Experimental games to teach farmers about weather index insurance in Kenya

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Formative evaluation report

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About 3ie

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About this formative study

This formative evaluation was submitted in partial fulfilment of the requirements of grant TW13.I.1040 awarded under Agricultural Insurance Evidence Programme. This version of the report is technically sound and 3ie is making it available to the public in this final report version as it was received. No further work has been done.

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Project summary

In this study we evaluate demand for weather index insurance (WII) among smallholder producers in Kenya's arid and semi-arid lands (ASALs), focusing on the role of basis risk. We estimate demand for two different products exhibiting differences in basis risk (i.e. mismatch between WII payouts and actual losses) and test an innovative "experiential" game to teach producers about basis risk and WII as a risk management tool.

During the experiment, demand for two unique insurance products are compared. These products differ in the amount of basis risk they present, holding all else constant. CHIRPS data can be downloaded at a resolution of 5x5 km; the true product uses this level of resolution for the index area. We call this high-resolution (HR) index insurance. A second product developed by Agriculture Climate and Risk Enterprise (ACRE) Africa averages the high resolution CHIRPS data to create a broader index area (10x10 km). We call this low-resolution (LR) index insurance.

We employ a 2x2 randomized control trial in which farmers are randomly assigned a contract type (HR or LR), and are also randomly exposed to a basic information treatment or to the basic treatment plus the insurance game. There are two versions of the game, one calibrated for each insurance product.

The primary outcome of interest is demand for WII, which we measure in two ways: (1) quantity of insurance demanded across a variety of prices elicited using a multiple price list auction (Anderson et al., 2007), which is a modified version of a Becker-DeGroot-Marschack (BDM) auction (Becker et al., 1964), and (2) actual purchases at the offered (subsidized) price. We also test farmer understanding of, and attitude towards, WII and basis risk at the time insurance is offered. Following treatment, all farmers have the opportunity to purchase the HR insurance product, and receive randomized discounts through the auction to do so.

We have three primary findings. First, we examine whether farmers are sensitive to basis risk by comparing demand for two insurance products that differ only by resolution. Basis risk is considered to be a major barrier to index insurance adoption yet relatively little is known about how sensitive farmer demand is to it. If improvements in the resolution of index insurance products do not increase farmer demand, it would suggest that commercially viable improvements in basis risk might not induce higher uptake on their own. We find that farmers are indeed sensitive to basis risk. In an auction explained to farmers as being binding, we observe a 39% increase in demand for higher resolution WII with lower basis risk.

Our second contribution is to evaluate the use of insurance games as an extension tool in the promotion of WII, and in particular, to help farmers understand basis risk. We analyse how an incentive compatible game focused on basis risk alters demand for insurance, as well as how individual experiences in the game affect demand. Experiential games increased uptake (in the auction) of the LR WII by 31% but had no effect on demand for HR insurance.

Despite evidence of impact of both interventions using the auction data, commitments made through the auction were not enforceable, and farmers were very reluctant to

actually purchase the insurance products they bid on. Specifically, only six of 487 farmers actually purchased WII through this study. This could be the result of external events (for example, a major contested election between the time of the auction and actual purchases), extreme hypothetical bias, or inconsistent preferences, or financial uncertainty or mismanagement. In any case, we must conclude that farmers will not purchase WII, even at highly subsidized prices. This third finding reflects the general trend from pilot studies globally – farmers are unwilling to independently purchase WII (Schickele, 2016).

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Abbreviations and acronyms

ACRE	Agriculture and Climate Risk Enterprise
ARC2	African rainfall climatology version 2
ASLS	Arid and semi-arid lands
AYI	Area yield insurance
BDM	Becker-DeGroot-Marschack
CHIRPS	Climate hazards group infrared precipitation with station data
CRAL	Climate resilient agricultural livelihoods
EABL	East African Breweries Limited
HR	High resolution index insurance
ICRAF	World Agroforestry Center
KCEP	Kenyan cereal enhancement program
KSH	Kenyan Shillings
LR	Low resolution index insurance
PCU	Program coordinating unit
RCT	Randomized control trial
ToC	Theory of change
WII	Weather index insurance

1. Introduction

In this study we evaluate demand for weather index insurance (WII) among smallholder producers in Tharaka South sub-county of Tharaka Nithi county in Kenya's arid and semi-arid lands (ASALs), focusing on the role of basis risk. We estimate demand for two products exhibiting differences in basis risk (i.e. mismatch between WII payouts and actual losses) and test an innovative "experiential" approach to teach producers about basis risk and WII as a risk management tool. This approach consists of an insurance game based on the one developed by Cai and Song (2017) and modified for WII, clearly illustrating basis risk to participants.

Unlike many agricultural innovations, learning about insurance products and other risk reducing technologies can take a long time. If shocks that result in payouts are infrequent, individuals who purchase insurance may not see that it pays out in bad years until a bad year occurs. Furthermore, for risks that are highly covariate, such as drought, one might not be able to readily learn from their peers, as experiences will not vary much within a given season. Thus, providing the opportunity for farmers to rapidly experience different outcomes with and without insurance could be an effective way to educate farmers and increase demand (Cai and Song, 2017). Learning about index insurance (as opposed to indemnity insurance) is further complicated because there is a wider range of outcomes. With indemnity insurance, a farmer will be compensated an amount corresponding to her loss. With index insurance, compensation may differ substantially from a farmer's own loss, and in some cases a farmer experiencing a loss will receive no compensation whatsoever. Or, on the contrary, a farmer who does not experience a loss may receive payment. The experiential games were intended to accelerate the learning process in a simulated environment.

The experiment also compared demand for two unique insurance products. These products differ in the amount of basis risk they present, holding all else constant. Climate Hazards group InfraRed Precipitation with Station (CHIRPS) data can be downloaded at a resolution of 5x5 km; the true product uses this level of resolution for the index area. We call this high-resolution (HR) index insurance. A second product developed by Agriculture and Climate Risk Enterprise (ACRE) Africa averages 5x5 km CHIRPS data to create a broader index area (10x10 km). We call this low-resolution (LR) index insurance.

We employ a 2x2 randomized control trial (RCT) in which farmers are randomly assigned a contract type (HR or LR), and then receive a basic information treatment or the same basic treatment plus the experiential game. There are two versions of the game, one calibrated for each insurance product. The primary outcome of interest is demand for WII, which we measure in two ways: (1) quantity of insurance demanded across a variety of prices elicited using a multiple price list auction (Anderson et al., 2007), which is a modified version of a Becker-DeGroot-Marschack (BDM) auction (Becker, DeGroot, and Marschak, 1964), and (2) actual purchases at the offered (and subsidized) price. We also test farmer understanding of and attitude towards weather index insurance and basis risk. Following treatment, all farmers will have the opportunity to purchase the HR insurance product, and receive randomized discounts through the auction to do so.

We make two primary contributions. First, we examine whether farmers are sensitive to basis risk by comparing demand for two insurance products that differ only by resolution. Basis risk is considered to be one of the greatest barriers to index insurance adoption (Carter et al., 2014), yet relatively little is known about how sensitive farmer demand is to it. McIntosh, Povel, and Sadoulet (2016) and Elabed and Carter (2015) provide evidence on basis risk sensitivity using games. Jensen, Barrett, and Mude (2016), Hill, Robles, and Ceballos (2016) and Mobarak and Rosenzweig (2012) provide evidence using actual purchase decisions. We believe this is an important question given continual efforts to improve the resolution of index insurance products. If such improvements do not increase farmer demand it would suggest that commercially viable reductions in basis risk will not induce higher uptake of WII on their own. Previous studies have used distance from weather stations as a proxy for basis risk, and in some cases found that demand is quite sensitive to it, particularly when the price is high (Hill, Hoddinott, and Kumar, 2013). However, it is possible that distance from weather stations is correlated with unobservable variables that also affect demand. Our design offers a transparent way to measure sensitivity to basis risk, albeit at only two different levels.

Our second contribution is to evaluate the use of experiential insurance games as an extension tool to promote index insurance, and in particular to help farmers understand basis risk. We analyze how a game focused on basis risk alters demand for insurance, and how individual or peer experiences in the game affect demand for insurance. Games have been used to study insurance demand in other contexts, including projects in Kenya (Janzen and Carter, 2013), Ethiopia (Norton et al., 2014), and Peru (Boucher and Mullally, 2010). Elabed and Carter (2015) use a compound lottery to estimate the effect of basis risk on insurance demand, but in the hypothetical. Cai and Song (2017) found that playing insurance games in China led to a 48% increase in yield insurance uptake (an increase of 9 percentage points), and that random shocks experienced within the game also increased insurance demand. Like Cai and Song (2017), we incorporate games into extension rather than using them solely as a research tool. Our games differ from Cai and Song (2017) in several important ways. First, they are incentive compatible (payouts are based on game results) in an attempt to increase salience. Second, they simulate WII, as opposed to standard indemnity insurance, and highlight the role of basis risk.

Our work should be of interest to policymakers studying risk management in the developing world in general, and is particularly relevant to the context of the Kenyan ASALs. No consensus exists on how to best educate farmers about index insurance or how to stimulate demand for insurance, which is vexingly low at present.

This report is structured as follows. In section 2 we describe the study context and offer some insights from focus group discussions. In section 3 we describe the intervention and the theory of change. In section 4, we describe the monitoring plan used to track the implementation and delivery of the intervention. Section 5 briefly describes our primary research questions, and then section 6 describes in detail our evaluation design and the data collected for the analysis. We continue in section 7 with the study timeline before presenting our primary findings in section 8 and the implications of those findings in section 9. Section 10 contains a brief discussion of the key challenges faced during the implementation process and lessons learned.

2. Context

Under our initial research design, the target population for our intervention included potential beneficiaries of the Climate Resilient Agricultural Livelihoods Window of the Kenyan Cereal Enhancement Program (KCEP-CRAL). Potential KCEP-CRAL beneficiaries include grain producers in eight Kenyan counties, with variations of the KCEP-CRAL program being delivered to farmers on different rungs of the agricultural development ladder. KCEP-CRAL documentation and discussions with the KCEP-CRAL Program Coordinating Unit (PCU) indicated that index insurance might be included with the input bundle received by program beneficiaries. Our initial design would have included testing the games and measuring demand for the product incorporated into KCEP-CRAL. However, through discussions with the PCU, it became clear that the insurance product to be offered under KCEP-CRAL would not be available in time for our study. Rather, they endorsed our study as a testing ground to better understand insurance demand in the area before finalizing the insurance component of the program.

Tharaka Nithi was selected as the study site because it was the only county to meet the following requirements: (a) KCEP-CRAL program area, (b) CHIRPS data (used to design the HR WII product) available, and (c) existing status quo insurance product. Since the program was in the very early stages, the PCU did not have the information needed to construct a sample frame from which program farmers could be selected for the study. A census was not possible given our budget. For this reason, the research took place in Tharaka South sub-county of Tharaka Nithi County, where ACRE's relationship with an aggregator (an individual who works with large groups of farmers, providing inputs and buying output) made it possible to build a sample frame. Although study farmers will not necessarily enroll in the KCEP-CRAL program, their characteristics are quite similar and they are likely to be targeted. As such, the KCEP-CRAL PCU remains highly interested in the results of this research project.

The aggregator currently works with smallholder farmers to help them access output markets, and in some cases supplies farmers ("program farmers") with a bundle of inputs to grow sorghum and/or green gram with deferred payment. Included in the input package is mandatory WII for the value of inputs. This "status quo" insurance contract was developed by ACRE using African Rainfall Climatology Version 2 (ARC2, Novella et al., 2012) data in 2013. In our study, program farmers and 30 additional farmers are given the chance to buy insurance. For farmers with mandatory input insurance as part of their input package, this will be additional insurance for the projected value of sorghum and/or green gram production. This WII product was developed by ACRE specifically for this study using the CHIRPS dataset (Funk et al., 2015).

Input and production insurance are complementary. The aggregator's model has been to cover the cost of input insurance for farmers (and presumably bundling it into the price of credit). Input insurance covers bad weather throughout the season, but only covers the value of the inputs the farmer purchases on credit. This protects both the aggregator and the farmer, as if there is bad weather the farmer will likely be unable to pay back the aggregator. But the farmer is still exposed to a tremendous amount of production risk, as their value of production will be low if the weather is bad. Production risk also affects the aggregator, as bad weather for the farmers will leave her with less to sell to downstream buyers. However, her production risk is spread among many farmers whereas the farmer bears all the risk from his own production. Thus, farmers should have a strong incentive to insure the value of their production to complement the protection afforded to them by the aggregator insuring the value of their inputs purchased on credit.

Tharaka Nithi is located in the greater Meru region of the former Eastern Province, near Mt. Kenya. The entire study sample resides in Tharaka South, one of the sub-counties of Tharaka Nithi, and most live in Chiakariga ward. According to local government officials, most people in Tharaka South are subsistence farmers growing sorghum or green gram, with fewer growing millet, maize, cowpeas or pigeon peas. The land is semi-arid and not naturally very fertile, but farmers often do not have the liquidity to purchase fertilizer. Households generally supplement their agricultural income with handicrafts or small trade, but farming is the main source of income. Few if any households use irrigation, which is fairly representative of the national average. Most households keep livestock, including chickens and cows. Across Kenya, 75% of the population participates in agriculture, and 75% of agricultural production is by small-scale farmers (CIA World Factbook 2017, USAID 2017).

The median land size among the sample population is three acres, and from the research team's observations, most live in homes with earthen walls and corrugated iron roofs. As of 2005, the poverty rate of Kenya as defined by government standards is 46%, while the poverty rate in Tharaka Nithi is 65% according to a local Tharaka Nithi government website (World Bank 2017, Kenya Mpya, 2012). A large majority of those surveyed in the study have access to a mobile phone, despite most homes not having electricity. Across Kenya, 81% have a mobile phone subscription, and 12% of rural areas are electrified, versus 68% of urban areas (World Bank, 2014).

Most families have a well or pump nearby to access water, although from the team's observations some households have to walk further to access water. In one town, participants complained that their water source is not suitable for drinking, and the research team noticed several children with developmental disabilities. According to USAID, about 60% of all Kenyans have access to an improved water source (USAID, 2017).

About half of participants under the age of 40 have finished grade eight, whereas the median educational attainment for subjects above 40 is six years. Across the entire sample, the median education level is equal between men and women, but men were more likely to have pursued higher education. Overall, slightly less than 75% claim to be literate. As of 2015, the Kenya national average literacy rate is 72% (UNICEF, 2016).

We conducted focus groups at the onset of the project to learn more about farming operations, constraints, and how decisions are made in the household. Farmers widely reported that the climate is changing, and rains are lighter and more unpredictable than in the past. This has made it more challenging for farmers to determine what to grow.

Farmers recognize the importance of certified seeds, fertilizer (inorganic fertilizers and foliar feed for top dressing), herbicides, and pesticides. Of these, they prioritize certified seed due to extension recommendation and their own experience. For sorghum these are for the *Sila* and *Gadam* varieties. Certified seeds are expensive, however, and farmers often cannot afford them. Some will sell assets, work for cash for a few days, or even illegally produce charcoal to raise funds.

