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Weather Uncertainty and Demand for Information in Agricultural Technology Adoption

The Case of Namibia

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Abstract

Climate change has compounded the uncertainties inherent in agriculture. Farmers have to make decisions faced with increasingly fluctuating weather, leaving them vulnerable. Access to climate-related information in developing countries, incidentally also the hardest hit by the adverse effects of climate change, is very limited. Given a choice set of technologies that yield different payoffs depending on seasonal weather outcomes, ambiguity arising from imprecise weather information may lead to sub-optimal choices. Using data from a framed experiment carried out with 300 farmers in northern Namibia, this study investigates how uncertainty about the weather affects farmers' decision making. To establish the demand for weather information, the study elicits farmers' willingness to pay for information at different levels of uncertainty. The experiment results show that high levels of weather uncertainty, in addition to subjective ambiguity aversion, dampen technology uptake. There is also a high demand for weather information that reduces this uncertainty, regardless of individual attitudes towards uncertainty. The results also show that access to weather information enables farmers to make welfare-improving choices given a set of farming technologies. These results highlight the importance of investing in the provision of weather information to farmers as a means of enhancing take-up of technology that creates resilience in agricultural production, in the face of the changing climate.

Keywords: climate, weather uncertainty, weather information, technology adoption, risk

JEL Codes: C93, D81, Q16, Q54

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1. Introduction

More than before, decision makers in the agricultural sector have to contend with an increasingly uncertain environment due to effects of climate change. Access to timely weather-related information can help these farmers prepare through adaptive or coping strategies to dampen the negative effects of climate change (Singh et al. 2017; Di Falco, Veronesi, and Yesuf 2011). While sub-Saharan Africa (SSA) has been projected as the region to be most affected by the negative effects of climate change (Pretty et al. 2011), it is also the region where availability and access to climate-related information is weakest (Mason et al., 2015).

The slow rate of technical change in developing countries has been blamed on low rates of diffusion of new technology to targeted populations. For the most part, development economists have attributed this problem to institutional barriers to adoption. Fairly recent literature describes poor farmers as caught in poverty traps due to underlying liquidity constraints and aversion to uncertain technologies, creating an inertia in the take-up of risky but high-yielding production technologies (Brick and Visser, 2015; Cole et al., 2013; Giné and Yang, 2009). Most literature on time preference also shows poor farmers to exhibit high discount rates, thus failing to invest in projects with no immediate returns (an exception is a recent study by Liebenehm and Waibel (2014) that surprisingly shows wealthier farmers to be more impatient). This has brought to the fore behavioural attitudes as key drivers in the technology diffusion and rural development literature (Feder and Umali, 1993).

While extant literature has explored how aversion to uncertainty affects agricultural technology uptake (Elabed and Carter 2015; Alpizar et al., 2011; Akay et al. 2012; Takahashi 2013), there is a dearth of evidence on how reducing this uncertainty improves technology adoption decisions. This is an important aspect in the fight against climate change since it gives prominence to the role of weather information provision in the adoption of stress-resilient technologies. To fill this gap in the literature, our study utilizes both survey data and a framed experiment to assess how providing weather information improves adoption decisions for improved agricultural technologies among smallholder farmers.

Further, the study elicits the willingness to pay (WTP) for such information at various levels of uncertainty, to establish its demand. While most weather information is publicly provided, studies show that this information is usually unreliable due to short lead time, frequency and accuracy (Tall, Coulibaly, and Diop 2018; Njau 2010). Eliciting demand for weather information among farmers could thus point to the potential for the entry of private weather information providers.

2. Choice Under Imprecise Information

Ellsberg's (1961) seminal work revived the problem of "Knightian uncertainty" in decision theory, whereby decision makers are faced with imprecise information on the likelihood of an event happening. This has seen an upsurge of research interest on imprecise information in decision making, both in theoretical and applied economics work. An unequivocal consensus as evidenced by studies shows that aversion to uncertainty affects decision making. For example, Yates and Zukowski (1976) found that subjects were willing to bet more on a bag where the precise number of blue and red chips was known compared to one where they did not have information on the proportion of chips in the bag.

Most of these studies assume decision making under complete uncertainty (where probability distributions are completely unknown). In most life decisions, however, decision makers have some information regarding the distribution of the likelihood of an event happening. This is exemplified in seasonal weather information, for example, which is the subject of interest in this article; farmers have some priors based on their farming experience and peer networks. One of the relevant early studies to investigate choice behaviour when a decision maker has formed some priors is Becker and Brownson (1964), who define ambiguity as any distribution of probabilities other than a point estimate.

Other recent literature on uncertainty with priors includes Gilboa and Schmeidler (1989), who posit that, given too little information in a bet to form a prior, the decision maker takes the minimum expected utility (MEU) over all priors in a probability set to evaluate the bet. Ghirardato et al. (2004) generalized the MEU model to allow decision makers to assign different weights on the minimum and maximum expected utility leading to the α-MEU model. Of interest is whether the effects of a decision maker's (DM's) "revealed" ambiguity on a dependent variable can be separated into its components: individual attitude towards ambiguity and the range of ambiguity itself. From these studies, it is not clear whether exhibiting a large aversion to ambiguity is due to the DM being more pessimistic (subjective) or due to the information being more imprecise (objective) (Hayashi and Wada, 2010). Klibanoff et al. (2005) explores what happens if a DM's ambiguity aversion is decreased while holding the priors and risk attitude constant or, conversely, what happens if the perceived priors change, holding ambiguity and risk attitudes constant. In their experiment, Hayashi and Wada (2010) controlled for the objective part (set of priors) and attempted to elicit the subjective part (ambiguity aversion).

Guided by the above premise of the separate effects of the subjective and objective sources of observed ambiguity, this study aims to look at the separate effects of subjective ambiguity aversion and objective uncertainty aversion on technology choice. To our knowledge, this is the first study to investigate this in the agricultural setting. Close studies include Tonsor (2018), who has looked at how uncertainty and reference point (best outcome experienced before) shape decision making among cattle producers in the United States.

Likewise, other similar studies have for the most part only looked into the subjective part of ambiguity aversion. For example, Cardenas and Carpenter (2013) found that ambiguity aversion was negatively correlated with well-being measures among participants drawn from Latin America. On climate change, Alpízar et al. (2011) focus on adaptation and show that ambiguity-averse farmers are more likely to take up adaptation measures in the face of climate change. Andrews et al. (2018), on the other hand, focus on mitigation and show experimentally that individuals invest in high-risk, high-reward mitigation technologies, thus exhibiting risk-seeking behaviour, when the stakes are high and certain but low-rewarding options are not sufficient to mitigate emissions.

Working on index-based insurance, Elabed and Carter (2015) focus on whether farmers exhibit aversion to compound risk and how this affects take-up of agricultural index-based insurance. Mcintosh et al. (2015), on the other hand, elicit coffee farmers' WTP for index-based insurance under varying degrees of rainfall and basis risk and compare this with a predicted optimal WTP given the expected utility with and without insurance, thereby exploring behavioural responses to probabilistic insurance. Our elicitation of subjects' WTP for uncertainty-reducing information (weather information) is similar in approach to Mcintosh et al. (2015), but our focus is on demand for weather information under various uncertainty levels, a novel contribution in the agricultural technology adoption literature.

Investigating farmers' choices under different uncertainty levels given their subjective attitudes towards uncertainty is an important aspect in the intervention space, especially relating to information provision. The implications of the study are of significance due to the rising uncertainty in farming environments driven by increasing climate variability. Predicting weather outcomes is now harder even among experienced farmers, and providing weather (climate) information could assist in stabilizing outcomes and sustaining livelihoods.

3. Study Area and Weather Information Use

The Namibian climate is characterized by sparse and erratic rainfall, with 92% of the land area defined as hyper-arid, arid or semi-arid (Tadross and Johnston, 2012). Most of the rain in the country is received in the northern part, which also has the highest population (Mendelsohn et al., 2002). Climate change is already affecting the fragile systems therein and projected impacts are grave unless urgent adaptive measures are taken (Reid et al., 2007). UNDP (2015) puts Namibia as the seventh most at-risk country in terms of climate change-related agricultural losses.

In the survey conducted in conjunction with this experiment, 52% responded that they receive information on weather regarding the management of their crops, while about 45% responded likewise regarding livestock management (See Figure 1). In an attempt to see if there is demand for climate information among non-recipients, we asked the remaining 48% and 55% that do not receive climate information on crop and livestock management respectively how they would use this information if they received it.

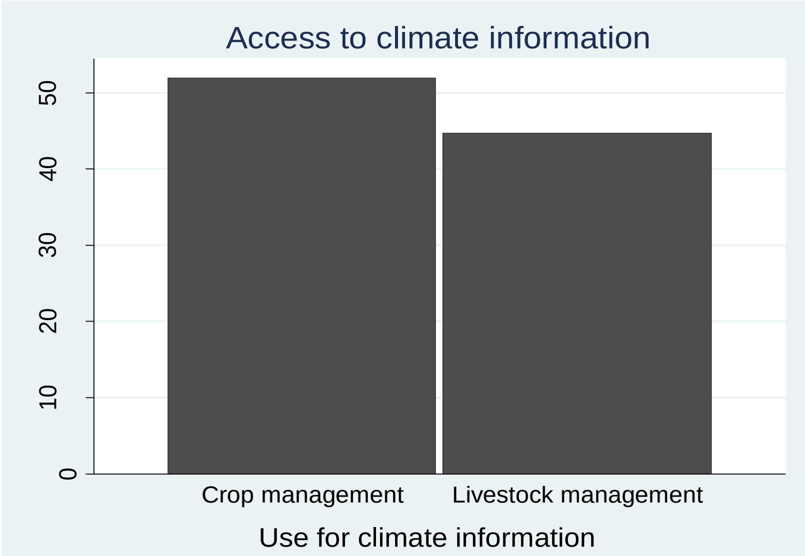

Figure 1. Access to Climate Information for Crop and Livestock Management

For crop management, a majority indicated they would change timing of activities, e.g., planting time (36%), while 28% indicated they would change crops and/or crop varieties that they planted, and a further 34% said they would change their grain storage (See Figure 2a).

