



University of Cape Town

**MEASURING RISK AVERSION AMONG ASSET POOR SMALL-
SCALE FARMERS IN THE WESTERN CAPE, SOUTH AFRICA**

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DECLARATION

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ABSTRACT

This paper presents an empirical analysis of the contentious issue regarding risk preferences of small-scale farmers in low-income countries. Resource-poor farmers have often been described as being inherently risk averse given their tendency to under-invest in risky yet profitable crop technologies. In contrast to this dominant view we argue that it is unlikely that these farmers have an inherent disposition towards risk aversion. We hypothesize that the observed under-investment in crop technologies is largely due to the financial constraints which these farmers face. In particular we argue that it is the inability of farmers to diffuse risk to third parties due to the unavailability of insurance and limited access to credit which engenders risk averse behaviour. To test this hypothesis we employ a two treatment field experiment with 125 small-scale farmers in South Africa using real money payoffs. The first treatment is designed to test whether resource-poor farmers are generally risk averse by asking them to select one of five options ranked from least to most risky. In the second treatment we examine whether farmers who are risk averse in the first treatment continue to exhibit risk averse behaviour even when their constraint set is relaxed through the provision of a bank loan and weather insurance. Our results suggest that extreme risk aversion is certainly not the norm. In treatment one, participants were on average moderately risk averse. Interestingly we find that when the constraint set was relaxed in treatment two participants exhibited even less risk aversion. A large proportion of the sample opted for the loan and insurance options which were relatively high risk investments. Our findings suggest that institutional deficiencies are largely responsible for the risk averse behaviour of resource-poor farmers and that there is a need to explore in greater detail willingness-to-pay for insurance as there appears to be effective demand for this risk mitigating mechanism among small-scale farmers.

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1. INTRODUCTION

The adoption of profitable farming techniques remains surprisingly low in Sub-Saharan Africa (SSA) where food security is one of the major development challenges. Indeed the adoption of crop technologies remains negligible in spite of their ability to boost agricultural productivity. Though profitable, these technologies are often associated with high income variation across farming seasons thereby making them risky investments. There is a vast body of literature which attributes the sub-optimal investment in these techniques to an inherent disposition towards risk aversion among small-scale farmers. Indeed resource-poor farmers are often deemed as being extremely risk averse, seeking to mitigate income fluctuations at the expense of economic growth.

In this paper we present a contrasting view. While we agree that small-scale farmers tend to avoid risky yet profitable crop technologies, we disagree with the view that resource-poor farmers are inherently risk averse. Specifically, we argue that it is the inability of farmers to diffuse risk to third parties due to the unavailability of insurance and limited access to credit which engenders risk averse behaviour. There is great disparity between the agricultural risks which resource-poor farmers face and the available means for self insurance and risk diffusion. Compared with commercial farmers who have access to credit to minimise economic loss, small-scale farmers face extreme credit constraints mainly because they lack productive assets which are acceptable as collateral. Indeed as McNamara noted in 1973:

The miracle of the Green Revolution¹ may have arrived, but for the most part, the poor farmer has not been able to participate in it. He simply cannot afford to pay for the irrigation, the pesticide, the fertilizer...For the small holder operating with virtually no capital, access to capital is crucial (cited in Giné & Yang, 2008).

In addition, small-scale farmers have limited access to crop insurance. South Africa lacks a comprehensive crop insurance scheme dedicated to mitigating the production risks of small-scale farmers. An initial attempt to provide extensive crop insurance was unsuccessful due to various reasons, including an insufficiently developed pricing structure. Farmers are therefore

¹ The term describes the phenomenal increases in the yields of global staple cereals (i.e. maize, rice and wheat) which occurred between 1970 and 1990, which resulted from the breeding of improved seed varieties.

vulnerable to various production risks such as variability in rainfall timing and rainfall level, crop diseases, pests and animal mortality due to infectious livestock diseases. With the intensification of climate variability the region is expected to experience an increase in the frequency of extreme weather events such as floods and droughts thereby further depleting the already minimal productive assets of small-scale farmers².

We argue that it is the inability of farmers to transfer risk to third parties in the event of an economic shock which triggers risk averse behaviour. We would therefore expect to observe less risk aversion where these credit constraints are relaxed. We test this hypothesis empirically by employing a two treatment field experiment with small-scale farmers in South Africa using real money payoffs. In the first treatment we follow Eckel & Grossman's (2008) experiment on risk aversion in examining whether resource-poor farmers are generally risk averse. We elicit risk preferences by presenting participants with a list of five options each with a different high and low monetary payoff. There is a 50/50 probability of receiving either the high or low payoff thus the options differ in terms of expected payoff and variance. Using variance as a proxy for risk we use these options to represent five distinct risk categories. Participants' risk preferences are subsequently determined based on which option they select.

In the second treatment the objective is to examine whether farmers who are risk averse in the first treatment continue to exhibit risk averse behaviour even when their constraint set (credit and insurance) is relaxed. We follow Patt et al's (2010) field experiment in which they examine small-scale farmers' willingness to adopt a risky crop technology which can be financed either by a bank loan or a package that combines both a bank loan and weather insurance. To the best of our knowledge ours is the first field experiment which combines these two treatments thereby controlling for individual risk aversion when studying the uptake of new technologies. In addition we add to the Patt et al. (2010) study risk preference categories, by calculating the coefficient of variation (CV) associated with each investment

² Commenting on the need to provide safety nets for small-scale farmers against uninsured risks such as natural disasters and extreme weather events, Alderman (2009) points out that "For many [small-scale farmers] asset accumulation is like the game of snakes and ladders: a decade of additions to one's assets can be eroded in a single storm or drought," (IRIN, 2009).

option and adjusting the CV such that the package which combines the loan and insurance has a lower CV than the bank loan option.

The need for increased agricultural productivity has become particularly pertinent in the face of climate change which is estimated to halve food production in Africa by 2020 (IPCC, 2007). Small-scale farmers will need to invest in high yield, drought resistant crops in order to cushion the impact of adverse climatic conditions. The Food and Agriculture Organisation (2006) predicts that hunger will worsen in SSA over the next two decades unless drastic measures are taken. With increased population growth increased food supply cannot come from area expansion or the expansion in irrigated area due to competition for water with urban demand (de Janvry et al., 2000/01). Indeed the adoption of crop technology will soon become a matter of necessity for small-scale farmers. It is therefore worthwhile to try and understand the reasons behind under-investment in crop technology.

The paper is structured as follows. Section 2 presents a brief background on small-scale farming in South Africa while Section 3 discusses the literature review. We present the under-pinning theoretical framework in Section 4 and in Section 5 we describe our methodology. In Section 6 we describe the sample and we present descriptive and econometric results in Section 7. Section 8 concludes with policy implications.

2. SMALL-SCALE FARMING IN SOUTH AFRICA—A BRIEF BACKGROUND

South Africa's agricultural landscape is characterised by a distinct dualism which is rooted in the socio-economic legacy of apartheid. Although land reform was central to the post-apartheid government's plans for redistribution, there remains a clear concentration of land, agricultural infrastructure and resources in the hands of a small minority of commercial farmers while the black majority continues to face limited access to land and agricultural production (Surplus People Project, 2009). While some advances have been made in promoting equitable access to the agricultural sector the redistribution process has been staggeringly slow. Only 5 percent of agricultural land had been redistributed through the Land Redistribution for Agricultural Development (LRAD) programme by mid-2008 (Surplus People Project, 2009). For this reason tenure insecurity is one of the fundamental challenges facing the majority of small-scale farmers in South Africa. It is a pertinent issue as it constrains the borrowing capacity of small-scale farmers and subsequently confines them in severe poverty. As Breen (IRIN, 2009) points out, small-scale farmers are trapped in a "vicious cycle of poverty...and they cannot raise [the] working capital as they don't have collateral- they don't even own the land they work on." In addition to tenure insecurity small-scale farmers in South Africa continue to face limited extension support, poor service delivery and limited access to credit and market information, all of which impact negatively on their livelihoods.

In 2000 it was estimated that there were 50 000 large-scale commercial farmers operating in South Africa (TSPSAA, 2009) and approximately 2.1 million households (out of a total of 8.6 million in the country) involved in small-scale farming (Nieuwoudt, 2000). Small-scale farmers are concentrated in four main provinces of the country, namely the Eastern and Western Cape (31% of the total), KwaZulu-Natal (27%) and the Northern Province (24%) (Nieuwoudt, 2000). These farmers can be subdivided into three main categories. The largest group comprising 1 540 000 farmers (75% of the total) consists of subsistence farmers who engage in both crop cultivation and livestock rearing on a full-time basis. The second largest group (380 000 farmers or 18%) consists of farmers who earn a living through other means but engage in farming as a side activity. The third group (140 000 farmers or 7%) comprises emerging farmers who earn an income from both farming and non-farming activities (Nieuwoudt, 2000).

3. LITERATURE REVIEW

3.1 Determinants of technology adoption

There are various factors which influence the adoption of new technology. Some of the key determinants which are particularly relevant to developing countries are social learning, individual risk preferences and credit constraints. In what follows we focus on the role of individual attitudes toward risk and credit constraints on technology adoption by asset-poor farmers.

3.1.1 Risk preferences and technology adoption³

For a long time the dominant view has been that farmers in resource-poor settings are burdened by extreme risk aversion as evidenced by their under-investment in risky crop technology. Cardenas and Carpenter (2005) capture the general view on this issue as follows:

An old fable in the development literature can be paraphrased as follows: people in underdeveloped countries are poor partially because they have preferences that are inconsistent with growth. They have high discount rates and are *risk averse enough* (emphasis mine) so that it is impossible for them to save and take the risks necessary to begin to accumulate capital (ibid: 18).

Studies on attitudes towards risk in developing countries present varying results. Binswanger's (1980) seminal study on risk aversion in rural India was the first to measure risk aversion using an experimental approach in a low-income country context. He measured attitudes towards risk through an experimental gambling approach which utilised real monetary payoffs. Specifically, farmers were asked to play a game in which they were presented with a form listing eight paired choices ranked from least to most risky and were asked to choose one of the options. The list was structured in such a way that an increase in expected value was coupled with an increase in variance, which was used as a proxy for risk. The first choice on the list was a risk-free option in that there was zero variance in the expected payoffs. As such an individual who selects this option is considered to be extremely risk averse. As one moves down the list the expected payoff increases while the individual's

³ For key contributions on risk analysis and technology adoption see Feder, Just & Zilberman (1985), Antle (1987) and Hassan et al (1998).

level of risk aversion decreases from severe to intermediate to moderate and finally to risk-neutral with the last option.

Binswanger (1980) finds that while some farmers are indeed risk averse, extreme and severe risk aversion are certainly not the norm. Based on his findings, he makes the following conclusion:

If these results can be extrapolated to farming decisions, they suggest that differences in investment behaviour observed among farmers facing similar technologies and risks cannot be explained primarily by differences in their attitudes but would have to be explained by differences in their constraint sets, such as access to credit, marketing, extension, etc. *It is not the innate or acquired tastes that hold the poor back but external constraints* (emphasis mine) (ibid: 406).

In another early study on risk attitudes Moscardi and de Janvry (1977) use an econometric approach in analysing the role of attitudes toward risk on the demand for fertilizer among subsistence farmers in Mexico. They introduce risk in a model of economic decision making as a safety-first rule. The safety-first rule stipulates that the choices made by a decision maker (e.g. a household head) in allocating productive resources and in particular, choosing among technological options is to a large extent influenced by the need to secure returns which are large enough to cover subsistence needs.

Moscardi and de Janvry (1977) argue that if we assume that this rule holds then the degree of risk aversion among farmers can be measured through observed behaviour. Specifically, they use the observed level of fertilizer use as a measure of the underlying degree of risk aversion. Based on the low levels of fertilizer use among the farmers in their sample they conclude that risk premiums are generally high among the farmers (*i.e.* the farmers are generally risk averse). The shortcomings of this methodology are self-evident. There are various other factors which may influence the decision to use a particular technology such as fertilizer. Firstly, it is possible that farmers may be willing to use fertilizer but might find it costly. Access to credit is therefore an important point to consider. Indeed in a field trial in Kenya Duflo et al. (2006) find various reasons for the low adoption of fertilizer by subsistence farmers, one being that farmers do not always have the necessary information regarding the

correct use of fertilizer. The study by Moscardi and de Janvry (1977) is therefore limited in its approach.

Dillon and Scandizzo (1978) assess risk attitudes among subsistence farmers in Northeast Brazil using the direct approach of assessing subjective valuations in which the individual is asked to make decisions in response to a large number of randomly arranged hypothetical bets and insurance schemes. Respondents were asked sets of questions relating to their opinions on gambling, their participation in actual gambles and lotteries and their use of natural signs and other omens in farming decisions. The study finds that most interviewees were risk averse and that in particular, farm owners were more risk averse than share croppers. Overall they find that respondents were more risk averse for games in which subsistence was at risk, an observation which relates to the safety-first approach adopted by Moscardi and de Janvry (1977).

3.1.2 Credit constraints and technology adoption

Several studies have cited credit constraints as a key barrier to the adoption of technology by small-scale farmers in low-income countries (see Nhemachena & Hassan, 2007; Yesuf & Bluffstone, 2007; Shewmake, 2008; Yesuf et al., 2008, Binswanger, 1980). Sub-Saharan Africa in particular is characterised by underdeveloped rural credit markets which poses a major challenge to agricultural productivity as credit (needed to finance either intermediate inputs or fixed capital) is a crucial determinant of growth and technological innovation (Eswaran & Kotwal, 1989). As Collier and Gunning (1998) explain credit constraints have negative ramifications for activity choice and for consumption smoothing, and hence for economic growth (ibid: 20). On this issue, Eswaran and Kotwal (1990) proceed to argue that “if individuals have identical risk preferences, those with access to greater amounts of consumption credit will have greater capacity to absorb risk,” (ibid: 473).

Hassan et al. (2008) report that access to credit increases the likelihood that Ethiopian farmers will utilize soil conservation methods, change planting dates and irrigate. Similarly, Binswanger and Sillers (1983) note the importance of institutions such as insurance and credit markets which, they argue would be useful in sharing the risk burden farmers face. Specifically they argue that unless farmers have available perfect means of self-insurance or risk diffusion, risk aversion will result in a reduction in investment in some risky farming

techniques in all environments, and this will be more apparent the higher the riskiness of agriculture in a particular environment (ibid:13).