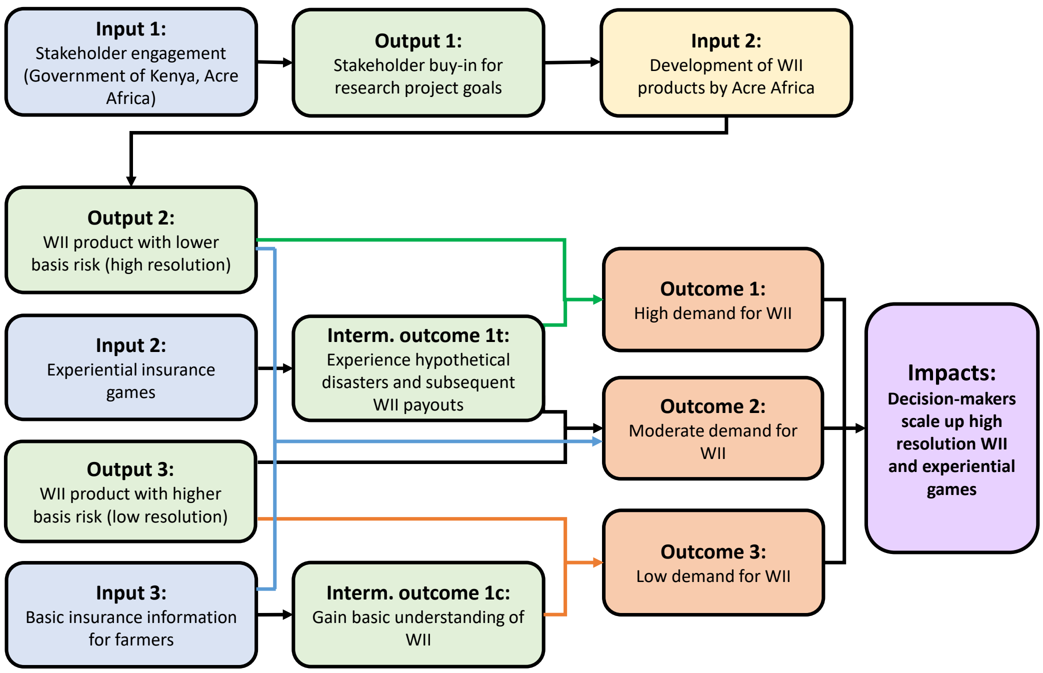
To obtain credit for certified seeds and other inputs, many farmers work with aggregators connected to East African Breweries Limited (EABL). The aggregator-producer group model was recently introduced in the sorghum growing areas (including our study area) when East African Breweries Limited (EABL) received a tax waver from the Government of Kenya on beer made from sorghum. Aggregators provide services such as technical advice, input supply on credit, extension services, as well as purchase the output. However, found that even when farmers can get certified seeds, they often plant them without inorganic fertilizer. That farmers are unable to afford the inputs they would like to use does not portend well for them using their scarce resources to purchase WII.

Both men and women say that men primarily make production decisions, and women provide much of the labour. Men often said that women decide what to do with crop income, whereas women said that was not the case. Two thirds of our sample was male, as we targeted the primary agricultural decision maker so that he (or she) could make a decision over insurance purchases.

3. Intervention description and theory of change

Our study evaluates two innovative interventions designed to increase demand for insurance: (a) an improved WII contract using unique high-resolution satellite-based data, and (b) experiential games to teach producers about basis risk and WII as a risk management tool. The theory of change (ToC) underlying our proposed impact evaluation as implemented is presented Figure 1 below and the corresponding discussion.

Figure 1: Theory of Change Diagram



As explained above, the Government of Kenya intends to offer WII to KCEP-CRAL's targeted producers. The KCEP-CRAL PCU remains engaged and interested in the results of the experiment. ACRE also has a keen interest in identifying effective teaching and marketing tools, while learning about sensitivity of WII demand to basis risk.

Engagement with each of these stakeholders (**Input 1**) led directly to stakeholder buy-in (**Output 1**), and subsequent development of two WII products for the purposes of this study (**Input 2**).

ACRE's development process culminated in the creation of the LR and HR WII products (**Outputs 2 and 3**). While the products were being developed and priced by Acre, the research team developed the experiential insurance games (**Input 2**). In partnership with Acre, the research team also created a basic information treatment (**Input 3**) mimicking the information that Acre usually shares with prospective insurance clients.

The remaining links in the causal chain as shown in figure 1 depend in part on treatment assignment. We assume that the baseline level of demand for WII is low. Under the assumption the status quo basic information treatment is not very effective farmers who receive this treatment and are exposed to the LR product will have low observed demand for WII (**Outcome 3**). Farmers who are exposed to the HR product and receive the basic information treatment might have somewhat higher demand for WII (**Outcome 2**), as long as they have some grasp of basis risk without playing the games.

Under the assumption that farmers engage with the game, farmers should gain a better understanding of basis risk and how index insurance works (Intermediate outcome 1t). Farmers who are exposed to the LR product and play the experiential games should therefore have somewhat higher demand for WII as a result of learning that WII can reduce their exposure to risk (**Outcome 2**), although it is possible that negative basis risk outcomes in the game could actually diminish demand. If the experiential game for LR insurance is equally effective as the HR game, farmers that participate in the games and are offered HR insurance should have the highest demand for WII. As a result of playing the games, farmers become savvier evaluators of different insurance products. Therefore game participants should be better equipped to observe the quality difference between HR and LR insurance, with demand responding accordingly. Only the interaction between the games and product quality can generate high WII demand under our hypothesized causal chain.

The causal chain depicted in figure 1 is expected to happen within the timeline of the study, with insurance uptake happening shortly after receipt of information (**Inputs 2 and 3**). If the causal chain proved to be accurate, and if the HR product appeared to be a viable alternative to Acre's current insurance offerings, we would have expected both the games and the HR product to be scaled up by Acre with potential inclusion of the games in KCEP-CRAL extension efforts. The extent to which the theory of change depicted in figure 1 actually occurred, and where key assumptions did not hold, will be discussed in sections 8 and 9.

4. Monitoring plan

Stakeholder engagement (**Input 1**) was monitored using back-to-office reports as well as notes taken by participants in meetings and phone calls with different stakeholders. Subsequent stakeholder buy-in (**Output 1**) was confirmed by the World Agroforestry Center (ICRAF) and Acre signing a contract for creation of the LR and HR WII products, as well as by the initial Letters of Support submitted by IFAD (backing the KCEP-CRAL PCU) and Acre. Creation of the LR and HR products (**Outputs 2 and 3**) was confirmed by Acre submitting term sheets to the research team for each product (indicating that both products were ready to be marketed).

Creation of the experiential games (**Input 2**) was confirmed by each team member reviewing the game script and protocol for data collection and other field activities. The basic information treatment (**Input 3**) was confirmed by creation of a script that would be used to administer the information sessions.

Indicators for remaining outcomes were collected by enumerators from farmers included in the study sample. All data was collected using paper questionnaires and subsequently converted into a digital database by the research team using CSPro software. To ensure data quality, all enumerators were trained and assessed prior to data collection. Once collected, data were checked for outliers and coding mistakes using summary statistics and graphical methods.

Indicators associated with game participation (**Intermediary outcome 1t**) include measures of game events, and knowledge and attitudes with respect to WII. Knowledge and attitude indicators were also collected from participants in the basic information sessions (**Intermediary outcome 1c**) using the exact same questions applied to game participants. Demand for WII was assessed for all farmers in the sample using a multiple price list auction. Data collected using questionnaires administered to session participants as well as experimental design are discussed in greater detail below.

5. Evaluation questions and primary outcomes

In this study we evaluate demand for weather index insurance (WII) among smallholder producers in Tharaka South sub-county of Tharaka Nithi county in Kenya's ASALs, focusing on the role of basis risk. We are interested in answering the following research questions:

1. Are farmers sensitive to basis risk?
   a) Is demand for HR insurance higher than for LR insurance?
2. Does experiential learning (the game) affect demand for insurance?
   a) Does playing the game increase or decrease demand for WII?
   b) Does playing the HR game have a different effect on demand for HR insurance than playing the LR game has on demand for LR insurance?
   c) Do negative basis risk events (to the farmer and to others) in the game decrease demand for WII?
   d) Do positive basis risk events (to the farmer and to others) in the game increase demand for WII?
3. Does experiential learning (the game) affect attitudes toward and knowledge of insurance?
   a) Does playing the game alter attitudes/understanding?
   b) Do negative basis risk events (to the farmer and to others) in the game alter attitudes/understanding?
   c) Do positive basis risk events (to the farmer and to others) in the game alter attitudes/understanding?

The primary outcomes of interest are demand for insurance and attitudes toward and knowledge of insurance.

6. Evaluation design, data and methods

Our evaluation design was influenced by background qualitative research conducted early in the life of the project. Dr. Judith Oduol led these efforts, and much of the work was completed during the supervision mission for the government of Kenya intervention, KCEP-CRAL. The mission was organized by IFAD to assess the progress made to date by the predecessor program, KCEP, and provide guidance on KCEP-CRAL's implementation. This activity provided an opportunity to gain understanding of the context and the target population. Additional qualitative research took place during two focus group discussions held in Machakos and Tharaka Nithi. The purpose of these focus groups was to assess farmer understanding of and access to crop insurance and the primary agricultural risks in the study area.

Stakeholder meetings, virtual interactions (mainly via email and phone), and key informant interviews were also important in understanding the policy context in order to adapt the study's design, to ensure relevancy. The meetings, in particular, were used as a platform to validate the proposed approaches for bolstering demand for crop insurance. In addition, we interfaced with other stakeholders who have implemented agricultural insurance products for smallholder farmers in Kenya to understand the challenges experienced and lessons learned.

The quantitative study relies on a randomized control trial with a 2x2 design where farmers are randomly assigned to an insurance contract type (HR or LR), and to either a basic information treatment or the basic information treatment and experimental game. Those assigned to the basic information treatment also played games to elicit prospect-theory (PT) based risk parameters (Tanaka, Camerer, and Nguyen, 2010). In other words, farmers were assigned to one of the following:

1. LR insurance, basic insurance information, PT game
2. LR insurance, basic insurance information, insurance game
3. HR insurance, basic insurance information, PT game
4. HR insurance, basic insurance information, insurance game

The basic insurance information treatment is purposefully simplistic. While farmers working with the aggregator have had insurance, most do not know this because it is the aggregator that purchases insurance to cover the inputs it has sold to farmers on credit to cover its own investment.

The promoter focused on the farmers' transition from subsistence to commercial farming, and explained to farmers that because they are now producing sorghum and green gram as a business, they need to protect that business. The promoter explained that with WII it is possible the farmers will not receive a payout even if they have a poor crop, but did not go into detail about probabilities. They also did not explain the system of triggers to farmers, as they believe that this is beyond their comprehension, and would have intimidated them. The promoter did explain, however, the size of the index area since this is how the two contracts differ.

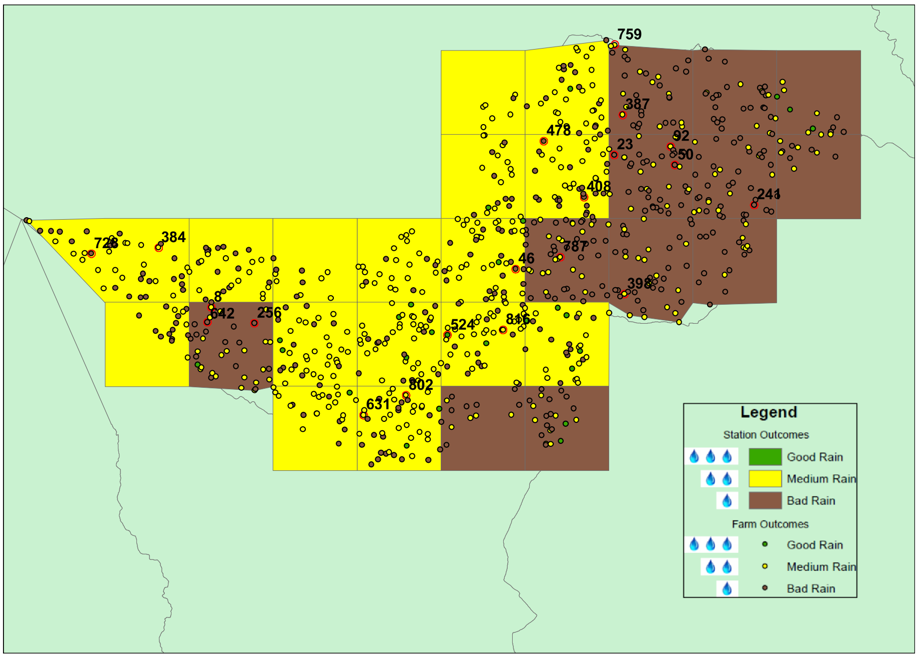
For the analysis presented here, the PT game serves as a placebo to replace the insurance game for the basic information treatment group. The PT game lasts about as long as the insurance game, which means farmers in all treatment groups would have been equally fatigued and impatient at the end of treatment, will have all participated in a game with the possibility of winning money, and will have spent an equal amount of time interacting with enumerators. We will use data from the PT game for a separate, tangentially related study on risk preferences and insurance demand.

The game uses maps specifically designed to teach farmers about basis risk. Maps consist of “farms” and grid squares. Before the game, one of the farms on the maps is randomly assigned to each individual farmer and used to calculate each farmer’s payout throughout the game. The payout is contingent upon two factors: production value, and for all farmers that buy insurance, insurance payouts and premiums. Production value for an individual farm is determined at the farm level, while insurance payouts are determined at the square level, which reflects the main feature of index insurance.

In order to heighten the realism of game outcomes, nine maps were drawn with the same CHIRPS weather data used to design the LR and HR insurance products. Specifically, we use data from nine different years, corresponding to nine total game rounds (two practice rounds followed by seven real rounds).[1] The maps from LR and HR differ only in the size of their grid squares, with the large-square maps determining insurance payouts for farmers with LR insurance and the small-square maps determining payouts for HR insurance. The nine maps were presented year by year, in the same order, in both types of insurance games.

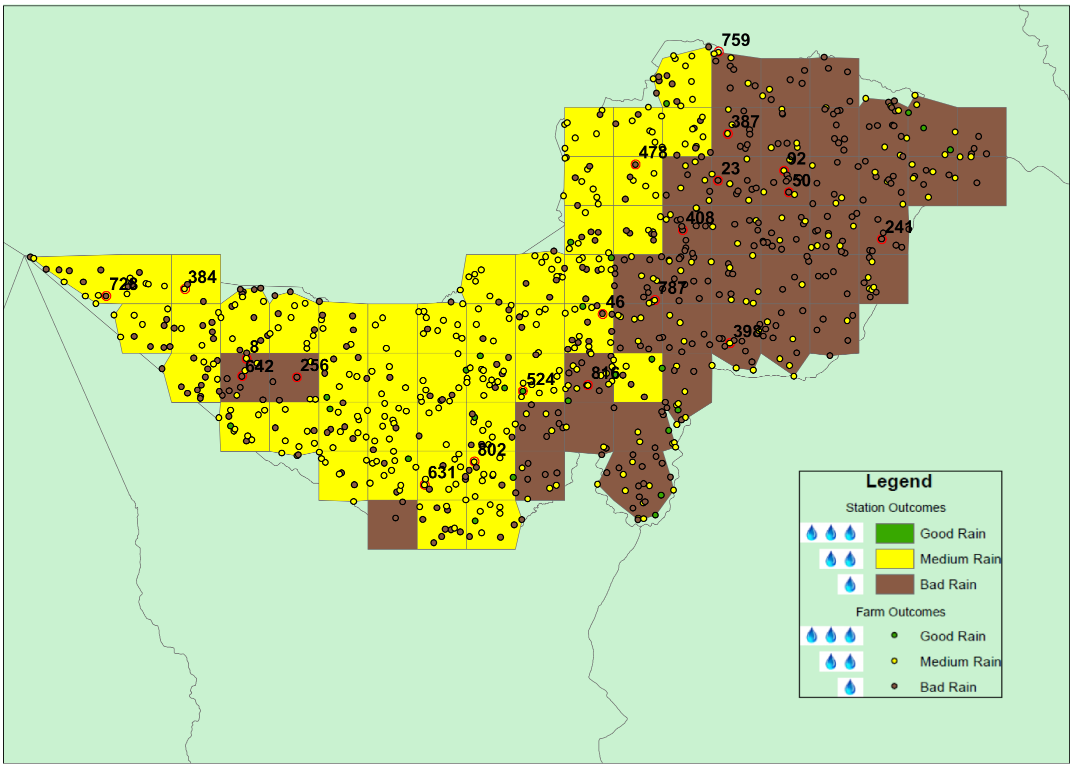
There are three levels of rainfall depicted in the maps: “bad” (brown), “medium” (yellow), and “good” (green). Farms and squares each take on one of these three colors, with farms not necessarily being the same color as the square containing them. Mismatches between farm and square are cases of basis risk events. Examples of the LR and HR maps are shown in Figures 2 and 3 below.

Figure 2: Low Resolution Game Map



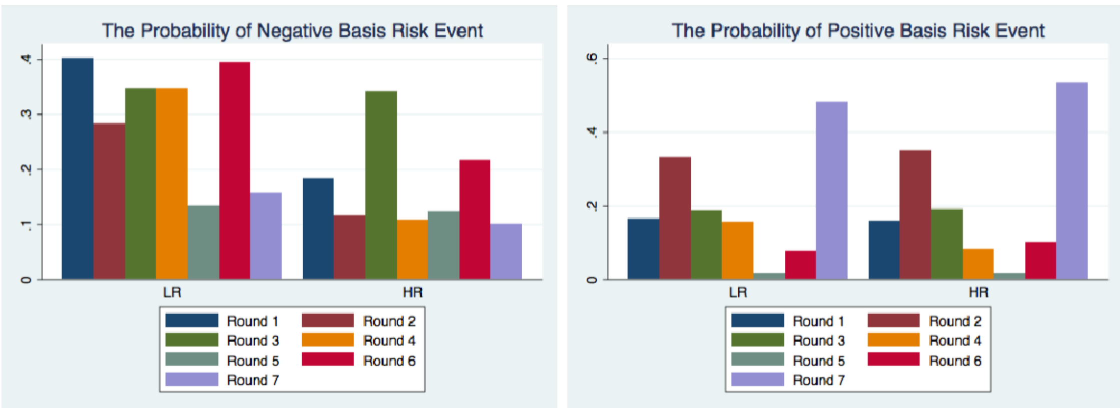
[1] The chosen years are 1988, 1990, 1991, 1995, 2002, 2004, 2007 and 2011 because the probabilities of basis risk was closest to the average in those years.

