Subsistence farmer preferences for alternative incentive policies to encourage the adoption of conservation agriculture in Malawi: A choice elicitation approach

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Abstract

Land degradation in most sub Saharan Africa is a widely recognized problem and is due in large part to poor land management practices. To address this problem, several policy-based incentives to increase the adoption of better land management practices have been proposed, including fertilizer subsidies, cash payments and, more recently, subsidized or commercially offered weather index-based insurance contracts. However, little is known about farmers' preferences among these policy alternatives, their relative effectiveness, and their likely fiscal implications. Using survey and choice elicitation data from 271 farmers in Central Malawi, this study examines smallholder farmers' preferences among four major policy options that provide incentives for adopting agroforestry based conservation practices. Our results suggest that even when the expected value of an ideal insurance contract which has no basis risk was 25 percent higher than the cash payment option, sixty percent of the sample preferred the cash payment. Further, the empirical results indicated that cash flow or liquidity constraints may limit farmers' willingness to use crop insurance as a risk management tool. We conclude that the potential scope for increasing the use of improved land management techniques through fertilizer subsidies, or cash or insurance incentives payments may be substantial, although fertilizer subsidies and cash payments may be less costly approaches than subsidizing insurance contracts.

Introduction

About fifty nine percent of sub-Saharan Africa's population lives on less than two dollars a day (Pinkovskiy and Sala-i-Martin 2010), a higher proportion than anywhere else in the world. Poverty is even more extensive in rural areas, where agriculture is the main form of economic activity. Land degradation in the region is also more severe than almost anywhere else (Bai et al., 2008), in large part because of poor land management practices (Munthali, 2007; Davies, Pollard and Mwenda, 2010). In Malawi, for example, less than half of one percent of the cultivated area was farmed under conservation agriculture[1] in 2011 (AQUASTAT 2011). Over time, conservation practices that include the use of agro-forestry reduce soil erosion, increase yields, and sequester carbon, mitigating global greenhouse gas emissions. When combined with the use of fertilizer, agroforestry based conservation practices provide even more substantial yield benefits (Akinnifesi et al. 2008). However, lags between the initial adoption of conservation practices, which involve relatively substantial labor investments by the household, and subsequent yield gains create barriers to their adoption by smallholder farmers.

Several policy-based incentives to solve the adoption problem have been proposed, including fertilizer subsidies, cash payments and, more recently, subsidized or commercially offered weather index-based insurance contracts (Antle 2003; FAO 2007). However, little is known about farmers' preferences among the policy alternatives, their relative effectiveness, and their costs in terms of government outlays. This study addresses these issues through framed choice elicitation experiments (Harrison and List 2004) in which smallholder farmers in central Malawi responded to a series of choice sets. The choice sets required each smallholder farmer to choose between different cash payments, fertilizer subsidies and insurance contracts as incentives for adopting conservation farming techniques in producing maize. In addition, each participant responded to a detailed survey about their household's farming operations, asset holdings, off farm employment and income, proximity to trading markets, and an array of household characteristics. The combined choice elicitation and household survey data facilitated an investigation of the determinants of respondent choices and preferences.

Two types of insurance contract are examined: an "ideal" insurance contract (from the perspective of the insured farmer) that always provides an indemnity when drought (poor rains) occurs, and an insurance contract that has a fifty percent "downside" basis risk;[2] that is, the farm household has only a fifty percent probability of receiving a payment when drought occurs. In each case, the selected insurance contract is given to the farmer (she pays no out of pocket premium) on condition that she adopts conservation agroforestry farming practices.

Subsistence farmers have relatively little experience with financial institutions or overtly risk spreading financial instruments such as insurance contracts. Therefore, an extensive initial education program was integrated into the choice elicitation experiment protocol. The education program utilized "hands on" dynamic games to enable farmers to understand the implications of insurance contracts with and without basis risk, as well as the implications of cash payments and fertilizer subsidies for their crop yields and general economic welfare. An important difference between the use of games in this study and in previous studies (for example, the game experiments played by Peruvian and Kenyan farmers described in Lybert et al. 2010) is that here the games are designed solely as education tools to inform farmers prior to the choice elicitation experiments about the structure of the policies and how they work over time. The farmers then make choices between policy alternatives (which imply different production practices) in which subsidies are set at different levels.