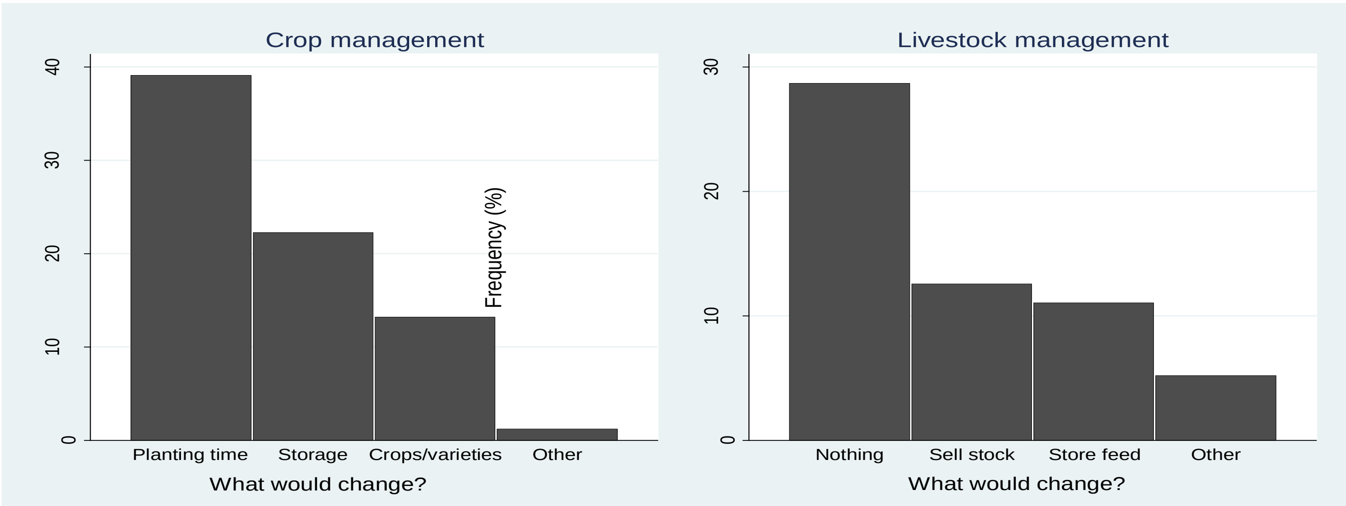

Figure 2 a-b. Potential Uses for Climate Information Among Non-Recipients

On the other hand, of those who did not receive climate information on livestock management, a majority indicated they might not use such information even if it was available to them (29%), a clear indication of the lack of awareness of strategies to mitigate against livestock losses in case of climate stressors like drought. However, 23% indicated they would use the information to manage stock size through selling and a further 25% felt that getting climate information might enable them to store livestock feed better (see Figure 2b).

4. Sample Selection

Selection of the sample followed two procedures: first, selecting respondents for the survey and second, selecting participants for the experiment. To achieve the first, a multistage sampling procedure was used to select 600 households from three regions in northern Namibia. In the first step, the three regions (Oshana, Omusati and Oshikoto) were purposively selected based on agricultural productivity and exposure to climate change. In the next step, one constituency was selected from Oshana, one from Oshikoto, and three from Omusati, representing the diversity within the regions. Random proportionate to size sampling was then employed to determine the number of villages from each constituency to include in the sample, with 10 households from each village being randomly selected for the study.

In the second process, a criterion of basic literacy was set to select who among the survey respondents would be included in the experiment. Qualifying participants had a minimum education level of grade three and could read and write in the local language (*Oshiwambo*). Given the low qualification criteria, many respondents in the survey qualified (an average of seven out of ten per village). However, logistical challenges, where the experiment team had to cover two villages (sessions) per day, meant that not all qualifying respondents from each village could be included, since some arrived late. Thus, at the end of the exercise, only half of the surveyed respondents participated in the experiment (see Table 1).

Table 1. Participant Characteristics (n=300)

Variable	Omusati	Oshana	Oshikoto	Overall
Gender (% female)	78	71	67	72
Age (years)	49.4 (16.6)	48.3 (18.4)	51.3 (15.8)	49.7 (16.9)
Education level (grade)	7.8 (3.2)	7.4 (3.5)	7.0 (3.5)	7.5 (3.6)

A high proportion of households in the study region are female-headed, as reflected in the sample. Mean education level was high, with the median participant having attained grade 7, though the dispersion around the mean is large given that the lowest level attained was grade three. While this may appear to show high education levels in the region, one must take into account that the participants were selected conditional on having gone to school. This is not unique in experimental studies where participants need to have some basic literacy level.

5. An Overview of Experimental Tasks Completed

There were five series of games to play in an experiment session (see Table 2). First, participants completed a simple risk experiment aimed at eliciting risk preferences (series 1), then moved on to a framed experiment involving choices of different technologies to use for farming in a typical season under varying chances of good weather. The framed experiment had four series of games (series 2 to 5). In series 2, the chances (probabilities) of good weather were disclosed to the participants before playing the games, while in series 3 the participants were only told the range of chances (probability set) within which good weather was likely to occur in the season.

Table 2. Overview of Games Played in the Experiment

Series 1	**Series 2**	**Series 3**	**Series 4**	**Series 5**
Simple risk preferences elicitation at [..] probability (set) of good outcome	Technology choice under risk at [..] probability of good weather	Technology choice under uncertainty at [..] probability set of good weather	WTP for information at [..] probability set of good weather	Technology choice with/out information at [..] probability set of good weather
50%	30%	0-100%	0-100%	0-100%
0-100%	50%	20%-40%	20%-40%	20%-40%
	70%	10%-50%	10%-50%	10%-50%
		60%-80%	60%-80%	60%-80%
		50%-90%	50%-90%	50%-90%

After completing series 3 games, where the chances of good weather in the season were uncertain, participants played information games (series 4), where they had an opportunity to purchase information on the precise probability of good weather. In the fifth and final series (series 5), participants played series 3 games again, but this time some had information on the precise probability of good weather (those who purchased information in series 4) and others knew only the range within which the chance of good weather was likely to occur (those who did not purchase information).

6. Experiment Design

This section presents designs of the risk preference elicitation methods, the framed experiment, and the elicitation of the willingness to pay for weather information.

6.1 Choice Under Risk and Uncertainty

A pre-test was conducted in the study area (in a region outside the sample) prior to collecting the data. This revealed that a detailed risk and ambiguity aversion elicitation method (e.g. the commonly used multiple price list) fatigued the participants before they got to play the framed experiment games.

A simpler version similar to the one by Eckel and Grossman (2002) was therefore adopted (see Table 3).

Table 3. Risk Preferences Elicitation

Gamble	Payoffs		✓
	Low outcome	High outcome	
1	24	24	
2	18	36	
3	12	48	
4	6	60	
5	0	72	

Participants were presented with five gambles, each with two possible outcomes. The probability of occurrence for the high outcome was set at 50% for the risk game and completely unknown for the ambiguity game.

6.2 Risk Aversion Measure

We let the number of the gamble be an index measure of the underlying continuous risk level. From the framing, an extremely risk-averse individual would sacrifice expected payoffs for certainty, thus opting for *gamble 1*, while moderately risk-averse participants would go for *gambles 3* or *4*. Conversely, risk-neutral participants would go for the maximum expected payoff, preferring *gamble 5*. Risk-seeking participants would also opt for a higher-risk option even if it involves the same or lower expected payoff and thus would choose *gamble 5* (Eckel and Grossman, 2002).

6.3 Ambiguity Aversion Measure

Following Klibanoff et al. (2005) and Cardenas and Carpenter (2013), we define ambiguity aversion with reference to a participant's risk aversion. In this regard, we use the standard deviations of the choices (high and low outcomes) so as to create a continuous measure, rather than use the discrete choices themselves. Ambiguity aversion is thus measured as the difference in the standard deviation of choice under risk and that under ambiguity. The constructed measure is therefore decreasing in ambiguity aversion; the lower the measure, the higher the degree of ambiguity aversion. Results show that the sample distribution of the measure is almost symmetrical with a mean of -0.47, implying a slightly higher proportion of the sample is ambiguity averse (see Figure 3).

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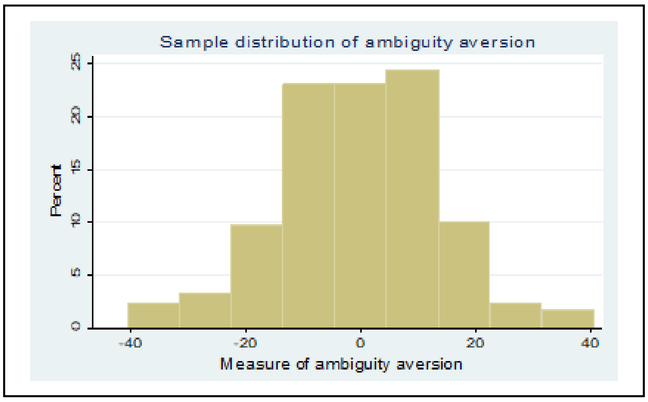

Figure 3. Sample Distribution of Ambiguity Aversion Measure

Following Cardenas and Carpenter (2013), we also allow for a spline specification where the ambiguity aversion measure is split into those who are strictly ambiguity averse (negative values of the ambiguity aversion measure) and those who seek more risk under ambiguity (positive values of the ambiguity aversion measure). This allows for a kink in the relationship between ambiguity aversion and the dependent variables discussed in the following sections, i.e.,

$$y_i = \beta_{0i} + \beta_{1i}(ambiguity_i - risk_i) + \beta_{2i} \max\{ambiguity_i - risk_i, 0\} + \theta \boldsymbol{X}_i + \boldsymbol{\varepsilon}_i$$

where y_i is the dependent variable of interest (e.g., choice of technology), $\boldsymbol{X}_i$ is a vector of controls and $\boldsymbol{\varepsilon}_i$ is an error term; and '$ambiguity_i - risk_i$' is a measure of a participant's reaction to uncertainty as explained above. The spline specification allows for the more ambiguity-averse (negative measure) participants to have different outcomes from the ones who seek more risk under ambiguity (positive measure).

6.4 Technology Choice: A Framed Experiment

The experiment adopts a within-subjects design to test how uncertainty shapes decisions over three technology choices. In the framing, a participant chooses a technology to use in a typical farming season from among three options: an off-farm work option, a seed technology adapted to climate stressors such as drought ('adaptive seeds'), and an improved seed technology (hybrid seed) (see Table 4). The off-farm work option has a constant payoff of N$75 in both good and bad weather outcomes and is analogous to the sure bet option in standard risk-aversion elicitation methods. The second option is that of an adaptive seed technology that is resilient even in bad weather, giving a net payoff of N$25 and a high of N$150 in good weather. The last option of improved seed technology has the highest payoff in good weather (N$225) but gives a negative payoff (-N$25) in bad weather. The negative payoff indicates that the farmer incurs costs, yet gets very low or zero returns in bad weather, thus incurring losses.

In similar studies (Brick and Visser, 2015; Jumare et al., 2018) , 'traditional seed' is used in lieu of the 'off-farm work' option to represent resilience of landraces in bad weather. In our study area, this might be true in the case of sporadic rainfall but is unrealistic in the case of droughts, which are growing in frequency and which lead to crop failure even for the traditional seeds. There exist several government and non-government organizations (NGO) funded programs in the study area; hence, the adoption of this framing is salient for the participants. Drought-resistant and hybrid seed varieties exist in the area too; hence, they are familiar concepts to the participants. The framing for the payoffs for each of these technologies, while not the same as in reality, reflects the payoff of each technology relative to the other. For example, while improved seeds do well in good weather compared to adaptive seeds, the latter do better in bad weather. One is also paid if working off-farm, whether the weather for that season is bad or good.

Table 4. Risk and Uncertainty Games

Choice	Weather outcome		Expected payoffs given probability (set)		
	Good	Bad	50%; 0-100%	30%; 20%-40%; 10%-50%	70%; 60%-80%; 50%-90%
Off-farm work	75	75	75.0	75.0	75.0
Adaptive seeds	150	25	87.5	62.5	112.5
Improved seeds	225	-25	100.0	50.0	150.0

Given the potential loss in the third option under the bad weather outcome, we made sure the initial endowment given to participants to incentivize the games was enough to cover this. We also varied the amount given to participants in different sessions (N$30 and N$60) to control for the effect of initial wealth on decisions made in the experiment. To control for order effects, games in each of the series (risk or uncertainty games) were randomized but participants always completed the risk games first before proceeding to the uncertainty games, in order to increase salience.