Murdoch (1995) echoes this view by explaining that where households expect being unable to borrow or insure, income smoothing is more likely to occur. Income smoothing normally takes the form of conservative production (e.g. reducing inputs and production techniques) or employment choices and diversifying economic activities. To illustrate, Murdoch cites an example from an Indian village which faces extreme credit constraints where one study has shown that although fertilizer is a highly productive input in wheat cultivation, its marginal product among these farmers remains 3.5 times its price which implies that these farmers are not achieving profit maximisation due to credit constraints (Bliss and Stern, 1982 cited in Murdoch, 1995).

In a more recent study Giné and Yang (2009) conduct a field experiment in Malawi with farmers whose main production risk is variability in rainfall level. They examine whether access to credit and insurance induces farmers to adopt high-yielding hybrid maize and groundnut seeds. Half of the sample is offered credit to purchase the seeds while the other half is offered a package whereby credit is bundled with insurance. They report a 33 percent uptake of the uninsured loan which they found to be uncorrelated with farmer education, income or wealth. On the other hand uptake of the insured loan was 13 percent lower than that of the uninsured loan. Since the insured loan carries less risk given that the insurance policy would partially forgive the loan if the rains were bad, it is possible that the farmers did not fully understand the concept of the insured loan. Indeed, Giné and Yang (2009) find a positive correlation between uptake of the insured loan and farmer education. This finding suggests that underinvestment in crop technology in resource-poor settings should be examined not only with respect to risk preferences and access to microfinance but also with respect to levels of education and financial literacy.

Patt et al. (2010) conduct a study which is almost similar to that of Giné and Yang (2009) with farmers in Ethiopia and Malawi. They run an economic experiment in which participants are presented with four investment options. With the first option farmers can use traditional seeds which result in a relatively low yield and for which no costs are involved. The second option involves the use of high yield improved seeds. Farmers who could not afford the improved seed could acquire a loan which would have to be repaid with interest at the end of each round irrespective of whether the rains were good or poor. The third option was a

protected loan which resembles the insured loan from Giné and Yang's (2009) study. The fourth option was a cash protected loan where farmers could purchase livelihood insurance in addition to acquiring the loan and paying an insurance premium. With this option not only would the farmer's loan be forgiven in the event of poor rainfall, but the farmer would also receive a cash payment. Findings from this study reveal a clear preference for the protected and cash protected loans over the traditional seeds option. These results suggest that the farmers were not extremely risk averse as the majority of farmers would have opted for the no loan option if they were. Treatment two of our experiment, which is outlined in Section 5, follows the approach by Patt et al. (2010).

The similarities are that our treatment was also played over eight rounds and participants faced variability in rainfall level as the main production risk. In addition farmers were presented with the option of using either traditional seeds or improved seeds. Furthermore, participants who did not have sufficient income to cover their expenses could not participate in subsequent rounds of the experiment.

However, there are a few differences. In treatment two of our experiment we control for risk aversion from treatment one and participants were presented with only three options (no loan, loan and loan & insurance). In addition, while there was a 50/50 chance of receiving either good or bad rainfall in the Patt et al. (2010) experiment there was a 0.33 percent probability of receiving good, low or very low rainfall in our treatment. This distinction between good, low or very low rainfall had an important bearing on the payout structure of our insurance contract. Furthermore we introduced liquidity constraints into our treatment by depriving farmers an initial endowment which farmers received in the Patt et al. (2010) experiment. Another difference was that farmers were not required to pay a living allowance in our treatment.

Perhaps the most important difference is that we add to the Patt. et al. (2010) experiment, risk categories for each investment option. We do this by calculating the coefficient of variation (standard deviation/expected payoff) for each option and then ranking the choices from least to most risky. This enables us to examine whether participants were generally risk averse, moderately risk averse or risk-neutral depending on which option they select.

Studies in which small-scale farmers are offered insurance have shown a general interest in and willingness to purchase it (see Galarza, 2009 and Peterson & Mullally, 2009) which

suggests that if farmers were provided a means of self-insurance and risk diffusion they would be interested in, investing in risky crop technology.

3.1.3 Crop Insurance

Crop insurance is designed to encourage farmers to adopt risky farming techniques which have the potential of increasing agricultural productivity. It also plays the role of mitigating economic loss in the event of an adverse climatic event such as a drought or a flood. With the intensification of climate variability and climate change small-scale farmers will increasingly require such safety nets.

The viability and effectiveness of crop insurance as a risk-mitigating instrument has been a topic of debate for a long time. In South Africa an initial attempt to provide an extensive crop insurance scheme failed after a ten year period due to several factors. It is argued that the scheme had an insufficiently developed pricing structure, the subsidy provided was insufficient and the existence of other avenues for receiving ad hoc drought assistance from the Department of Agriculture in the form of free disaster relief posed a disincentive to purchase insurance (Clover & Nieuwoudt, 2003: 293)⁴.

There are several concerns regarding conventional crop insurance. However, there are two primary problems inherent with this risk-mitigating instrument, *i.e.* information asymmetry and high transaction costs. With regards to information asymmetry, adverse selection is a particular concern given that less experienced farmers or those most likely to incur crop losses will be the individuals most likely to purchase insurance. Moral hazard is an additional concern whereby a farmer alters his or her behaviour (*e.g.* by working less hard) thereby increasing the probability of an insurance payout. This, of course does not work in the favour of a private insurance company as it will have to make frequent payouts to these farmers.

In addition, traditional crop insurance is associated with high administrative costs. It entails frequent farm visits by insurance agents to determine farmers' output and to verify crop losses on which the insurance payout (indemnity) is based. This is a time consuming process for the insurance company which also implies that in the event of an adverse event such as a drought or flood farmers will not receive indemnity immediately.

⁴ Clover and Nieuwoudt (2003) argue that post-disaster liquidity in the form of government relief programmes deals with disasters after they have happened and largely ignores prevention and risk reduction.

In an attempt to overcome some of the major shortcomings of traditional crop insurance, a new type of insurance (index insurance) has been introduced in a few developing countries. Currently, it is in its early phases of implementation in countries such as Malawi, Ethiopia and Kenya. Preliminary results from pilot projects in these countries suggest that this is indeed a promising risk-mitigating instrument. If designed and packaged appropriately, this could be an effective climate adaptation measure for smallholder agriculture in South Africa and one which could be used to encourage asset-poor farmers to adopt risky high yield seed varieties.

Index-based insurance has several advantages over traditional insurance which makes it a more viable and effective risk management instrument. It is linked to a weather index such as rainfall as opposed to possible consequences of weather such as crop failure. In other words, in contrast to traditional insurance whereby payouts are calculated based on crop losses, index insurance is based on the outcome of an agreed on weather index and threshold (Barrett et al., 2007). Where rainfall is adopted as the insurance index, if the rainfall amount in a cropping season falls below a certain threshold the insurer immediately pays out the indemnity to the insurance holder.

It is immediately clear that this type of insurance mitigates both adverse selection and moral hazard. Moreover, because it designed around a particular weather variable it is not necessary for insurance agents to conduct farm visits to verify crop losses. As such, it lowers administration costs and in the event of a drought insurance payouts are issued immediately. This is an important point as farmers often have to sell some of their productive assets in times of hardship as they await aid from donors or government agencies. The loss of assets implies that farmers become dependent on aid for a longer period after the drought has ended (Hellmuth et al., 2007: 76).

Because farmers are guaranteed immediate payouts in the event of a rainfall deficit, a major advantage of this type of insurance is that it enables and encourages risk-averse farmers to invest in new crop technology such as improved seeds and fertilizers. Holding an insurance contract can thus be used as collateral to acquire loans by smallholder farmers. Hellmuth et al., 2007 argue that “drought insurance is at its most powerful when it is combined with loans for investment in risky farming technology which has the potential to increase agricultural productivity (Hellmuth et al., 2007: 76).

However, as Carter et al. (2008) point out, it is important to ensure that farmers understand that index insurance provides partial protection against production risk. Because it is calculated against an index such as rainfall deficit, crop losses resulting from other sources *e.g.* pests and diseases are not covered by this type of insurance. This is termed basis risk. However, if drought is the primary threat to crops in a particular region index insurance is still an effective risk management tool. Another point which needs to be emphasized to farmers is that insurance offers stochastic benefits: “sometimes a payout is made; at times no payment is made” (Carter et al., 2008: 2). Where rainfall deficit is chosen as the weather-index, the threshold is determined by the amount recorded at the official meteorological station. If rainfall in a given sowing period exceeds this threshold no payment is made even if an insured farmer suffered crop losses due to the purchase of expired seeds for example. Osgood et al (2009) argue that “at the end of the day, the point of insurance is not, what is not covered, but that important risks are covered,” (ibid: 5).

4. THEORETICAL FRAMEWORK

4.1 Expected Utility Theory and Risk Aversion

Expected utility theory (EUT) is widely acknowledged as one of the most instructive models for normative decision making under uncertainty⁵. It stipulates that an individual faced with several risky or uncertain options will always select the option which maximizes his/her expected utility (*i.e.* satisfaction or enjoyment). It has been argued however, that people do not always select options which maximise their expected utility as predicted by the expected utility theory. To address this shortcoming, Kahneman and Tversky (1979) introduced prospect theory (PT) as an alternative model of rational choice, and later cumulative prospect theory (1991). The main criticism levelled against EUT (and which PT addresses) is that it assumes linear subjective probabilities. Prospect theory on the other hand incorporates probability weighting in individual choices. On this issue Humphrey and Verschoor (2004) argue that EUT does not accommodate the possibility that decisions under uncertainty are not only a result of attitudes towards risk, but are also influenced by the manner in which individuals subjectively view the probabilities of particular events. While there is some merit in these criticisms, analysis in this paper is guided by the EUT framework. We are of the view that while the EU model restricts what one can find out about individual risk attitudes, for the purposes of this study it allows us to find out enough to support the analysis we wish to conduct (Barr, 2010).

The expected utility framework rests on three key axioms: ordering, continuity and independence. The⁶ ordering axiom stipulates that when an individual is faced with two probability distributions $h1$ and $h2$ (of wealth consequences), she will either prefer one over the other or she will be indifferent between them. Where there are three distributions and $h1$ is preferred to $h2$ preferred to $h3$, then $h1$ will be preferred to $h3$. Following on from this, the continuity axiom stipulates that where an individual prefers the probability distribution $h1$ to $h2$, and prefers $h2$ to $h3$ then there exists a unique probability p such that the individual is indifferent between $h2$ and a lottery with a probability p of yielding the distribution $h1$ and a

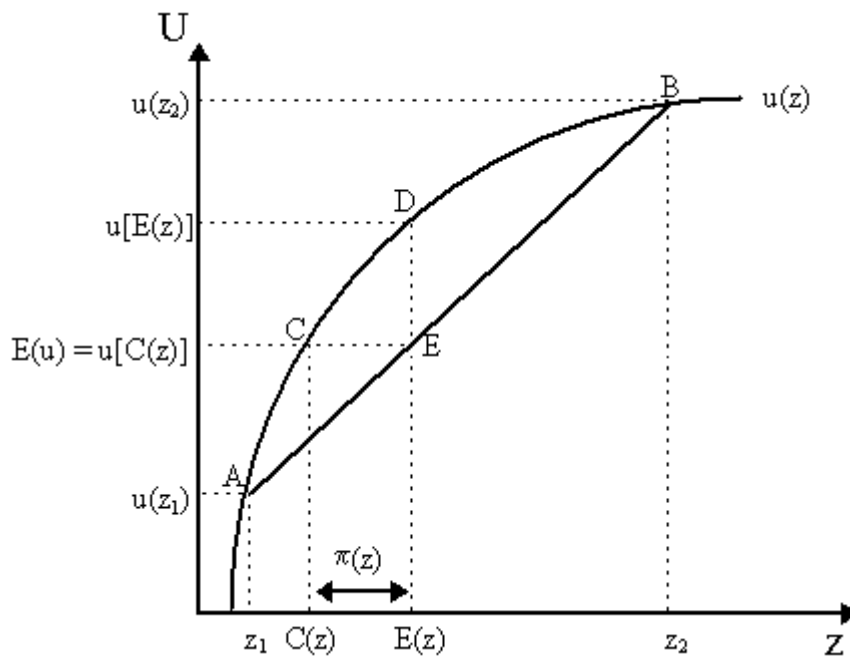
⁵ Some of the main competing theories include prospect theory (Kanheman & Tversky, 1979) and rank-dependency theory (Quiggin, 1982, 1993).

⁶ This paragraph is taken verbatim from Roumaset et al. (1979).

probability $(1-p)$ of yielding the distribution h_3 . The independence axiom stipulates that if h_1 is preferred to h_2 and h_3 is some other probability distribution, then a lottery with h_1 and h_3 as prizes will be preferred to a lottery with h_2 and h_3 as prizes if the probability of h_1 and h_2 is the same in both cases

For an individual whose preferences do not violate these axioms there exists a function U called a utility function. That the function is curved is derived from the principle of decreasing marginal utility which states that while we derive increased utility (satisfaction) from consuming increasing amounts of a particular good, the total satisfaction we get increases at a decreasing amount. In other words, after consuming a certain amount of a good the satisfaction we derive from each additional unit of that good will start to decrease.

This is illustrated in Figure 1. below.



Source: <http://homepage.newschool.edu/het//essays/uncert/aversion.htm>

Figure 1. Risk aversion and expected utility

In the above figure we assume that an individual derives utility from a good z (income) which has two outcomes (z_1, z_2) . The probability that z_1 occurs is p while $(1-p)$ is the probability that z_2 happens. As such, the expected income is $E(z) = p(z_1) + (1-p)(z_2)$. The utility of expected income is denoted by D above. The expected utility on the other hand is derived from $pu(z_1) + (1-p)u(z_2)$ and is denoted by E in the figure above.

Furthermore there is an amount of income which the individual believes would yield the same utility if held, as the lottery (i.e. getting either z_1 or z_2). In other words, it is the amount an individual would rather have with certainty, than taking the risk of playing the lottery. This amount is called the certainty equivalent and is denoted by $C(z)$ above. The lower the certainty equivalent relative to the expected value, the more risk averse an individual is. On the other hand, a risk-neutral person is indifferent between the certain amount and the lottery and as such the certainty equivalent will be equal to the expected value. For a risk-loving person the certainty equivalent exceeds the expected value.

The difference between the expected value of the lottery and the certainty equivalent is called the risk premium ($\pi(z)$). By definition the risk premium is the amount an individual is willing to pay in order to stabilize his/her income stream. The higher the risk premium the greater the degree of risk aversion.

