI, the data show no significant relationship between risk preference and SRI adoption.

The data show that risk perceptions do play a role. At the first glance, it seems that a positive perception of SRI leads to its adoption. SRI farmers find SRI to be less risky than the conventional method. However, a significant difference is found between *dis- adopters* and *adopters. Dis-adopters* find SRI to be more risky than *adopters.* In conducting this research and attempting to shed more light on the role or risk in SRI adoption, the most notable research implication that emerges is to investigate whether SRI is appropriate for different types of farmers. Although adoption of SRI is high, the rate of dis- adoption is high as well.

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APPENDIX A
Survey
Farmer characteristics:

ID.1	Identification No:	
ID 2	R. ID No.	
ID.3	Farmer name:	
ID.4	Caste:	
ID.5	Village name:	
ID.6	Mandal name:	
ID.7	District name:	Mahubub Nagar
ID.8	Date:	
ID.9	Enumerator:	

ID. 10	Gender	F	M
ID. 11	Age		
ID. 12	Years in farming		
ID. 13 ID. 14 ID. 15	# Household members	Total: Working: Non- Working:	
ID. 16	Wealth		
ID 17	Participation in casual labour:		

Farm Characteristics:

ID 18	Total Land holding (ac)	
ID 19 ID20	Total paddy area	AC: Plots:

ID 21 ID 22	Land under SRI	AC: Plots:
D 23	Year of start SRI	
ID 24	Total area with other crops (ac):	
ID 25	How many seasons have you done SRI?	

Q.No.	**Question**
Q.1	Suppose that a farmer in your village is trying a new technology of irrigation, it is working really good and doesn't cost much, how likely is it that you try the new technology?
Q.2	Suppose a seed vendor comes to your door and offers you to buy some really good rice seed, this seed is 10% more expensive than the one you have now, how likely is it that you buy it?
Q.3	Suppose you have sunk a borewell 3 times and it has not gotten water, how likely is it you try for the 4^{th} time?
Q.4	Suppose that a new seed variety is introduced in the village, some farmers are already using it, this new seed variety needs half the water of the one you have now. The yields are pretty high, but this new seed variety is not resistant to pests and diseases. How likely is it you adopt this seed variety?
Q.5	Suppose that an agricultural assistant comes to the village with a new crop variety you can try, he says the yields are very high ONLY if you do all the operations following a strict schedule time. How likely is it that you will plant this crop?
Q.6	Suppose you get some money from a family member, that money is just enough to buy an ox. But you could also invest in a risky project which can return you twice the investment with a 50% chance. Other 50% is you lose all your money. How likely are you to choose for the risky project?
Q.7	Suppose an agricultural assistant comes to your village and introduces a new crop that has never been planted in the village. From experiences in other places it seems that the crop has very high yields, the yields depend on the weather. If the weather is good, the yields are very high; if weather is bad the yields are very low. How likely is it you adopt the new crop?
Q.8	Suppose you can 'buy' the knowledge of the weather for next season (Rabbi), with this knowledge you can know exactly what the weather will be like. How many rupees are you willing to pay for this knowledge?

Part II: 2.1 Nursery

<table>
<tr><td>Q10
Q11</td><td>Do you hire labour for nursery?</td><td>SRI: NON- SRI:</td></tr>
<tr><td>Q12
Q13</td><td>How much labour do you use for nursery? Per acre.</td><td><table><tr><td></td><td>Family</td><td>Hired</td></tr><tr><td>SRI</td><td></td><td></td></tr><tr><td>Non- SRI</td><td></td><td></td></tr></table></td></tr>
<tr><td>Q14
Q15</td><td>No. of working hours in nursery. Per acre.</td><td>SRI: ……………… hours for ……………. Days