6.5 Willingness to Pay for Weather Information

After playing the third series of the games (uncertainty games), we introduced the possibility of reducing this uncertainty by receiving information on the precise probability of good weather in the season. Participants were given the opportunity to purchase this information before playing the uncertainty games again. The Becker, Degroot and Marschak (1964) (hereafter BDM) method was used to incentivize the payments and elicit true WTP for the uncertainty-reducing information (weather information). Participants first stated their WTP, then a random price was drawn. If the stated WTP was equal to or above the drawn price, the participant received information; if it was lower, the participant was not given information. This was done for all the five uncertainty ranges represented by the different probability sets of good weather (the fourth series of the games). All participants played the uncertainty games a second time (the fifth and last series of the games) either with or without information on precise probabilities of good weather as determined using the BDM method explained above.

Most of the climate- (weather) related information in developing countries is provided for free, either by government agencies or development aid organizations. Thus there is little cost information on which to base our bidding prices. Ultimately, a price range of 0 - N$25 was chosen based on participants' ability to pay using the initial endowments given and expected payoffs. A zero-information cost was included to capture the non-willingness to pay for some probability sets and is in congruence with the actual situation on the ground where information is given out for free.

7. Experiment Procedures

As mentioned in the preceding section, the experiment adopted a within-subject design where participants completed all the games in the five series (see Table 2), i.e., two games in *series 1*; three games in series *2*; and five games each in series *3*, *4* and *5.* Given the low literacy levels of the participants, a key concern was to make sure that the length of the experiment did not compromise data quality due to fatigue. Each session was thus split into two, where *series 1* to *3* games were played first before a half-hour refreshment break, then the rest of the games completed. The games were also made as easy as possible to understand, using visual aids as explained further in this section.

At the beginning of the experiment session, participants were given cards as they entered the venue, indicating the experiment number and showing them where to sit. The games were then explained, including how winning (and losing) would occur in the games. Participants were told that they had been allocated money for showing up, which they could use to pay for any losses in the games, as well as use to buy information in the WTP games. The remaining amount plus any winnings in the games would be handed out at the end of the sessions. This point was reiterated several times during the course of the games especially where it involved incurring losses and in the payment for information games. To disentangle the wealth effect on decisions made in the games, the initial endowment was varied at N$30 (low) and N$60 (high) and randomly assigned in sessions. This does not seem to have had any effect on choice behaviour, based on the results presented later in the results section.

The study utilized big posters translated to the local language, Oshiwambo, to represent the games. To explain concepts such as probability, white and black balls were used, where the black balls represented the probability of good weather. To explain a 30% probability of good weather, for instance, three black and seven white balls were put in an opaque bag and participants were told that if a black ball was drawn, the weather for that game (season) was good. Practice rounds were played to demonstrate this. Similarly, in the uncertainty rounds, participants were told that the bag could contain a range of a number of black or white balls depending on the particular probability set of good weather under consideration. In the 20%-40% probability set, for instance, the bag could contain two black and eight white balls, or three black and seven white balls, or four black and six white balls. This was demonstrated in examples, and the big posters representing the game also had these different variations of possible bag compositions drawn on the side.

In the WTP for weather information games (*series 4*), after the participants in a session had finished indicating how much they were willing to pay for information in a particular probability set, one of them volunteered to draw a card from a stack labelled 0 to 25. The drawn number represented the actual cost of the information and participants with equal or above stated WTP qualified to receive information for that particular game.

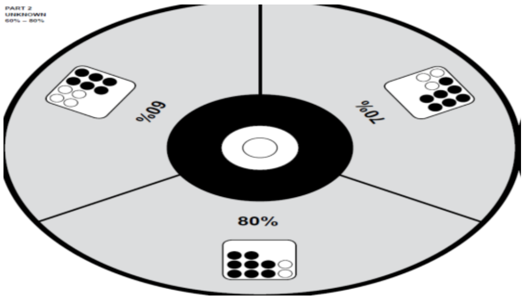

Figure 4: Spinning Wheel to Determine Precise Probabilities (60%-80% uncertainty range)

Next, a wheel with the appropriate number of ball variants for the specific probability set (e.g., the example in Figure 4) was spun to determine the precise probability of good weather. This was done discreetly and the information revealed to only the participants who qualified to receive information.

8. Results and Discussion

Results from the experiments and a discussion of these findings are presented next.

8.1 Risk and Ambiguity Aversion Measures

Consistent with similar field experiment studies (Brick and Visser, 2015; Cardenas and Carpenter, 2013), the results of the baseline risk gamble show prevalent risk aversion in the sample with a mean choice of 2.94, which is closest to lottery gamble 3 (see Table 5).

Table 5. Risk and Ambiguity Preferences (n=300)

Gamble	Payoff		Expected payoff (50% prob.)	Risk (standard deviation of payoff)	Frequency (%)	
	Low	High			Risk choice	Ambiguous choice
1	24	24	24	0	13.24	15.33
2	18	36	27	9	23.69	22.30
3	12	48	30	18	31.36	31.01
4	6	60	33	27	19.51	21.25
5	0	72	36	36	12.20	10.10
Mean gamble					**2.94 (0.071)**	**2.89 (0.071)**

The distribution in the complete uncertainty framing is similar to the risk framing but shifts slightly to the left to represent more conservative choices under ambiguity, as seen in Figure 3 earlier in this article. For example, more participants chose the 'safe' gamble (gamble 1) under uncertainty (15%) than under risk (13%). Likewise, more chose the riskiest option (gamble 5) under risk (12%) than under uncertainty (10%). The mean choice of 2.89, however, is most similar to the one under risk and corresponds to gamble 3.

8.2 Technology Choice under Risk and Uncertainty

Next, we investigate how participants' attitudes towards risk and uncertainty affect technology choice. As expected, the mean choice of technology was highest at 70% and lowest at 30% probabilities of good weather (see Figure 5a). Because our choice variable is increasing in riskiness and expected payoffs (0=Off-farm work; 1=Adaptive seed; 2=Improved seed), this implies that with a higher probability of good weather, participants opted for riskier technologies associated with higher expected payoffs, relative to the safe but low return option (off-farm work). The opposite applies for low probability of good weather (30%). At a 50% probability of good weather, the mean choice corresponds to the adaptive seed option, indicating the trade-off of high expected payoffs in the improved seed option for low variance in yields associated with the adaptive seed option.

Under uncertainty, the mean choice was highest at the 60%-80% probability sets and lowest at the 20%-40% probability sets (see Figure 5b). Observed mean choice at complete uncertainty (0-100% probability set) is about the same as that at the 50% risk level, corresponding to the adaptive seed option. Given the wide range of uncertainty, participants seem to choose a low variance technology to "hedge" against risk, while still getting a better expected payoff than the baseline option (off-farm work). This zero-variance, low expected payoff option is mostly chosen for the low probability sets (20%-40% and 10%-50%), as the low mean choices for these probability sets reveal.

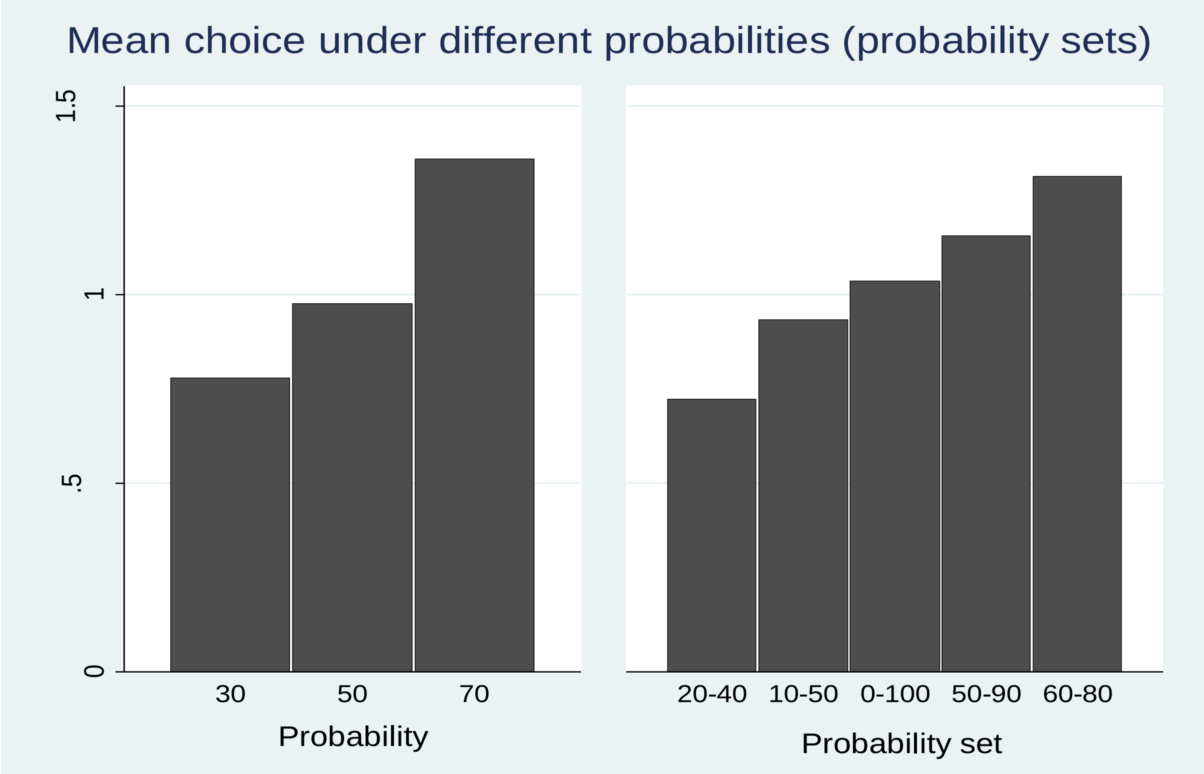

Figure 5 a-b: Technology Choice under Risk and Uncertainty

On the other hand, participants go for riskier, higher-yielding technologies in probability sets with higher probabilities of good weather (50%-90% and 60%-80%). Non-parametric tests using a Wilcoxon sign-rank test show that these differences in choices are significant (see Table 6).

Table 6. Difference in Choices under Different Probabilities (Probability Sets) of Good Weather

Probability (set) %	Probability (set) %	z	Prob > |z|
Risk choices			
30	50	-3.595	0.0003
30	70	-7.909	0.0000
50	70	-7.445	0.0000
Uncertainty choices			
20-40	10-50	-3.579	0.0003
20-40	60-80	-8.081	0.0000
20-40	50-90	-6.183	0.0000

20-40	0-100	-4.845	0.0000
10-50	60-80	-5.381	0.0000
10-50	50-90	-3.372	0.0007
10-50	0-100	-1.928	0.0539
60-80	50-90	3.123	0.0018
60-80	0-100	4.414	0.0000
50-90	0-100	2.110	0.0349

Higher preference for riskier technologies at 60%-80% probability than at 50%-90% probability could imply that participants over-weight the lowest probability in the set, thus choosing more conservatively at 50%-90%, in line with the MEU theory discussed before. The reverse happens for lower probability possibility sets, however, where more participants choose the safe option at 20%-40% probability than at 10%-50% probability. It would thus seem that for low probability sets, the highest possible probability in the set, rather than the lowest, biases the choice. The choice under the 0-100% probability set seems to confirm this, as riskier choices are made in this set compared to 10%-50% and 20%-40%, even though the least possible probability in this set is zero.