Figure 3: High Resolution Game Map



Farmers were randomly allocated one of 16 farms and kept that farm for each round. Below are comparisons of the average probability of a negative and positive basis risk event, round by round, for LR and HR insurance. The probability of a positive basis risk event is fairly similar between the two, whereas the probability of a negative basis risk event is substantially greater in most rounds (Figure 4).

Figure 4: Probability of Negative and Positive Basis Risk Events within the Game



One numerator worked with two farmers at a time, with each enumerator playing the game as an individual. The enumerator alternated back and forth between farmers throughout the game, making sure each farmer understood every step. At the beginning of each year, a random insurance price is selected from the following values: 100; 200;

500; 700; 1,000; 1,500; and 2,000 game shillings.[2] Farmers are then asked whether they would like to purchase zero, one, or two units of insurance at the drawn price. After each farmer decides how much insurance to purchase, a map displayed farm-level outcomes. Bad years, medium years, and good years (at the farm level) pay out 5,000, 7,000, and 10,000 shillings, respectively. Once all farm-level outcomes are revealed, a second map showing both farm and square results is shown. One unit of insurance pays out 2,500 shillings in a bad year (at the square level), 1,500 in a medium year, and nothing in a good year. These values were chosen so that two units of insurance fully compensates a farmer for the maximum possible loss.

The most a farmer can earn in a round is 149 KSH (having purchased two units of insurance at 100 each then experienced good farm rain and bad square rain). The least a farmer can earn is 10 KSH (having purchased two units of insurance at 2,000 each with bad farm rain and good square rain). To avoid dynamic game play, farmers are told at the beginning of the game that payouts will be based on a single randomly selected round, excluding the two practice rounds. The intervention took approximately one hour. Further details of game design can be found in the registered pre-analysis plan (https://www.socialscienceregistry.org/trials/2401). The game protocol and worksheet can be found in Appendix A and Appendix B, respectively.

Experimental games are often played for real earnings in order to incentivize and motivate participants. Cai and Song (2017) use a non-incentivized game in order to avoid income effects. Their game does result in substantially higher insurance relative to a non-game information treatment, although the difference is not statistically significant at conventional levels. However, incentivized game play has been shown to differ from non-incentivized play (see Jaspersen (2016) for a recent review), meaning that participants treat non-incentivized games differently and may not learn as much, or not learn the same things. Smith (1982) goes so far as to state that economic experiments must involve real payouts to be considered experiments. Because we want farmers to face real (albeit small) risks in the game, we opted to use real payouts. To mitigate income effects, average game payouts across treatments (including the PT game played by the basic information group) were calibrated to be equal. Furthermore, the amount of money given to farmers is very small relative to the actual price of insurance. At actuarially fair prices, insuring one acre of sorghum production costs approximately 3,600 KSH. Thus, we do not believe the income effect will result in differences in auction bids or eventual insurance purchases.

We worked with 487 farmers in Tharaka South sub-county. Our sample consists of all 457 farmers who previously worked with the aggregator, plus 30 farmers who had not worked with the aggregator previously but will become program farmers through this study (they had already expressed interest). The farmers targeted for the study are semi-subsistence producers with no more than 10 acres of land.

Data collection was led Dr. Odoul at ICRAF with support from a UGA graduate student (Soye Shin) and an undergraduate student (Bailey Palmer). ICRAF hired local

[2] One hundred game shillings equals one real shilling (100 KSH = 1 USD). We use these higher amounts to more closely resemble actual payouts and insurance prices.

enumerators following a formal application and interview process. Enumerators were trained to approach subjects in a way that is culturally appropriate. Local enumerators were trained by Dr. Oduol (a Kenyan National), Dr. Magnan, Ms. Shin, and Ms. Palmer, to ensure that the way in which subjects are approached is appropriate for the local context. The research design was approved by the Institutional Review Board of Montana State University. Participants were provided snacks and tea for participating, won at least some money by playing games, and received insurance subsidies.

To ensure data quality, three research team members (Oduol, Palmer, Shin) accompanied the enumerator team on each field trip to collect data and supervised the proceedings. Each day, two sessions were held. On a daily basis, one session was randomly assigned to the LR product and the other was assigned to sell HR product. In each session, we worked with the aggregator to assemble groups of approximately 32 farmers from various villages at a central location. Each day's participants were drawn from different groups of villages, while session locations were chosen to be as convenient as possible for participants. Gathering farmers in this manner is standard procedure for the aggregator. We had initially intended to have farmers assigned at random to a morning or afternoon session. However, this proved to be impossible. Instead, assignment of individual farmers to morning or afternoon sessions was left up to a lead farmer, although the lead farmer was unaware of which treatment type would take place in any given session.

At the beginning of a session, the research team announced to the enumeration team the correct insurance product to introduce to farmers per the randomization. In either session, once all 32 farmers were gathered the promoter provided them with the basic insurance information treatment. One of our Kiswahili-speaking team members would then confirm that he/she delivered the information as specified in the basic information script to ensure consistency across sessions.

After that, the farmers were randomly assigned to one of the two treatments (i.e. insurance game or PT game) by drawing a numbered card from an envelope. After assigning the treatment, the research team was divided in two with each student member taking charge of one treatment group in a given session, and Dr. Oduol overseeing both. Activities for the two groups in each session took place simultaneously and separately, with enough space between groups to avoid spillovers during session activities. Groups of one to three farmers worked with a single enumerator to complete PT or insurance game activities, depending on treatment.

To further ensure data quality, on-site researchers clarified questions brought up by enumerators during the survey. Researchers sometimes corrected mistakes observed by walking among enumerator-farmer pairs, and shared these corrections with the rest of the enumerator team to avoid their repetition. However, they took care to not walk around too often because it could give unnecessary pressure to the enumerators and participants. The on-site research team conducted back checks and fixed any errors such as missing identification codes or incorrect id numbers (e.g., treatment code, insurance code etc.). If unclear answers to the survey questions were discovered, the researchers confirmed with the enumerator the intended meaning the following morning. In addition, the on-site research team regularly gathered feedback from enumerators to assess the level of farmers' understanding of the activities and concerns about spillover effects. Regarding the latter, enumerators reported that some farmers had already heard of our research from previous farmer participants, in which case the session was cancelled. Enumerators also reported in one session that a farmer had attended sessions twice, and the research team kindly asked the farmer to leave the session.

We measure demand for insurance using a semi-binding auction as well as actual uptake of insurance. WII is a new product to these farmers, and asking them to pay potentially large sums of money for WII the first day they learned about it did not seem reasonable (Acre was confident farmers would not purchase insurance under these circumstances). In addition, our auctions took place before the normal period over which insurance is purchased (this was due to both constraints on grant spending and the August 8, 2017 election in Kenya). Although we encouraged farmers to fulfill their commitments, the auction is semi-binding in that we cannot compel farmers to follow through on their auction commitments when the time comes to actually purchase. However, we limit discrepancies between the auction and actual transaction data by not allowing farmers to purchase more insurance than what was demanded at the auction. This and other details of the auction and follow-up visits are discussed below.

The semi-binding auction takes place immediately after the insurance game or PT game. Enumerators worked with the same pair of farmers, but this time completed the entire auction for one farmer and then the other. The auction took approximately 20 minutes per farmer. The auction relies on a multiple price list format similar to that of Lybbert et al. (2013). Our auction design makes it possible to elicit quantity demanded of a good or service at various prices, and then drawing a random price that determines actual transaction price. In India, Cole et al. (2016) show that a binding auction for a fixed amount of WII coverage results in uptake rates similar to a case where each farmer faces a single randomly assigned price. We extend the approach of Cole et al. (2016) by allowing producers to choose their desired coverage level at several prices.

Insurance quantities are coverage amounts (in shillings), and premiums (prices) are measured as a percentage of the amount covered. During piloting, we found that farmers were confused by quantity and price described in these terms. After piloting different ways to auction WII, we opted to sell “units” of insurance. Each unit provides KSH 5,000 of coverage. Prices of insurance units are percentages of 5,000 KSH (50, 150, 250, 350, 500, 750, and 1,000 KSH), and farmers state how many units of coverage they would like to buy at each price.

The auction unfolds as an iterative process in which an assistant first tells a farmer how many units of insurance it would take to insure her entire crop value, and how much this would cost, at a very low price (e.g., 50 KSH). The farmer then typically agrees to insure the entire value of her crop at that price. The assistant then proceeds to raise the price of a unit of insurance to successively higher levels, and the farmer states a desired number of insurance units at each new price. Once all prices in the list have been covered or a price is reached where the farmer has zero demand for insurance, a single price is randomly selected as the actual transaction price. The enumerator then confirms with the farmer that they have committed to purchase the amount of coverage they said they wanted at that price.

At the conclusion of the auction, farmers offered the LR product are told that during follow-up visits they will be purchasing an insurance product that is better than what they saw during the game or basic information session, and that the product being sold uses a 5x5 km resolution rather than 10x10. In the follow-up visit made by the promoter, each farmer is reminded about the price that was drawn during the game session and the quantity of insurance demanded at that price. Farmers are not allowed to purchase more than they said they would during the auction at the drawn price, but are allowed to purchase a smaller quantity than originally pledged. The auction script and worksheet can be found in Appendix C and Appendix D, respectively.

Knowledge of insurance and basis risk are measured using the following brief series of true/false questions on a survey administered immediately following the auction:

1. If I buy rainfall insurance, I will always receive money back at the end of the season, regardless of the weather.
2. It is possible to receive an insurance payout even if I have received enough rain on my fields.
3. To determine how much rain has fallen, the insurer measures average rainfall over larger squared areas, not at a single farm.
4. The smaller the squared area the insurer uses to measure rainfall, the greater the similarity between rainfall measured by the insurer and rainfall on my fields.

The number of correct replies is used as a knowledge index. The index is our main indicator for measuring impacts of the games on WII knowledge.

Attitudes regarding insurance are measured using the following brief series of questions where respondents could choose to agree or disagree:

1. I feel like I have enough information to make an informed decision about purchasing rainfall insurance.
2. Rainfall insurance is a valuable service.
3. The information shared during today's activities was difficult to understand.

Questions (1) and (2) above are used independently as outcome variables. Question (3) is intended to help us determine whether farmers understood the experiment and auction. Because the basic information group played a potentially confusing TCN game, we cannot use this group as a basis of comparison for those who played the insurance game.

During the survey preceding receipt of treatment, we collected data on a limited number of farmer characteristics. These data allow us to describe our sample, test for balance across treatments, and improve precision. Second, treatment effects may vary by farmer characteristics, and it is possible to exploit heterogeneous WTP for novel products to improve targeting and make subsidies more efficient (Lybbert et al., 2013). We therefore are interested in correlations, causal or not, between several key farmer characteristics and WII demand. Third, while using farmer characteristics as control variables is not necessary to estimate the effects of our interventions without bias, it can improve precision if farmer characteristics are correlated with insurance demand, as we expect them to be.

The demographic survey took place privately as individuals were randomly assigned to treatment groups after the information session. This survey covered:

1. gender
2. age
3. religion
4. formal education level
5. literacy
6. primary occupation
7. landholdings (owned)
8. anticipated sorghum (or green gram if no sorghum) area to plant this season (in land area)
9. anticipated sorghum (or green gram if no sorghum) yield this season (in land area)
10. anticipated sorghum (or green gram if no sorghum) price this season (in KSH)
11. anticipated total value of sorghum (or green gram if no sorghum) this season (in KSH)
12. number of last 5 seasons in which fields did not get enough rain
13. if household could secure a loan for the upcoming season if needed
14. possession of a formal savings account

Appendix E contains the complete questionnaire.

As Cai and Song (2017) demonstrated, outcomes within an experimental game can influence real life decisions. In this game, a number of outcomes are possible based on farmers' decisions and random weather events. Because we are most interested in basis risk, we can differentiate between good and bad basis risk events, occurring for both the farmer and others in his session, as explanatory variables in some of our econometric analysis.

Data from the paper-based surveys and activity forms were entered directly into CSPro survey software as is. After converting into a data set for a statistical program, we performed a consistency check for primary variables and fixed errors. Twice, we found two farmers with the same name and phone number, and confirmed that it was the same individual. To deal with these four observations representing two people, we kept the data collected on their first show-up day and dropped their second observation. We wrote the code for econometric analysis according to the pre-analysis plan to avoid data mining. We imputed missing age and education values as their median values respectively. We handled outliers for insurance quantity demanded by top-coding at the 99th percentile.

We use regression analysis to analyze the data. Treatment effects were estimated by regressing outcomes on treatment status. The mode of inference was appropriate for the level of randomization of each treatment. Additional details of statistical methods are presented in section 8.

7. Study timeline

Table 1 below provides an overview of key activities that were undertaken as part of the evaluation. The timeline was affected by delays in the contract design, and Kenya's August elections.

Table 1: Timeline

Date	Activity
Oct	Get IRB approval
Nov-Dec	3ie pre-award workshop, qualitative research and stakeholder engagement, Provide CHIRPS data to Acre
Jan-Feb	Develop protocol and script for game and information session, create maps for game session, develop questionnaire and auction protocol
Mar	Meet with aggregator for key informant interview, additional FGDs if necessary
Mar-Apr	Revise research tools and questionnaire
Apr-May	Acre develops WII contracts
May	Finalize research tools and questionnaire
May-Aug	Write pre-analysis plan
June	3ie workshop to present preliminary results
June	Acquire sample frame, Pilot games, info sessions, survey
June-July	Stakeholders meetings to plan impact evaluation
July	Games, info sessions, survey (details below)
August	Data cleaning and descriptive statistics
September	Follow up calls and sales visits, quantitative analysis, disseminate results, write final evaluation report, write impact evaluation proposal

In addition to the overall timeline, it is worth describing the fieldwork timeline in greater detail. The order of activities for recruitment of aggregator clients was as follows:

7.1 First visit

1. Using the list provided by the aggregator, the representative of the aggregator contacted the lead farmer of each farmer group.
2. The representative of the aggregator requested that lead farmers invite farmers to the study who were members of the group and who would be able to make a decision about whether the household would purchase insurance.
3. Lead farmers informed group members that they have been selected to participate in an activity about agriculture, but did not inform them of their treatment status. They also informed them of time and place of activity.
4. Lead farmers informed farmers that they would be offered an opportunity to purchase insurance at a discounted price. The members were told that if they wanted insurance, they would be asked to commit to purchasing the insurance during the activity. However, the members were also told that no sales of insurance would take place at the activity. Instead, each member pays at the beginning of the planting season.

Recruitment of the 30 non-aggregator clients proceeds in a very similar manner, except that contact and organization of individual farmers is the responsibility of local extension officials.

7.2 Information session (approximately two days later)

1. At the meeting place, if the farmer was not initially present for the activity, the survey team visited or called them to encourage them to come.
2. All farmers received the basic information presented by the aggregator's representative.
3. After the basic information, farmers were randomly assigned to treatment groups by drawing numbered cards from an envelope.
4. In each group, informed consent was acquired and demographic data were collected.
5. All farmers participated in assigned game (PT or insurance)
6. The experimental auction was conducted for all farmers in their respective groups.
7. At the conclusion of the auction, enumerators conducted a brief survey on their understanding of insurance and basis risk.