NON- SRI: ……………… hours for ……………. days</td></tr>
<tr><td>Q16</td><td>If hired labour, how difficult is it for you to find labour during nursery stage?</td><td><table><tr><td>Very easy</td><td>Easy</td><td>Difficult</td><td>Very difficult</td></tr><tr><td></td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>Q17</td><td>If hired labour, where do you get your labour from?</td><td><table><tr><td>Exchange</td><td>Daily wages</td><td>Contractual</td></tr><tr><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>Q18
Q19</td><td>How often have you lost your nursery in the past 10 years?</td><td><table><tr><td>SRI</td><td></td></tr><tr><td>Non- SRI</td><td></td></tr></table></td></tr>
<tr><td>Q20
Q21</td><td>What are the reasons for the losses?</td><td>SRI:
NON- SRI:</td></tr>
<tr><td>Q22
Q23</td><td>What is to be done to reduce the loss?</td><td>SRI:
NON- SRI:</td></tr>
<tr><td>Q24
Q25</td><td>How risky do you find SRI and Non- SRI to be regarding nursery?</td><td><table><tr><td></td><td>N. R. at all</td><td>Little R.</td><td>Risky</td><td>Very R.</td></tr><tr><td>SRI</td><td></td><td></td><td></td><td></td></tr><tr><td>Non- SRI</td><td></td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>Q26</td><td>Why?</td><td></td></tr>
</table>

2.2 Transplanting

<table>
<tr><td>Q27
Q28</td><td>Age of seedlings at the time of transplantation (days)</td><td>SRI:
NON- SRI:</td></tr>
<tr><td>Q29
Q30
Q31</td><td>Why X days on SRI?</td><td>1.
2.
3.</td></tr>
<tr><td>Q32
Q33</td><td>No. of seedlings per hill</td><td><table><tr><td>SRI</td><td>Non- SRI</td></tr><tr><td></td><td></td></tr></table></td></tr>
<tr><td>Q34</td><td>For SRI, why X amount of seedlings per hill?</td><td></td></tr>
<tr><td>Q35</td><td>How is marking done?</td><td>With ropes / with roller marker / with tined marker</td></tr>
<tr><td>Q36
Q37</td><td>Type of planting</td><td>SRI: Square planting / row planting / random planting
N-SRI: Square planting / row planting / random</td></tr>
</table>

<table>
<tr><td></td><td></td><td>planting</td></tr>
<tr><td>Q38
Q39</td><td>How much labour do you use for transplantation? Per acre.</td><td><table><tr><td></td><td>Family</td><td>Hired</td></tr><tr><td>SRI</td><td></td><td></td></tr><tr><td>Non- SRI</td><td></td><td></td></tr></table></td></tr>
<tr><td>Q40
Q41</td><td>No. of working hours for transplantation. Per acre.</td><td>SRI: hours for Days
NON- SRI: hours for Days</td></tr>
<tr><td>Q42</td><td>For transplantation, where do you get your hired labour from?</td><td><table><tr><td>Exchange</td><td>Daily wage</td><td>Contractual</td></tr><tr><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>Q43
Q44</td><td>How difficult is it for you to find labour during transplantation stage?</td><td><table><tr><td></td><td>Very easy</td><td>Easy</td><td>Difficult</td><td>Very difficult</td></tr><tr><td>SRI</td><td></td><td></td><td></td><td></td></tr><tr><td>Non- SRI</td><td></td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>Q45
Q46</td><td>What can go wrong during transplantation?</td><td>1.
2.</td></tr>
<tr><td>Q47</td><td>How often has that happened in the last 10 years?</td><td></td></tr>
<tr><td>Q48</td><td>What can be done to reduce that?</td><td></td></tr>
<tr><td>Q49
Q50</td><td>How risky do you find SRI and Non- SRI regarding transplantation?</td><td><table><tr><td></td><td>N. R. at all</td><td>Little R.</td><td>Risky</td><td>Very R.</td></tr><tr><td>SRI</td><td></td><td></td><td></td><td></td></tr><tr><td>Non- SRI</td><td></td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>Q51</td><td>Why?</td><td></td></tr>
</table>