8.3 Risk Aversion and Technology Choice

To build up the analysis, we first look at the effect of risk aversion on choice under the risk scenarios (30%, 50% and 70%). In the analysis, we control for socio-demographic and household characteristics of the participant, such as education, age, gender and household income. We also control for the initial wealth given to each participant at the start of the experiments. The results in Table 7 are from an Ordinal Logit model and are displayed as proportional odd ratios; the risk-aversion measure is standardized to one standard deviation and zero mean.

Risk aversion significantly affects choice of technology at 50% and 70% probability of good weather; as risk aversion increases, participants are more likely to opt into the off-farm work ("safe") option relative to adaptive and improved seed options. Specifically, for a one standard deviation increase in risk-aversion attitude, the odds of opting into off-farm work relative to the adaptive and improved seed options are 1.28 and 1.36 times greater at the 50% and 70% probabilities of good weather outcome, respectively.

Pooling across the risk levels enables us to look at the effect of the probability levels of good weather in addition to the effect of risk aversion. As expected, results show that as the probability increases from 30% (baseline) to 50% and 70%, the odds of opting into on-farm activity (adaptive and improved seed options combined) relative to off-farm work increases. Specifically, for an increase in the probability of a good weather outcome from 30% to 50%, the combined odds of opting into adaptive and improved seed options relative to off-farm work are 1.6 times greater. These odds are even greater (4.8 times) for an increase in the probability of good weather from 30% to 70%.

Risk aversion in the pooled regression still affects technology choice in the same direction as in the individual probability levels. For a one standard deviation increase in risk-aversion attitude, the odds of opting into off-farm work relative to the combined options of adaptive and improved seeds are 1.14 times greater.

Table 7. Technology Choice under Risk

	(1)	(2)	(3)	(4)
VARIABLES	**30%**	**50%**	**70%**	**Pooled**
Risk aversion	0.886	1.280**	1.363***	1.142*
	(0.102)	(0.152)	(0.162)	(0.0864)
Initial wealth	0.991	1.137	1.122	1.077
	(0.141)	(0.167)	(0.166)	(0.102)
Gender	1.030	0.860	0.678	0.843
	(0.268)	(0.230)	(0.186)	(0.146)
Age	1.001	1.007	1.006	1.004
	(0.00807)	(0.00794)	(0.00833)	(0.00522)
Occupation	0.996	1.000	1.007	1.002
	(0.0208)	(0.0214)	(0.0220)	(0.0140)
Education	0.934*	1.026	1.072*	1.007
	(0.0372)	(0.0411)	(0.0443)	(0.0264)
Household size	0.973	0.983	1.000	0.981
	(0.0379)	(0.0380)	(0.0401)	(0.0249)
Tropical Livestock	0.985	1.006	1.036**	1.009
Units (TLU)	(0.0148)	(0.0139)	(0.0167)	(0.00919)
Marital status	1.002	0.917	0.860*	0.931
	(0.0744)	(0.0709)	(0.0667)	(0.0462)
Income	0.982	0.994	0.982	0.988
(‘0000)	(0.0155)	(0.0121)	(0.0116)	(0.00810)
50%				1.642***
Probability				(0.260)
70%				4.756***
Probability				(0.828)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Individual and household control variables do not seem to explain choice in the pooled data. However, education level, livestock holdings (measured in tropical livestock units or TLU) and marital status explain choice at a 70% probability of good weather. An increase in one year of education increases the combined odds of opting for adaptive and improved seed technologies by 1.07 times relative to the off-farm work option, while an extra TLU score increases the same odds by 1.04. At a 30% probability of good weather, an increase in a year of education increases the odds of opting for off-farm work relative to adaptive and improved seeds, implying prudence given the low probability of good weather.

8.4 Ambiguity Aversion and Technology Choice

Results for the relationship between ambiguity aversion and technology choice are shown in Table 8, also displayed as proportional odds ratios and with the ambiguity aversion/seeking attitudes standardised to one standard deviation and zero mean. Ambiguity aversion significantly affects choice for the 20%-40% and 10%-50% probability sets, while an ambiguity-seeking attitude affects choice in the 0-100%, 20%-40% and 10%-50% probability sets. For a one standard deviation increase in ambiguity aversion, the odds of opting into off-farm work relative to combined adaptive seed and improved seed technologies are 1.8 times greater when the probability set is 20%-40%, and 1.6 times greater for a 10%-50% probability set.

Table 8. Technology Choice under Uncertainty

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	**0-100%**	**20%-40%**	**10%-50%**	**60%-80%**	**50%-90%**	**Pooled**
Ambiguity	1.217	1.812**	1.592**	0.973	1.105	1.267**
aversion	(0.246)	(0.434)	(0.333)	(0.197)	(0.224)	(0.141)
Ambiguity	0.675*	0.666*	0.575***	1.062	0.817	0.745***
seeking	(0.139)	(0.153)	(0.120)	(0.225)	(0.168)	(0.0841)
Initial	0.989	1.409**	0.865	1.006	1.053	1.048
wealth	(0.143)	(0.213)	(0.122)	(0.148)	(0.152)	(0.0828)
Gender	1.210	0.624*	1.332	0.795	1.314	1.024
	(0.318)	(0.175)	(0.341)	(0.213)	(0.338)	(0.146)
Age	1.008	1.008	1.006	0.997	1.000	1.004

	(0.00800)	(0.00827)	(0.00800)	(0.00827)	(0.00776)	(0.00436)
Occupation	0.976	0.980	0.987	0.981	0.975	0.980*
	(0.0203)	(0.0214)	(0.0207)	(0.0213)	(0.0205)	(0.0113)
Education	1.003	0.956	1.016	1.055	1.014	1.009
	(0.0403)	(0.0393)	(0.0419)	(0.0426)	(0.0397)	(0.0220)
Household	0.988	1.135*	1.064	0.944	1.011	1.030
size	(0.0750)	(0.0873)	(0.0796)	(0.0721)	(0.0752)	(0.0425)
TLU	0.991	0.922*	0.993	0.909**	0.952	0.953**
	(0.0401)	(0.0386)	(0.0370)	(0.0372)	(0.0375)	(0.0205)
Marital	0.987	0.992	1.010	1.048***	1.001	1.006
status	(0.0137)	(0.0151)	(0.0144)	(0.0177)	(0.0125)	(0.00753)
Income	0.990	0.999	0.995	0.994	0.987	0.993
(‘0000)	(0.0139)	(0.0148)	(0.0119)	(0.0119)	(0.0119)	(0.00686)
20-40	-					0.446***
probability						(0.0719)
10-50						0.767*
probability						(0.120)
60-80						2.025***
probability						(0.325)
50-90						1.269
probability						(0.198)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The results also show that the ambiguity-seeking participants are opting for the safe option relative to adaptive and improved seed options, especially for the 10%-50% probability set (the odds are about 43% higher for off-farm work relative to the combined odds of adaptive and improved seed options). Compared to their ambiguity-averse counterparts, however, the odds for off-farm work for the ambiguity-seeking are slightly less. For example, for the 20%-40% probability set, the odds for opting for the off-farm option relative to the combined odds of adaptive and improved seed options are 81% for the ambiguity-averse and only 33% for the ambiguity-seeking (1 less 0.67).

Pooling across the probability sets enables us to look at the important aspect of how choices differ with different ranges of probability sets, in addition to attitudes towards ambiguity. In Table 8, the baseline is complete uncertainty, i.e., the 0 to 100% probability set. A reduction in the range of uncertainty from 0-100% to 10%-50% or 20%-40% has the effect of increasing the odds of opting for off-farm work relative to adaptive and improved seed options. An explanation for this could be that farmers are more willing to take risks under a wider probability set (0-100%), which includes high possible probabilities in the set compared to narrower probability sets (20%-40% and 10%-50%), which have low highest-possible probabilities in the set. The result for the 60%-80% probability set seems to confirm this, whereas decreasing the range of uncertainty from 0-100% to 60%-80% has the opposite effect; the odds of opting for combined options of adaptive and improved seed relative to off-farm work are more than twice as high.

8.5 Demand for Weather Information under Uncertainty

Results show that, on average, participants' WTP was more than N$12.5 for all the uncertainty ranges. The highest range of uncertainty (0-100%) had the highest mean WTP, with the median range (10%-50%; 50%-90%) having the second-highest mean WTP, and the lowest range (20%-40%; 60%-80%) having the least mean WTP (see Figure 6).

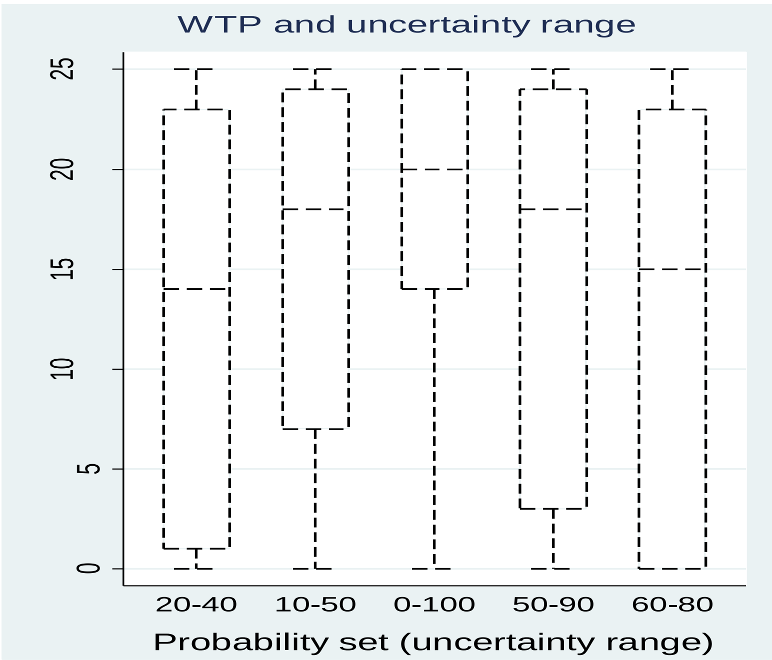

Figure 6. Mean WTP at Different Uncertainty Ranges (probability sets)

Non-parametric tests show that these differences are significant (see Table 9); the wider the range of uncertainty, the higher the amount participants were willing to pay for information on precise probabilities of good weather. The amount paid in the complete uncertainty round was significantly higher than that paid in any other uncertainty range. In the low probability sets, more was paid in the 10%-50% range than in the 20%-40% probability set, while in the high probability sets, more was paid in the 50%-90% range than in the 60%-80% probability set.

Comparisons between low and high probability sets that have an equal uncertainty range show no significant mean differences in WTP. Participants pay the same for the 20%-40% and 60%-80% probability sets as for the 10%-50% and 50%-90% probability sets. This implies that, under similar uncertainty levels, improving their understanding of the chance of having good weather is equally valuable to the participants.

Range1 (%)	Range2 (%)	Ambiguity averse (t)	Ambiguity neutral/seeking (t)	Overall (t)
0-100	20-40	4.85***	5.56***	7.84***
0-100	10-50	2.58**	3.31***	5.04***
0-100	60-80	5.19***	5.30***	7.89***
0-100	50-90	3.17***	3.70***	5.76***
20-40	10-50	-2.18**	-2.22**	-4.01***
20-40	60-80	0.33	-0.11	0.15
20-40	50-90	-1.46	-1.79*	-2.96***
10-50	50-90	0.66	0.42	1.05
10-50	60-80	2.51**	2.06**	3.90****
60-80	50-90	-1.78*	-1.64	-3.71***

Table 9. Tests for Difference in Mean WTP for Information under Different Uncertainty
Ranges
*** p<0.01, ** p<0.05, * p<0.1

To complete the analysis, a comparison between a low probability set with a narrower range, e.g. 20%-40%, and a high probability set with a wider range, e.g. 50%-90%, shows that participants pay more for the latter than the former. Similarly, participants pay more for low probability sets with a wider range, e.g., 10%-50%, compared to a high probability set with a narrower range, e.g., 60%-80%.