The evidence from the choice elicitation experiments indicates that many subsistence farmers are highly resistant to insurance contracts with basis risk. When offered a choice between an ideal insurance contract with no basis risk and cash payments that are equivalent to actuarially fair premium rates a substantial majority rejected the ideal insurance contract. When the opportunity cost increases to a level comparable to the cost of providing commercial insurance, even fewer farmers were willing to use an ideal insurance contract. This finding, obtained from a framed choice experiment in which farmers choose between alternative incentive programs for technology adoption, is consistent with previous results from willingness to pay studies as well as studies of the demand for insurance (Goodwin and Smith, 2010; Smith and Watts, 2009; Sarris, Karfkis, and Christiaensen 2006; Fraser 1992; Coble and Knight 1997; Bardsley and Davenport 1984; McCarter 2003; Patrick 1988). Farmers also generally prefer fertilizer subsidies to cash payments or insurance instruments, perhaps partly because of their previous "hands on" experience with such programs.

Theoretical Issues

Models of technology adoption by smallholder farmers typically follow a structure proposed by Singh, Squire and Strauss (1986). Households maximize utility from consumption and are assumed to produce and consume some or all of the crops and livestock products they produce as well as leisure. Consumption and production decisions are not separable because the household produce and market their products. Additionally, households allocate labor and other inputs to crop production as well as off farm employment, and allocate income from farm profits and off farm labor to the consumption of commodities and services.[3]

Some smallholder household production models are dynamic (Barrett and Moser 2006; Shah, Love and Shwart 1994) and the household's optimization problem is couched in terms of the inter-temporal maximization of appropriately discounted expected utility of consumption goods and leisure (see Besely and Case (1993) for a review). Others are static, involving single period utility maximization. In either case, the household's utility maximization objective is restricted by various market conditions and household constraints, including the prices of farm inputs, outputs, and purchased consumption goods, as well as cash income from off farm employment, the availability of household labor, endowments of fixed assets, access to production technologies and access to credit markets (Singh, Squire and Strauss 1986; Taylor and Adelman 2003).

Within this general framework, subsidies for inputs such as fertilizer that are complementary to more productive technologies are likely to increase their adoption by lowering the implied rental rate for the use of those technologies through the first order effect of lowering the price of the input to the household. Secondary effects may also include relaxing constraints on access to cash income and, by reducing the risk of adverse outcomes, encouraging risk-averse households to adopt more productive technologies that are also more costly in terms of purchased input requirements. Cash payments, perhaps especially when tied to the adoption of new technologies with those characteristics or that simply require initial investments of family labor (with implied losses of cash income from off farm employment), will have similar effects.[4] Finally, as discussed by Carter (2012), Vargas Hill and Viceisza (2011), Boucher, Carter, and Guirkinger (2008), insurance contracts may encourage risk averse farmers to adopt a new technology because the contract provides indemnities in years when adverse growing conditions result in poor yields from that technology, and the technology is perceived to generate lower returns in those years than current farming practices.[5]

Models of household production also generally imply that variables that reduce constraints on access to cash or credit will increase the likelihood that farmers will adopt such new technologies. These include off-farm wages and incomes, the availability of off-farm employment, the availability and frequency of income from the sale of crops and livestock products, and the value of farm assets and livestock. Other variables may limit or have ambiguous effects on technology adoption. These include household size (which increases on-farm consumption but may also increase the household's supply of labor), the education level of the household decision maker and the household's current and recent farming practices (including pre-existing conservation efforts and experience with the use of purchased inputs such fertilizer).

In addition, attitudes towards risk may be important as risk averse farmers may be less likely to adopt some technologies than risk neutral or risk loving farmers. Empirical analyses of smallholder farmers' technology choice decisions or preferences with respect to alternative incentive programs tied to the adoption of new technologies should account for such effects as described in this section.