4.2 Measures of risk aversion

A precise definition of risk aversion proceeds as follows:

An individual is a risk averter if for any arbitrary risk he prefers the sure amount equal to the expected value of the risk, to the risk itself. If we take w as the individual's initial wealth, and we let z , a random variable be his risky prospect, the individual is risk averse if: $u[w+E(z)] > E[u(w+z)]$ (Menezes & Hanson, 1970:482).

Put differently, a person is risk averse if she prefers the certain prospect (x) to any risky prospect with expected value x . A risk averse individual is willing to forego some expected returns if this also reduces the extent of variability of her income stream. Consequently, she will under-invest relative to the risk-neutral or socially optimal level. By contrast, a risk-neutral individual will attempt to maximise average or expected net returns notwithstanding the extent of variability in these returns (Binswanger, 1981).

There are various measures of risk aversion. Three measures are prominent in the literature: constant absolute risk aversion (CARA), constant relative risk aversion (CRRA) and constant partial risk aversion (CPRA).

Absolute risk aversion traces an individual's aversion to risk as their wealth rises but the risk remains unchanged. We typically assume decreasing absolute risk aversion, which implies that an individual's willingness to accept a given fair gamble should rise as wealth rises (Binswanger, 1981). If we let w stand for final wealth, absolute risk aversion is captured by

the Arrow-Pratt⁷ function: $A(w) = \frac{-u''}{u'(w)}$

Relative risk aversion traces the behaviour of an individual as both wealth and risk increase by the same proportion. Arrow (1971) hypothesised increasing relative risk aversion, which implies that an individual is less willing to accept a given gamble when both wealth and all outcomes of a gamble are multiplied by the same constant (Binswanger, 1981). If we again let w stand for final wealth, relative risk aversion is captured by the following function:

$$R(w) = \frac{-wu''(w)}{u'(w)}$$

⁷ Pratt and Arrow (1965) were the first to propose the theoretical measure of risk aversion.

Partial risk aversion traces the behaviour of an individual when the scale of the risk is varied by a factor k but wealth remains fixed. Increasing partial risk aversion implies a decrease in the willingness of the individual to take a gamble as the scale of the prospect increases (Binswanger, 1981). More precisely increasing partial risk aversion means that an individual faced with the unfavourable prospect of losing an amount X with probability p would be willing to pay an increasing proportion of X as insurance against the loss of X as the size of the loss increases. On the other hand, for favourable games it means that the subjective valuation of each alternative would be a declining proportion of the expected value of the alternative as the scale of the game increases (Binswanger, 1978). Indeed one would expect an extremely risk averse individual to pay (or be willing to pay) a relatively high risk premium as he or she places a high money value on income stabilization. As risk aversion declines, we would expect this risk premium to also decline.

In a review of experimental studies on risk aversion in several developing countries, Binswanger and Sillers (1983) conclude that the relatively gradual increase in mean risk aversion observed for each of the samples they considered suggests that:

utility functions which exhibit constant partial risk aversion are likely to provide better summaries of farmer preferences toward risk than functions with constant absolute risk aversion, a point that may be helpful when specific information on the risk preferences of a particular group is not available (Binswanger & Sillers, 1983:11).

5. METHODOLOGY

5.1 Experimental Design

The purpose of this paper is to examine the following development conundrum: why do small-scale farmers in developing countries under-invest in new crop technologies which have the potential to boost agricultural productivity? Could it be a result of their extremely high levels of risk aversion as a vast body of literature asserts or can we attribute this anomaly to other factors such as institutional gaps?

To this end we employ a two treatment field experiment using real monetary rewards in eliciting risk preferences and to assess whether the availability of insurance and access to credit has an impact on farmers' willingness to invest in high yielding seed varieties. In the first treatment we conduct a risk aversion game which is played over one round. This is followed by an insurance game which is played over eight rounds.

The first treatment is an adaptation of the gamble-choice activity from Eckel and Grossman's (2008) experiment on risk aversion⁸. Participants are presented with a list of five options each with a high and low payoff. The scale is designed in such a way that options offering a higher expected value are also associated with a large variance which is used as a proxy for risk in this experiment. The payoff structure is presented in Table 1 below.

The methodology used in this treatment is also similar to the approach employed by Binswanger (1980) which is described in Section 3. In that experiment Binswanger (1980) uses a risk aversion classification whereby the riskless option is described as extreme risk aversion and the riskiest option is described as neutral-to-negative. Individuals were subsequently classified into these risk aversion categories depending on their selections. While Eckel and Grossman (2008) do not label their options in a similar manner, we make use of this classification in discussing our results in Section 7.

As such, we consider individuals who select options 1 and 2 to be extremely risk averse while those who choose option 3 are described as moderately risk averse. Participants who select options 5 and 6 are deemed risk-neutral or risk-loving.

⁸ By contrast to the Eckel & Grossman paper we do not measure loss aversion in our treatment.

Table 1. Options, expected payoffs and risk

Choice	Event	Probability	Payoff ⁹ (R)	Expected Payoff	Risk ¹⁰
1.	A	50	24	24	0
	B	50	24		
2.	A	50	18	27	9
	B	50	36		
3.	A	50	12	30	18
	B	50	48		
4.	A	50	6	33	27
	B	50	60		
5.	A	50	0	36	36
	B	50	72		

⁹ Payoffs are in South African Rand where 1US\$= ± R7.4. Our payoff structure differs from that used by Eckel & Grossman (2008) where option one offers US\$10 and the highest payoff is US\$48. We scaled down our payoffs given that participants would also earn a R20 show-up fee and additional income in treatment two.

¹⁰ Measured as standard deviation of the expected value.

5.1.2 Treatment 1 (Risk aversion game)

Participants were handed numbered stickers upon arrival at the venue. These served as their player identity throughout the two treatments. They were then randomly assigned to one of the chairs in the venue by asking them to locate a corresponding number on the chairs. We commenced the session by introducing the research team which comprised the person conducting the experiment in Afrikaans, one monitor and three research assistants. A brief outline of the purpose of the experiment was given as well as the general procedures. Participants were informed that they would earn a R20 show-up fee and that they could earn additional income in the following treatment if they decided to stay for the entire duration of the experiment. Consent forms were then distributed and after all participants had signed them, the forms were collected and the first treatment commenced.



Picture 1. Facilitator explains game instructions to participants in Clanwilliam (Cederberg)

In this treatment we ran an unframed experiment in which farmers were told that there were five options from which to choose¹¹. A large poster was placed in front of the room which

¹¹ Instructions were given orally in Afrikaans in both treatments, by the same person.

had a payoff structure similar to that in Table 2 below. Because participants were Afrikaans speaking, all instructions were given in Afrikaans and all the material used (posters and decision sheets) were translated into Afrikaans.

Table 2. Treatment one payoffs

Choice	LOW (50%)	HIGH (50%)	Your choice Mark only one (✓)
Option 1	R24	R24	
Option 2	R18	R36	
Option 3	R12	R48	
Option 4	R6	R60	
Option 5	R0	R72	

Participants were handed pieces of paper with a similar payoff table to enable them to follow the instructions of the game closely. The monitor explained that the options were paired in such a way that they could either receive the high amount or the low amount depending on which option they chose. In addition, as we move down the right hand column the amounts increase from R24 to R72¹² while in the left hand column, amounts decrease from R24 to R0. Participants were told that their task in this activity was to choose only one of these options bearing in mind that they would only receive one of the payoffs, that is, either the high amount or the low amount.

We assumed that farmers faced the same probability and as such we used five balls labelled high and five labelled low as a randomizing device to determine the amount due to each participant according to their selection. The balls were placed into a bag one at a time in full

¹²These amounts were chosen carefully with the consideration that the daily average wage for a farm worker in the area is about R50 which was approximately \$US6.75 at the time of the experiment.

view of the farmers. To illustrate how the amounts would be determined the monitor picked a volunteer to draw a ball from the bag. The group was then asked how much the farmer would have received if she had selected one of the options and drawn that particular ball. Once the farmers showed sufficient understanding of the instructions decision sheets were distributed and participants were asked to make their selections. They were given a few minutes to select one of the options and were informed that they should not discuss their choices with each other. The assistants walked around the room while participants completed the forms to assist participants who had questions. After all decisions sheets were filled in the assistants collected the forms and proceeded to enter the data into a computer. One participant was selected at random to draw out a ball on behalf of the entire group. The ball which had been drawn (*i.e.* high or low) was entered onto the spreadsheet and the respective payouts were automatically calculated for each participant. To avoid influencing their choices in the next game participants were not given feedback for that treatment until the end of treatment two. For detailed instructions of the game, see Appendix A.

5.1.3 Treatment 2 (Insurance game)

In this treatment we examine the relationship between the availability of insurance and credit and farmers' willingness to adopt high yielding seed varieties. The design of our treatment is an adaptation of the insurance game conducted by Patt et al. (2010) with farmers in Ethiopia and Malawi with a few modifications (see section 3.1.2).

Participants were told from the outset that the game would be repeated over eight rounds, each of which represented a farming season. They were told that they had two options: they could either grow traditional seeds or invest in high yield seed varieties (HYVs). If they preferred the former they would receive a relatively low payoff of R10 if the rains were good, R10 if the rains were low and R10 if the rains were very low. In other words, this was a completely risk-free option. We assume that the farmer does not incur a cost in using traditional seeds (see Table 3 below).

On the other hand, the farmer may prefer to purchase HYVs which result in a R40 yield when rains are good, R30 if the rains are low and R0 if the rains are very low. Because of this variability in payoffs HYVs are a risky technology when compared to traditional seeds. A farmer who is interested in using HYVs would be required to borrow R10 from the bank, to be paid back at the end of the farming season (*i.e.* at the end of the round) with R1 interest. Therefore the total cost of the loan is R11. The payoffs for this option are calculated as follows: payoff from seed – loan repayment (see Table 3 below). A farmer who failed to repay the total loan amount at the end of the round (or farming season) was declared bankrupt and disqualified from the game.

In addition to the loan participants could also purchase insurance. In explaining the concept of insurance we made the assumption that variability in the level of rainfall was the only production risk facing these farmers. Other risks such as pests and crop diseases were not mentioned. Under this option an individual who desired protection from economic loss was required to pay a risk premium of R2 at the beginning of the round. The insurance contract was designed in such a way that in the event of good rainfall those who had purchased insurance did not receive an indemnity (*i.e.* payout) from the insurance company. When the rains were low however, those who had purchased insurance received R4 from the insurance company and when the rains were very low, the indemnity was R8. The payoffs for each round are shown in Table 3 below.

A blue ball was used to denote good rainfall, while a yellow ball indicated that low rainfall had been recorded at the rain gauge. Very low rainfall was represented by a red ball. After farmers indicated that they understood the concept of index insurance and after several examples, the session began. Three balls of each colour were placed in a bag while the farmers observed. Participants were then asked to take a few minutes to select one of the options: 1) traditional seed, 2) new improved seed (loan) or 3) new improved seed (loan and insurance) on the decision sheet in front of them. The answer sheets were then collected after each round and participant selections were captured on the computer by the experiment monitor. One participant was selected at random to draw a ball on behalf of the group and the ball colour was entered onto the spreadsheet. This returned participant earnings for the round as well as their total income after each round. Participants received feedback regarding their earnings after each round. A participant who did not have enough money to proceed to the next round was immediately disqualified (see Appendix A for detailed experiment instructions)

In line with our under-pinning theoretical framework described in Section 4, we calculate the expected payoffs associated with each option (see Table 3 below). Traditional seeds which result in a relatively low yield have the lowest expected payoff of the three options (R9). However, because yield is constant irrespective of rainfall level, they are the least risky option with a standard deviation of 0.94. New improved seeds result in higher payoffs when rainfall is good or low. As such they offer a high expected payoff relative to the traditional seeds. They are however, a riskier option given that the farmer does not receive any income when the rains are bad. This is captured by the relatively large standard deviation of 16.17. Lastly, the insured loan has the highest expected payoff (R12.9) due to the insurance payouts in the event of low or very low rainfall. These also serve to lower the risk associated with this option as reflected in the standard deviation of 13.24.

We proceed to calculate the coefficient of variation (CV) associated with each option which is derived by dividing the standard deviation by the expected payoff. It captures the idea that a farmers' investment decision incorporates both the risk level and expected payoff associated with each option. As such it enables us to classify each of the options according to overall risk level. A high CV reflects a relatively high level of risk. As can be seen in Table 3 below, the loan option has the highest CV of 146 percent compared to 102 percent for the insured loan and only 10 percent for the traditional seeds. With this classification we can then

proceed to measure risk aversion among the participants. Farmers who select the traditional seeds (no loan) option are classified as risk averse as this has the lowest CV. On the other hand, farmers who select the insured loan option are considered to be moderately risk averse. Participants who select the loan option are considered risk-neutral.

Table 3. Payouts resulting from farmers' choices and amount of rainfall in each farming season

	OPTION	Earnings if rainfall is good, low or very low			Expected payoff	Standard deviation	Coefficient of Variation
		GOOD	LOW	VERY LOW			
1.	NO LOAN PAYOFF	R10	R10	R10	9	0.94	10.4%
	Income for this round	R10	R10	R10			
2.	LOAN (HYVs) PAYOFF	R40	R30	R0	11.1	16.17	145.63%
	Minus cost of loan (R10) plus interest (R1) = R11	-R11	-R11	-R11			
	Income for this round:	R29	R19	-R11			
3	LOAN & INSURANCE (HYVs) PAYOFF	R40	R30	R0	12.9	13.24	102.6%
	Minus cost of loan (10) plus interest (R1) = R11	-R11	-R11	-R11			
	Minus cost of insurance (R2)	-R2	-R2	-R2			
	Plus what you get back from insurance	+R0	+R4	+R8			
	Income for this round:	R27	R21	-R5			

6. STUDY AREA AND SAMPLE

Our study was conducted in the West Coast District of the Western Cape Province. We drew our sample from two local municipalities within the district, namely, Matzikama¹³ Municipal Area which is situated in the far northern zone of the West Coast and Cederberg Municipality.