The third and fourth columns show that the mean WTP for ambiguity-averse and ambiguity-seeking/neutral participants are quite similar. Both categories of participants value information similarly and are willing to pay significantly more for information in wider ranges of uncertainty than in narrower ones. One can thus conclude that subjective ambiguity aversion does not seem to be important in explaining willingness to pay for information, but rather the range of uncertainty (objective ambiguity aversion) helps explain WTP. To investigate this further, we ran a regression analysis to see what informs WTP, controlling for observables and attitudes towards uncertainty.

These results are displayed in Table 10. The dependent variable is continuous (0 to 25) indicating the possible range of WTP in the games. Ambiguity aversion/seeking attitudes are as discussed before and a categorical variable for the pooled data regression (last column) indicates the range of uncertainty.

Table 10. Determinants of Willingness to Pay for Weather Information

	(1)	(2)	(3)	(4)	(5)	(6)
	0-100%	**20%-40%**	**10%-50%**	**60%-80%**	**50%-90%**	**Pooled**
Ambiguity aversion	-0.0232	0.0956	0.0757	0.111	0.105	0.0379
	(0.0551)	(0.0782)	(0.0711)	(0.0805)	(0.0752)	(0.0479)
Ambiguity seeking	0.0569	-0.125	-0.103	-0.0224	-0.121	-0.0120
	(0.0995)	(0.140)	(0.128)	(0.144)	(0.136)	(0.0876)
Initial wealth	-0.914*	0.821	-0.627	-0.327	0.147	-0.226
	(0.546)	(0.760)	(0.706)	(0.783)	(0.745)	(0.497)
Gender	0.717	0.677	-0.289	0.218	-0.251	0.119
	(0.987)	(1.370)	(1.273)	(1.410)	(1.347)	(0.896)
Age	0.0298	0.0325	0.0342	0.00867	0.0139	0.0221
	(0.0303)	(0.0420)	(0.0391)	(0.0432)	(0.0413)	(0.0275)
Occupation	-0.0258	-0.114	-0.0798	0.0802	0.0778	-0.0144
	(0.0797)	(0.111)	(0.103)	(0.114)	(0.109)	(0.0726)
Education	-0.109	-0.291	0.265	-0.284	-0.202	-0.135
	(0.151)	(0.209)	(0.195)	(0.215)	(0.206)	(0.137)
Household size	-0.0758	0.434**	0.335*	-0.246	-0.102	0.0655
	(0.148)	(0.205)	(0.191)	(0.211)	(0.202)	(0.134)
TLU	0.0138	-0.150**	0.00979	-0.0739	0.00490	-0.0387
	(0.0515)	(0.0714)	(0.0665)	(0.0736)	(0.0703)	(0.0468)
Marital status	0.0786	-0.484	-0.0413	0.170	-0.544	-0.151
	(0.281)	(0.390)	(0.364)	(0.402)	(0.384)	(0.256)
Income (‘0000)	-0.0142	-0.0494	-0.0963	-0.0418	0.0555	-0.0295

	(0.0474)	(0.0657)	(0.0612)	(0.0676)	(0.0647)	(0.0431)
20-40 probability	-	-	-	-	-	-5.334***
						(0.628)
10-50 probability	-	-	-	-	-	-2.844***
						(0.628)
60-80 probability	-	-	-	-	-	-5.436***
						(0.628)
50-90 probability	-	-	-	-	-	-3.448***
						(0.627)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The analysis confirms that attitudes toward uncertainty do not affect participants' WTP but the level of uncertainty does. Specifically, compared to the baseline probability set category (0-100%), a probability set of 20-40% receives N$5.3 lower in WTP while a 50%-90% probability set receives N$3.4 lower. These results underscore the value of weather information to farming households, irrespective of their subjective attitudes towards ambiguity.

8.6 Choice After Information Games

As explained under the section on methods, the information (precise probability) given to participants was randomly generated based on the probability set under consideration. It is interesting to see whether decisions made before the information games *(*series *4* of the games) were significantly different from those made after the information games, whether or not a participant received information. While the preceding discussion shows that farmers value weather information, it is interesting to see what they would do with this information, i.e., whether assessing weather information leads to a change in technology choice and whether that change is welfare-improving.

Non-parametric tests show that in all but one of the rounds, the choices made before and after receipt of information are significantly different for participants who received information (see Table 11). This is very similar for participants who did not receive information, with the choices made before and after the information games being significantly different in three out of the five uncertainty ranges (note that all participants made choices after the information games, whether or not they received information on precise probabilities of good weather outcomes). For the lower probability sets (20%-40% and 10%-50%), participants became conservative in their choices after the information games, whether or not they received information.

Conversely, in the probability sets with high possible probabilities of good weather (0-100%, 60%-80% and 50%-90%), riskier but high-yielding technologies were chosen after the information round for participants who received information. Those who did not receive information changed their choice only for the complete uncertainty probability set (0-100%).

Table 11. Test for Difference in Choice before and after Information

Probability set **(%)**	Received information		Did not receive information	
	z	Prob > |z	z	Prob > |z|
20-40	0.360	0.7189	2.544	0.0110
10-50	3.296	0.0010	2.835	0.0046
0-100	-1.824	0.0682	-1.734	0.0829
60-80	-2.060	0.0394	-1.239	0.2152
50-90	-2.234	0.0255	-1.334	0.1821

The results imply that technology uptake is higher when farmers have access to weather information, especially if this indicates higher chances of good weather, compared to a situation where the chances are not known precisely. In the case where the chances of good weather are low, weather information can help farmers avoid losses by choosing adaptive technologies or other safer options.

To ground these conclusions further, analysis is required on whether access to information actually made the recipients better off as a result of their choices, since non-recipients of information also changed their before and after information choices. To do this, we use the randomly generated precise probability revealed to the qualifying participants to calculate the expected payoffs after the information rounds for both the recipients and non-recipients of information. These are then compared to the expected payoffs before the information games, calculated using the expected probability for each of the probability sets. The results of this analysis are shown in Table 12.

Table 12. Comparison of Expected Payoffs of Choice before and after Information

Uncertainty range	Received information				Did not receive information		
(%)	Expected payoff *before* information	Expected payoff *after* information	t	Mean information cost	Expected payoff *before* information	Expected payoff *after* information	t
20-40	66.65	65.34	0.54	8.70	66.24	68.99	-1.15
10-50	61.02	68.17	-1.09**	10.70	61.68	63.29	-0.45
0-100	91.45	105.88	-2.35**	9.77	97.78	101.75	-0.38
60-80	128.79	132.0	-0.71	10.60	133.51	135.68	-0.48
50-90	130.61	133.96	-0.61	11.36	118.51	118.54	-0.005

*** p<0.01, ** p<0.05, * p<0.1

Providing information to participants enabled them to make choices with higher expected payoffs for the complete uncertainty (0-100%) and 10%-50% uncertainty range scenarios. The sub-sample of non-recipients of information made no welfare-improving changes in their before and after choices for any of the uncertainty ranges. The most important point of these results is that in cases where real losses are imminent with low chances of good weather, providing information helps people make welfare-improving changes. This is more so with high levels of uncertainty and very low possible probabilities of good weather, as exemplified in the 10%-50% and 0-100% probability sets. This is intuitive, since providing information would not matter much for welfare if the possible chances of good weather were all high, for example in the 60%-80% and 50%-90% probability sets. The same intuition follows in the case of the 20%-40% probability set, where, no matter the information provided, everything points to low chances of good weather and hence the best response is to use the safest technology.

We complete the analysis by considering whether the decisions made to buy information at a particular cost by the participants are rational. Considering only the uncertainty ranges that resulted in welfare-improving changes after purchase of information, the 0-100% uncertainty range seems the most cost-effective, in that participants spent N$10 on average and gained an extra N$14. However, as stated earlier, climate information is a public good given freely by government and sometimes by development aid organizations. The aim of this piece was to look at whether the level of uncertainty matters for decision making, whether there is actual demand for weather information, and whether accessing weather information improves welfare.

9. Conclusion and Policy Implications

The link between behavioural attitudes and technology adoption has been unequivocally established in the literature. In agriculture, subjective attitudes toward uncertainty (ambiguity aversion) have been shown to play an important role in diminishing agricultural technology diffusion among the poor in rural households (Barham at al., 2014; Elabed and Carter, 2015). Others show that ambiguity aversion leads to lower well-being outcomes (e.g. Cardenas and Carpenter, 2013). Our study extends this strand of literature by showing that information that reduces the uncertainty level (objective uncertainty) leads to increased take-up of risky but high-yielding technologies and can thus be used to help ambiguity-averse farmers overcome their inertia in improved technology adoption. We also show that, with access to information, farmers make welfare-improving choices in technology. In the increasingly uncertain environment due to climate change, these results are important for policy. Available weather information that reduces uncertainty in seasonal outcomes can be a clear pathway towards resilience in agricultural production in regions most affected by climate change.

Borrowing from emerging theoretical literature on the importance of objective uncertainty in decision making (e.g. Klibanoff et al., 2005), the analysis begins by showing how objective uncertainty (level of uncertainty) in addition to subjective uncertainty (ambiguity aversion) affects technology choice. In the next step, the study shows that there is a clear demand for uncertainty-reducing information (weather information) among both ambiguity-averse and ambiguity-seeking farmers. The wider the uncertainty, the higher the demand for information, implying the critical role played by uncertainty levels in farming decisions.

In the final step of the analysis, we show that expected payoffs of technology choices without information differ significantly from expected payoffs of choices with information. Farmers who access information make welfare-improving choices compared to those who don’t, especially when there is a threat of a climate catastrophe such as drought. The results show that these gains in welfare are also cost-effective, considering the amount spent by farmers to acquire the information. This is despite the fact that such information ought to be a public good. This demonstrates the clear gains in investing in such a policy of climate (weather) information.

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APPENDIX

EXPERIMENT PROTOCOLS

[Large posters including visual aids like flash cards were used for the graphics as presented here to support the explanations]

INTRODUCTION

My name is [NAME], and I am a researcher with [UNIVERSITY 1 NAME] and [UNIVERSITY 2 NAME]. These are my colleagues [NAMES]. We have invited you here so you can participate in an experiment with games where you have the opportunity to earn money based on the decisions you make.

INITIAL ENDOWMENT

There are several games in this experiment. You will have the opportunity to earn money in the course of playing these games today. **It is also possible to lose some money in some of these games**. For this reason we will give you a start-up amount of money (which we will call your *initial wealth*) before starting the games, equal to N$150. The money you will receive as your initial wealth is enough to cover any of these losses that you may incur. Any additional money you earn in the game and also any amount of initial wealth that you don't spend on losses, you can keep and take home with you at the end of this session.

How much money you earn today depends on the decisions you make during the games. That is why it is very important that you understand the rules of the games, which I am going to explain to you as we go along. **The money you earn today from the games will be paid to you at the end of the whole session in cash.**

You play these games as individuals, not in groups. So please don't talk to anyone while we are playing the games. If you have **ANY** questions at any stage you can just raise your hand and someone will come and answer your question privately.