7.3 Follow-up visit (two months later)

Follow-up visits took place after the August 8th election. It was determined that no field activities should take place two weeks before or after the election as participants would be unavailable. The team followed-up only with households who said they would buy insurance during the auction (at the randomly selected subsidized price). During the follow-up visit, only the HR product will be offered. Farmers originally assigned to the LR product during the auction were told that they would actually be buying HR insurance when given the chance to do so. The process went as follows:

1. All individuals were reminded, via text message, of the total value of insurance they com- mitted to buy at the auction. The text message read (in Kiswahili): Hello (name), you said you would purchase (quantity of insurance) units of insurance at price (drawn price) per unit. We will complete this transaction on (date). The text message was sent by ACRE in late August 2017.
2. During a follow-up call in early September, conducted by a representative of the aggregator, farmers were encouraged to fulfill their commitment, and asked to confirm their willingness to buy the original amount stated at the auction. If a farmer said that she no longer wants to purchase the amount stated at the auction, she was given the chance to decrease the total amount of insurance. In other words, farmers were only told that they may adjust the value insured if they state that they no longer wish to purchase the amount of insurance requested at the auction. In the event that a farmer wants to change the amount of insurance purchased, he or she may purchase less coverage, but not more.
3. Two subsequent follow-up calls were made by a representative of the aggregator prior to September 10th to remind the farmer of their commitment and how to pay via mobile phone.
4. Meetings organized by Acre and the aggregator took place in mid-September for transactions. An extension to October 13 was given to farmers needing more time to raise funds for the premium.
5. By the October 13 deadline only six farmers paid for insurance. This transaction data was recorded and shared with the research team.

A pre-analysis plan was finalized and registered in August, and data analysis took place in September.

8. Analysis and findings from the evaluation

8.1 Relevance of the intervention

8.1.1 Intervention effect on stated demand

To estimate the impacts of our two treatments we regress outcomes on treatment status, controlling for insurance price and a list of covariates. We have seven observations, one at each price, for each farmer, for a total N of 3,409. The model is specified as:

$$Qij = \alpha + \beta_1 GLR_i + \beta_2 NGHR_i + \beta_3 GHR_i + \beta_4 P_{ij} + X_i' \beta_X + \varepsilon_{ij} \quad (1)$$

In equation (1), Qij is the quantity of insurance demanded in KSH by farmer *i* at price *j*. The three indicator variables for treatment status include GLR_i (participating in the game and offered LR insurance), $NGHR_i$ (not participating in the game and offered HR insurance), and GHR_i (participating in the game and offered HR insurance). The omitted treatment indicator variable is for not participating in the game and offered LR insurance (the status quo). P_{ij} is the price at which demand was reported. Because we do not interact P_{ij} with treatment status in this base specification, we are testing only for intercept (and not slope) shifts in demand.

To improve precision we include a vector of control variables, X_i'. These include age, education, a literacy indicator variable, gender, landholdings, reported instances of drought in the past five years, whether the household has a formal savings account (including M-Pesa), acres of the insured crop, anticipated harvest value of the insured crop, an indicator for the insured crop being sorghum (as opposed to green gram), and enumerator fixed effects. ε_{ij} is a stochastic error term. Because insurance resolution was assigned by session, we cluster our standard errors at this level using a wild cluster bootstrap due to the small number of clusters (Cameron and Miller, 2015; Webb 2013).

Treatment effects from the estimation of equation (1) are in Table 2, rows 1 and 2. In the status quo treatment group, mean insurance demand across all prices is KSH 13,269. Farmers offered the LR insurance participating in the experimental game demanded KSH 4,123 more insurance relative to the status quo (a 31 percent increase). Farmers offered HR insurance not participating in the game demanded KSH 5,093 mode insurance (a 38% increase). These differences were both significant at $p < 0.01$. Thus, both treatments *independently* increase demand substantially.

Strangely, the effect of the combined treatment is no larger than the effect of either individual treatment. Farmers in the group offered HR insurance and participating in the experimental game exhibited demand KSH 3,649 more insurance that the status quo, which is only a 27% increase ($p<0.1$). While this effect was not statistically different from either of the individual treatments, the point estimate is smaller.

The model shown in (1) allows the intercept of the demand curve to shift, but not the slope. If treatment effects vary by price, the slope of the demand curve may also change. We can test for intercept and slope effects by estimating a more flexible model:

$$Qij = \alpha + \beta_1 GLR_i + \beta_2 NGHR_i + \beta_3 GHR_i + \beta_4 P_{ij} + \beta_5 GLR_i \cdot P_{ij} \quad (2)$$

$$+\beta_6 NGHR_i \cdot P_{ij} + \beta_7 GHR_i \cdot P_{ij} + \beta_4 P_{ij} + X_i'\beta_X + \varepsilon_{ij}$$

In (2), treatment variables interacted with price signify the slopes of the demand curves. We find no significant treatment effects on slope. Point estimates for changes to demand curve intercepts are roughly the same as in (1), but not significant at conventional levels. These results can be found in Table 2, columns 3 and 4.

Table 2: Treatment effects on demand over all prices

	KSH coverage	p-value	KSH coverage	p-value
NG/LR mean	13,269.1		13,269.1	
G/LR	4,123.3**	0.015	3,375.1	0.272
NG/HR	5,093.9***	0.004	4,070.7	0.243
G/HR	3,648.8*	0.057	5,258.3	0.133
G/LR x P			1.717	0.766
NG/HR x P			2.348	0.693
G/HR x P			-3.694	0.511
N	3409		3409	

Omitted variable is NG/LR. The sample is top coded at the 99th percentile of insurance demand. Wild cluster bootstrapped p-values reported; *** p < 0.01, ** p < 0.05, * p < 0.1.Control variables are age, education, literacy, male, land size, drought, loan availability, formal saving, acre of crop, projected net value of production, crop, and enumerator fixed effects.

Many of the prices at which we measured demand were very low. From a policy perspective, it may be most interesting to estimate treatment effects at policy-relevant prices, e.g., the actuarially fair price and the market price. We re-estimate model (1) using observations at each of these prices and find similar results (Table 3). In both cases the effect of either being offered HR insurance or playing the game was large, significant, and positive. The effect of being offered HR insurance *and* playing the game, was lower and on the margins of significance.

Table 3: Treatment effects on demand at policy-relevant prices

	KSH coverage at actuarially fair price	p-value	KSH coverage at market price	p-value
NG/LR mean	14,431.1		7,207.4	
G/LR	5,740.5**	0.017	4,996.4***	0.003
NG/HR	5,728.0***	0.006	7,346.5***	0.003
G/HR	4,670.6	0.104	2,121.1	0.172
N	487		487	

Omitted variable is NG/LR. The sample is top coded at the 99th percentile of insurance demand. Wild cluster bootstrapped p-values reported; *** p < 0.01, ** p < 0.05, * p < 0.1. Control variables are age, education, literacy, male, land size, drought, loan availability, formal saving, acre of crop, projected net value of production, crop, and enumerator fixed effects.

We have two hypotheses for why the experimental game had no impact on HR insurance demand. The first hypothesis is that each farmer has some maximum level of insurance demand. From the status quo, this maximum can be reached either by being offered a higher resolution product or by participating in the experimental game, but cannot be surpassed by combining both. In other words, the effects are neither additive nor multiplicative.

The second hypothesis is that differences between the experimental game using the HR data and the game using the LR data led the game to only be effective for increasing LR demand. We carefully calibrated the games so that the HR game would result in equivalent or better outcomes, and the data show that it did.[3] In exploratory analysis we include events within the game in our estimation of (1), and find that controlling for events within the game do not change our treatment effects estimates reported above. Thus, differences in basis risk events within the game did not make it less effective at increasing demand for the HR product than for the LR product.

8.1.2 Intervention effect on learning

Another possibility is that the HR game (Figure 3) was not as aesthetically appealing as the LR game (Figure 2). With many more grid squares, the HR map is much busier. Also, because the grid squares are smaller they can better fit the contours of the county shown on the map. Thus, the border of the gridded area is more jagged. If this is true, perhaps the HR maps were less effective learning tools than the

In our analysis we find no empirical evidence that the HR map made it harder to understand basis risk. In fact, we find the game increased a knowledge score (how many questions about WII answered correctly out of four) by 0.23 for farmers offered the HR insurance while having no significant effect on those offered LR insurance. We also find no significant effect of the game on attitudes for farmers offered either insurance product (Table 4).

We note that among farmers who did not play the game, knowledge scores were already quite high (farmers who did not play the insurance game answered 3 of 4 questions correctly). There was also little variation whether or not they thought they had enough information and whether or not they believed WII is valuable, meaning there was little room for impact to these knowledge questions.

Finally, we are not overly confident in these outcome data because of reports that enumerators "coached" respondents to get the right answer, which may have inhibited our ability to see effects. Still, point estimates do not even have the sign one would anticipate if the HR game resulted in less learning.

Table 4: Treatment effects on learning and attitude

	Test Score (0-4)	p-val	Enough info (0,1)	p-val	WII is valuable (0,1)	p-val	Info difficult (0,1)	p-val
NG/LR mean	2.943		0.905		0.975		0.647	
G/LR	0.071	0.322	0.009	0.876	0.008	0.745	0.019	0.681
NG/HR	0.035	0.773	0.023	0.533	0.000	0.999	-0.091	0.313
G/HR	0.229**	0.023	0.018	0.670	0.012	0.589	-0.111	0.208
N	487		474		482		477	

Omitted variable is NG/LR. The sample is top coded at the 99th percentile of insurance demand. Wild cluster bootstrapped p-values reported; *** p < 0.01, ** p < 0.05, * p < 0.1. Control variables are age, education, literacy, male, land size, drought, loan availability, formal saving, acre of crop, projected net value of production, crop, and enumerator fixed effects.

[3] Farm rainfall was the same between the two versions of the game; whereas grid square level outcomes were more likely to result in insurance outcomes in the HR version of the game. There were fewer negative basis risk events in the HR version of the game, and the same number of positive basis risk events between the two. Farmer payouts were higher in the HR than the LR version of the game.

8.1.3 Intervention effect on actual purchases

We were very encouraged by the demand data elicited through the experimental auctions. There was substantial stated demand, even at higher prices, and the demand curve was downward sloping for all treatment groups. Our first follow up call revealed three quarters of those who said they would purchase insurance through the auction still intended to do so. But after a second call, as well as a additional text messages and a field visit, only six of the 361 farmers who were supposed to purchase insurance actually did.

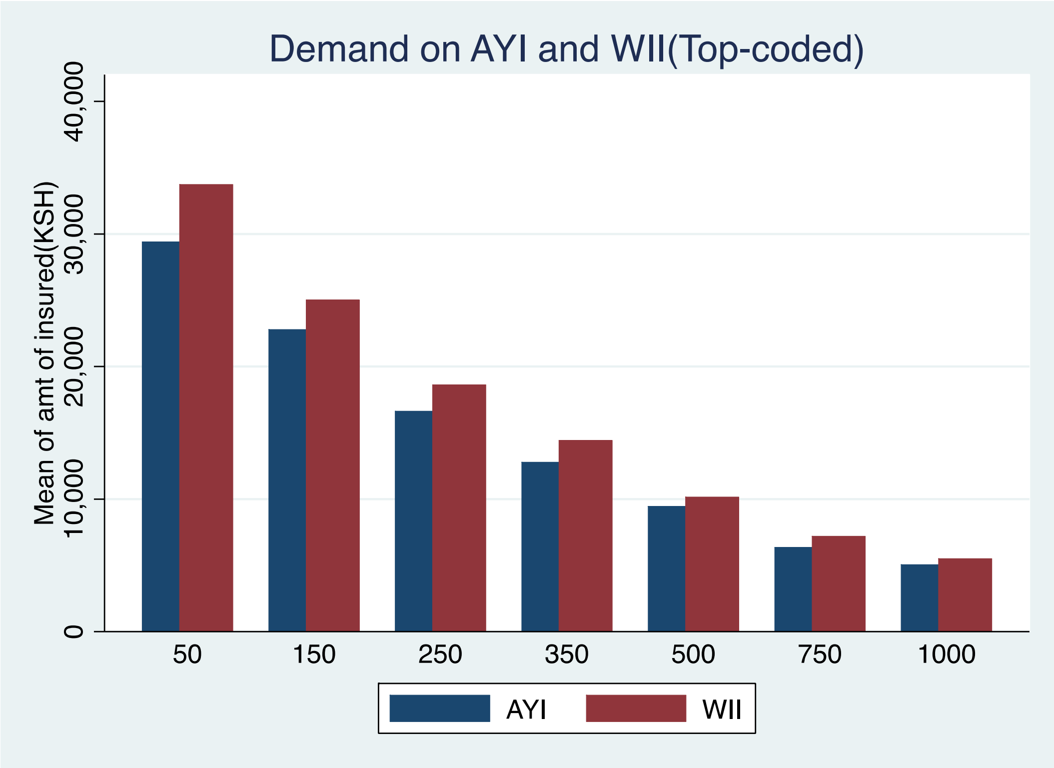
Perhaps this should not be surprising given the many studies that have shown low demand for WII at market prices. However, even at highly (93%) subsidized prices farmers were unwilling to purchase insurance. Further discussion with farmers indicated that pressing needs (e.g., school fees, medication) prevented many farmers from raising enough money to pay the premium. Others reported that the timing was bad, as payment was requested at the onset of the school year. Others reported that the timing was bad because sales were made at the end of the month, before men working menial jobs received their income (although neither deadline was at the end of the month). Lastly, some farmers said that they lost their crop the previous year and therefore had no money to pay premiums.

We also speculate that too much time passed between the intervention and planting time. This was due to the election, which required us to pause all field activities for three weeks. Making matters worse, the election was historically chaotic (and was eventually nullified). Clearly our timing was not ideal, but the election date and funding window left no other options. We are still gathering data on why farmers are not purchasing insurance, but lack of trust in the product and lack of available cash appear to be the most prevalent reasons.

8.1.4 Intervention effects on demand for a hypothetical Area Yield Insurance product

After the conclusion of the WII auction, enumerators explained that farmers would bid on a hypothetical AYI product with the same payout probability distributions as the WII product. Enumerators emphasized that even though the auction was not for a real product, and therefore no money would change hands, that farmers should take it seriously. We found that demand for AYI was slightly lower than for WII at all prices (Figure 5). This goes against our intuition for two reasons. First, we would expect hypothetical bias to drive bids for AYI upwards. Second, we expected that farmers would prefer AYI because it covers multiple risks, not just low rainfall.

Figure 5: Demand for Area Yield Insurance versus Weather Index insurance



Treatment effects for AYI were nearly the same as for WII demand, which is unsurprising given the high correlation between the two. It is entirely possible that by this point farmers were very tired, and just used a slightly lower value than that they used in the WII auction without giving it much thought. Unfortunately, we do not believe we can glean anything about farmers' preferences for AYI compared to WII from this study beyond that farmers do not appear to vastly prefer AYI to WII after the rather quick explanation our enumeration team gave.

8.1.5 Other results

We are still analysing impacts of events within the experiential game. One preliminary result is that negative basis risk events depress demand, indicating that experiences within the game do matter for stated WII demand.

8.1.6 Perception of the product among beneficiaries

Farmers were not offered both products as part of the experiment. Thus, it was not possible to observe their reaction to being offered insurance products with a higher resolution and lower resolution at the same time. Field staff reported no difference in farmers' reactions to being offered LR or HR insurance, although the data clearly show they could differentiate between the two and preferred the HR product. Given the minimal explanation of resolution and why it matters, this came as a surprise.

Farmers were very receptive to the experiential game. They quickly caught on after one or two practice rounds, and appeared deliberate in their choices. Most participants also appeared to learn that they were not guaranteed a payout if their farm experienced a drought; the payout was determined by the square and thus, we believed, learned about basis risk. They were highly engaged, pleased with good outcomes within the game, and slightly dismayed with bad outcomes. It seemed they clearly understood why they did and did not get payouts in the various rounds of the game. The game did not, however, significantly improve knowledge of or attitudes towards WII, although we have doubts about the quality of knowledge and attitude data.

8.1.7 Actual versus planned study sample

Our sample consisted of smallholder farmers in Tharaka-Nithi county, a semi-arid area 200 km northeast of Nairobi. We selected this area because it is a KCEP-CRAL area, high-resolution CHIRPS data is available, and we were told an existing status quo insurance product did exist. We could not work with actual KCEP-CRAL farmers because the management unit for the program did not have beneficiaries selected yet, and doing a census in KCEP-CRAL's targeted villages was prohibitively expensive. Thus, we composed our sample of smallholder farmers who purchase inputs through an aggregator, who in turn insures the value of these inputs to farmers. Because the aggregator had contact information for these farmers, we were able to identify a sample. While these farmers may or may not become KCEP-CRAL farmers, their characteristics are similar to those likely be targeted.