Matzikama comprises small towns and villages which include: Vredendal (which is the economic and administrative centre), Vanrhynsdorp, Lutzville, Ebenhaezer, Doringbaai, Klawer, Papendorp, Strandfontein, Koekenaap and Klawer. Matzikama is characterised by an arid environment and cool temperatures and covers the area of the lower Olifants River Valley with the Atlantic Ocean as the western boundary (Matzikama IDP 2009-2010). The Clan William Dam and the Olifants River support the agricultural sector which is built primarily on viniculture, vegetables, citrus fruits and livestock. Other economic activities in this area include the processing of agricultural products, a dwindling fishing industry and mining (Matzikama IDP, 2009-2010). The region also attracts tourists during the flower season.

Cederberg Municipality is situated approximately 100 kilometres from Cape Town. The main towns in this municipality are Clanwilliam, Citrusdal and Graaffwater. At the time of the 2001 Census there were 400 000 people living in the Cederberg Municipality, 78 percent of whom were Coloured (Cullis & Versfeld, 2006).

The West Coast District faces various socio-economic challenges. It is characterised by a high rate of unemployment and low-income households whose livelihood is centred mainly on agriculture. Approximately 58 percent of individuals in Matzikama and Cederberg earn a monthly income of R800 or less, with individuals in the former faring marginally better (Cullis & Versfeld, 2006). In terms of employment, 8.98 percent of the population in the two municipalities (15-65 age group) was unemployed at the time of the 2001 Census (Cullis & Versfeld, 2006).

Tenure insecurity, water rationing and poor extension support are some of the major challenges faced by these farmers. We conducted purposive sampling aided by a non-profit

¹³ Matzikama means “place of water.”

organisation working in the municipal area and through the assistance of the chairman of an Emerging Farmer’s Association. Our sample comprised 125 farmers from the towns of Vanrhynsdorp, Lutzville, Klawer, Clanwilliam and Wupperthal who were drawn from varying socio-economic backgrounds although the majority were poor.

6.1. Participant characteristics

Table 4 below presents the key socio-economic characteristics of the sample. The subject pool comprised 57 women (46%) and 68 men (54%), all of whom were Coloured and Afrikaans speaking. The sample had an average age of 43 years and the average participant had completed 9.2 years of schooling. Household size was 4.7 on average and participants had an average monthly income of R2363. The large standard deviation associated with the latter statistic implies a wide dispersion of income across households with R8 being the smallest recorded value for monthly income and R10 135 being the highest.

Table 4. Socio-economic characteristics across all five communities

Age	42.93 (16.34)
Education	9.22 (3.03)
Male	54.4
Household size	4.69 (2.05)
Monthly Income	R2363 (1891)
Observations	125

† Standard deviations are in parentheses

Table 5. Descriptive Statistics by community

COMMUNITY: VANRHYNSDORP		
Male	Education	Age
13 (48.0%)	9.78	37.28
Observations: 25		
COMMUNITY: LUTZVILLE		
Male	Education	Age
22 (59.5%)	8.51	49.1
Observations: 37		
COMMUNITY: KLAWER		
Male	Education	Age
6 (60.0%)	9.6	42.1
Observations: 10		
COMMUNITY: CLANWILLIAM		
Male	Education	Age
17 (48.6%)	9.18	41
Observations: 35		
COMMUNITY: WUPPERTHAL		
Male	Education	Age
10 (55.6%)	9.81	42.6
Observations: 18		

7. SURVEY RESPONSES

After the two treatments participants were asked to answer a questionnaire which comprised personal descriptive questions and questions on labour market participation, farming activities, climate change awareness and credit and insurance. In this paper we report responses to only four of these questions which are drawn from the credit and insurance section of the survey (see Appendix B for detailed questionnaire). These questions are related to the analysis which follows in section 7.2.

Have you ever applied for a loan?

A mere 1.64 percent of the sample responded yes to this question, while the rest (98%) indicated that they had never applied for a loan. Participants gave varying reasons in explaining why they had never attempted to borrow money from a financial institution. However, “I dislike borrowing” was the main reason given, followed by “loans are too expensive.” A few participants mentioned a combination of both these factors as reasons for not ever having applied for a loan, while only three participants pointed out that they felt they would not be granted the loan if they applied.

Have you ever heard of insurance?

81 percent of the participants reported that they knew what insurance was while 19 percent did not. Our survey did not however proceed to test participants’ understanding of insurance concepts as does Patt et al. (2010). In their study, they find a poor understanding of basic insurance concepts among small-scale farmers in Ethiopia and Malawi.

Would you be willing to pay for insurance?

69 percent of those who had heard of insurance indicated that they would be willing to pay for insurance while 31 percent said they would not purchase insurance.

Participants were subsequently asked to rate their personal risk attitude. For this question they were presented with the following options:

1= I always take risks

2=I sometimes take risks

3=I never take risks

Table 6 below presents the results obtained for this question.

Table 6. Self-Rated Risk Attitude

	Option	Percentage of participants
1	I often take risks	17.6%
2	I sometimes take risks	49.6%
3	I never take risks	24.8%
4	No-response	8%

Half of the sample regarded themselves as being moderately risk averse while 25 percent regarded themselves as being extremely risk averse. These results are interesting, especially when juxtaposed against the risk preferences revealed in Treatment 1 (results below) which used real monetary payoffs. We discuss results from this treatment in the next section.

7.1 Treatment One Results (Risk Aversion Game)

To reiterate, a person is considered risk averse if she prefers the certain prospect (x) to any risky prospect with expected value x . An individual who is risk averse is willing to forego some expected returns if this also reduces the extent of variability in her income stream. By contrast, a risk-neutral individual will attempt to maximize expected returns notwithstanding the extent of variability in the returns (Binswanger, 1980). Therefore an individual who selects option 1 below is deemed to be extremely risk averse while anyone who chooses option 5 is considered risk-neutral. Table 7 below presents the results.

Table 7. Overall distribution of risk preferences

Option	All participants	Men	Women
1	24 (19.2%)	14 (20.59%)	10 (17.54%)
2	29 (23.2%)	12 (17.65%)	17 (29.82%)
3	40 (32.0%)	26 (38.24%)	14 (24.56%)
4	25 (20.0%)	13 (19.12%)	12 (21.05%)
5	7 (5.6%)	3 (4.41%)	4 (7.02%)
Total	125 (100%)	68 (54%)	57 (46%)

While the results suggest a relatively higher incidence of risk aversion among our participants in comparison with the Eckel & Grossman (2008) sample, our results suggest that these farmers are by no means extremely risk averse as has often been suggested. Had that been the case, we would expect to see a larger proportion of responses in the first category. As the results stand we find that only 19 percent of the sample opted for the risk-free option. It is indeed interesting that option 3 was the preferred option among the farmers, accounting for 32 percent of responses. In the Eckel & Grossman study Option 3 was also the popular choice, with 32.8 percent of the sample selecting it. The results however suggest that the incidence of risk-neutrality was low among our participants with only 6 percent of the farmers selecting the last option on the list.

Eckel and Grossman (2008) conducted their experiment with a larger sample comprising 261 undergraduate students from two tertiary institutions in the United States. The average age was 20 years and 81 percent of their participants were Caucasian. Only 4.3 percent of their sample chose option 1 while 16.4 percent chose option 2. 22.7 percent chose option 4 compared to 20 percent in our experiment. By contrast to our findings, 23.8 percent selected option 5 in the Eckel and Grossman (2008) study which suggests a relatively high incidence of risk-neutrality.

It is interesting that the farmers' self-reported risk attitudes (subjective risk) appear consistent with their revealed risk preferences. Some studies have found discrepancies between participants' subjective and objective risk preferences with many individuals stating that they are risk-loving in questionnaires and subsequently exhibiting risk averse behaviour during the experiment with real money payoffs. As the figures below indicate our participants' preferences were largely congruent across the questionnaire (results reported in Table 6) and the experiment.

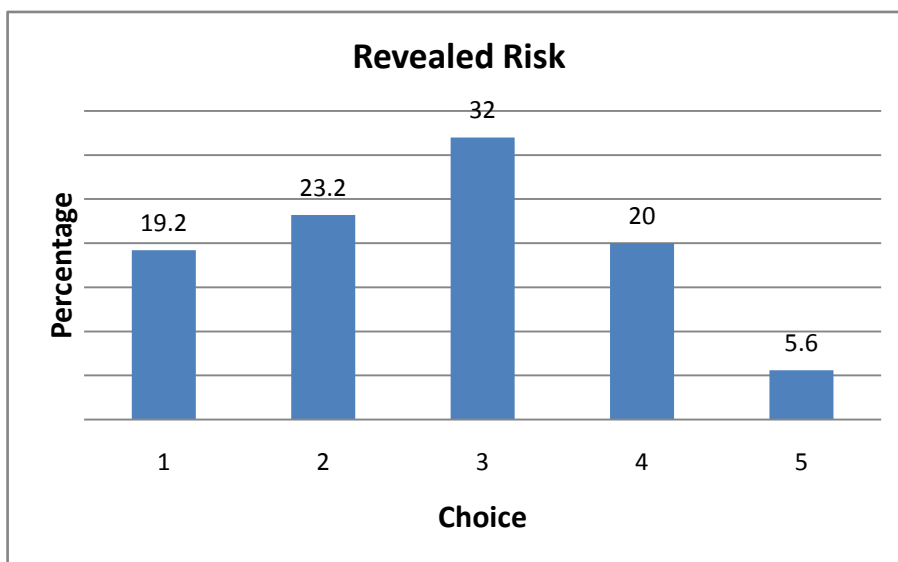
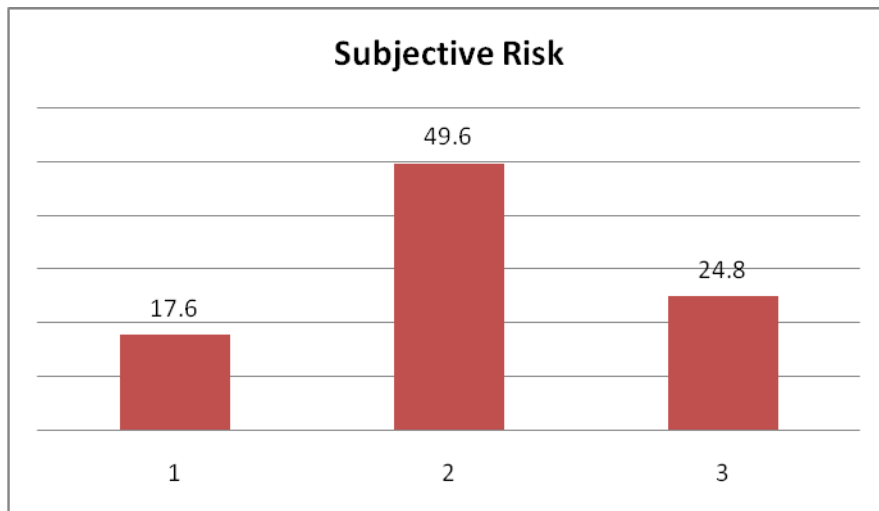


Figure 2. Comparison of subjective and objective risk

When we analyse risk aversion by gender (Figure 3 below) we find mixed results. Using a two sample t-test (equal variances assumed) we find that there is no statistically significant difference between the mean choice for males and females ($t= 0.1422$ and $p=0.8853$). See Appendix E for detailed results. Eckel and Grossman (2008) found that men were significantly less risk averse than women in their study.

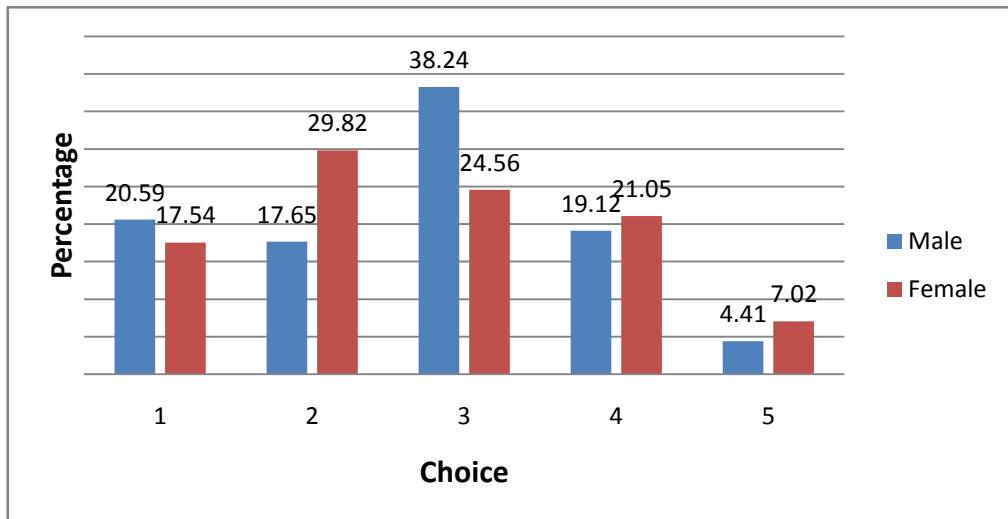


Figure 3. Choice by gender

7.2 Treatment Two Results (The Insurance Game)

Results from the previous section have shown that while risk aversion is relatively high among the farmers in comparison with participants from the Eckel & Grossman (2008) study, the incidence of extreme risk aversion is by no means excessive. This suggests that other factors need to be examined in explaining the sub-optimal investment in crop technologies.

In this section we analyse results from treatment two of our experiment in which farmers were presented with three investment choices: 1) traditional seeds (which has the lowest CV), 2) new improved seeds which require securing a loan (and which also has the highest CV) and 3) the insured loan (which has the second highest CV).

As mentioned above, a high CV reflects a relatively high level of risk. To reiterate, the traditional seed (no loan) option is the least risky option with a CV of 10.4 percent. The insured loan is the second riskiest option with a CV of 102 percent. The riskiest option is the loan option with a CV of 145.6 percent.

If farmers are indeed extremely risk averse we would expect to find a vast proportion of participants opting for traditional seeds across all rounds as this is the least risky investment choice (with a CV of 10 % compared with 146% for the loan option and 102% for the insured loan option). In addition, a significantly high uptake of the insured loan would suggest that the farmers are moderately risk averse and that low investment in crop technology would have to be explained by institutional gaps.

Table 8 below shows the number of participants opting for each of these options across all three communities and across all eight rounds of the experiment.