The Choice Elicitation Framework

Targeted subsidies that reduce liquidity constraints and encourage technology adoption have been widely discussed and, in some cases, empirically evaluated.[6] However, empirical analyses that directly compare alternative incentive programs for the adoption of new technologies, either in terms of farm household preferences or their relative costs of achieving the same technology adoption rates, have not been carried out. Here we utilize a framed choice elicitation experiment (List 2004) in which those comparisons can be made. We consider four programs that could be used as incentives for the adoption of agro-forestry conservation practices in maize production: cash subsidies (at various levels), fertilizer subsidies, and two insurance contracts that would be offered at no premium cost to the farmer. One is an ideal insurance contract in that there is no basis risk (the farmer always gets an indemnity payment when the farm experiences a loss). The other is an insurance contract with a fifty percent "downside" basis risk of not receiving an indemnity when the farm experiences a loss (but no likelihood of receiving a payment when there is no loss).

In each choice set, farmers were given three alternatives, one of which was always to continue with current "traditional" farming practices. The other two alternatives consisted of either (a) a cash payment and a "ideal" insurance contract, (b) a cash payment and a fertilizer subsidy, (c) a fertilizer subsidy and a ideal insurance contract, and (d) a ideal insurance contract or an insurance contract with a 50 percent basis risk. Farmers who accepted either a cash subsidy or an insurance contract had to adopt ACPs. If farmers accepted a fertilizer subsidy, they were required to combine the use of fertilizer with agro-forestry conservation practices.

Yields under alternative farming practices

The distinction between farming practices is important because yields are substantially higher when ACP is utilized than under traditional farming practices, and even higher when agro-forestry conservation is combined with fertilizer use. To ensure that farmers were presented with credible (to them) production alternatives, yields for each farming practice were identified under drought conditions (described to farmers as poor rains in the research protocol) and good growing conditions (described as good rains) through a careful survey of the agronomic literature and face-to-face meetings with agronomic experts based at Malawi's national experimental station in Chitedze (including those seconded from the World Agroforestry Center and Michigan State University), as well as experts from a Malawi based regional non-government organization (NGO) carrying out on-farm research and extension on better land management practices and their impacts on smallholder maize yields in Southern Africa.[7]

Table 1 presents the resulting yield estimates for the three farming practices – traditional, ACP, and ACP with effective fertilizer use (one bag per hectare) – under drought and good growing conditions.[8] Adopting conservation agroforestry essentially doubles per hectare yields in both poor rain conditions (from 0.5 tons to 1 ton) and good rain conditions (from 1 ton to 2 tons) while adding fertilizer to ACP further increases yields by an additional 25 percent in each state of the world (to 1.25 tons when rains are poor and 2.5 tons when rains are good). However, in addition to an initial investment of labor, ACP also involves annual labor costs for maintenance purposes, estimated to have a market value equivalent to about a quarter of a ton of maize.

Challenges in Implementing Choice Elicitation Experiments Among Subsistence Farmers

Many subsistence farmers in Malawi, as in other areas of sub-Saharan Africa and many other developing countries around the world, have received very limited formal education. Some have no formal education, but more typically a farmer is likely to have some primary education, perhaps some secondary education, and, very rarely, some tertiary education.[9] In a choice elicitation experiment setting, therefore, many respondents' literacy and numeracy skills will be limited and, in some cases, they may not have such skills (Lybbert et al. 2010; Barrett et al. 2008; Carter et al. 2008; Vargas Hill and Viceisza 2011). Moreover, when financial instruments such as insurance contracts or innovative government policies are a focus of the choice sets, almost all of the participants will have had no experience with those or similar instruments and programs.

These facts have important implications for the structure of choice experiments implemented in such settings. First, a protocol has to be developed that allows the respondents to understand the alternatives between which they are being asked to choose and the general implications of the choices they make. Second, the range of choices offered in any individual choice set has to be relatively limited so that options are clear. Third, respondents are likely to need some time to assess each choice set and may also need explanations about the individual options in each choice set (because they cannot read or understand written numbers). Hence, for example, isolating individuals in front of a computer to work through 80 to 100 choice sets is infeasible. However, isolating individual respondents from one another and preventing any feedback between those who have and have not completed the choice sets is essential in maintaining the integrity of the experiment (see, for example, Harrison and List 2004; Vargas Hill and Viceisza 2011). Finally, enumerators should not bias participant responses. These concerns were each addressed in the protocol.