8.1.8 Actual versus planned intervention

The interventions were carried out mostly as originally planned. One substantial difference is that we only offered one type of insurance to each farmer, and for farmers playing the experiential game, only administered one version of the game. When we piloted the game using two insurance products, it was very long and quite complex. Moreover, farmers are normally not in a position to choose between two similar insurance policies. By posing farmers with a direct comparison, we worried the data would overstate the difference in demand between the two. Thus we decided to only offer one product to each farmer and measure treatment effects as the difference in averages between groups, rather than using differences within farmers and across groups.

The downside of this approach is that it resulted in four treatment groups rather than two, and thus reduced statistical power. However, we believe the finding that farmers exhibit higher demand for higher resolution is more credible given individual farmers were not making a comparison between two products.

A second difference is that we could not compare the improved high resolution WII to the product currently used by ACRE. The improved WII uses CHIRPS data, which is available at 5 x 5 resolution. ACRE used 10 x 10 ARC2 data previously. After we began working with the CHIRPS data we learned that even though it is higher resolution, many experts believe the ARC2 data is superior. At a minimum, it is different. To ensure that the higher resolution insurance was unambiguously better than that lower resolution insurance in terms of basis risk, we created a 10 x 10 CHIRPS dataset with which to make the low-resolution version of the game.

A third difference is that insurance resolution was assigned at the session rather than individual level. This did not end up costing us that much power, however, as the intra-cluster correlation for insurance demand was less than 0.05, and inference with standard errors clustered at the session level is very similar to inference with standard errors clustered at the farmer level.

8.1.9 Compliance

Nearly all farmers asked by the aggregator to participate in the experiment did so. The potential winnings were a strong incentive to participate, and we had to turn away many farmers not working with the aggregator in order to respect our budget. We do not have a complete list of the aggregator's farmers, only those that did attend a session. However, the number of farmers included in the sample was very close to the number the aggregator initially said they had.

8.1.10 Balance

One possible source of bias in small sample experiments such as this is imbalance across treatments. We do find some imbalance, but not much more than would be expected by chance. We regress farmer characteristics on treatment status and find that four of 33 coefficient estimates are significantly different than zero at the 0.1 confidence level. These differences are that:

1) *Farmers in the Game/LR group are 12% more likely to be male than in the No Game/LR group.*
2) *Farmers in the Game/LR group have 0.5 more acres of than farmers in the No Game/LR group*
3) *Farmers in the Game/HR group are 24% less likely to have experienced a drought in the past five years than farmers in the No Game/LR group*
4) *Farmers in the Game/HR group are 11% more likely to be literate than farmers in the No Game/LR group*

If not controlled for, the first imbalance could lead us to find that the game was more (less) effective than it actually was at increasing demand for LR insurance if males (females) have higher demand. We find that males have higher insurance demand (not accounting for other variables). Therefore this bias would likely work against our counterintuitive findings.

The second could lead us to find that the game was more effective than it actually was if farmers with more land have higher demand. Again, this bias would likely work against our counterintuitive findings.

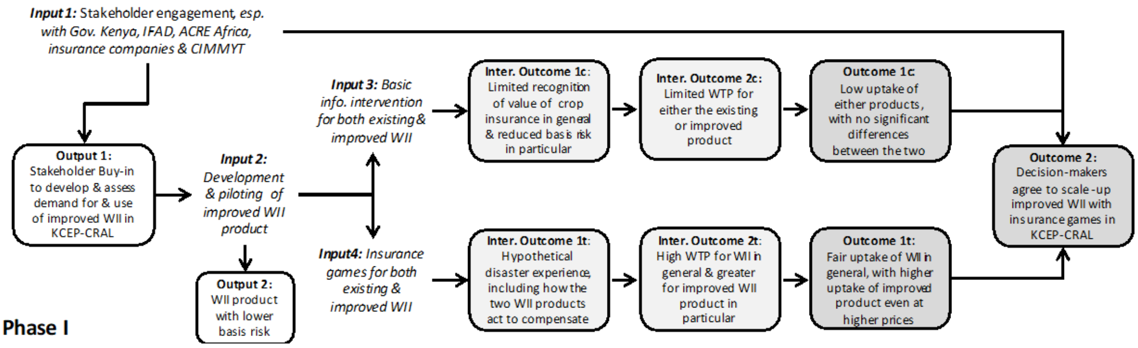
The third imbalance could lead us to find that the game was less effective at increasing demand for HR insurance than it actually is if farmers who have experienced a drought in the past five years have higher insurance demand. The fourth imbalance could lead us to find that the game was more effective at increasing demand for HR insurance than it actually is if literate farmers have higher insurance demand. Both of these biases would work towards our counterintuitive findings.

Imbalance is not uncommon in small sample experiments. To address potential imbalance we control for variables we have data on that are likely to influence insurance demand, whether or not they are found to be imbalanced (Bruhn and McKenzie 2009). Thus, our results should not be biased by imbalance in observable variables. There is nothing we can do to control for imbalance amount unobserved factors that are not highly correlated with observable ones. A balance table can be found in Appendix F.

8.1.11 Impact Pathways

Figure 6 contains the original theory of change diagram from our phase 1 proposal. There were several things that did not go as planned, and assumptions that did not hold, which we describe below.

Figure 6: Theory of Change Diagram from Phase 1 Proposal



It is uncertain whether the improved WII product (**Output 2**) was really better than the status quo given that the HR insurance was made using the CHIRPS data and the status quo insurance was made using the ARC2 data.

Both the basic information session (**Input 3**) and insurance games (**Input 4**) were made for a single product, rather than to explain both products to the same farmers. The games did effectively exhibit lower basis risk with the HR insurance than the LR insurance (**Intermediate Outcome 1t**), but these differences did not lead to higher demand for HR insurance than LR insurance (**Intermediate Outcome 2t**) among farmers who played the game, as expected. Playing the game did lead to higher demand for LR insurance among farmers offered that product. Strangely, the game did not lead to higher demand for HR insurance among.

Somewhat surprisingly, and encouragingly, farmers had higher demand for the HR insurance than LR insurance without playing the game (**Intermediate Outcome 1c**). We did find higher insurance demand with the insurance game than without it (**Outcome 1t**), although this effect was concentrated among farmers offered low-resolution insurance. We did not find extremely low demand for either product among farmers who did not play the game (**Outcome 1c)**, although stated demand was much higher for the HR product.

These results leave considerable uncertainty over the effectiveness of the games. If the games were ineffective in the HR format because they were less aesthetically appealing, it is easy to rescale them to convey the same information (probabilities) as the current HR game, but look like the LR game. If it is the case that demand for HR insurance is maxed out without a game, it still may be possible to raise demand for ACRE's typical insurance product, which is at 10 x 10 resolution. In our Phase 2 proposal we include further small scale testing of the experimental game in year 1 before scaling up in year 2 (**Outcome 2**).

9. Implications of study findings

9.1 Implications for the intervention

9.1.1 Revised timeline

We deviated from our original Phase 1 timeline we engaged in extended discussion over the most appropriate type of insurance to use for the project. These discussions, and the ensuing delay in creating insurance using CHIRPS data, made it more feasible to conduct the study leading up to the fall season rather than the spring season. Furthermore, ACRE informed us farmers were more prone to insure for the short rainy season in the fall, when rainfall is more uncertain. Thus we pushed all activities forward five months, but were able to adhere closely to this new timeline and complete our project on time. Table 5 presents our actual implementation timeline.

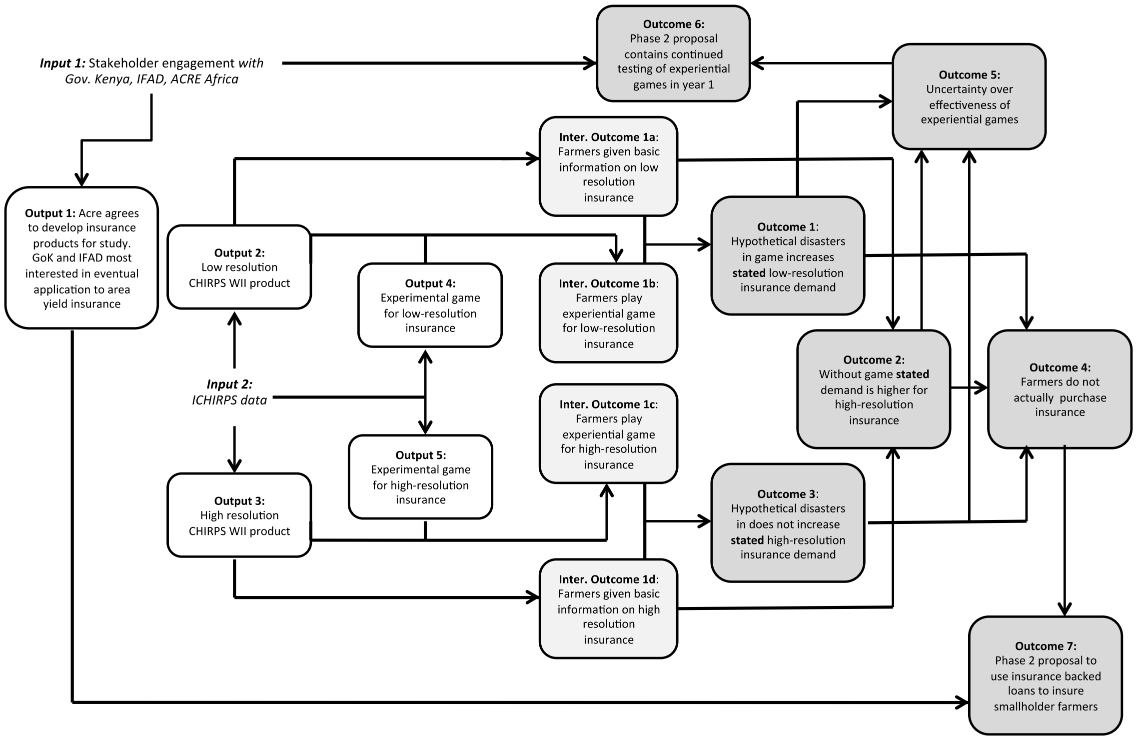
Table 5: Actual timeline of intervention

Dates (2017)	Activities
Jan- Feb	Develop protocol and script for game and information session, create maps for game, develop questionnaire and auction protocol. Pilot protocol with graduate students at University of Georgia
Mar-Apr	Revise and calibrate experimental game and auction
May	Finalize game and auction for piloting
June	Pilot game and auction in Kenya, develop basic information session with Acre and aggregator representatives
July	Conduct games, information session, surveys
Aug	Elections in Kenya delay sale of insurance
Sep	Follow up calls and meetings to sell insurance to farmers based on auction results

9.1.2 Revised theory of change

Our revised theory of change diagram can be found in Figure 7 below. The main difference between the planned and actual intervention is that we had four treatment groups rather than two for the aforementioned reasons. Our first assumption that did not hold is that the game would be more effective at increasing demand for HR insurance than LR insurance. The opposite was true. Our second assumption that did not hold is that farmers would actually purchase the insurance they committed to purchasing in the auction. The auction was explained as being a commitment. While we expected some farmers to not follow through and purchase insurance, we did not expect that nearly all farmers would not purchase insurance. This has large implications for our Phase 2 proposal.

Figure 7: Theory of Change Diagram Reflecting Actual Outcomes



9.2 Implications for further research

In Phase 1 we learned that farmers are sensitive to the resolution of index insurance products. We also learned that games can be effective at promoting stated insurance demand, although there is uncertainty as to under what conditions. We also learned, unfortunately, that the farmers in our study area will not actually purchase weather index insurance on its own.

We believe there is great value in continuing this line of research in Phase 2, but with changes to the index insurance product. With our implementing partner ACRE, we propose bundling index insurance with credit. Index insurance-backed loans will allow farmers to invest in production with less risk because the loan will be forgiven if the insurance strike point is hit. Lenders will be able to offer more favorable rates because they will be insured against covariate farmer default risk. Lending to many farmers will average out idiosyncratic risk. We intend to build on our Phase 1 results by using modified experiential games to promote insurance, but place most of our focus on using insurance-backed loans to protect farmers from climate risk rather than trying to sell them insurance as a standalone product.

We also propose, if possible, to offer area yield insurance rather than weather index insurance. The Government of Kenya and KCEP-CRAL are focusing on this type of index insurance for smallholder farmers, and farmers may prefer it because it covers multiple perils, and is based on yields and not the relationship between weather and yields as predicted by crop models and historical data. While KCEP-CRAL is certain about offering AYI to farmers, the mode of delivery (i.e. the roll out plan) has yet to be determined and will be informed through a feasibility study that has not been carried out to date. Once this study is complete we can better establish a timeline.

We believe that all of our key findings generally apply to AYI: Farmers are sensitive to basis risk, experiential games show potential to teach farmers about index insurance but need refinement, and farmers are resistant to purchasing index insurance as a standalone product. This third point could be different for AYI: It is possible farmers prefer it. However, we asked farmers, in the hypothetical, if they preferred AYI to WII and less than half did. Stated demand was no higher for AYI than WII. Given the policy environment, however, we believe there is more potential to scale up AYI products than WII products.

10. Major challenges and lessons learnt

We experienced several major challenges over the life of the project, as described below.

First, engaging the GoK as a key implementing partner has proven difficult. Although we had support from IFAD, a major donor for the intervention, it was not enough to influence the government to support a rigorous Phase 2 impact evaluation. Nonetheless, the government has remained very interested in our activities and especially our findings. Although we are not proposing an impact evaluation of KCEP-CRAL for Phase 2 as originally intended, we anticipate our findings will be of continued interest to the KCEP-CRAL PCU, and we will continue to engage them as key stakeholders.

Due to this bounded support from the GoK we opted to work more closely with Acre for implementation of Phase 1. Although not listed as an official implementing partner for Phase 1, our original proposal included a letter of support from Acre and a commitment from them to support the design of the improved WII. This partnership has been very fruitful. In addition to meeting their original commitments, Acre provided access to a sample population (through the aggregator) very similar to the KCEP-CRAL target population. This accommodated analysis of the proposed research questions without disrupting KCEP-CRAL program activities, while ensuring policy relevance. Given the positive relationship that has developed between the research team and Acre, we plan to continue our partnership with Acre in Phase 2, as described in our proposal.

In November 2016, we became aware of the Government of Kenya’s plans to promote and subsidize AYI, rather than WII, throughout much of the country by 2020. AYI has many advantages over WII, most notably, the payout is based on actual yields and therefore covers multiple perils, so it is likely to reduce basis risk. However, AYI is often more expensive to provide and has important data limitations. Although obviously policy relevant, our assessment revealed it would be impossible to design an AYI for the target region at this time given data limitations. Nonetheless, we found it highly challenging to convince the government of Kenya of the policy relevance of continuing a study focused on WII rather than AYI (despite pointing out that basis risk would still be applicable to both, and the games could be used to promote either type of insurance product). Extended discussions of whether the proposed study on WII remained policy relevant, and attempts to positively engage with the GoK, affected the work plan resulting in delays. These delays allowed for additional time to more carefully design the research tools prior to conducting fieldwork in June and July.

The solution to this challenge was to conduct an auction for a hypothetical AYI product, and introduce the following two questions into our survey: “Area yield insurance operates like rainfall insurance, but payments are based on average yields in the area instead of average rainfall. If this type of insurance were developed in your area for the same price as rainfall insurance, which product would you prefer to buy?” If the respondent stated a preference for AYI, they were then asked “would you be willing to pay more for AYI than rainfall insurance?” with possible responses being (a) yes, much more, (b) yes, slightly more, or (c) no. The data shows that 40% of respondents prefer AYI, but of those only 27% are willing to pay “much more for it” (and 18% are not willing to pay more for it at all). These findings have been shared with the KCEP-CRAL leadership.

Through these challenges we have learned a great deal regarding how to positively engage with stakeholders in order to ensure policy relevance and stakeholder buy-in. If funded for Phase 2, we anticipate that the invested efforts in stakeholder engagement, improved understanding of the cultural and institutional context, and an increasingly positive relationship with Acre will lead to a rewarding Phase 2 collaboration.

Appendix A: Game protocol

This document describes how to administer the insurance game intervention, which is intended to help subjects understand the concept of basis risk. Subjects will learn about two weather based index insurance products with different degrees of basis risk through the interactive game experience. Section 2 introduces the game to participants. Section 3 and 4 provide participants with multiple practice games for their better understanding. Section 5 contains 7 rounds of real games. At the conclusion of the session, the final payout for participants will be determined with the help of their assistants (Section 6).

This document is to be read by the Game Master (GM) in a way that is accessible to participants, except for sections that directly address Assistants.