Table 8. Investment choice across all eight rounds

ROUND	Number of farmers TRADITIONAL SEEDS--NO LOAN, NO INSURANCE (%)	Number of farmers UPTAKE OF NEW IMPROVED SEEDS- -LOAN (%)	Number of farmers UPTAKE OF NEW IMPROVED SEEDS- -LOAN & INSURANCE (%)
1	87 (69.6%)	38 (30.4%)	0 (0.0%)
2	53 (50.5%)	38 (36.2%)	14 (13.3%)
3	56 (60.9%)	20 (21.7%)	16 (17.4%)
4	48 (52.1%)	23 (25.0%)	21 (22.8%)
5	51 (55.4%)	15 (16.3%)	26 (28.3%)
6	42 (45.6%)	24 (26.1%)	26 (28.3%)
7	42 (45.6%)	28 (30.4%)	22 (24.0%)
8	35 (38.0%)	27 (29.3%)	29 (31.5%)

†Note: Row totals do not add up to 125 after round one due to the 11 participants who were disqualified after the first round in Vanrhynsdorp and 9 participants from Wupperthal. In addition, 13 participants were disqualified after round 2 in Clanwilliam¹⁴.

From Table 8 we see a sharp decrease in the use of traditional seeds from round one to round two and a steady decline as the game progressed, with 70 percent of the sample selecting that option in round one and only 38 percent selecting it in the final round. By contrast, uptake of the insured loan option increased significantly, more than doubling from 13 percent in round two to 32 percent in round eight. We disregard the first round in analyzing the insured loan option. Participants could not purchase insurance in that round as they had not yet made any money in the game and therefore could not afford the R2 insurance premium. Uptake of the loan option (which is also the riskiest option of the three) does not follow a clear trend with a

¹⁴ For a breakdown of uptake in each round for each community please see Appendix C.

high uptake in some rounds (round 1, 2 and 7) and a decrease in others (3 and 5). On average 27 percent of the sample selected this option across all rounds which is interesting given that this was the riskiest option. This again suggests that extreme risk aversion is not the norm.

It is also interesting to note that although 98 percent of the participants reported that they had never applied for a loan because they dislike borrowing and because of the high cost of borrowing, there was a clear preference for loans during the experiment. In their study, Patt et al. (2010) report an almost similar pattern to what we observe in our sample. Their results point to a clear preference for the choices that included insurance while the no loan option was less favoured.

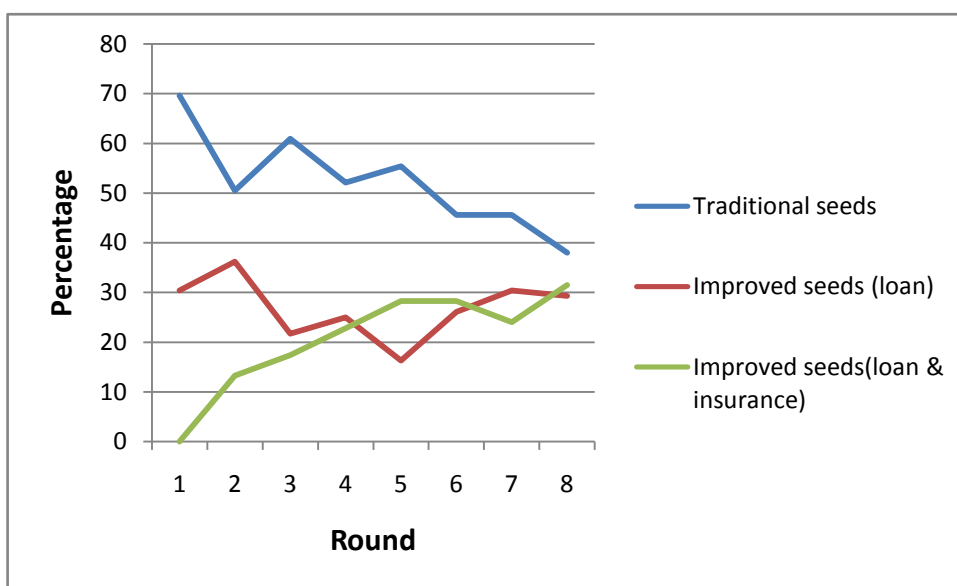


Figure 4. Uptake of traditional and new seeds across all rounds

Approximately 60 percent of participants who opted out of the loan option selected the insured loan across all the rounds, which offered a higher expected payoff and is less risky. In their study Patt et al. (2010) note that the increasing uptake of insurance towards the end of the experiment could be a result of the so-called “endowment effect” (Kahneman et al., 1990 and Kahneman & Tversky, 1979), whereby participants become less risk averse as they do not want to lose the earnings made during the game. We do not find evidence of this in our experiment as the uptake of insurance increases steadily from the beginning of the experiment right through to the last round. In addition the majority of participants who opt out of traditional seeds across the rounds favour the insured loan which has a significantly higher coefficient of variation (102 % compared with 10% for traditional seeds).

7.2.1 Bankruptcy Rule

It should be noted that 11 participants (15%) from Vanrhynsdorp were disqualified after the first round having selected the loan option and subsequently drawing a red ball which symbolized very low rainfall. In Wupperthal nine participants were also disqualified for the same reason. Because the loan option required that the participant should repay R11 (R10 loan plus R1 interest) before proceeding to the next round, these participants found themselves unable to continue as they had not yet earned any money in the game to pay back the loan. It is interesting that these participants chose the loan option in round one given that they were fully aware of the risk involved (a one-third probability of a red ball being drawn).

In Lutzville the loan option was also moderately popular in the first round with 12 participants (32.4%) selecting it. However, due to a yellow ball (low rainfall) being drawn participants who had selected this option were able to pay back the R11 loan from their R30 payoff and were therefore not disqualified. In Klawer only two participants (20%) selected the loan option in the first round. A blue ball was drawn for this round signifying good rainfall; hence the participants were able to continue in the game as they could repay the loan from their R40 payoff.

In Clanwilliam, 13 participants (37%) who had selected the loan option in round two and the traditional option in round one, were disqualified at the end of round two after a red ball (very low rainfall) was drawn in round two. The results for Clanwilliam are interesting as the remaining participants became strikingly risk averse following the disqualification of the 13 farmers. Across the remaining rounds 80% of the participants selected traditional seeds while only one participant opted for the insured loan. Indeed Clanwilliam exhibited the highest level of risk aversion during treatment two, relative to the other communities. However, because the disqualification occurred very early on in the game it is difficult to infer whether their aversion to risk was due to the disqualification or whether the group was simply less risk taking than the other four communities.

There are three points worth making from the results illustrated in Figure 2 above. Firstly we observe that when participants have a limited set of options, traditional seeds are the option of choice with more than half the sample selecting that option. As the game progresses and as another option becomes viable (i.e. insurance) participants increasingly opt for the insured loan. This observation supports the central thesis of this paper that small-scale farmers in

developing countries face constraints (i.e. incomplete markets) which hinder them from adopting risky crop technologies which can boost agricultural productivity. Where these risk-mitigating options are made available farmers will be more inclined to take the risk of planting improved seeds.

Secondly, farmers increasingly opt for the loan and insurance option as they amass income from one round to another. Participants received feedback of earnings accrued in each round as well as their total income up to that point before the next round commenced. As farmers became increasingly richer they became more willing and able to invest in improved seeds. This is consistent with decreasing absolute risk aversion, which stipulates that an individual's willingness to accept a given gamble should rise as wealth rises (Binswanger, 1981). Following this line of reasoning we would expect that those who did not earn high incomes in successive rounds would continue to invest in traditional seeds as opposed to the new seeds.

If we use the risk aversion classification in treatment one, we find that while 15 participants (12%) who were classified as being extremely risk averse selected the traditional seeds in round one, there was a steady decline as the game progressed. By round eight only six (7%) of these participants continued to select traditional seeds¹⁵. It is interesting to note that the participants who opted out of the traditional seeds option favoured the insurance option (which has a significantly larger CV) and that once they opted out they did not revert to the traditional seeds option. This might suggest that the selection of traditional seeds should rather be explained by liquidity constraints as opposed to high levels of risk aversion.

Finally, we examine whether the ball colour drawn in each round (and therefore rainfall level) may have had an impact on the farmers' investment decision in subsequent rounds. It is important to remember here that participants were required to select their choices first before the ball was drawn. In the second community (Lutzville) for example, we find no evidence of this. Three red balls (i.e. very low rainfall) were drawn in rounds 3, 7 and 8. In Round 3 eleven participants (29.7%) selected the insured loan. In round four we see a drop in the uptake of the insured loan with only nine participants (24.3%) selecting it. If there had been a relationship between ball colour and investment decision, one would expect to see an increase in the uptake of the insured loan in round four. In round 5 we see an increase in the uptake of

¹⁵ See Appendix D for a breakdown of participant choices by risk category.

the insured loan to 37.8 percent after a blue ball (good rainfall) had been drawn in round 4. The red ball drawn in round 7 did not affect uptake in the final round with 12 participants selecting this choice in both rounds. A chi-square test shows that there is no statistically significant relationship between the ball colour chosen in a previous round and the option selected in the following round (see Appendix E for results).

7.2.2 Risk aversion by gender

Given that men were slightly less risk averse than women in treatment one, it is interesting to test whether a similar pattern persisted in treatment two. Specifically, we compare the number of men and women who selected the loan option in each round, as this was the riskiest investment choice. Because 11 participants were disqualified in Vanrhynsdorp after the first round and given that the Klawer group was relatively small we use Lutzville in the following analysis as this was the largest group¹⁶.

Table 9. Uptake of loan option by gender

ROUND	MALE (%)	FEMALE (%)
1	7 (18.9%)	5 (13.5%)
2	9 (24.3%)	4 (10.8%)
3	4 (10.8%)	6 (16.2%)
4	9 (24.3%)	5 (13.5%)
5	4 (10.8%)	6 (16.2%)
6	7 (18.9%)	6 (16.2%)
7	11 (29.7%)	9 (24.3%)
8	7 (18.9%)	7 (18.9%)

¹⁶ In Clanwilliam only three participants opted for the loan option from round two onwards.

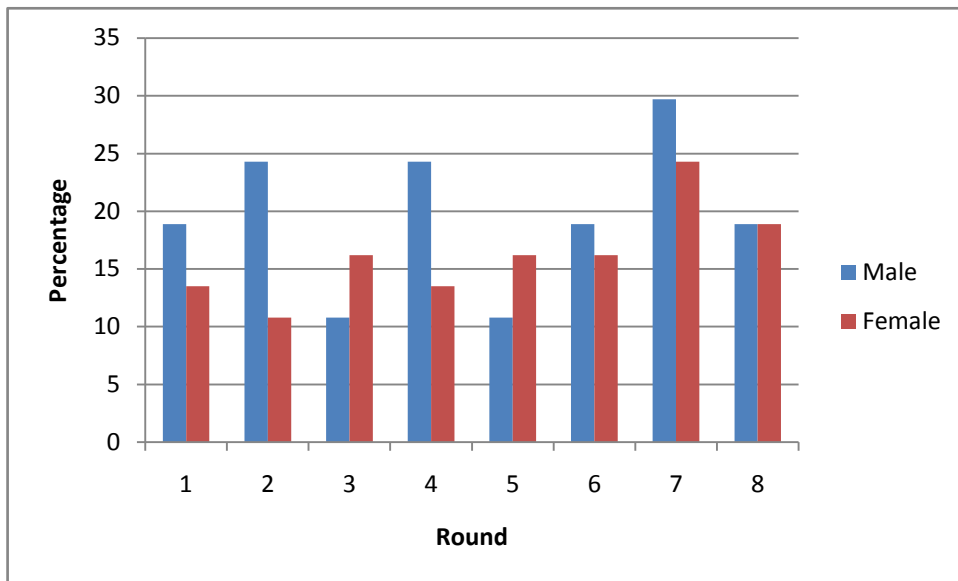


Figure 5. Uptake of loan option by gender across all rounds

We do not observe overwhelming interest in the loan option across the eight rounds with less than 50 percent uptake in all but one of the rounds (round 7). The above results are mixed but suggest that male participants in Lutzville were slightly more risk-neutral than women, on average. With the exception of rounds 3, 5 and 8 more men invested in the loan option than women. Interestingly, there was an upsurge in uptake in the penultimate round by both men and women with approximately 30 percent of the men selecting this option and 24 percent among the women. This result clearly contradicts the endowment effect mentioned earlier whereby participants are deemed to become less risk averse toward the end of the game.

We use a two sample t-test (equal variances assumed) to compare the means of the investment choices of the two groups. The results indicate there that there is no statistically significant difference in the mean choice of men and women across all eight rounds (see Appendix E for detailed results).

7.3 ECONOMETRIC ANALYSIS¹⁷

7.3.1 Panel Data Estimation

In this section we analyse the results of the insurance game (Treatment 2) using panel data econometric analysis. We treat each of the eight rounds as a separate time period which results in a short panel given that $n > T$ ($n=125$ and $T=8$). Because of the bankruptcy rule which resulted in the disqualification of some participants from the game, there is a large number of missing values across the rounds; therefore the panel is unbalanced.

The¹⁸ main advantage of using panel data analysis is that it enables us to assess the dynamics of change across the rounds through the analysis of repeated cross section of observations. Also, because we are analysing the behaviour of different individuals across time, there is bound to be heterogeneity in the sample. Panel data estimation allows us to capture individual-specific variables. In addition, combining time series of cross-section observations affords greater variability, less collinearity among variables, more degrees of freedom and more efficiency, while also providing more information. Panel data can also minimize bias that might result from aggregating individuals into broad categories.

The hypothesis presented at the beginning of this paper is that investment choice is a function of the availability of credit and insurance. Therefore we set investment choice as the dependant variable (Choice). It is also plausible that investment choice is influenced by an individual's years of education. Specifically, we would expect an individual with a higher level of education to prefer the loan and/insurance options given the benefits associated with the improved seeds and risk diffusion. However, the individual might be risk averse though educated and so we also include risk preference as a regressor. For the latter, we utilise the revealed risk from Treatment one. As such risk preference appears in the regression as an ordinal variable with five distinct categories where 1 represents extreme risk aversion and 5 denotes risk-seeking behaviour.

We include age as a regressor under the assumption that the older the individual the more farming experience they are likely to have. We include cumulative income to verify the

¹⁷ This paper presents very basic data analysis. Detailed econometric analysis will be presented in future work.

¹⁸ This paragraph is adapted from Gujarati (2003).

argument we make in the previous section that the uptake of traditional seeds should rather be explained in terms of liquidity constraints. We also include gender.