The exercise today will take three-four hours. **Participation in the sessions is voluntary**. If you decide not to take part, you may leave at any time, even after you have started playing – **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 indicating your consent to participate in the games.

[HAND OUT THE CONSENT FORMS]

This form says that you understand participation in these games is voluntary and that you can leave whenever you want to. **But if you do leave before we have finished playing all the games, you won't receive any money**.

Is everyone finished signing the forms? Ok, someone is going to come around and collect the forms from you.

[COLLECT FORMS]

THE GAMES

As I have said, we will be playing games with real money. At the end of the day, whatever money you have earned is yours to keep and take home.

Let's talk about how today will work. There are **four** parts in this experiment; part one has **two** games, part two has **three** games and part three to four each has **five** games. Most of these games are quite similar as we will see. Everyone will play all the games today. We will indicate on the [poster] which games we have played and which are remaining as we go on.

[POINT TO THE POSTER AS YOU EXPLAIN THIS]

Part 1	**Part 2**	**Part 3**	**Part 4 (a & b)**
Game 1	Game 1	Game 1	Game 1
Game 2	Game 2	Game 2	Game 2
	Game 3	Game 3	Game 3
		Game 4	Game 4
		Game 5	Game 5

Besides the initial wealth that was allocated to you at the start of the session, **you will also earn money from two of these games; from one game in Part I and any one game from Parts 2 to 4.** You will only find out which of these games you will be paid for at the **end of the session!** So it is important to play **all games as if real money is at stake in every game**. In total you stand to earn between N$50 and N$375 for today's activities. Your earnings depend on the choices you make in the games.

Are there any questions before we begin? Great! Let's start the first game!

PART 1: RISK AND AMBIGUITYAVERSION

I am now going to explain the rules of games in Part one

Game 1: 50% Probability of High Outcome

Gamble	Payoffs		✓
	Low outcome	High outcome	
1	24	24	
2	18	36	
3	12	48	
4	6	60	
5	0	72	

This poster is a large version of the sheet of paper that is in front of you.
In this game, you must choose from among the 5 gambles [REFER TO POSTER]. There are two payoffs for each of these gambles; Low outcome and High outcome.

If you choose Gamble 1, you will earn N$24 whether the game results in a Low or High outcome. If you choose Gamble 2, you will earn N$18 if the game results in a Low outcome and N$36 if the game results in a High outcome. If you choose Gamble 3, you will earn N$12 if the game results in a Low outcome and N$48 if the game results in a High outcome. If you choose Gamble 4, you will earn N$6 if the game results in a Low outcome and N$60 if the game results in a High outcome. If you choose Gamble 5, you will earn N$0 if the game results in a Low outcome and N$72 if the game results in a High outcome.

As you can see, the amount earned from the Low outcome decreases as you move from Gamble 1 through to Gamble 5; it has decreased from N$24 in Gamble 1 to zero in Gamble 5. On the other hand, the amount earned from the High outcome increases as you move from Gamble 1 through to Gamble 5; It has increased from N$24 in Gamble 1 to N$72 in Gamble 5. To illustrate, if you choose Gamble 1, you will earn N$24 whether the game results in High or Low outcome but if you choose Gamble 5, you will earn N$72 if the game results in a High outcome and earn nothing if the game results in a Low outcome! [EXPLAIN EARNINGS FOR THE OTHER GAMBLES]

To determine whether the game results in a Low or High outcome, we are going to draw a ball from this bag [SHOW THE BAG]. There are 10 balls in the bag; FIVE black balls and FIVE white balls. If we draw a BLACK ball, then the outcome of the game is High and if we draw a WHITE ball, the outcome of the game is Low.

[DEMONSTRATE DRAWING THE BALL AND INDICATE POSSIBLE EARNINGS]

Does anyone have any questions before we start?

Ok, let's start. Please write the number we gave you at the start of the experiment on the sheet where it says experiment number [SHOW WHERE THEY MUST PUT THEIR NUMBER].

Please tick beside the gamble you prefer.

Game 2: Uncertain Probability of High Outcome

This game is similar to the one you have just played. The main difference in this game however is that the **number of BLACK and WHITE balls in the bag is UNKNOWN**. Just like before, you must choose from among the 5 gambles. Once again, there are two payoffs for each of these gambles; Low outcome and High outcome. The BLACK ball is still the one indicating High outcome if drawn.

Just like before, you have a sheet before you resembling the poster in front [POINT AT POSTER]. You will tick beside the gamble you prefer.

Remember, you now have to make your choices without knowing the number of black or white balls in the bag. At the end of today's session, if we draw this game as the game we are paying you for, we will reveal how many black balls there are in the bag and then make a draw to see if the outcome for the game is High or Low.

I have with me a spinning wheel with different slices and an arrow with a pointer on top. Each slice on the wheel contains a picture of a bag with 10 balls in different combinations of black and white; these range from zero black and ten white balls in the bag to ten black and zero white balls. We are going to spin this wheel and the ball combination that comes under the pointer indicates the number of black and/or white balls that we are going to put in the bag.

After putting these balls in the bag, one of you will then come up and draw one ball from the bag. **Remember the bag will only contain TEN balls, and that if a black ball is drawn the game outcome is High and if the drawn ball is WHITE, the game outcome is Low.**

Are there any questions? [CHECK TO SEE ALL HAVE UNDERSTOOD]

Please write the number we gave you at the start of the experiment on the sheet where it says experiment number [GESTURE TO WHERE THEY MUST PUT THEIR NUMBER].

Please tick beside the gamble you prefer.

PART 2-4: Choice of Off-Farm Work *OR* Farming using Improved or Adaptive Seeds in an Uncertain Weather Environment

Preamble

Before we start let's talk about some of the decisions you make in your daily life and particularly when it comes to farming decisions. Different periods during the year often call for certain decisions to be made. For example, during rainy seasons, you may have to decide if you are going to cultivate crops during that season or just undertake off-farm activities (such as working on a government project), if these are available. You may also opt to undertake a mix of these activities. In case you decide to cultivate crops, you also have to decide on the type of inputs you have to use, key among these being the type of seeds you are going to plant. You may decide to use improved (hybrid) seeds, which normally give a very good return when there are enough rains during that season, but can also perform very poorly in case the rains are not enough or are too much. On the other hand, you may also decide to plant seeds that are specifically bred to withstand weather stress (drought or floods). Thus decisions that us as farmers make during this period are greatly influenced by our expectations about the weather. For example, if we have reason to believe that the rains are going to be good, then we are better off using the improved seeds, while on the other hand if we believe the rains will not be adequate, then we would better use the adaptive seeds. In case we have off-farm activities, we may just decide not to undertake any crop farming that season. It might also be the case that someone decides to use a bit of each of these; for example plant some improved seed in some plots while in others plant adaptive seed, or do crop cultivation while still involved in an off-farm activity.

In the games we will play now, you will be tasked with making decisions involving such choices which are similar to what you are doing in your day to day life. However, in this game setting we are going to assume that you only make one choice per season; choosing to devote your time to off-farm activities or to engage in crop farming where you will either choose to plant improved seeds OR drought-resistant seeds.

Weather Information

Understanding the weather patterns for each season is important for farmers in order to decide what to plant. While decades of farming experience helps to understand the weather patterns, some farmers also rely on traditional methods able to predict the weather. From time to time, we receive outside information from government agencies and researchers that tell us PRA the weather is going to be like in a particular season, i.e. whether it's going to rain or not. Such information is often given by government agencies free of charge. Sometimes this information is lacking and farmers have to rely on their experience in farming to decide what to plant for the coming season, not knowing exactly what the weather will be like. While it may not be possible to predict EXACTLY what the weather will be like in a coming season, knowing the CHANCE of having good rainfall or drought in the coming season is helpful in making decisions of what to plant.

In this game we will also give information about the CHANCE of having good or bad weather to help you make decisions.

Instructions

In the following series of games, in each game you are given a choice between three options: working in an off-farm activity, or choosing to engage in crop farming, where you either choose to plant seeds adapted to harsh weather "adaptive seeds", or you choose to plant improved seeds. While in real life it may be possible to do more than one such activity at a time, let us for now assume that only one of these can be undertaken at a time.

What you earn from the off-farm activity is not affected by weather outcomes and has a constant payoff in good and bad weather.

The improved seed on the other hand has very high yields if the rainfall is good but in the event of low rainfall or droughts, it is possible to make losses given the cost of inputs. On the other hand, the seed variety adapted to dry weather conditions has somewhat lower yields than the improved seeds during good rainfall, but on the upside, when there is a drought it still gives positive yields (although lower than for good rains).

Your task is to choose whether to farm or do off-farm work, and if you farm which seed type to plant. You are told that the chance of good rainfall is not known with certainty. Instead, you will be given information about the chance of there being good rainfall or a drought to help with your decision making. The chance of getting a good or a bad weather outcome will be presented by a bag with black and white balls, where if we draw a black ball from the bag it indicates good rainfall and if we draw a white ball it represents bad rainfall or drought conditions.

In some of these games you will be asked to make your decision without having much information about the weather conditions. In other games we will give you the option to buy information about the chance of having good or poor rainfall, which could help you to make better decisions.

Experiment Number:__________

	Weather		✓
			
Off-farm work	**75**	**75**	
Adaptive seeds	**150**	**25**	
Improved seeds	**225**	**-25**	

Part 2: Risk Games

Game 1: 30% Probability of Good Weather

You are going to make a choice among three livelihood options; off-farm work, farming using seeds adapted to harsh weather "adaptive seeds" or farming using improved seeds. [POINT TO POSTER]. The payoffs for each choice depend on how the weather turns out to be in this season.

Note that you are only going to make ONE CHOICE; so you either have to choose off-farm work, farming using adaptive seeds or farming using improved seeds. The off-farm work option has constant payoffs, meaning it does not matter what the weather turns out to be, you always get N$75. On the other hand, for the adaptive seed option you earn N$150 if the season has good rains or N$25 if the rainfall is poor. So it has a higher payoff in case of good weather than in the case of bad weather, but you still get to earn some money either way. The improved seed option will give a very high payoff if it's good weather but if the weather is bad you will make a loss (N$225 in case of good rains or –N$25 in case of bad rains).

To determine whether the season will have good rainfall (good weather) or poor rainfall (bad weather), we are going to make a draw from TEN balls in this bag. The bag contains THREE black and SEVEN white balls. A draw of a BLACK ball implies that the season has GOOD rains, while a draw of a WHITE ball implies the season has BAD rains or drought conditions.

[DEMONSTRATE DRAWING THE BALLS AND IMPLICATION ON EARNINGS]

EXAMPLE: So, if you choose the off-farm activity option, you will earn N$75 whether the colour of the ball we draw is black or white (whether good or bad weather). If you choose the adaptive seeds **and** we draw a black ball (good weather), you earn N$150, but if we draw a white ball (bad weather), you earn N$25. Let's say you choose the improved seed option and we draw a black ball (good weather), you earn N$225. If we draw a white ball (bad weather), **you incur a debt of N$25!**

Are there any questions? [CHECK TO SEE ALL HAVE UNDERSTOOD]

Please write the number we gave you at the start of the experiment on the sheet where it says experiment number [GESTURE TO WHERE THEY MUST PUT THEIR NUMBER], then mark next to your choice. **You can only choose one of these options!**

Game 2: 50% Probability of Good Weather

Again you are going to make a choice among three livelihood options: off-farm work, farming using seeds adapted to harsh weather "adaptive seeds" or farming using improved seeds. [POINT TO POSTER]. The payoffs for each choice depend on how the weather turns out to be in this season.