1. Introduction

[ASSISTNATS: Start by greeting farmers and signing them in as they arrive. Each farmer will receive a numbered piece of paper to help identify him/her during the exercises. Each farmer will be assigned to an assistant (2 farmers per assistant). Once assigned a farmer, the assistant should introduce himself politely and ask the farmer to have a seat with him. When everyone seat, game master starts the session.]

GAME MASTER: "Thank you for coming. My name is (NAME), and I working with a team of researchers from Nairobi and America. The purpose of this visit is to learn about how farmers like you understand and appreciate crop insurance. If you decide to participate in the study, you will play in some entertaining games. You will earn a minimum of 120 KSH for participating. On top of that you will have a chance to earn money in the games. No one will leave with less money than they came in with. Before beginning the game, your assistants will now ask you a few questions.

[ASSISTANTS: You will have a packet for each participant that contains (1) the human subjects form, (2) the introductory questionnaire, (3) the game worksheets, (4) auction bid sheets, and (5) exit questionnaire. Begin by reading the farmer the informed consent form and asking if he/she agrees to participate. If so, either have the farmer sign or sign on his/her behalf is the farmer consents and is unable to sign. If the farmer agrees, begin the survey.]

Is everyone finished? Great! We are ready to explain the insurance product.

2. Basic Introduction without Games

Have any of you heard of insurance before? What do you know about it, if anything?

[ASSISTANTS: If they have heard of insurance before, continue to the next paragraph. If not, state the following: Insurance is a product you can buy to protect you when bad things happen. You pay a fee each year or season, and if something bad happens, you receive a payout. You must pay the fee even if nothing bad happens, which is how the insurer is able to cover their costs. There are many kinds of insurance, like motorbike insurance, life insurance, and health insurance, for example.

Our colleague described agricultural insurance to you today. Specifically, he described "Weather based Index Insurance (WII)". WII is insurance you can purchase before the beginning of an agricultural season. If rainfall is poor in your area and you have purchased WII, you will receive a payment to compensate you for your likely losses. Recall that WII does not pay out based on the losses on your farm, or the rainfall on your farm, but based on the overall rainfall in your area.

We would like to show you one insurance product for this game. Then you will play insurance games to help you better understand how the insurance works. In each round of the games, you will choose whether to buy the insurance and see how much you will earn from both your harvest and your insurance payout depending on rainfall.

How insurance payouts are calculated

[Map with dots] This is a map of your county. The black dots represent farms. WII divides a given region into many squares **[Map with dots and squares].** [5X5 GROUP: The squares are 5km by 5 km. 5 kilometers is about from X location to Y location. 10X10 GROUP: The squares are 10 km by 10 km. 10 kilometers is about from X location to Y location.] Satellites estimate the amount of rainfall in each square. The cameras on the satellites are no strong enough to see the amount of rainfall on individual farms; they can only estimate it for larger areas. Insurance payouts are based on the amount of rainfall in the squares.

Now, we will explain how insurance payouts are decided using a [WII] map**.** A farm can receive good rain, medium rain, or poor rain. On the map, 'Green' means rainfall is good, 'Yellow' means rainfall is medium, and 'Brown' means rainfall is bad. Let's see what rainfall farms receive [**Display maps with rainfall**]. Those with Green farms had good rainfall. Those with yellow farms had medium rainfall. Those with brown had poor rainfall.

WII payouts are based on the overall rainfall calculated for the square where a farm is located. Just like for the farms, there are three outcomes for the squares: Green, Yellow and Brown. Green means rainfall was good overall in the square, Yellow means rainfall was medium overall in the square, and Brown means rainfall was bad overall in the square.

Let's see what the rainfall outcomes measured for the squares are **[Display rainfall results in [WII] squares].** If a farmer's square is Green, he will not receive any payout because the overall rainfall in his/her square is good. If a farmer's square is Yellow and he bought insurance, he will receive a medium sized payout. If a farmer's square is brown and he bought insurance, he will receive a larger payout. Once again, insurance payouts depend only on the overall rainfall in the square where a farm is located, not on the rainfall the farm itself receives. Therefore, to best protect farmers from poor rainfall, the overall rainfall in the square should be as close to possible as the rainfall on the farm.

How to earn money in the game

Before playing the game, I will go over how you earn money in the game. In the game, you all expect to earn 10,000 KSH from your production of sorghum and green gram. You draw a card that indicates what farm you have on the map. The game has seven rounds; each round is like a short rain season. In each round, you will decide how much insurance to purchase, if any, before planting. The price of the insurance products will vary round by round. After you make your insurance decision, we will reveal rainfall for that round of the game.

If the rain on your farm is good (green), you earn 10,000 KSH. If it is medium (yellow) you earn 7000 KSH. If it is bad (brown) you earn 5000 KSH.

In this game, you can buy one or two units of insurance, or none at all if you think the price is too high. One unit of insurance will pay you 1500 KSH if your square gets medium rain (yellow), or 2500 KSH if your square gets bad rain (brown). Remember, you don't get any payout if your square gets good rain. If you buy two units of insurance, then you need to pay 3,000 KSH because one unit of insurance costs 1500 KSH, but the insurance payout also doubles. Two units of insurance will pay you 3000 KSH if your square gets medium rain (yellow), or 5000 KSH if your square gets bad rain (brown).

[ASSISTANTS: Go over these values with the farmers until they understand. Refer to the following table:

	1 unit of insurance	2 units of insurance
Green	0	0
Yellow	1500	3000
Brown	2500	5000

Your assistant will walk you through each round of the game, record your decisions and tell you the outcome of each round. After we are done playing all seven rounds of the game, we will select one of these rounds at random. We will divide the payout of the selected round by 100 and add this calculated value to your participation fee, 100 KSH.

Now let us determine which farm on the map is yours. Please draw a card with a farm number on it [**Display map with farm numbers].** Please match the number on your card to the farm in the map. Can everyone find your farm? Great! Let's begin!

Before we begin the seven rounds of the game, we will do a few practice rounds for you to better understand how the game works.

[**ASSISTANTS:** You will fill out the game worksheets as the game proceeds**]**

3. Insurance game with the [WII] (without prices)

First, you are going to play one round game where you will decide how many units of insurance you want to purchase the [WII] product. Suppose you are given the [WII] product *for free*. That means the insurance premium in this round is Ksh 0. Please tell your assistant if you will accept one unit of the [WII] for free. [ASSISTANTS: If your farmers decide to accept, please circle "Yes" in the column marked "Accept?"].

Did everyone accept the insurance? [Game master: If someone did not accept the free insurance, ask them why. Explain to the group that because is insurance will pay them if rain is medium or bad, and the insurance costs nothing to them, it is a good idea to take the insurance].

Now, we will show you a randomly chosen map that shows the rainfall for this round of the game. **[Display Map 1 with farm rainfall outcomes.]** Now please check whether rainfall is good (Green), medium (Yellow) or bad (Red) on your farm? Please draw a circle in the column marked "Farm Rainfall". [Assistant: Help the participant find their farms on the map and draw a circle in the column marked "Farm rainfall".] Did everyone check? Great. Now, please check your overall rainfall outcomes measured for the squares. [**Display Map 1 with station rainfall outcomes.]** Please draw a circle your rainfall outcome in the column marked “Square Rainfall”. [Assistant: Help the participant find their square on the map and draw a circle in the column marked “Square Rainfall”.] We can help you calculate your expected payoff based on your outcomes. Since there is no price in this round, only parts you need to pay attention to are “Farm Rainfall” and “Rainfall Outcome”.

[ASSISTANTS: Calculate their payout by referring to the “Payout Reference Table”. Explain step by step with simple words. The conversation starts like that: You earn Ksh * for harvest value, because your farm rainfall is (Green/Yellow/Brown). You receive Ksh * for insurance payout, because the rainfall outcome is Yellow (Brown). (Or, You don’t receive insurance payout, because the rainfall outcome is Green). Since the insurance price is Ksh ?, your final payout is …]

[ASSISTANTS: Then go through what kind of net income they would have receive if they made different insurance decisions. If they purchased 2 units, what would have happened if they purchased 1, or no insurance?]

Do you understand how this insurance works? Let’s move on to another practice round.”

4. Insurance game with the [WII] (with prices)

“Now, we will impose a random price for the [WII]. **[Ask a farmer to blindly pick a price from the envelope**] Suppose the price of 1 unit of the [WII]product for your land is Ksh *P*. That means you need to pay this amount of money if you want to buy 1 unit of insurance. If you want two units of insurance, you must pay 2**P*. You still have farms in the same location as before. Please tell your assistants whether you would like 0,1, or 2 units of insurance.[ASSISTANTS: Write down the price in the column marked “Price” and circle the number of units they want to buy. Then write the total cost under “Insurance Cost”].

Now, we will show you a randomly chosen map that shows the rainfall for this round of the game. **[Display Map 2 with rainfall outcomes.]** Now please check whether rainfall is good (Green), medium (Yellow) or bad (Brown) on your farm? Please draw a circle in the column marked “Farm Rainfall”. [Assistant: Help the participant find their farms on the map and draw a circle in the column marked “Farm rainfall”.] Did everyone check? Great. Now, please check your overall rainfall outcomes measured for the squares. [**Display Map 2 with station rainfall outcomes.]** Please draw a circle your rainfall outcome in the column marked “Square Rainfall”. [Assistant: Help the participant find their square on the map and draw a circle in the column marked “Rainfall Outcome”.] We can help you calculate your expected payoff based on your outcomes. If you bought the insurance you need to subtract the price of the insurance from your payout. Then, pay attention to “Farm Rainfall” and “Square Rainfall”.

[ASSISTANTS: Calculate their payout by referring to the “Payout Reference Table”. Explain step by step with simple words. The conversation starts like that: You earn Ksh * for harvest value, because your farm rainfall is (Green/Yellow/Brown). You receive Ksh * for insurance payout, because the rainfall outcome is Yellow(Brown). (Or, You don’t receive insurance payout, because the rainfall outcome is Green). Since the insurance price is Ksh ?, your final payout is …]

[ASSISTANTS: Then go through what kind of net income they would have receive if they made different insurance decisions. If they purchased 2 units, what would have happened if they purchased 1, or no insurance?]

5. Insurance game with the REAL money (with prices)

Now, you are going to play 7 rounds of the same game but with prices and real money involved. In each of the 7 rounds, you are asked to choose how many units of insurance you want at the drawn price. The price of the insurance product is randomly chosen in each round. You still have farms in the same location as before. Note that the outcomes from previous rounds do not affect the next rounds. That means, you always start a new round. At the end of the games, we will randomly select one round as your binding round. Then, We will divide the payout of the selected round by 100. Your final payouts will be your show-up fees plus your calculated payout of the one randomly chosen round among 7.

(Round 1-7)

Now, let's begin the round 1. Remember, your final payout with real money is going to be decided among these 7 rounds of the game. We will show you the price of the insurance product **[Ask a farmer to blindly pick a price from the envelope**]. Please tell your assistants whether you would like 0,1, or 2 units of insurance. [ASSISTANTS: Select 0/1/2 according to how many units of insurance your farmer would like to buy. [ASSISTANTS: Write down the price in the column marked "Price" and circle the number of units they want to buy. Then write the total cost under "Insurance Cost"].

Now, we will show you a randomly chosen map that shows the rainfall for this round of the game. **[Display the next map with rainfall outcomes.]** Now please check whether rainfall is good (Green), medium (Yellow) or bad (Red) on your farm? Please draw a circle in the column marked "Farm Rainfall". [Assistant: Help the participant find their farms on the map and draw a circle in the column marked "Farm rainfall".] Did everyone check? Great. **[Display the next map with square outcomes.]** Now, please check your overall rainfall outcomes measured for the squares. Please draw a circle your rainfall outcome in the column marked "Square Rainfall". [Assistant: Help the participant find their square on the map and draw a circle in the column marked "Square Rainfall".] We can help you calculate your expected payoff based on your outcomes. If you bought the insurance you need to subtract the price of the insurance from your payout. Then, pay attention to "Farm Rainfall" and "Square Rainfall".

[ASSISTANTS: Calculate their payout by referring to the "Payout Reference Table". Explain step by step with simple words. The conversation starts like that: You earn Ksh * for harvest value, because your farm rainfall is (Green/Yellow/Brown). You receive Ksh * for insurance payout, because the rainfall outcome is Yellow(Brown). (Or, You don't receive insurance payout, because the rainfall outcome is Green). Since the insurance price is Ksh ?, your final payout is …]

(Same procedures go on for rest of the rounds.)

6. Closing

Now, we are going to draw a number for round which will be binding. We have prepared seven cards from number 1 to 7.

[GM: Shows each card separately and announce the number as you hold up the card for everyone to see.]

We will mix up these cards and place them in an envelope. The number card that is drawn will be the binding round at which your payout from the game is decided.

[GM: Have one of the farmers draw a card. Hold up and announce the drawn card.]

Ok, the drawn number is [NUMBER]. Your assistants will help you calculate your payout from the binding round. The calculated value will be your game payout of this binding round.

[ASSISTANTS: Divide the net income of the binding round by 100 (e.g., If your farmer's payout for round [NUMBER] is KSH 12500, you divide KSH 12500 by 100. The final payout from the game will be KSH 125).]

Now, your assistants calculate your final payout by adding your game payouts to your participation fees.

[ASSISTANTS: Calculate your farmer's final payout by adding his/her game payout to his/her show-up fee, and record the final number in the game worksheet.

The payout transaction will take place at the end of the all sessions we have prepared.

Appendix B: Game worksheet

Farmer name: **Farm number (in game):**
Farmer ID: **Assistant:**

P1. Practice round (free insurance)

Price	Units bought	Farm Rainfall	Net income
0	0/ 1/ 2	Green/ Yellow/ Brown	Farm income:
			Insurance income:
		Square Rainfall	Insurance cost:
		Green/ Yellow/ Brown	Net income:

P2. Practice round (with price)

Price	Units bought	Farm Rainfall	Net income
	0/ 1/ 2	Green/ Yellow/ Brown	Farm income:
			Insurance income:
		Square Rainfall	Insurance cost:
		Green/ Yellow/ Brown	Net income:

1. Real round 1

Price	Units bought	Farm Rainfall	Net income
	0/ 1/ 2	Green/ Yellow/ Brown	Farm income:
			Insurance income:
		Square Rainfall	Insurance cost:
		Green/ Yellow/ Brown	Net income:

2. Real round 2

Price	Units bought	Farm Rainfall	Net income
	0/ 1/ 2	Green/ Yellow/ Brown	Farm income:
			Insurance income:
		Square Rainfall	Insurance cost:
		Green/ Yellow/ Brown	Net income:

3. Real round 3

Price	Units bought	Farm Rainfall	Net income
	0/ 1/ 2	Green/ Yellow/ Brown	Farm income:
			Insurance income:
		Square Rainfall	Insurance cost:
		Green/ Yellow/ Brown	Net income:

4. Real round 4

Price	Units bought	Farm Rainfall	Net income
	0/ 1/ 2	Green/ Yellow/ Brown	Farm income:
			Insurance income:
		Square Rainfall	Insurance cost:
		Green/ Yellow/ Brown	Net income:

5. Real round 5

	Units bought	Farm Rainfall	Net income
	0/ 1/ 2	Green/ Yellow/ Brown	Farm income:
			Insurance income:
		Square Rainfall	Insurance cost:
		Green/ Yellow/ Brown	Net income:

6. Real round 6

Price	Units bought	Farm Rainfall	Net income
	0/ 1/ 2	Green/ Yellow/ Brown	Farm income:
			Insurance income:
		Square Rainfall	Insurance cost:
		Green/ Yellow/ Brown	Net income:

7. Real round 7

Price	Units bought	Farm Rainfall	Net income
	0/ 1/ 2	Green/ Yellow/ Brown	Farm income:
			Insurance income:
		Square Rainfall	Insurance cost:
		Green/ Yellow/ Brown	Net income:

Final Income

Binding Round	
Net income	
Take-home pay	

Appendix C: Auction script

The following is a script for a modified multiple price list auction for weather index insurance (WII). The auction activities will be conducted right after the treatment activity. Section I introduces the auction to participants. Section II uses common goods to help participants understand the auction mechanism. Section III elicits bids for insurance products for sorghum and green gram respectively. Section IV elicits farmers' WTP for Area Yield Insurance (AYI) in hypothetical setting. This product does not yet exist for this area. At the conclusion of the session participants will sign their intention letters to purchase insurance based on auction outcomes (Section V).

This document is to be read by the Game Master (GM) in a way that is accessible to participants, except for sections that directly address Assistants.