We estimate the following function:

$$Y_{it} = \alpha + X'_{it}\beta + u_{it} \quad i = 1, 2, \dots, 125 \quad t = 1, 2, \dots, 8$$

where i denotes the individual and t denotes the time (in this case, round). We utilize a one-way error component model for the disturbance, such that

$$u_{it} = \mu_i + v_{it}$$

where μ_i is time-invariant and captures the unobservable individual specific effect such as an individual's inherent dislike of borrowing money which may not necessarily be a risk preference but a cultural trait. The remainder disturbance is captured by v_{it} and varies with individuals and time.

7.3.2 Multinomial Regression model

The dependent variable Choice, is constructed to capture the three options, 1) use of traditional seeds, 2) use of new seeds which requires a loan and 3) use of new seeds financed through a loan and insurance. Because the variable comprises three nominal categories we use a multinomial logit regression model in estimating the above function, which is often the method of choice where there are more than two unordered categories.

We set traditional seeds as the reference category and compare the probability of choosing the other two options to the probability of choosing traditional seeds. Because have three categories we calculate two equations (m-1) as follows:

$$\ln \frac{P(Yi=m)}{P(Yi=1)} = \alpha_m + \sum_{k=1}^K \beta_{mk} X_{ik} = Z_{mi}$$

As such there will be two predicted log odds, one for new seeds (loan) relative to traditional seeds and another for new seeds (loan and insurance) relative to traditional seeds.

Table 10. Regression Results

```
. mlogit Choice Age Ed_years male RiskAv CumInc, base(1)
Iteration 0:  log likelihood = -729.90611
Iteration 1:  log likelihood = -667.8531
Iteration 2:  log likelihood = -664.81562
Iteration 3:  log likelihood = -664.80456
Iteration 4:  log likelihood = -664.80456

Multinomial logistic regression          Number of obs   =          723
                                          LR chi2(10)     =          130.20
                                          Prob > chi2     =           0.0000
Log likelihood = -664.80456              Pseudo R2       =           0.0892
```

```
-----+-----
Choice |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-----+-----
```

TRADITIONAL SEEDS | (base outcome)

```
-----+-----
LOAN           |
Age | -.0012508   .0065449   -0.19   0.848   -.0140786   .0115769
Ed_years | -.0914582   .0348591   -2.62   0.009   -.1597808  -.0231356
male | .0885297    .1814009    0.49   0.626   -.2670095   .4440689
RiskAv | .1685476    .0747929    2.25   0.024   .0219562    .315139
CumInc | .00709      .0027108    2.62   0.009   .0017771    .012403
_cons | -.6352805   .5834452   -1.09   0.276   -1.778812   .508251
-----+-----
```

LOAN & INSURANCE |

```
Age | .0062917    .0078082    0.81   0.420   -.0090121   .0215955
Ed_years | .0543088    .0425842    1.28   0.202   -.0291547   .1377722
male | .1909452    .2202594    0.87   0.386   -.2407553   .6226456
RiskAv | -.1426587    .0918863   -1.55   0.121   -.3227525   .0374352
CumInc | .0297498    .0032331    9.20   0.000   .0234131    .0360865
_cons | -3.331196   .7337415   -4.54   0.000   -4.769303  -1.893089
```

The results suggest that for a one unit increase in cumulative income, we expect the relative risk of choosing the loan option over traditional seeds to increase by 1.013. Similarly for a one unit change in cumulative income we expect the relative risk of choosing the insured loan over traditional seeds to increase by 1.028. In other words, as we pointed out earlier, at higher levels of income (cumulative income) the traditional seed option becomes increasingly less attractive. This is consistent with decreasing absolute risk aversion. More importantly, it affirms the argument we make above that liquidity constraints rather than risk aversion maybe the reason behind sub-optimal investment in crop technologies.

The positive coefficient on the risk aversion coefficient (loan uptake) is consistent with our expectations given that the less risk averse an individual is (*i.e.* a one unit increase) the more likely they are to select the loan option which is the riskiest option of the three. The coefficient of the insured loan option is not statistically significant and carries a different sign.

The negative coefficient on age (loan uptake) suggests that the older farmers prefer traditional seeds in comparison with the loan option. We could explain this in terms of low levels of financial literacy among the older participants. However, the positive coefficient on the insured loan suggests the opposite view. It may therefore be that older individuals, who are naturally more risk averse, opt for traditional seeds, but given the option to lower their risk via insurance, they would prefer to invest in modified higher yielding seeds too.

The negative coefficient on years of schooling for the loan option suggests that for a one year increase in education the log of the ratio of the two probabilities, $P(\text{option}=2)/P(\text{option}=1)$ will decrease by 0.0877. Therefore there is an inverse relationship between years of education and uptake of a risky loan. In contrast the relationship between years of education and uptake of the insured loan is positive, confirming our suggestion that these farmers are willing to take calculated risks when they have a choice of financial instruments available.

8.0 CONCLUSION

This paper set out to investigate the impact of relaxing the binding constraint sets (credit and insurance) on farmers' investment decisions. It has often been argued that resource-poor farmers in low-income countries have an inherent disposition towards risk aversion which deters them from making choices which are consistent with growth.

By contrast to the dominant view, we argued that while resource-poor farmers do indeed exhibit risk averse behaviour, they are not extremely risk averse as has often been asserted. More importantly, we hypothesised that when the credit and insurance constraints they face are relaxed, this results in a reduction of risk aversion. To test this hypothesis we conducted a two treatment field experiment with small-scale farmers from the Western Cape Province of South Africa. In the first treatment we investigated whether resource-poor farmers are generally risk averse. We employed an unframed experiment in which farmers were presented with a list of choices ranked from least to most risky. We found that contrary to the popular view, farmers were not extremely risk averse, with only 19 percent of the sample selecting the risk-free option. We also found that men were slightly less risk averse than women.

In the second treatment we investigated whether farmers continue to exhibit risk aversion even when their constraint set is relaxed. As such, farmers were presented with three different investment options, namely, a) traditional seeds which did not require acquiring a loan (the risk-free option), b) the option to use new improved seeds by acquiring a loan (which was the riskiest option) and c) the use of new improved seeds, financed through a bank loan and insurance (which carried moderate risk). To the best of our knowledge ours is the first field experiment which combines these two treatments thereby controlling for individual risk aversion when studying the uptake of new technologies. Our findings from this treatment are interesting and have significant policy implications.

We find a significant reduction of risk aversion in treatment two when the constraint set is relaxed, with participant responses indicating a clear preference for the third option (insured loan) over traditional seeds across all rounds. Specifically, we find that farmers who opted out of the traditional seeds favoured the insurance option which has a higher CV and that once they opted out they did not revert to traditional seeds. This finding refutes the notion

that resource-poor farmers are excessively risk averse, and suggests that the selection of traditional seeds should rather be explained in terms of liquidity constraints.

While our small sample size limits the conclusions that we can draw from this study, our results strongly suggest that it is worthwhile to explore farmers' willingness-to-pay for weather insurance on a more extensive scale as there appears to be effective demand for it among small-scale farmers. Given the intensification of climate variability and climate change and the limited adaptive capacity of resource-poor farmers, the provision of a risk diffusion instrument such as weather insurance is a worthwhile endeavour. Not only would it serve to reduce farmers' economic loss but it would also facilitate the adoption of high yield seed varieties which would increase agricultural productivity. In the absence of effective farm-level adaptation measures climate change will perpetuate the poverty which small-scale farmers already face and it will confine them further in so-called poverty-traps. It is therefore imperative to explore effective ways of safeguarding their livelihoods

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APPENDICES

APPENDIX A: GAME INSTRUCTIONS

INSTRUCTION SHEET

[We will start with greeting farmers and signing them in as they arrive. Each farmer receives a numbered sticker; this number will be used to identify farmers during the games and the survey.]

Thank you for coming. My name is (NAME), and I am a researcher with the University of Cape Town. These are my colleagues [NAMES]. We have invited you here to participate in our study. The purpose of this study is to understand how emerging farmers in Matzikama are coping with changes in the weather pattern i.e. changes in rainfall level, rainfall timing and temperatures. If you decide to take part in the study you will participate in two different activities that we have designed. You will earn R20 just from participating. In addition you will have a chance to earn more money by making decisions related to using vegetable seeds. You will not be asked to use any of your own money in these activities. The income you earn during today's activities will be paid to you by the end of today's session in the form of a cash cheque which you can cash at any branch of ABSA bank.

We will be completing two different activities. ACTIVITY 1 is played over one round and ACTIVITY 2 is played over eight rounds. Participation in these activities is voluntary. If you decide not to take part, you may leave at any moment, even after you have started playing a few rounds of the game, but then you will not earn any money. If you prefer to stay we ask that you sign the form that our assistants are bringing around right now.

[ASSISTANTS: YOU WILL HAVE A CONSENT FORM FOR EACH PARTICIPANT. HAVE EACH PARTICIPANT SIGN THE CONSENT FORM. BE SURE TO RECORD THE NAME AND NUMBER OF EACH PERSON CORRECTLY. WHEN YOU FINISH WITH ALL THE PARTICIPANTS, NOTIFY THE MCEE.]

Is everyone finished? Are there any questions before we begin? Great! We are ready to start the first activity.

Activity 1

We will start by describing the first activity. In this activity you will be asked to choose **between five possible options**. Each of these options has two amounts; a high amount and a low one. The figure at the front of the room shows you what these options are. Depending on what you choose, you will get one of the amounts from each of these pairs. For example if you choose option 2 you can **either get R36 or you can get R18**. **You can only receive one of these amounts, not both.**

Option 1 gives you a sure amount of R24.

Option 2 as I mentioned gives you **either R36 or R18**.

Option 3 gives you **either R48 or R12**.

Option 4 gives you **either R60 or R6**.

Option 5 gives you **either R72 or 0**.

Choice	Low (50%)	HIGH (50%)	Your choice Mark only one (✓)
Option 1	R24	R24	
Option 2	R18	R36	
Option 3	R12	R48	
Option 4	R6	R60	
Option 5	R0	R72	

You will be given a piece of paper which lists all these five options. Your task in this activity is to decide which of these options you want. Once you have decided, you will place a tick against your choice on the piece of paper that will be handed to you. To help us determine how much you will actually get, we will use five balls labelled high and five balls labelled low which are all in this bag [SHOW THEM THE BAG]. If you pull out a low ball from the bag you will receive one of these amounts in the left-hand column of the table. However, if you draw out a high ball you will receive one of these amounts in the right-hand column of the table.

Exactly how much you get will depend on which option you chose before you draw out the ball. So let's say for example you decide to choose Option 3. You place a tick against 3 on your piece of paper. We will then ask one person to draw out a ball for the group. Let's say the person draws out a high ball. How much will you receive? You will get R48. If you had pulled out a low ball instead, how much will you have earned? You would have earned R12.

The assistants will now give you the answer sheets [HAND OUT ANSWER SHEETS]. OK, let's begin this exercise. We shall give each of you a few minutes to think carefully about your choice. We ask that you do not speak to your neighbours about your choice. When you have all made your selection on the decision sheets in front of you our assistants will come to each one of you and collect your answer sheets. You will only find out what you earned for ACTIVITY 1 after we finish with ACTIVITY 2. Is this clear to all?

[MCEE: AFTER A FEW MINUTES HAVE ELAPSED, FIND OUT IF THEY HAVE ALL MADE THEIR SELECTION. ASSISTANTS: GO TO EACH PARTICIPANT AND COLLECT THE ANSWER SHEETS. PLEASE MAKE SURE THAT YOU COLLECT THEM IN THE CORRECT ORDER. NOW ASK ONE OF THE PARTICIPANTS TO DRAW OUT A BALL FROM THE BAG]

We have finished ACTIVITY 1. You stand a chance of earning more money in ACTIVITY 2 if you decide to continue playing.

For now, let's take a ten minute break. During the break we shall serve refreshments. **Also, during the break we kindly ask that you do not discuss which options you chose in the activity we have just played. You are free to do so at the end of the day, after you have received payment.**

Activity Two

Let's begin the next activity. We will do **eight rounds** of this activity and **each round will represent a farming season**. In this exercise we are going to imagine that you are at the start of a farming season. You have to make a decision about the type of seeds you are going to use for this season. Your income will depend on what type of seed you plant and the amount of rainfall the district receives.

RAINFALL

To see how much rainfall there is for the round we will draw a ball from this bag. If we draw a blue ball that means the rainfall is good. If a yellow ball is drawn that means the rainfall is low and if a red ball is drawn the rainfall is very low. There are three blue balls in the bag, three yellow balls and three red balls. [SHOW THEM ALL THE BALLS THAT WILL GO INTO THE BAG]

Alright let me ask you a question. If I pull out a ball from the bag, is it more likely that it will be a blue ball, a yellow ball or a red ball?

[WAIT FOR RESPONSE]

[IF THEY GET IT RIGHT] That's right. There is an equal chance of drawing out a blue ball, a yellow ball or a red ball. Why? Because there are three balls of each colour.

[IF THEY GET IT WRONG] Actually, there is an equal chance of drawing out a blue ball, a yellow ball or a red ball because there is exactly the same number of balls of each colour.

Let's do an example. Would anyone like to pull a ball out of the bag?

[PICK A VOLUNTEER]

You sir? You are going to draw a ball out of the bag. [HAVE HIM OR HER PULL OUT A BALL FROM THE BAG]. A [COLOUR OF BALL] ball. So is the rain collected by the rainfall meter good, low or very low? [WAIT FOR RESPONSE; HELP THEM IF THEY HAVE TROUBLE]. Yes, it will be [RAINFALL TYPE].

TRADITIONAL SEEDS:

You have always used a certain type of seed every year which we shall call traditional seeds. Compared with other types of seeds these traditional seeds give you a lower yield. However they always give you the same yield whether the rains are good, low or very low. In other words, you always know what to expect. If you decide to plant these seeds, come harvest time, you will receive R10 for your yield for this farming season if the rains are good, low or very low.

If you would like to stick with the traditional seeds there is no cost in using these seeds. We will assume that you have been storing some of these seeds after every farming season over the years. So you can go ahead and start planting.

NEW IMPROVED SEEDS:

On the other hand, you have heard that new types of seeds have been introduced in Matzikama and that only a few farmers have started using them. You have not yet used these seeds but you have heard great things about them and you are wondering if you should try them. The few farmers who have started using these new seeds have told you that the seeds are drought resistant and can increase the yield on your piece of land substantially.