2.3 Water management

<table>
<tr><td>Q52</td><td>What type of irrigation do you use for paddy?</td><td></td></tr>
<tr><td>Q53</td><td>What is the ratio of water requirement of SRI and non-SRI?</td><td></td></tr>
<tr><td>Q54</td><td>IF SRI, how difficult is it to practice alternate wetting and drying?</td><td><table><tr><td>Very easy</td><td>Easy</td><td>Difficult</td><td>Very difficult</td></tr><tr><td></td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>Q55-
Q61</td><td>In the last 10 years how many times your borewell failed
a) Due to burning of motor
b) Drying up of groundwater
c) Lost of crop</td><td><table><tr><td></td><td>Burning motor</td><td>Drying Groundwater</td></tr><tr><td>Kharif</td><td></td><td></td></tr><tr><td>Rabi</td><td></td><td></td></tr><tr><td>Lost of crop</td><td></td><td></td></tr></table></td></tr>
<tr><td>Q62</td><td>When you see that you are not going to have enough water, what do you do?</td><td></td></tr>
<tr><td>Q63
Q64</td><td>How risky do you find SRI and Non- SRI regarding water management?</td><td><table><tr><td></td><td>N. R. at all</td><td>Little R.</td><td>Risky</td><td>Very R.</td></tr></table></td></tr>
</table>

		SRI			
		Non- SRI			

Q65	Why?	

2.4 Weeding

Q66 **Q67**	Type of weeding	

	Manual	Weeder alone	Weeder and manual
SRI			
Non- SRI			

Q68- **Q80**	How often do you weed and how many days after transplantation is the weeding?	

	SRI		Non- SRI	
	Type	No. of days	Type	No. of days
1st weeding				
2nd weeding				
3rd weeding				

Q81	For SRI: If later than 10 days, why?	
Q82 **Q83**	No. of working hours for one weeding Per acre.	SRI: hours for Days NON- SRI: hours for Days
Q84 **Q85**	How much labour do you use for one weeding? Per acre.	

	Family	Hired
SRI		
Non- SRI		

Q86 **Q87**	How difficult is it for you to find labour for weeding?	

	Very easy	Easy	Difficult	Very difficult
Manual				
W. weeder				

Q88	If SRI, has the new way of weeding (rotary) brought you any problems?	
Q89 Q90	On the risky scale, how risky do you find SRI and Non SRI regarding weed management? Risk in terms of..?	

	N. R. at all	Little R.	Risky	Very R.
SRI				
Non- SRI				

Q91	Why?	

2.5 Pest and diseases

Q92 Q93	What is the intensity of pests and diseases in your rice plots?	<table><tr><td></td><td>Very little</td><td>Little</td><td>Much</td><td>Very much</td></tr><tr><td>SRI</td><td></td><td></td><td></td><td></td></tr><tr><td>NON-SRI</td><td></td><td></td><td></td><td></td></tr></table>
Q94	Which rice plant do you think has less incidence of pests and diseases?	SRI or NON- SRI
Q95 Q96	Has it happened that a pest or a disease has ruined your crop? If *yes*, how many times in last 10 years?	SRI: NON- SRI:
Q97 Q98	On the risky scale, how risky do you find SRI and Non SRI regarding diseases?	SRI: NON- SRI:
Q99	Why?	

2.6 General

Q100	Reason of start SRI	
Q101 Q102 Q103	Reasons for not covering all plots with SRI?	1. 2. 3.
Q104	If not SRI, reason	
Q105 Q106	What has been your highest yield on SRI and NON-SRI? Bags/Ac	SRI: Non- SRI:
Q107 Q108	What has been your lowest yield on SRI and NON-SRI? Bags/Ac	SRI: Non- SRI:
Q109 Q110	What is the yield in an 'average' year for SRI and Non-SRI? Bags/Ac	SRI: Non- SRI:
Q111 Q112	On the risky scale, how risky do you find SRI- and Non-SRI farming?	SRI: NON- SRI:
Q113	Comparing yourself to other farmers of the village, how 'risky' are you?	<table><tr><td>Very risk averse</td><td>Risk averse</td><td>Risk seeking</td><td>Very Risk seeking</td></tr><tr><td></td><td></td><td></td><td></td></tr></table>

Q114	Order these operations from less (1) risky to more risky (7) 1-Land Preparation, 2-Nursery, 3-Transplantation, 4-Weeding, 5-Finding labour on time, 6-Irrigation, 7-Disease control, 8-Acting in time	SRI: Non- SRI