Just like the previous time, you are only going to make ONE CHOICE; so you either have to choose off-farm work, farming using adaptive seeds or farming using improved seeds. The off-farm work option has constant payoffs, meaning it does not matter what the weather turns out to be, you always get N$75. On the other hand, for the adaptive seed option you earn N$150 if the season has good rains or N$25 if the rainfall is poor. So it has a higher payoff in case of good weather than in the case of bad weather, but you still get to earn some money either way. The improved seed option will give a very high payoff if it's good weather but if the weather is bad you will make a loss (N$225 in case of good rains or –N$25 in case of bad rains).

To determine whether the season will have good rainfall (good weather) or poor rainfall (bad weather), we are going to make a draw from TEN balls in this bag. The bag now contains FIVE black and FIVE white balls. A draw of a BLACK ball implies that the season has GOOD rains, while a draw of a WHITE ball implies the season has BAD rains or drought conditions.

[DEMONSTRATE NUMBER OF BALLS IN BAG AND DRAW IMPLICATIONS]

Are there any questions? [CHECK TO SEE ALL HAVE UNDERSTOOD]

Please write the number we gave you at the start of the experiment on the sheet where it says experiment number [GESTURE TO WHERE THEY MUST PUT THEIR NUMBER], then mark next to your choice. **You can only choose one of these options!**

Game 3: 70% Probability of Good Weather

Again you are going to make a choice among three livelihood options: off-farm work, farming using seeds adapted to harsh weather "adaptive seeds" or farming using improved seeds. [POINT TO POSTER]. The payoffs for each choice depend on how the weather turns out to be in this season.

Just like the previous time, you are only going to make ONE CHOICE; so you either have to choose off-farm work, farming using adaptive seeds or farming using improved seeds. The off-farm work option has constant payoffs, meaning it does not matter what the weather turns out to be, you always get N$75. On the other hand, for the adaptive seed option you earn N$150 if the season has good rains or N$25 if the rainfall is poor. So it has a higher payoff in case of good weather than in the case of bad weather, but you still get to earn some money either way. The improved seed option will give a very high payoff if it's good weather but if the weather is bad you will make a loss (N$225 in case of good rains or –N$25 in case of bad rains).

To determine whether the season will have good rainfall (good weather) or poor rainfall (bad weather), we are going to make a draw from TEN balls in this bag. The bag now contains SEVEN black and THREE white balls. A draw of a BLACK ball implies that the season has GOOD rains, while a draw of a WHITE ball implies the season has BAD rains or drought conditions.

[DEMONSTRATE NUMBER OF BALLS IN BAG AND DRAW IMPLICATIONS]

Are there any questions? [CHECK TO SEE ALL HAVE UNDERSTOOD]

Please write the number we gave you at the start of the experiment on the sheet where it says experiment number [GESTURE TO WHERE THEY MUST PUT THEIR NUMBER], then mark next to your choice. **You can only choose one of these options!**

Part 3: Uncertainty Games

The games in this part are similar to ones you just completed. The only difference is that unlike before, the probability of good weather is now not known precisely. You will make decisions based on information given in each game indicating the possible range within which the precise probability of good weather might lie.

Game 1: 0-100% Probability of Good Weather

Again, you are going to make a choice among three livelihood options: off-farm work, farming using seeds adapted to harsh weather “adaptive seeds” or farming using improved seeds. [POINT TO POSTER]. The payoffs for each choice depend on how the weather turns out to be in this season.

Just like before, to determine whether the season will have good rainfall (good weather) or poor rainfall (bad weather), we are going to make a draw from TEN balls in this bag, where a BLACK ball implies that the season has GOOD rains and a draw of a WHITE ball implies the season has BAD rains or drought conditions**.** In this game however, **we do not know how many white or black balls are in the bag**. In other words, we do not know precisely what the chances are of the weather in a season being good or being bad.

After you have each made a choice among the three livelihood options [POINT AGAIN TO THE POSTER], we will use a spinning wheel to determine the number of black and white balls to put in the bag. We will then make a draw from a bag to determine the weather outcome.

Now, this is how we are going to determine the information on the chance of good or bad weather at the end of the session. I have with me a spinning wheel divided into different segments. On each segment is a picture of a bag containing 10 balls with different combinations of black and white balls. We are going to spin this wheel and when the wheel stops turning, the picture that ends up under this arrow indicates the number of black and/or white balls that we must put in the bag.

[DEMONSTRATE USING THE SPINNING WHEEL]

Remember the bag will only contain TEN balls, and that if a black ball is drawn it indicates good weather. If the arrow points at the bag with no black balls, we are going to put ten white balls in the bag, and no black ball, meaning that there will be no chance of good rains this season. If the arrow points at the bag with 10 black balls, we are going to put ten black balls in the bag and no white ball, meaning there is no chance of bad rains this season. If the arrow points to the bag with five black balls, we are going to put five black balls in the bag and five white balls, meaning there is an even chance of good rains this season. This is similar for all other numbers on the wheel. [REPEAT THIS SECTION].

Are there any questions? [CHECK TO SEE ALL HAVE UNDERSTOOD]

Please write the number we gave you at the start of the experiment on the sheet where it says experiment number [GESTURE TO WHERE THEY MUST PUT THEIR NUMBER], then mark next to your choice. **You can only choose one of these options!**

Game 2: 20% to 40% Probability of Good Weather

This game is similar to one played before. The only difference is that now we have some information of the range of probabilities within which good rains may occur in the season. To demonstrate this chance of good weather, the bag will contain either two black and eight white balls, three black and seven white balls, OR four black and six white ball. [DEMONSTRATE THIS]. Just like before, a draw of a BLACK ball implies that the season has GOOD rains, while a draw of a WHITE ball implies the season has BAD rains.

Again, we will use a spinning wheel to determine the number of black and white balls to put in the bag. We will then make a draw from the bag to determine the weather outcome.

The spinning wheel now is divided into different segments each with a picture of a bag containing TEN balls ranging from two to four black balls. We are going to spin this wheel and when the wheel stops turning, the picture that ends up under this arrow indicates the number of black and white balls that we must put in the bag. **Remember the bag will only contain TEN balls, and that if a black ball is drawn it indicates good weather.** If the arrow points at the bag with two black balls, we are going to put two black and eight white balls in the bag, meaning that there will be a very small chance of good rains this season. If the arrow points at the bag with three black balls, we are going to put three black and seven white balls in the bag, meaning there is a small chance of good rains this season. If the arrow points to the bag with four black balls, we are going to put four black and six white balls in the bag, meaning there is a somewhat larger chance of good rains this season. This is similar for all other numbers on the wheel. [REPEAT THIS SECTION].

Are there any questions? [CHECK TO SEE ALL HAVE UNDERSTOOD]

Please write the number we gave you at the start of the experiment on the sheet where it says experiment number [GESTURE TO WHERE THEY MUST PUT THEIR NUMBER], then mark next to your choice. **You can only choose one of these options!**

Game 3: 10% to 50% probability of good weather

This game is similar to one played before. The only difference is that now we have some information of the range of probabilities within which good rains may occur in the season. To demonstrate this chance of good weather, the bag will contain either one black and nine white balls, two black and eight white balls, three black and seven white balls, four black and six white balls OR five black and five white balls. [DEMONSTRATE THIS]. Just like before, a draw of a BLACK ball implies that the season has GOOD rains, while a draw of a WHITE ball implies the season has BAD rains or drought conditions.

Again, we will use a spinning wheel to determine the number of black and white balls to put in the bag. We will then make a draw from the bag to determine the weather outcome.

The spinning wheel now is divided into different segments each with a picture of a bag containing TEN balls ranging from one to five black balls. We are going to spin this wheel and when the wheel stops turning, the picture that ends up under this arrow indicates the number of black balls that we must put in the bag. **Remember the bag will only contain TEN balls, and that if a black ball is drawn it indicates good weather.** If the arrow points at the bag with one black ball, we are going to put one black and nine white balls in the bag, meaning that there will be a very small chance of good rains this season. If the arrow points at the bag with two black balls, we are going to put two black and eight white balls in the bag, meaning that there is still a small chance of good rains this season. If the arrow points at the bag with three black balls, we are going to put three black and seven white balls in the bag, meaning there is a somewhat small chance of good rains this season. If the arrow points at the bag with four black balls, we are going to put four black and six white balls in the bag, meaning there is an improved chance of good rains this season. If the arrow points to the bag with five black balls, we are going to put five black and five white balls in the bag, meaning there is an even chance of good or bad rains this season. This is similar for all other numbers on the wheel. [REPEAT THIS SECTION].

Are there any questions? [CHECK TO SEE ALL HAVE UNDERSTOOD]

Please write the number we gave you at the start of the experiment on the sheet where it says experiment number [GESTURE TO WHERE THEY MUST PUT THEIR NUMBER], then mark next to your choice. **You can only choose one of these options!**

Game 4: 60% to 80% Probability of Good Weather

This game is similar to one played before. The only difference is that now we have some information of the range of probabilities within which good rains may occur in the season. To demonstrate this chance of good weather, the bag will contain either six black and four white balls, seven black and three white balls, OR eight black and two white balls [DEMONSTRATE THIS]. Just like before, a draw of a BLACK ball implies that the season has GOOD rains, while a draw of a WHITE ball implies the season has BAD rains or drought conditions.

Again, we will use a spinning wheel to determine the number of black and white balls to put in the bag. We will then make a draw from the bag to determine the weather outcome.

The spinning wheel now is divided into different segments each with a picture of a bag containing TEN balls ranging from six to eight black balls. We are going to spin this wheel and when the wheel stops turning, the picture that ends up under this arrow indicates the number of black balls that we must put in the bag. **Remember the bag will only contain TEN balls, and that if a black ball**

is drawn it indicates good weather. If the arrow points at the bag with six black balls, we are going to put six black and four white balls in the bag, meaning that there will be a slightly higher chance of good rains this season. If the arrow points to the bag with eight black balls, we are going to put eight black and two white balls in the bag, meaning there is a very high chance of good this season. This is similar for all other numbers on the wheel. [REPEAT THIS SECTION].

Are there any questions? [CHECK TO SEE ALL HAVE UNDERSTOOD]

Please write the number we gave you at the start of the experiment on the sheet where it says experiment number [GESTURE TO WHERE THEY MUST PUT THEIR NUMBER], then mark next to your choice. **You can only choose one of these options!**

Game 5: 50% to 90% Probability of Good Weather

This game is similar to one played before. The only difference is that now we have some information of the range of probabilities within which good rains may occur in the season. To demonstrate this chance of good weather, the bag will contain either five black and five white balls, six black and four white balls, seven black and three white balls, eight black and two white balls, OR nine black balls and one white ball [DEMONSTRATE THIS]. Just like before, a draw of a BLACK ball implies that the season has GOOD rains, while a draw of a WHITE ball implies the season has BAD rains or drought conditions.

Again, we will use a spinning wheel to determine the number of black and white balls to put in the bag. We will then make a draw from the bag to determine the weather outcome.