I. Introduction

Now you will have the opportunity to purchase the [WII insurance] product that we introduced in the previous session. This policy has been designed by and will be sold by ACRE. As in the previous session, you will work with the assistant in this session. At any point if you have questions, you should ask your assistant.

We will show you one insurance product offered by ACRE that resembles the insurance product our team previously described to you.

The best strategy for this auction is to state the true amount of insurance you would purchase at each price. The auction does not reward you only stating you will purchase insurance at very low prices. You should not bid low amounts to try to get a deal. The eventual prices of the insurance products are determined by a draw from an envelope, not by your bids. You will purchase insurance at the corresponding price drawn from the envelope if and only if you bid at least that much. You will not pay more or less than the price drawn from the envelope.

This next point is very important: Nobody else's choices affect whether or not you will purchase insurance or the price you will pay for insurance. Only your own decisions and the prices drawn from the envelopes will affect whether or not you buy insurance, and how much insurance you buy.

This may seem complicated, but we will do some practice auctions that should make things clear. Before we move on, your assistants will ask you about output and input values for sorghum and green gram you expect this short rain season.

[ASSISTANT: Ask questions in Table C1 of the bid sheet to your farmer and fill out each row in the Table C1. If your farmer grows only one of the two crops, then ask the relevant questions about that one crop they grow.]

Table C1: Output values

A	Acres of **sorghum**	
B	Projected **sorghum** yield (**kg** per acre)	
C	Expected **sorghum** price received (KSH per **kg**)	
D	Expected total value of **sorghum** produced [A x B x C]	

E	Expected input value of **sorghum** purchased	
F	Expected net value of **sorghum** produced [E-F]	
G	Acres of **green gram**	
H	Projected **green gram** yield (**kg** per acre)	
I	Expected **green gram** price received (KSH per **kg**)	
J	Expected total value of **green gram** produced [G x H x I]	
K	Expected input value of **green gram** purchased	
L	Expected net value of **green gram** produced [J-K]	

Has everyone finished? Great, let's move on to the first practice auction.

II. Example auction using common goods

We will start with an auction where you bid on only one good. In this case, the good is cookies. We will do a round where your bids can lead to you purchasing real cookies with real money. You all have KSH 50, because we gave you some as a gift for your participation. You can use this money to purchase [cookie A] if you would like, however you don't need to use this money to buy [cookie A] if you don't want cookies.

Real bids

We have [cookie A] on the Table. We have enough for everyone to purchase [cookie A]. You are NOT competing against the other farmers in the auction to purchase [cookie A]. We would like to know if how many cookies you would like to purchase at different prices. Your helper will ask you this question for several different prices. Please talk with your helper privately, as not to influence the decisions of other participants.

[ASSISTANT: Work separately and quietly with the farmer to complete the Table 2. Start by asking "If the price of [cookie A] is Ksh A1 each, how many [cookies A] would you want to purchase? Put the number of cookies the farmer wishes to purchase, even zero, in Table 2 under KSH 1. Confirm the number of [cookies A] the farmer will receive (# of cookies chosen) and amount the farmer will pay (# of cookies chosen x KSH 1) if KSH 1 is drawn. Ask the farmer if this is correct. If so, continue. If not, ask again how many cookies they would like to purchase at 1 KSH.

Continue asking for KSH 2, KSH 5, and KSH 10 until he/she says he/she does not want to purchase any cookies at this price. At this point, say "It sounds like you are not willing to pay more than [highest price with a positive number] for [cookies A]. Is this right?" Once he/she is satisfied, turn to the next farmer who you are helping, and conduct the same procedure.]

Table C2: Real cookie

1	Price of cookie	Ksh 1	Ksh 2	Ksh 5	Ksh 10
2	How many they want to buy				
3	Total paid for cookies				

Now that you have completed your purchase decisions, we will describe how we will determine the price of the [cookie]. We asked you how many cookies you were willing to buy at four different prices. We have prepared five cards, one with each of these prices.

[GM: Shows each card separately and announce the price as you hold up the card for everyone to see]

To determine what the price will be, we will mix up these cards and place them in an envelope. The price card that is drawn will be the price at which you purchase cookies. You will purchase the number of cookies you said you would purchase at this price.

[GM: Have one of the farmers draw a price card. Hold up and announce the drawn card.]

Ok, the drawn price is [Price]. Your assistants will circle this price on Table 2 in row 1.

[ASSISTANT: Circle the corresponding price in (row 1) of the Table 2 of the bid sheet.]

If you said you would like to purchase any number of [cookie A] at this price, this is the price you will pay per cookie for the number of [cookies A] you said you wanted to buy.

If you said you didn't want to buy any [cookies A] at this price, you do not get to buy any [cookies A]. None of you should be sad or have any regrets about not being able to purchase [cookies A] for [Price] because you said you did not want to buy any [cookies A] at a price of [Price].

Do you understand how this auction works? You must consider your decision at each price carefully because you do not know which price will be drawn from the envelope. ***As long as you make your decision at each price carefully, you will not have regrets no matter what price is drawn.*** Do you have any questions?

III. Auction for Insurance:

1. Real Bids for Weather Index Insurance

Now you are going to actually bid on WII insurance as you did for [cookie A] before. Your bids are a commitment to pay real money for a real insurance policy. As you did in the games, you will decide how many units of insurance you would like to purchase for your crops, which is sorghum and/or green gram, given different prices. This may not be as easy as bidding on cookies, because you are more familiar with cookies than insurance. However, your assistants will help you to understand how this auction works. If you have any questions during the auction, feel free to ask your assistants. Remember that it is important you bid the true amount of insurance you would like to purchase at each price.

The coverage of 1 unit of insurance is Ksh 5,000 for both of sorghum and green gram. This means if you bought 1 unit of insurance, you can receive ***maximum*** Ksh 5000 when rainfall is bad, which is brown color in the game. What is the maximum amount of money when rainfall is brown, if you bought 2 units? Yes, you can receive ***maximum*** Ksh 10,000 when rainfall is bad. Remember, we said "maximum". You already learn from the games that you may not receive the full payout, or even receive no payout, even if you bought insurance. This payout depends on the overall rainfall for your squared area, not on your farm. You will bid on the product to purchase and receive up to Ksh 500,000 worth of protection. This is 100 units. In addition, the price of 1 unit of insurance ranges from Ksh 50 to Ksh 1,000.

In the introduction of the auction, your assistants asked you output values for sorghum and green gram you expected to harvest, right? Based on the value, your assistants will help you to calculate how much it will cost to insure for sorghum and/or green gram at the different prices.

[ASSISTANT] Read carefully how to explain the auction to farmers

You will start from sorghum. If your farmer only grows green gram, then you will skip the auction for sorghum and start from green gram.

Start from [Row F] (Start from [Row L] if your farmer only grows green gram) of Table 1, "Expected net value of sorghum (green gram) produced". Suppose the value is Ksh 28,300. This value is between 25,000 (5 units of insurance) and 30,000 (6 units of insurance). Then, by referring the price table, start the conversation like

"[Farmer name], you said your total net value from sorghum (green gram) is Ksh 28300, right? Ok, let's start with the first price. The price of 1 unit of insurance is Ksh 50. If the ***maximum*** amount of insured is Ksh 25000, which is close to your harvest value, Ksh 28300, you need to buy 5 units of insurance, right? Then, you need to pay Ksh 250 because you buy 5 units with Ksh 50 per unit. Are you comfortable to pay Ksh 250 to be insured at maximum Ksh 25000? [In this moment, ASSISTANT should emphasize that Ksh 25000 is the **maximum** amount that the farmer can receive when bad rainfall happens.] If Ksh 250 is too expensive for you, you can decrease the units of insurance you buy. [If farmers says he/she wants to buy 4 units of insurance] Ok, if you buy 4 units then now you will pay Ksh 200 but, your maximum payout when rainfall is bad is Ksh 20000. Are you comfortable to pay Ksh 200 to be insured at maximum Ksh 20000? [Same procedure goes on until farmers decide. Suppose your farmer decided to buy 4 units of insurance at Ksh 50. Write down "4" on row 2, "20000" on row 3 and "200" on row 4 of Table 3.]

Now, the price of 1 unit of insurance is Ksh 100. You bought 4 units when the price was Ksh 50, because your maximum amount of insured was Ksh 20000. If you still want to buy 4 units then now you need to pay Ksh 400 because the price is now Ksh 100. Are you comfortable to pay Ksh 400 to be insured at maximum Ksh 20000? [In this moment, ASSISTANT should emphasize that Ksh 20000 is the **maximum** amount that the farmer can receive when bad rainfall happens.] If Ksh 400 is too expensive for you, you can decrease the units of insurance you buy. [If farmers says he/she wants to buy 3 units of insurance] Ok, if you buy 3 units then now you will pay Ksh 300 but, your maximum payout when rainfall is bad is Ksh 15000. Are you comfortable to pay Ksh 300 to be insured at maximum Ksh 15000? [Same procedure goes on until farmers decide.]"

[Do the same procedure for green gram too. If your farmer does not grow green gram, then stop there.]

NOTE: If farmers do not want to purchase insurance at any prices, do not convince him/her to buy insurance.

Table C3: Real WII (Sorghum)

1	Price of WII	50	100	150	250	350	500	750	1000
2	**Units** to insure								
3	**Amount** to insure (Ksh)								
4	Total paid for WII								

Table C4: Real WII (Green gram)

1	Price of WII	50	100	150	250	350	500	750	1000
2	**Units** to insure								
3	**Amount** to insure (Ksh)								
4	Total paid for WII								

Now that you have made your decisions, we will determine the price of WII insurance for sorghum first. Of course, the farmers who do not grow sorghum will not be affected by this price because you don't need to buy this insurance. One farmer will draw a price card for the sorghum insurance product.

[GM: Have a farmer pull out the card from the envelope for Price of WII insurance for sorghum. Hold up the card and announce the price.]

The drawn price of 1 unit WII insurance for sorghum, is [P]. Your assistant circles this price on the Table 3.

[ASSISTANT: Circle the [P] in (row 1) of Table 3.

The drawn price of 1 unit insurance for sorghum is [P]. If you said you would like to purchase a non-zero unit of the WII insurance for sorghum at this price, you purchase that units of the insurance you said you would buy by paying [P] per unit. If you said you did not want to buy any quantity of the WII insurance for sorghum at this price, you will not buy any WII insurance.

Ok, now we will determine the price of WII insurance for green gram. Of course, the farmers who do not grow green gram will not be affected by this price because you don't need to buy this insurance.

One farmer will draw a price card for the green gram insurance product.

[GM: Have a farmer pull out the card from the envelope for Price of WII insurance for green gram. Hold up the card and announce the price.]

The drawn price of 1 unit WII insurance for green gram, is [P']. Your assistant circles this price on the Table 4.

[ASSISTANT: Circle the [P'] in (row 1) of Table 4.

The drawn price of 1 unit insurance for green gram is [P']. If you said you would like to purchase a non-zero unit of the WII insurance for green gram at this price, you purchase that units of the insurance you said you would buy by paying [P'] per unit. If you said you did not want to buy any quantity of the WII insurance for green gram at this price, you will not buy any WII insurance.

2. Outcomes of binding

Now, for those who end up purchasing insurance products, your assistants will collect your contact information to notify ACRE of your purchase decision. The agents of ACRE will visit you later to help you complete the contract.

[ASSISTANTS: Collect your farmer's contact information (phone number and address) and record in the bid sheets]

We only have one auction left. This is for a product that does not yet exist for farmers in your area, but that ACRE is considering developing. We therefore want to know how much you value this product.

IV. Hypothetical Area Yield Insurance

1. Overview of Area Yield Insurance Products

Now you are going to bid hypothetically on a slightly different insurance product called "Area Yield Insurance (AYI)." Area Yield Insurance is similar to Weather Index Insurance, but is based on the actual yields of an area instead of rainfall outcomes. While Weather Index Insurance uses overall rainfall for your squared area to determine if you receive a payout, Area Yield Insurance uses the overall yield of farms in your squared area to determine whether you receive a payout. If your area's overall yield for that season is bad, you receive a payout if you purchased insurance at the beginning of that season. Whether you receive a payout does not depend on the yield of your farm, but on the overall yield of your area.

This insurance product is not yet available because it takes time to design, so you will not make an actual purchase based on the results of this auction, but you should bid realistically because the results of this auction may help develop future AYI products.

2. Hypothetical Bids for Area Yield Insurance products

[ASSISTANT] <u>Read carefully how to explain the auction to farmers</u>

If your farmer grows only one of the crops, then please ask the relevant questions about that one crop only. If your farmer grows both of crops, ask him/her which product he/she wants to insure. If he/she choose one crop, then ask the relevant questions about the chosen one crop only.

Start from [Row F] (Start from [Row L] if your farmer only grows green gram OR, choose green gram) of Table 1, "Expected total value of sorghum (green gram) produced". Suppose the value is Ksh 28,300. This value is between 25,000 (5 units of insurance) and 30,000 (6 units of insurance). Then, by referring the price table, start the conversation like

"[Farmer name], you said your total harvest value from sorghum (green gram) is Ksh 28300, right? Ok, let's start with the first price. The price of 1 unit of insurance is Ksh 50. If the ***maximum*** amount of insured is Ksh 25000, which is close to your harvest value, Ksh 28300, you need to buy 5 units of insurance, right? Then, you need to pay Ksh 250 because you buy 5 units with Ksh 50 per unit. Are you comfortable to pay Ksh

250 to be insured at maximum Ksh 25000? [In this moment, ASSISTANT should emphasize that Ksh 25000 is the **maximum** amount that the farmer can receive when bad yield in their area happens.] If Ksh 250 is too expensive for you, you can decrease the units of insurance you buy. [If farmers says he/she wants to buy 4 units of insurance] Ok, if you buy 4 units then now you will pay Ksh 200 but, your maximum payout when the yield of your area is bad is Ksh 20000. Are you comfortable to pay Ksh 200 to be insured at maximum Ksh 20000? [Same procedure goes on until farmers decide. Suppose your farmer decided to buy 4 units of insurance at Ksh 50. Write down “4” on row 2, “20000” on row 3 and “200” on row 4 of Table 5.]

Now, the price of 1 unit of insurance is Ksh 100. You bought 4 units when the price was Ksh 50, because your maximum amount of insured was Ksh 20000. If you still want to buy 4 units then now you need to pay Ksh 400 because the price is now Ksh 100. Are you comfortable to pay Ksh 400 to be insured at maximum Ksh 20000? [In this moment, ASSISTANT should emphasize that Ksh 20000 is the **maximum** amount that the farmer can receive when bad yield in their area happens.] If Ksh 400 is too expensive for you, you can decrease the units of insurance you buy. [If farmers say he/she wants to buy 3 units of insurance] Ok, if you buy 3 units then now you will pay Ksh 300 but, your maximum payout when the yield of your area is bad is Ksh 15000. Are you comfortable to pay Ksh 300 to be insured at maximum Ksh 15000? [Same procedure goes on until farmers decide.]”

NOTE: If farmers do not want to purchase insurance at any prices, do not convince him/her to buy insurance.

Table C5: Hypothetical AYI (Circle: Sorghum or Green gram)

1	Price of AYI	50	100	150	250	350	500	750	1000
2	**Units** to insure								
3	**Amount** to insure (Ksh)								
4	Total paid for AYI								

Now that you have made your decisions, we will determine the price of the AYI for sorghum first.

[GM: Have a farmer pull out the card from the envelope for price of sorghum AYI. Hold up the card and announce the price.]

The drawn price for sorghum AYI insurance is [P2]. For those who chose sorghum, your assistant circles this price on the Table 5.

[ASSISTANT: Circle the [P2] in (row 1) of Table 5.

The drawn price is [P2]. If you said you would like to purchase a non-zero quantity for sorghum AYI insurance at this price, you will pay [P2] and purchase that quantity for the sorghum insurance you said you would buy. If you said you did not want to buy any quantity of the sorghum AYI insurance at this price, you will not buy any sorghum AYI insurance.

Next, we will determine the price of the AYI for green gram for those who chose green gram.

[GM: Have a farmer pull out the card from the envelope for price of green gram AYI. Hold up the card and announce the price.]

The drawn price for green gram AYI insurance is [P2’]. For those who chose green gram, your assistant circles this price on the Table 5.

[ASSISTANT: Circle the [P2’] in (row 1) of Table 5.

The drawn price is [P2’]. If you said you would like to purchase a non-zero quantity for green gram AYI insurance at this price, you will pay [P2] and purchase that quantity for the green gram insurance you said you would buy. If you said you did not want to buy any quantity of the green gram AYI insurance at this price, you will not buy any green gram AYI insurance.