If you choose to use these new seeds and if the rains are good you earn R40 in one farming season. If the rains are low you earn R30 which is more than the R10 you get from the traditional seeds. But, you are told that there is a disadvantage to using the new seeds. If the rains are very low you will not get any yield from your land. You have a decision to make. Do you want to plant traditional seeds which always give you the same yield when rains are good and even when they are bad? Or do you want to try the new seeds which give you a higher yield when the rains are good or low, but which give you a zero yield when the rains are very low?

LOAN FOR BUYING NEW IMPROVED SEEDS:

However, if you decide to grow the new seeds you will have to borrow money from the bank to buy these seeds. They are expensive because they give you higher yields than the traditional seeds in most cases. You are required to take out a R10 loan in order to buy these new seeds. At the end of the season you are required to pay back the R10 plus an additional R1, which is

interest on the loan. So, in total, if you would like to purchase the new seeds, the loan will cost you R11.

Are there any questions?

[PAUSE TO ANSWER QUESTIONS]

LOAN AND INSURANCE

In addition to the loan, you can also buy insurance that will protect you from losing income if rainfall is low or very low. We will call this insurance “rainfall insurance.”

We will first explain about the insurance. Insurance is a way to protect against losses. You pay a little bit before the season begins to protect against losses. In the case of rainfall insurance if the rains are low or very low in a particular farming season the insurance company will give you some money to make up for the losses due to not having enough rain. But if the rains are good you do not receive any money from insurance. Why? Because your crops received enough rainfall. Losses that you experience on your farm as a result of other things such as pests or crop disease are not covered by this type of insurance. Also, whether the rainfall is low or not you must always pay for the insurance before the round begins if you want this protection against losses.

The money that is paid out by the insurance to you is meant to protect against losses suffered due to the rains being below what you would normally expect. How does the insurance company decide if the rains are low or not? A container which measures rainfall is placed in a central location in each town and village in Matzikama. This container acts as a rainfall meter. It records how much rain you receive in the area during the rainy season. If the rains are good (a blue ball is drawn from the bag), the container will have a lot of water in it when the insurance company goes to check it.

If you decide to buy insurance, you will receive money from the insurance company only if [STRESS THIS POINT] the rain collected by the rainfall meter is low or very low; that is, if a yellow or red ball are pulled out from the bag in each round.

What the insurance company does not know is the actual crop yield you get on your farm. To do this they would have to go from farm to farm, asking everyone with insurance whether they had

a large, average or small harvest. This would cost too much money and make the insurance very expensive. Therefore we will only use the amount of rainfall recorded at the rainfall meter to determine the amount you will receive from insurance.

So how does this really work? This figure [POINT TO FIGURE IN FRONT OF THE ROOM] explains how rainfall amounts are tied to insurance payments. Remember that if you want insurance payouts you must first pay for insurance at the beginning of the round. Insurance costs R2.

	If a blue ball is drawn from the bag GOOD RAINFALL	If a yellow ball is drawn from the bag LOW RAINFALL	If a red ball is drawn from the bag VERY LOW RAINFALL
You pay the premium	R2	R2	R2
With insurance, you receive	R0	R4	R8

As I said earlier you only receive money from the insurance if rain collected by the rainfall meter is low or very low, or when a yellow or red ball is pulled from the bag.

As you can see from the chart you receive a big payment from insurance of R8 when a red ball is pulled out meaning rain is very low in the rainfall meter. You receive the smaller payment of R4 when a yellow ball is drawn out meaning rain is low in the rainfall meter. You will not receive anything from the insurance if a blue ball is drawn because this means that the rains were good. Remember that if you are interested in buying insurance, you always pay R2 for insurance at the beginning of the round.

BANKRUPTCY RULE:

At the end of every round we will give you information about what your earnings for that round was and also what your TOTAL EARNINGS for Activity 2 are so far. If at the end of any round in this activity, if you have made a loss you can still continue to the next round if your TOTAL INCOME for Activity 2 so far (which includes your income from previous rounds) can cover your losses. If not, you will be disqualified from the ACITIVITY 2, which means you will not be able to continue to the next round. **You will however each receive R15 at the end of this activity to cover you for such losses so that you will not lose any of your own money or money that you earned in ACTIVITY 1.**

EXAMPLE OF ACTIVITY 2:

So now that I have explained everything to you, lets do an example.

In this activity you have to decide if you want to use **traditional seeds** or **new seeds**. If you want to use the traditional seeds you do not have to worry about borrowing money or buying insurance.

If however you decide to use the new seeds you **will have to** [STRESS THIS POINT] borrow R10 from the bank to pay for the seeds. Remember that you will have to pay this back with **R1** interest at the end of the round. In total you will have to pay back R11.

If you want to use the new seeds you could in addition to taking out a loan, also buy insurance for R2 which will pay out R4 if the rainfall is low and R8 if the rain is very low.

The figure on this board (or wall) shows you exactly how this all works. Let's go over the figures in this table: [SHOW THEM THE TABLES]

INCOME IF YOU USE TRADITIONAL SEED:

If you decide to use traditional seeds you will receive R10 in the first round if the rains are good. If the rains are low, you will also receive R10 and when the rains are very low you will still receive R10. Are there any questions?

[PAUSE TO ANSWER QUESTIONS]

		Earnings if rainfall is good, low or very low		
	OPTION	If a blue ball is drawn from the bag GOOD RAINFALL	If a yellow ball is drawn from the bag LOW RAINFALL	If a red ball is drawn from the bag VERY LOW RAINFALL
1.	If you choose to use traditional seeds you receive (for your harvest)	R10	R10	R10
	Income for this round	R10	R10	R10
	Total income for all previous rounds:
2.	If you choose to take out a loan to buy improved seeds, you receive (for your harvest):	R40	R30	R0
	Minus cost of loan (R10) plus interest (R1) = R11	-R11	-R11	-R11
	Income for this round:	R29	R19	-R11
	Total income for all previous rounds:
3	If you choose to take out a loan and to also buy insurance, you receive (for your harvest):	R40	R30	R0
	Minus cost of loan (10) plus interest (R1) = R11	-R11	-R11	-R11
	Minus cost of insurance R2	-R2	-R2	-R2
	Plus what you get back from insurance	+R0	+R4	+R8
	Income for this round:	R27	R21	-R5
	Total income for all previous rounds:

INCOME IF YOU TAKE OUT A LOAN TO BUY NEW SEEDS

If you decide to use new seeds you have to borrow R10 from the bank so that you can buy the new seeds. If the rains are good, that is, if a blue ball is drawn from the bag, you will receive R40. **However, from that R40 you will have to pay back the bank the R10 you borrowed at the start of the round plus an additional interest of R1. So in total you will owe the bank R11. You will be left with R29 after paying back the loan. This is your TOTAL INCOME for Activity 2 so far.**

If the rains are low, that is, if a yellow ball is pulled out, you will receive R30 at the end of the round. **Again you will have to pay back the R11 to the bank, leaving you with R19. This is your TOTAL INCOME for Activity 2 so far.**

If the rains are very low, that is, if a red ball is drawn out, you will not receive any income for your harvest. This is because your seeds failed to germinate. However, you still need to pay back the money you borrowed from the bank. So although you did not make any money, you still owe the bank the R10 you borrowed at the beginning of the round plus the R1 interest. **This leaves you with a LOSS (or negative income) of –R11 for this round.**

This is where the bankruptcy rule comes in. If you make a loss we will have to check if you have enough TOTAL INCOME (from previous rounds) to cover your losses and to continue. If you don't, you will not be able to continue to the next round, and you will be disqualified from the activity. [EXPLAIN TO THEM THAT IN THE FIRST ROUND THEY WILL NOT HAVE FUNDS FROM PREVIOUS ROUNDS TO COVER SUCH LOSSES]

As we explained before, even though you have made a loss – you will receive R15 at the end of Activity 2 to cover any such losses.

Are there any questions?

[PAUSE TO ANSWER QUESTIONS]

LOAN AND INSURANCE

If you decide to use new seeds and in addition to the loan you also want to buy insurance this will cost you an additional R2. In the first round none of you will be able to afford insurance, since you have not received any income for your harvest yet. Remember what we said about the insurance. You have to pay for it before the round begins if you are interested in

insurance and this will cost you R2 at the beginning of the round. [SHOW THEM THE DISTRIBUTION CHART AGAIN]

So, if we draw out a blue ball this means that the rains are good and you receive R40 and the insurance pays out nothing. But remember that we will subtract the R11 you owe for taking out a loan, and that you already paid R2 for insurance coverage, so your income for this round is R27.

If the rains are low, that is, if we draw out a yellow ball, you will receive R30 and the insurance will pay out another R4. **Again you will owe the bank R11, and remember that you paid R2 for insurance, so your income for this round will be R21.** [SHOW THEM THE DISTRIBUTION CHART AGAIN]

If we draw out a red ball, we assume that your crops failed and so you do not earn any money from your farm. Your seeds were unsuccessful and you did not make any money, but the insurance pays out R8. **Once again you owe the bank R11, and remember that you paid R2 for insurance coverage, so you make a loss (negative income) of –R5 for this round.** [SHOW THEM THE DISTRIBUTION CHART AGAIN].

Once again this is where the bankruptcy rule comes in. If you make a loss we will have to check if you have enough TOTAL INCOME (from previous rounds) to cover your losses and to continue. If you don't, you will not be able to continue to the next round, and you will be disqualified from the activity. [EXPLAIN TO THEM THAT IN THE FIRST ROUND THEY WILL NOT HAVE FUNDS FROM PREVIOUS ROUNDS TO COVER SUCH LOSSES]

As we explained before, even though you have made a loss – you will receive R15 at the end of Activity 2 to cover any such losses.

We have given you a lot of information today and I am sure there are some questions. If anything is unclear please feel free to ask before we begin the activity. Remember you are playing for real money so make sure you understand all this before you start playing.

[PAUSE TO ANSWER QUESTIONS]

The assistants will hand out new pieces of paper which you will use to indicate the option you want i.e. 1, 2 or 3 [ASSITANTS: HAND OUT SHEETS. POINT OUT

DIFFERENT PARTS OF THE WORKSHEET AS EMCEE EXPLAINS THEM]. **At the end of each round, you will be asked to indicate your choice on this sheet of paper as you did in the first activity. After you've circled the option you want our assistants will come round to you and collect your answer sheets. We will work out how much each person gets. Before we move on to the next round we will give each person receipt feedback sheet which tells you how much money you earned in this round and what you TOTAL INCOME is for Activity 2 so far.**

Before we begin, let's do an example.

[EMCEE: PICK ANOTHER VOLUNTEER]. You sir. Please choose one of the three options. Now pick someone else to draw a ball from the bag. [PARTICIPANT DRAWS BALL]. You drew a [COLOUR OF BALL] ball from the bag. This means the rainfall for this round is [RAINFALL TYPE]. How much would he have earned if we were playing an actual round?

We need to explain here that in this activity only one person will draw out a ball for the entire group in each round. Why do you think this is the case? The reason is that if there is high rainfall in your town, you are all likely to receive the same amount or very similar amounts of rainfall on your farm. If there is low rainfall in the rainfall meter it is likely that you all received low rains on your farms, so we only need one person to draw out a ball for us.

Does anyone have any questions? Ok, we are ready to start this exercise. [ASSISTANTS SHOW YOUR GROUP MEMBERS HOW TO MAKE THEIR CHOICES]. After they have finished making their choices find a volunteer to draw out a ball for the group. Record earnings for the round.

[REPEAT AS IN ROUND 1 FOR ROUNDS 2-8]

Conclusion

We have finished today's activities. Now remember that we said we would let you know what your earnings from the first Activity are after we have finished with Activity 2. In Activity 1 you chose one of 5 options. For each option there was the possibility that you would get a high amount if we draw a "high" ball from the bag or a low amount if we draw a "low" ball from the bag. We have already recorded this and we will now add this to your earnings from Activity 2. To this we shall also add a show-up fee of R20 as we mentioned and an additional R15.

After we have done this for everyone we will print out a receipt which tells you your TOTAL EARNINGS for today.

While we are calculating your TOTAL INCOME and preparing the receipts and cheques, we would like to ask each of you to fill in this form with questions on such things as your age, education level, gender and so on, that we are handing out now. It is very important for us that you fill in every question, so please think carefully about each question and answer it in detail.

Thereafter we will pay each of you.

Thank you very much for participating!

APPENDIX B: QUESTIONNAIRE

Experiment number: _____

BACKGROUND INFORMATION

1. Age: _____

2. Gender: [put a tick in the relevant box]

Male

Female

EDUCATION

3. How well can you read in your home language?

I cannot read

Not well

Fair

Very well

Prefer not to answer

4. How well can you write in your home language?

I cannot write

Not well

Fair

Very well

Prefer not to answer

5. What is the highest level of education that you have completed?

- No schooling
- Sub A
- Sub B
- Standard 1
- Standard 2
- Standard 3
- Standard 4
- Standard 5
- Standard 6
- Standard 7
- Standard 8
- Standard 9
- Diploma/certificate with less than a Standard 10/Matric certificate
- Standard 10/ Matric
- Diploma or certificate (with a Standard 10/Matric certificate)
- Degree
- Postgraduate degree or diploma

INCOME

6. How many people (including you) live in your household? _____
(here, you should include all those people who sleep in the same household as you on a regular basis)

7. How many people aged less than 18 live in your household? _____
(here, you should include all those people who sleep in the same household as you on a regular basis)

8. Are you the main breadwinner in your household?

Yes

No

9. Thinking about your own household's financial situation, would you describe yourself as:

Poor

Lower income

Middle income

Upper income

Rich

10. What is your household's monthly income? R_____

11. Do you have a sufficient amount of food in your household?

We always have enough food in our household

Most of the time we enough food in our household

We often do not have enough food in our household

We never have enough food in our household

EMPLOYMENT

12. Besides your own farming activities, do you have a job?

Yes

No

13. If yes, what job do you do? _____

14. What is your monthly income from this job? R_____

15. Is the job full-time or part-time?

Full-time

Part-time

I do not have a job

16. If you are not working, do you have any other form of income?

Pension: if so, how much do you receive each month? R_____

Child Care Grant: if so, how much do you receive each month? R_____

Disability Grant: if so, how much do you receive each month? R_____

Remittances: if so, how much do you receive each month? R_____

17. In addition to your farming activities and any job that you have already told us about, do you have a part-time job or do you do any activity to earn money for yourself?