The spinning wheel now is divided into different segments each with a picture of a bag containing TEN balls ranging from five to nine black balls. We are going to spin this wheel and when the wheel stops turning, the picture that ends up under this arrow indicates the number of black balls that we must put in the bag. **Remember the bag will only contain TEN balls, and that if a black ball is drawn it indicates good weather.** If the arrow points at the bag with five black balls, we are going to put five black and five white balls in the bag, meaning that there will be an even chance of good or bad rains this season. If the arrow points to the bag with nine black balls, we are going to put nine black balls and only one white ball in the bag, meaning there is an extremely high chance of good rains this season. This is similar for all other numbers on the wheel. [REPEAT THIS SECTION].

Are there any questions? [CHECK TO SEE ALL HAVE UNDERSTOOD]

Please write the number we gave you at the start of the experiment on the sheet where it says experiment number [GESTURE TO WHERE THEY MUST PUT THEIR NUMBER], then mark next to your choice. **You can only choose one of these options!**

PART 4: Willingness to Pay for Weather Information and Choice after Information

INSTRUCTIONS

The games in these parts are similar to ones you have been playing. Again, you will be asked to make a decision about three livelihood options (off-farm work, farming using drought resistant or “adaptive seeds” and farming using improved seeds), and as before you have to make this decision not knowing what the exact chances of good weather are. However, this time **you have the option to purchase information that tells you what the chances of good or bad weather are**. By paying for this information, you are going to be given precise information about the chance of getting good or bad rains. You are thus given a chance to play the game knowing the exact number of the black and white balls in the bag.

Like before, we use the spinning wheel to determine the precise probability of good weather; this time, however, **we can reveal this information to you before you make your choice, if you pay enough for it**. If you feel that this information will be valuable for you to make your decision, you can use some of your initial wealth to purchase the information. The cost of this weather information ranges from zero to twenty-five Namibian dollars (N$0 to N$25).

In the answer sheet given to you, you will indicate the amount you want to put down as payment for this weather information, ranging from N$0 to N$25. After we have collected your answer sheets, we are going to make a draw from this pack of 26 cards in my hand to determine the actual cost of information. The cards are labelled from 0 to 25 [SHOW THE CARDS WITH NUMBERS WRITTEN ON THEM]. The number on the card that is drawn will be the cost of the weather information.

Experiment number: _________

	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
✓																										

If the amount of money you indicated on the answer sheet **is less than the number on the card that has been drawn, you will not receive weather information.** This means that you will have to make your choice about which of the three livelihood options (off-farm work, farming using drought resistant or “adaptive seeds” and farming using improved seeds) to pick, without having any information about the number of white and/or black balls in the bag. Also, you will not have to pay anything if the amount you indicate on the answer sheet was less than the actual price that we drew from the pack of cards.

On the other hand, if you indicated the amount of money you are willing to pay to receive information **as equal to or greater than the number on the card we drew from the bag, you will receive information** on the chances of good or bad weather before you choose the livelihood option. In other words, you will be told the number of black and white coloured balls in the bag before you make your choice among the three livelihood options. **The cost of the information (which will range from 0-25) is equal to the number on the card we draw from the pack of cards.** You will pay for this information from your initial wealth.

Game 1a: WTP for weather information (0%-100% probability range)

This game is similar to one you played where the chances of good weather are completely unknown. In other words, you have no idea how many black or white balls are in the bag. There could be all black and no white balls in the bag, indicating chances of good weather are certain, or there could also be all white balls and no black balls in the bag, indicating chances of bad weather are certain. There could be all other different combinations of black and white balls in the bag. [DEMONSTRATE THIS]

You will indicate how much you would like to pay for information to know how many black balls (chances of good weather) there are in the bag **before you make your choice**, in this particular case where the chances are completely unknown.

Are there any questions?

Ok, let's start. Please write the number we gave you at the start of the experiment on the sheet where it says experiment number [GESTURE TO WHERE THEY MUST PUT THEIR NUMBER].

Indicate (tick) the amount you are willing to pay on the sheet provided.

Game 1b: Choice after Weather Information Round (0%-100% probability range)

After your WTP choice and the draw of the actual cost of information, we have determined who is receiving information before making a livelihood choice. If you are among those receiving the information, we are going to hand you an **envelope including a picture of a bag with 10 balls, showing you how many black and white balls there are in the bag**. Do not reveal this picture to anyone else. If you are not receiving information, you will also receive this envelope but there will be no information inside. Everybody will then make their decisions.

Check the envelope handed to you and use the information inside to help you choose a livelihood option, given the chance of good weather as contained in the information in the envelope. If you have received an empty envelope, it means you did not qualify to receive information and are required to make a choice without information on the precise number of black or white balls in the bag.

Are there any questions? [CHECK TO SEE ALL HAVE UNDERSTOOD]

Please write the number we gave you at the start of the experiment on the sheet where it says experiment number [GESTURE TO WHERE THEY MUST PUT THEIR NUMBER], then mark next to your choice. **You can only choose one of these options!**

Game 2a: WTP for Weather Information (20%-40% probability range)

This game is similar to one you just played. You have some information that the chances of good weather lie between 20% and 40%. In other words, there could be two black and eight white balls in the bag, three black and seven white balls in the bag OR four black and six white balls in the bag. [DEMONSTRATE THIS]

You will indicate how much you would like to pay for information to know precisely how many black balls (chances of good weather) there are in the bag before you make your choice, in this particular case where the chances lie between 20% and 40%.

Are there any questions?

Ok, let's start. Please write the number we gave you at the start of the experiment on the sheet where it says experiment number [GESTURE TO WHERE THEY MUST PUT THEIR NUMBER].

Indicate (tick) the amount you are willing to pay on the sheet provided.

Game 2b: Choice after Weather Information Round (20%-40% probability range)

Again, we have determined who is receiving information before making a livelihood choice. Just like before, if you are among those receiving the information, we are going to hand you an envelope including a picture of a bag with 10 balls, showing you how many black and white balls there are in the bag. Do not reveal this picture to anyone else. If you are not receiving information, you will also receive this envelope but there will be no information inside. Everybody will then make their decisions.

Check the envelope handed to you and use the information inside to help you choose a livelihood option, given the chance of good weather as contained in the information in the envelope. If you have received an empty envelope, it means you did not qualify to receive information in this game and are required to make a choice without information on the precise number of black or white balls in the bag.

Are there any questions? [CHECK TO SEE ALL HAVE UNDERSTOOD]

Please write the number we gave you at the start of the experiment on the sheet where it says experiment number [GESTURE TO WHERE THEY MUST PUT THEIR NUMBER], then mark next to your choice. **You can only choose one of these options!**

Game 3a: WTP for Weather Information (10%-50% probability range)

This game is similar to one you just played. You have some information that the chances of good weather lie between 10% and 50%. In other words, there could be one black and nine white balls in the bag, two black and eight white balls in the bag, three black and seven white balls in the bag, four black and six white balls in the bag OR five black and five white balls in the bag. [DEMONSTRATE THIS]

You will indicate how much you would like to pay for information to know precisely how many black balls (chances of good weather) there are in the bag before you make your choice, in this particular case where the chances lie between 10% and 50%.

Are there any questions?

Ok, let's start. Please write the number we gave you at the start of the experiment on the sheet where it says experiment number [GESTURE TO WHERE THEY MUST PUT THEIR NUMBER].

Indicate (tick) the amount you are willing to pay on the sheet provided.

Game 3b: Choice after Weather Information Round (10%-50% probability range)

Again, we have determined who is receiving information before making a livelihood choice. Just like before, if you are among those receiving the information, we are going to hand you an envelope including a picture of a bag with 10 balls, showing you how many black and white balls there are in the bag. Do not reveal this picture to anyone else. If you are not receiving information, you will also receive this envelope but there will be no information inside. Everybody will then make their decisions.

Check the envelope handed to you and use the information inside to help you choose a livelihood option, given the chance of good weather as contained in the information in the envelope. If you have received an empty envelope, it means you did not qualify to receive information in this game and are required to make a choice without information on the precise number of black or white balls in the bag.

Are there any questions? [CHECK TO SEE ALL HAVE UNDERSTOOD]

Please write the number we gave you at the start of the experiment on the sheet where it says experiment number [GESTURE TO WHERE THEY MUST PUT THEIR NUMBER], then mark next to your choice. **You can only choose one of these options!**

Game 4a: WTP for Weather Information (60%-80% probability range)

This game is similar to one you just played. You have some information that the chances of good weather lie between 60% and 80%. In other words, there could be six black and four white balls in the bag, seven black and three white balls in the bag OR eight black and two white balls in the bag. [DEMONSTRATE THIS]

You will indicate how much you would like to pay for information to know precisely how many black balls (chances of good weather) there are in the bag before you make your choice, in this particular case where the chances lie between 60% and 80%.

Are there any questions?

Ok, let's start. Please write the number we gave you at the start of the experiment on the sheet where it says experiment number [GESTURE TO WHERE THEY MUST PUT THEIR NUMBER].

Indicate (tick) the amount you are willing to pay on the sheet provided.

Game 4b: Choice after weather information round (60%-80% probability range)

Again, we have determined who is receiving information before making a livelihood choice. Just like before, if you are among those receiving the information, we are going to hand you an envelope including a picture of a bag with 10 balls, showing you how many black and white balls there are in the bag. Do not reveal this picture to anyone else. If you are not receiving information, you will also receive this envelope but there will be no information inside. Everybody will then make their decisions.

Check the envelope handed to you and use the information inside to help you choose a livelihood option, given the chance of good weather as contained in the information in the envelope. If you have received an empty envelope, it means you did not qualify to receive information in this game and are required to make a choice without information on the precise number of black or white balls in the bag.

Are there any questions? [CHECK TO SEE ALL HAVE UNDERSTOOD]

Please write the number we gave you at the start of the experiment on the sheet where it says experiment number [GESTURE TO WHERE THEY MUST PUT THEIR NUMBER], then mark next to your choice. **You can only choose one of these options!**

Game 5a: WTP for Weather Information (50%-90% probability range)

This game is similar to one you just played. You have some information that the chances of good weather lie between 50% and 90%. In other words, there could be five black and five white balls in the bag, six black and four white balls in the bag, seven black and three white balls in the bag, eight black and two white balls in the bag, OR nine black and one white ball in the bag. [DEMONSTRATE THIS]

You will indicate how much you would like to pay for information to know precisely how many black balls (chances of good weather) there are in the bag before you make your choice, in this particular case where the chances lie between 50% and 90%.

Are there any questions?

Ok, let's start. Please write the number we gave you at the start of the experiment on the sheet where it says experiment number [GESTURE TO WHERE THEY MUST PUT THEIR NUMBER].

Indicate (tick) the amount you are willing to pay on the sheet provided.

Game 4b: Choice after Weather Information Round (50%-90% probability range)

Again, we have determined who is receiving information before making a livelihood choice. Just like before, if you are among those receiving the information, we are going to hand you an envelope including a picture of a bag with 10 balls, showing you how many black and white balls there are in the bag. Do not reveal this picture to anyone else. If you are not receiving information, you will also receive this envelope but there will be no information inside. Everybody will then make their decisions.

Check the envelope handed to you and use the information inside to help you choose a livelihood option, given the chance of good weather as contained in the information in the envelope. If you have received an empty envelope, it means you did not qualify to receive information in this game and are required to make a choice without information on the precise number of black or white balls in the bag.

Are there any questions? [CHECK TO SEE ALL HAVE UNDERSTOOD]

Please write the number we gave you at the start of the experiment on the sheet where it says experiment number [GESTURE TO WHERE THEY MUST PUT THEIR NUMBER], then mark next to your choice. **You can only choose one of these options!**