V. Closing

We thank you very much for your time and interest throughout the exercise. Please turn in your bid sheets to your assistant. Your assistants will ask some of the questions [Second survey]. Those who finish completing the questionnaires, you are free to go.

[ASSISTANTS: Fill out the second survey]

Appendix D: Auction worksheet

Village: **Date and time:**

Farmer name: **Assistant name:**

Farmer ID:

Table D1: Output values

A	Acres of **sorghum**	
B	Projected **sorghum** yield (kg per acre)	
C	Expected **sorghum** price received (KSH per kg)	
D	Expected total value of **sorghum** produced [A x B x C]	
E	Expected value of **sorghum** input purchased from KPMC	
F	Expected net value of **sorghum** produced [D-E]	

Table D2: Real cookie

1	Price of cookie	Ksh 1	Ksh 2	Ksh 5	Ksh 10
2	How many they want to buy				
3	Total paid for cookies				

Table D3: Real Sorghum WII (One unit = 5000 KSH)

Circle the drawn price								
1	Price of WII	50	150	250	350	500	750	1000
2	**Units** to insure							
3	**Amount** to insure (Ksh)							
4	Total paid for WII							

Table D4: Hypothetical Sorghum AYI (One unit = 5000 KSH)

1	Price of AYI	50	150	250	350	500	750	1000
2	**Units** to insure							
3	**Amount** to insure (Ksh)							
4	Total paid for AYI							

Farmer's contact information		
1	Phone number	
2	Address	

Appendix E: Questionnaire

WEATHER INDEX INSURANCE GAMES IN THARAKA NITHI: INITIAL PARTICIPANT SURVEY

INTERVIEWER: INSTRUCTIONS AND QUESTIONS TO BE ANSWERED BY YOU ARE IN CAPITAL LETTERS. Questions for the respondent are in lower case.

PARTICIPANT IDENTIFICATION

(0.01) SESSION CODE	(0.02) GROUP CODE	(0.03) INSURANCE CODE	(0.04) INDIVIDUAL CODE
☐☐	☐☐	☐☐	☐☐

SESSION AND INTERVIEW DATA (CONTROL)

(0.05) ENUMERATOR CODE: ☐

(0.06) DATE OF SESSION:

A. MONTH (2 DIGITS): ☐☐

B. DAY (2 DIGITS): ☐☐

C. SESSION TIME: 1. MORNING 2. AFTERNOON (ENTER CODE) ☐

DEMOGRAPHICS

READ: Before we begin our activities today, I would like to ask you a few questions about yourself and your household, starting with your name.

(1.01) What is your name? (WRITE THE RESPONDENT'S NAME IN THE SPACE BELOW)

____

(1.02) Are you the head of your household? (THE HEAD OF THE HOUSEHOLD IS THE MAIN PERSON EMPOWERED TO MAKE DECISIONS IN THE HOUSEHOLD. SELECT THE CORRECT CODE). ☐

1. Yes 2. No

(1.03) What is your religion? (SELECT THE CORRECT CODE) ☐

1. Catholic 2. Protestant 3. Muslim 4. Other indigenous

5. Other (specify______________________)

(1.04) How many years of education have you completed? (WRITE THE NUMBER OF YEARS COMPLETED. DO NOT COUNT REPEATED YEARS). ☐

(1.05) Do you know how to read and write? (SELECT THE CORRECT CODE) ☐

1. Yes 2. No

(1.06) SELECT THE CODE FOR GENDER OF THE RESPONDENT. ☐

1. Male 2. Female

(1.07) What is your primary occupation? (SELECT THE CORRECT CODE) ☐

1. Farmer 2. Other (specify______________________________)

FARMING AND ACCESS TO FINANCE

(1.17) How many acres of land does your household own? (WRITE THE NUMBER OF ACRES AS A DECIMAL)

(1.18) Think back through the last five agricultural seasons. In how many of those seasons did your fields not receive enough rain? (WRITE THE NUMBER OF YEARS)

(1.19) If your household needed a loan for the upcoming agricutural season, could you get it? (WRITE THE CORRECT CODE)

1. Yes 2. No

(1.20) Do you or anyone else in your household have a savings account in a bank or other formal financial institution? (WRITE THE CORRECT CODE)

1. Yes 2. No

SAVING

(1.21) Have you ever saved in the past one year?

1. Yes 2. No

INTERVIEWER: IF THE RESPONDENT ANSWERED 1 TO QUESTION (1.19),SKIP TO QUESTION (1.21).

(1.22) Why you don't save? (After answeing to this, Go to 1.23)

1. cannot access to banks
2. have family, friends or relatives to ask for money
3. do not have enough money after spending on necessity
4. need to spend on special events
5. spend on snack, soda, tobacco or alcohol too often
6. Other (Specify:)

(1.23) How do you save (SELECT THE ALL CODES THAT APPLY)?

1. cannot access to banks or their agencies
2. have family, friends or relatives to ask for money
3. do not have enough money after spending on necessity
4. need to spend on special events
5. spend on snack, soda, tobacco or alcohol too often
6. Other (Specify:)

NOTE for (1.15): Do NOT read the choices, but rather ask the questions in an open-ended manner and then circle a response based on your interpretation of the respondent's answer.

(1.24) If you have saved before, why are you saving (SELECT THE ALL CODES THAT APPLY)?

1. to cope with a shock
2. to invest
3. household consumption
4. education
5. special occasion (e.g., wedding, funeral etc.)
6. Other (Specify:)

CONSUMPTION

(1.25) In the last week, how many times did you buy snack or soda?

1. 1-2 times 2. 3-5 times 3. 6-8 times 4. over 8 times 5. 0 times

(1.26) How much did you spend on them in total?(WRITE THE NUMBER IN KSH) KSH

(1.36) In the last week, how many times did you buy alcohol or tobacco?

1. 1-2 times 2. 3-5 times 3. 6-8 times 4. over 8 times 5. 0 times

(1.37) How much did you spend on them in total?(WRITE THE NUMBER IN KSH) KSH

MOBILE

(1.38) Which services do you use with your phone? (SELECT THE ALL CODES THAT APPLY)

1. make and receive a phone call
2. receive text messages
3. send text messages
4. no phone
5. Other (Specify:)

(1.39) Do you use M-pesa?

1. Yes 2. No

INTERVIEWER: IF THE RESPONDENT ANSWERED 2 TO QUESTION (1.30), FINISH THE FIRST SURVEY.

(1.40) Why are you using M-pesa?(SELECT THE ALL CODES THAT APPLY)

1. to pay
2. to send and receive money
3. to save
4. Other (Specify:)

ENUMERATOR: STOP HERE AND RESUME QUESTIONS AFTER COLLECTING AUCTION BIDS

POST-GAME QUESTIONS(Control)

READ: Before we finish, I would like to ask you a few questions about the activities we did today. First, I would like to ask you some questions about the group you were seated with today.

QUESTIONS ABOUT ACTIVITY GROUP

INTERVIEWER: FOR EACH QUESTION, WRITE DOWN THE NUMBER OF INDIVIDUALS STATED BY THE RESPONDENT.

(1.41) During today's activities, you were seated with a group. How many of your group members did you know before starting today's activities? ☐

INTERVIEWER: IF THE RESPONDENT ANSWERED 0 TO QUESTION 1.41,SKIP TO QUESTION 1.44.

(1.42) Have you ever talked about farming with any of the individuals in your group? If so, with how many? ☐

(1.43) Have you ever talked about any of the following topics -insurance, savings, or credit- with any of the individuals in your group? If so, with how many? ☐

INSURANCE AND BASIS RISK

INTERVIEWER: FOR EACH QUESTION, MARK THE BOX CORRESPONDING TO THE ANSWER GIVEN BY THE RESPONDENT WITH AN **X**.

(1.44) True or false: If I buy the insurance, I will always receive money back at the end of the season, regardless of the weather.

True ☐ False ☐

(1.45) True or false: It is possible to receive an insurance payout even if I have received enough rain on my farms.

True ☐ False ☐

(1.46) True or false: To determine how much rain has fallen, the insurer measures overall rainfall over larger squared areas, not at a single farm.

True ☐ False ☐

(1.47) True or false: The smaller squared area the insurer uses to measure rainfall, the greater the similarity between rainfall measured for the squared area and rainfall on my farms.

True ☐ False ☐

READ: Now I am going to read you a few statements, and I would like to tell me whether you agree with statement, disagree with the statement, or if you are unsure/do not know.

INTERVIEWER: FOR EACH QUESTION, MARK THE BOX CORRESPONDING TO THE ANSWER GIVEN BY THE RESPONDENT WITH AN **X**.

(1.48) I feel like I have enough information to make an informed decision about purchasing rainfall insurance.

Agree ☐ Disagree ☐ Do not know ☐

(1.49) Rainfall insurance is a valuable service.

Agree ☐ Disagree ☐ Do not know ☐

(1.50) The information shared during today's activities was difficult to understand.

Agree ☐ Disagree ☐ Do not know ☐

POST-AUCTION QUESTIONS

(1.51) Area yield insurance operates like rainfall insurance, but payments are based on average yields in the area instead of average rainfall. If this type of insurance were developed in your area for the same price as rainfall insurance, which product would you prefer to buy?

AYI ☐ Rainfall ☐ Do not know ☐

(1.52) If answered AYI in 1.29, would you be willing to pay more for AYI than rainfall insurance?

Yes, much more ☐ Yes, slightly more ☐ No. ☐ Do not know

INTERVIEWER: THIS IS THE END OF THE QUESTIONNAIRE

Appendix F: Balance test

Table F1: Test of Balance in Baseline Characteristics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
GLR	0.312	-0.443	-0.025	0.119***	0.503**	0.129	0.145	1,754	-0.028
	(1.278)	(0.523)	(0.060)	(0.037)	(0.232)	(0.093)	(0.220)	(11,001)	(0.032)
NGHR	0.970	0.583	0.071	-0.000	0.812	0.024	0.151	6,618	-0.000
	(2.268)	(0.353)	(0.054)	(0.071)	(0.586)	(0.144)	(0.190)	(11,618)	(0.038)
GHR	-0.730	0.327	0.107*	0.121	-0.280	-0.235*	0.090	-3,107	-0.042
	(1.963)	(0.540)	(0.060)	(0.099)	(0.451)	(0.123)	(0.198)	(10,051)	(0.033)
Control Mean	40.139	6.934	0.705	0.270	4.110	2.787	1.863	49,853	0.951
N	487	487	487	487	487	487	487	487	487

Note. Standard errors (in parentheses) clustered at session level. All regressions include enumerator fixed effects. *** p < 0.01, ** p < 0.05, * p < 0.1. Column headings are as follows: (1) Age, (2) Education, (3) Literacy, (4) Male, (5) Land size, (6) Drought, (7) Acres of crop, (8) Net harvest value, (9) Sorghum farmer.

References

Anderson, S., G.W. Harrison, M.I. Lau, and E.E. Rutstrom. 2007. "Valuation Using Multiple Price List Formats." *Applied Economics* 39:675–682.

Becker, G.M., M.H. DeGroot, and J. Marschak. 1964. "Measuring Utility by a Single-Response Sequential Method." *Behavioral Science* 9:226–232.

Boucher, S., and C. Mullally. 2010. Evaluating the Impact of Index Insurance on Cotton Farmers in Peru, Inter-American Development Bank.

Bruhn, M. and D. McKenzie. 2009. In pursuit of balance: Randomization in Practice in Development Field Experiments. American Economic Journal 1,4: 200-232.

Cai, J., and C. Song. 2017. "Do Disaster Experience and Knowledge Affect Insurance Take-Up Decisions?" Journal of Development Economics 124:83–94.

Carter, M., A. de Janvry, E. Sadoulet, and A. Sarris. 2014. "Index-Based Weather Insurance for Developing Countries: A Review of Evidence and a Set of Propositions for Up-Scaling." Development Policies Working Paper 111.

CIA World Factbook. "Kenya Overview." 2017. https://www.cia.gov/library/publications/the-world-factbook/geos/ke.html.

Cole, S., A.N. Fernando, D. Stein, and J. Tobacman. 2016. "Field Comparisons of Incentive- Compatible Preference Elicitation Techniques." Unpublished manuscript.

Elabed, G., and M.R. Carter. 2015. "Compound-Risk Aversion, Ambiguity and the Willingness to Pay for Microinsurance." *Journal of Economic Behavior & Organization* 118:150–166

Funk, C., P. Peterson, M. Landsfeld, D. Pedreros, J. Verdin, S. Shukla, G. Husak, J. Rowland, L. Harrison, and A. Hoell. 2015. "The Climate Hazards Infrared Precipitation with Stations–A New Environmental Record for Monitoring Extremes." *Scientific Data* 2:150066 2052–4463.

Hill, R.V., J. Hoddinott, and N. Kumar. 2013. "Adoption of Weather-Index Insurance: Learning from Willingness to Pay among a Panel of Households in Rural Ethiopia." *Agricultural Economics* 44:385–398.

Hill, R.V., M. Robles, and F. Ceballos. 2016. "Demand for a Simple Weather Insurance Product in India: Theory and Evidence." *American Journal of Agricultural Economics*, pp. aaw031

Janzen, S.A., and M.R. Carter. 2013. "After the Drought: The Impact of Microinsurance on Consumption Smoothing and Asset Protection." Working paper.

Jaspersen, J.G. 2016. "Hypothetical Surveys and Experimental Studies of Insurance Demand: A Review." *Journal of Risk and Insurance* 83:217–255

Jensen, N.D., C.B. Barrett, and A.G. Mude. 2016. "Index Insurance Quality and Basis Risk: Evidence from Northern Kenya." American Journal of Agricultural Economics 98:1450–1469.

Kenya Mpya. “Tharaka Nithi County.” 2012.

http://www.kenyampya.com/index.php?county=Tharaka%20Nithi.

Lybbert, T.J., N. Magnan, A.K. Bhargava, K. Gulati, and D.J. Spielman. 2013. “Farmers’ Hetero- geneous Valuation of Laser Land Leveling in Eastern Uttar Pradesh: An Experimental Auction to Inform Segmentation and Subsidy Strategies.” *American Journal of Agricultural Economics* 95:339–345

McIntosh, C., F. Povel, and E. Sadoulet. 2016. “Utility, Risk, and Demand for Incomplete Insurance: Lab Experiments with Guatemalan Cooperatives.” Unpublished manuscript.

Mobarak, A.M., and M.R. Rosenzweig. 2012. “Selling Formal Insurance to the Informally Insured.” Unpublished manuscript.

Norton, M., D. Osgood, M. Madajewicz, E. Holthaus, N. Peterson, R. Diro, C. Mullally, T.L. Teh, and M. Gebremichael. 2014. “Evidence of Demand for Index Insurance: Experimental Games and Commercial Transactions in Ethiopia.” *Journal of Development Studies* 50:630–648.

Novella, N. and W. Thiaw. 2012. “African Rainfall Climatology Version 2 data for Famine Early Warning Systems.” *Journal of Applied Meteorology and Climatology* 52: 588-606.

Schickele, A. “Make it Rain”. 2016. Abdul Latif Jameel Poverty Action Lab Bulletin. February. Available at https://www.povertyactionlab.org/sites/default/files/publications/make-it-rain-high.pdf.

Smith, V.L. 1982. “Microeconomic systems as an experimental science.” *American Economic Review* 72:923–955.

Tanaka, T., C.F. Camerer, and Q. Nguyen. 2010. “Risk and Time Preferences: Linking Experimental and Household Survey Data from Vietnam.” *American Economic Review* 100:557–271.

UNICEF. “State of the World’s Children Statistical Tables.” 2016. http://data.unicef.org/resources/state-worlds-children-2016-statistical-tables/.

USAID “Agriculture and Food Security | Kenya.” 2017. https://www.usaid.gov/kenya/agriculture-and-food-security.

Webb, M. 2013. “Reworking Wild Bootstrap Based Inference for Clustered Errors.” Unpublished, Queen’s Economics Department Working Paper No. 1315.

World Bank. “Kenya Access to Electricity.” 2014. Sustainable Energy for All (SE4ALL). https://data.worldbank.org/indicator/EG.ELC.ACCS.RU.ZS?locations=KE.

World Bank. “Kenya Country Profile.” 2017. http://databank.worldbank.org/data/Views/Reports/ReportWidgetCustom.aspx?Report_Name=CountryProfile&Id=b450fd57&tbar=y&dd=y&inf=n&zm=n&country=KEN