Yes: if so, tell us what you do: _____

No

18. How much do you earn each month from this job or activity? R_____

FARMING ACTIVITIES

19. How many years have you been involved in farming? _____

20. What kind of crops do you grow? _____

21. How much do you earn during a farming season from farming activities?
R_____

22. On what type of land do you grow crops or rear animals on?

- Land which you or a household member owns
- Land which you or a household member has access to as an employee on a commercial farm
- A land reform project on state land
- An equity share scheme on a commercial farm
- Communal land
- Land in/near an informal or urban settlement in which the household lives

23. How many hectares is the land that you farm? _____

CLIMATE CHANGE

24. Have you noticed any of the following changes?

Changes in the frequency and timing of rainfall? Yes No

Changes in the rainfall level? Yes No

Changes in the rainfall intensity? Yes No

An increase in temperature? Yes No

An increase in the number of pests? Yes No

25. Which of the changes have affected your crop yield?

- These changes have not affected my crop yield
- Changes in the frequency and timing of rainfall
- Changes in the level of rainfall
- Changes in the rainfall intensity
- An increase in the temperature
- An increase in the number of pests

26. How has your crop yield been affected?

- My yield has increased
- My yield has decreased
- My yield has been affected

NEW FARMING PRACTICES

27. Please indicate whether you have adopted any of the farming strategies listed below:

[Please tick all the options that apply to you]

- I have not adopted any new farming practices
- Growing more drought resistant crops → when: Year: _____ Month: _____
- Using improved seeds → when: Year: _____ Month: _____
- Intercropping → when: Year: _____ Month: _____
- Mulching → when: Year: _____ Month: _____
- Applying fertilizer → when: Year: _____ Month: _____
- Applying organic manure → when: Year: _____ Month: _____
- Changing planting dates → when: Year: _____ Month: _____
- Planting wind breaks → when: Year: _____ Month: _____
- Using irrigation → when: Year: _____ Month: _____
- Other: _____ → when: Year: _____ Month: _____

28. If you have adopted new farming practices, how have they affected your yield?

- My yield has increased
- My yield has decreased
- My yield has stayed the same

29. If you have not adopted new farming practices, why have you not?

- I do not know what measures to take (or what methods to use)
- I do not have the money to adopt these measures
- The risk of crop failure is too great
- Other: _____

CREDIT AND INSURANCE

30. Are you a member of a savings group?

- Yes
- No
- I used to

31. If YES, have you contributed this year?

- Yes; if so: how much did you contribute this year? R_____
- I have not yet contributed
- Will not contribute this year
- I prefer not to answer

32. If you want to invest in farming equipment or other farming inputs, where do you obtain the money for this?

- From my savings
- I borrow money from my savings group
- I request a loan from the bank
- I request a loan from a financial institution
- I borrow money from friends and/or relatives
- Other; please specify: _____

33. Have you ever applied for a loan from a bank or other formal institution for farming activities?

Yes

No

34. Did you take any bank loans for farming this year?

Yes; if so: how much was requested: R_____ ; if so: was the loan granted? Yes No

No

35. If you have never attempted to borrow money, why have you not?

There are no formal lending institutions

I did not need credit

I dislike any borrowing

The loans are too expensive

I would have like to apply for a loan but did not apply because I felt that the loan would not be granted

Other (please specify):

36. Have you heard of insurance?

Yes

No

37. Would you consider purchasing insurance?

Yes

No

SOCIAL

38. Which of the following statements describes you the best?

- I often take risks
- I sometimes take risks
- I never take risks

APPENDIX C: BREAKDOWN OF PARTICIPANT CHOICES FOR EACH COMMUNITY

1. VANRHYNSDORP

round	choice			Total
	1	2	3	
-----+-----+-----+-----				
1	14	11	0	25
	56.00	44.00	0.00	100.00
-----+-----+-----+-----				
2	9	2	3	14
	64.29	14.29	21.43	100.00
-----+-----+-----+-----				
3	9	3	2	14
	64.29	21.43	14.29	100.00
-----+-----+-----+-----				
4	7	2	5	14
	50.00	14.29	35.71	100.00
-----+-----+-----+-----				
5	9	2	3	14
	64.29	14.29	21.43	100.00
-----+-----+-----+-----				
6	9	0	5	14
	64.29	0.00	35.71	100.00
-----+-----+-----+-----				
7	9	1	4	14
	64.29	7.14	28.57	100.00
-----+-----+-----+-----				
8	3	2	8	13
	23.08	15.38	61.54	100.00
-----+-----+-----+-----				
Total	69	23	30	122
	56.56	18.85	24.59	100.00

2. LUTZVILLE

round	choice			Total
	1	2	3	
1	25	12	0	37
	67.57	32.43	0.00	100.00
2	17	13	7	37
	45.95	35.14	18.92	100.00
3	16	10	11	37
	43.24	27.03	29.73	100.00
4	14	14	9	37
	37.84	37.84	24.32	100.00
5	13	10	14	37
	35.14	27.03	37.84	100.00
6	11	13	13	37
	29.73	35.14	35.14	100.00
7	5	20	12	37
	13.51	54.05	32.43	100.00
8	11	14	12	37
	29.73	37.84	32.43	100.00
Total	112	106	78	296
	37.84	35.81	26.35	100.00

3. KLAWER

round	choice			Total
	1	2	3	
1	8	2	0	10
	80.00	20.00	0.00	100.00
2	2	5	3	10
	20.00	50.00	30.00	100.00
3	3	4	3	10
	30.00	40.00	30.00	100.00
4	4	3	3	10
	40.00	30.00	30.00	100.00
5	2	2	6	10
	20.00	20.00	60.00	100.00
6	2	2	6	10
	20.00	20.00	60.00	100.00
7	3	2	5	10
	30.00	20.00	50.00	100.00
8	2	1	7	10
	20.00	10.00	70.00	100.00
Total	26	21	33	80
	32.50	26.25	41.25	100.00

4. CLANWILLIAM

round	choice			Total
	1	2	3	
1	31	4	0	35
	88.57	11.43	0.00	100.00
2	18	16	1	35
	51.43	45.71	2.86	100.00
3	21	1	0	22
	95.45	4.55	0.00	100.00
4	17	4	1	22
	77.27	18.18	4.55	100.00
5	20	1	1	22
	90.91	4.55	4.55	100.00
6	18	3	1	22
	81.82	13.64	4.55	100.00
7	19	2	1	22
	86.36	9.09	4.55	100.00
8	13	7	2	22
	59.09	31.82	9.09	100.00
Total	157	38	7	202
	77.72	18.81	3.47	100.00

5. WUPPERTHAL

round	choice			Total
	1	2	3	
1	9	9	0	18
	50.00	50.00	0.00	100.00
2	7	2	0	9
	77.78	22.22	0.00	100.00
3	7	2	0	9
	77.78	22.22	0.00	100.00
4	6	0	3	9
	66.67	0.00	33.33	100.00
5	7	0	2	9
	77.78	0.00	22.22	100.00
6	2	6	1	9
	22.22	66.67	11.11	100.00
7	6	3	0	9
	66.67	33.33	0.00	100.00
8	6	3	0	9
	66.67	33.33	0.00	100.00
Total	50	25	6	81
	61.73	30.86	7.41	100.00

APPENDIX D: PARTICIPANT CHOICES BY RISK CATEGORY

Choice:

- 1: Traditional Seeds
- 2: Improved Seeds (Loan)
- 3: Improved Seeds (Loan and Insurance)

Round 1

Risk Category	Choice		Total
	1	2	
1	15	9	24
	62.50	37.50	100.00
2	21	8	29
	72.41	27.59	100.00
3	26	14	40
	65.00	35.00	100.00
4	20	5	25
	80.00	20.00	100.00
5	5	2	7
	71.43	28.57	100.00
Total	87	38	125
	69.60	30.40	100.00

Round 2

Choice

Risk Category	1	2	3	Total
+-----+-----+-----+				
1	12	5	5	22
	54.55	22.73	22.73	100.00
+-----+-----+-----+				
2	11	9	3	23
	47.83	39.13	13.04	100.00
+-----+-----+-----+				
3	15	10	5	30
	50.00	33.33	16.67	100.00
+-----+-----+-----+				
4	13	11	0	24
	54.17	45.83	0.00	100.00
+-----+-----+-----+				
5	2	3	1	6
	33.33	50.00	16.67	100.00
+-----+-----+-----+				
Total	53	38	14	105
	50.48	36.19	13.33	100.00

ROUND 3

Risk Category	Choice			Total
	1	2	3	
1	15	2	5	22
	68.18	9.09	22.73	100.00
2	13	3	4	20
	65.00	15.00	20.00	100.00
3	16	6	3	25
	64.00	24.00	12.00	100.00
4	11	6	3	20
	55.00	30.00	15.00	100.00
5	1	3	1	5
	20.00	60.00	20.00	100.00
Total	56	20	16	92
	60.87	21.74	17.39	100.00

ROUND 4

Choice

Risk Category	1	2	3	Total
+-----+-----+-----+				
1	12	4	6	22
	54.55	18.18	27.27	100.00
+-----+-----+-----+				
2	9	4	7	20
	45.00	20.00	35.00	100.00
+-----+-----+-----+				
3	14	6	5	25
	56.00	24.00	20.00	100.00
+-----+-----+-----+				
4	11	6	3	20
	55.00	30.00	15.00	100.00
+-----+-----+-----+				
5	2	3	0	5
	40.00	60.00	0.00	100.00
+-----+-----+-----+				
Total	48	23	21	92
	52.17	25.00	22.83	100.00

ROUND 5

Choice

Risk Category	1	2	3		Total
+-----+-----+-----+-----+					
1	11	6	5		22
	50.00	27.27	22.73		100.00
+-----+-----+-----+-----+					
2	9	2	9		20
	45.00	10.00	45.00		100.00
+-----+-----+-----+-----+					
3	17	0	8		25
	68.00	0.00	32.00		100.00
+-----+-----+-----+-----+					
4	11	5	4		20
	55.00	25.00	20.00		100.00
+-----+-----+-----+-----+					
5	3	2	0		5
	60.00	40.00	0.00		100.00
+-----+-----+-----+-----+					
Total	51	15	26		92
	55.43	16.30	28.26		100.00

ROUND 6

Choice

Risk Category	1	2	3	Total
+-----+-----+-----+				
1	8	8	6	22
	36.36	36.36	27.27	100.00
+-----+-----+-----+				
2	10	2	8	20
	50.00	10.00	40.00	100.00
+-----+-----+-----+				
3	14	4	7	25
	56.00	16.00	28.00	100.00
+-----+-----+-----+				
4	9	6	5	20
	45.00	30.00	25.00	100.00
+-----+-----+-----+				
5	1	4	0	5
	20.00	80.00	0.00	100.00
+-----+-----+-----+				
Total	42	24	26	92
	45.65	26.09	28.26	100.00

ROUND 7

Risk Category	Choice			Total
	1	2	3	
+-----+-----+-----+				
1	11	6	5	22
	50.00	27.27	22.73	100.00
+-----+-----+-----+				
2	11	2	7	20
	55.00	10.00	35.00	100.00
+-----+-----+-----+				
3	11	7	7	25
	44.00	28.00	28.00	100.00
+-----+-----+-----+				
4	8	10	2	20
	40.00	50.00	10.00	100.00
+-----+-----+-----+				
5	1	3	1	5
	20.00	60.00	20.00	100.00
+-----+-----+-----+				
Total	42	28	22	92
	45.65	30.43	23.91	100.00

ROUND 8

Risk Category	Choice			Total
	1	2	3	
+-----+-----+-----+				
1	6	9	7	22
	27.27	40.91	31.82	100.00
+-----+-----+-----+				
2	8	3	9	20
	40.00	15.00	45.00	100.00
+-----+-----+-----+				
3	10	7	7	24
	41.67	29.17	29.17	100.00
+-----+-----+-----+				
4	9	6	5	20
	45.00	30.00	25.00	100.00
+-----+-----+-----+				
5	2	2	1	5
	40.00	40.00	20.00	100.00
+-----+-----+-----+				
Total	35	27	29	91
	38.46	29.67	31.87	100.00

APPENDIX E: NONPARAMETRIC TESTS

1. Results of a two sample t-test to test whether there is a difference between the mean choices of men and women in the risk aversion game (Treatment 1).

Two-sample t test with equal variances

```

-----
      Group |      Obs      Mean      Std. Err.      Std. Dev.      [95% Conf. Interval]
-----+-----
      Female |      456      2.701754      .0555151      1.185479      2.592657      2.810852
      Male   |      544      2.691176      .048405      1.12899      2.596092      2.786261
-----+-----
      combined |     1000      2.696      .0365091      1.15452      2.624357      2.767643
-----+-----
      diff |              .0105779      .0733386              -.1333376      .1544935
-----
      diff = mean(0) - mean(1)                                t =      0.1442
Ho: diff = 0                                                degrees of freedom =      998

      Ha: diff < 0              Ha: diff != 0              Ha: diff > 0
Pr(T < t) = 0.5573          Pr(|T| > |t|) = 0.8853          Pr(T > t) = 0.4427

```

2. Results of a chi-square test to assess whether there is a relationship between the ball colour drawn out in a previous round and the participants' choices in the subsequent round, where 1) represents traditional seeds, 2) denotes investment in new seeds financed by a bank loan and 3) denotes investment in a new seeds financed by both a bank loan and insurance.

Ball Colour_1	7 Rounds			Total
	1	2	3	
Blue	183	111	78	372
Yellow	81	43	37	161
Red	149	59	39	247
Total	413	213	154	780

Pearson chi2(4) = 8.7854 Pr = 0.067

3. Results of a two sample t-test to assess whether there is a difference between the mean investment choices of men and women in Lutzville in the insurance game (Treatment 2).

Two-sample t test with equal variances

```

-----
      Group |      Obs      Mean  Std. Err.  Std. Dev.  [95% Conf. Interval]
-----+-----
      Female |      120   1.833333   .069344   .7596254   1.696025   1.970641
      Male   |      176   1.920455   .0616037   .817265   1.798873   2.042036
-----+-----
  combined  |      296   1.885135   .0461647   .7942475   1.794281   1.975989
-----+-----
      diff   |           -.0871212   .0940501           -.272218   .0979756
-----+-----

      diff = mean(0) - mean(1)                                t =  -0.9263
Ho: diff = 0                                                degrees of freedom =    294

      Ha: diff < 0                Ha: diff != 0                Ha: diff > 0
Pr(T < t) = 0.1775                Pr(|T| > |t|) = 0.3550                Pr(T > t) = 0.8225

```