The Pre-Choice Elicitation Experiment Education Program

An experiential learning protocol was developed that relied heavily on the use of dynamic learning games. The purpose was to provide the respondents with reasonably accurate and unbiased information about each of the five strategies included in the sixteen choice sets. The baseline strategy was simply continued use of traditional farming practices with no incentives being offered. The other four strategies, which required the adoption of conservation agroforestry, were a cash payment, an ideal insurance instrument that always paid the farmer when drought (poor rains) occurred, a basis risk "weather" insurance instrument with a 50 percent risk of non-payment even though the farmer had a loss, and a fertilizer subsidy that required the use of a specified amount of fertilizer but also substantial out-of pocket expenditures by the farmers to obtain those amounts.

The experiential learning games were relatively complex, given that there were several learning objectives. The first objective was to enable farmers to understand how the ideal insurance instrument worked and how an insurance instrument with basis risk would work. The other objectives were to enable farmers to understand how each of the five choice set alternatives would affect a typical village household over a five to seven year period.

To accomplish these objectives, the same protocol was used in fourteen different villages over a five week period between May 25th and June 15th of 2011 by a team of six enumerators who were supervised in each education and data collection session by a project leader (one of the authors). The enumerators, all of whom were fluent in Chichewa, the language spoken in the villages, received two weeks of intensive training before carrying out the education programs and framed choice elicitation experiments.[10]

In each of the 14 villages, drawn from two districts, one to two groups of 12 to 18 farmers participated in the data collection effort. Each group was selected by drawing a random sample of farmers in each village from the population lists provided by the Malawi government. The total sample of 271 respondents was about eight percent of the total population of those 14 villages and the participation rate was 95 percent.

The education protocol was implemented as follows. First, the team leader verified that each farmer in the group had been selected through the random sampling process. Then farmers were provided with a general introduction to the project, in which the choice alternatives were described, including the requirements for the adoption of ACPs. Emphasis was placed on the fact that incentive programs would be operated for at least five to seven years. Farmers had no difficulty in understanding cash payments or, because of their previous experience with similar government programs, fertilizer subsidy programs. They also understood the requirements of the conservation practices. However, as expected, they were not familiar with the idea of crop insurance.

The second step was to introduce the farmers to the idea of insurance indemnities and basis risk though a dynamic game. In the first version of the game (game 1), following an approach similar to those used by Lybbert et al (2010), Barrett et al. (2008), and Carter et al (2008), an opaque bag was filled with five red balls and five green balls of equal size. The green balls represented years in which rains were "good", and the red balls years in which drought occurred.[11] A farmer was then asked to draw a ball from the bag. If a red ball was drawn, an indemnity payment of 5,000 Malawi Kwacha (MK), worth about $35 and equivalent in value to 0.25 tons of maize at local prices, became available; if a green ball was drawn, yields were good and no indemnity payment would be made.

To illustrate fifty percent basis risk, one blue and one orange ball were placed in a second large second opaque bag. An enumerator would put both hands into the bag and hold one of them in each hand. A farmer was then asked to pick either the enumerator's right or left hand, at which point the same farmer removed the bag. If the selected hand held the orange ball, then the indemnity was paid, but the ball was blue then no indemnity was paid.

A series of five to seven harvest years (rounds) was then played with successive groups of farmers. In each round (year), first a draw was made from the bag with red and green balls and then a draw was made from the bag with the orange and blue balls. Depending on the draws, each farmer received or lost white disks. For example, if a red ball was drawn and a blue ball then selected, the farm with an ideal insurance contract would achieve a maize yield of one ton or 4 white disks, and receive an MK 5,000 indemnity payment represented by one white disk. Of the five white disks (1.25 tons of maize) the farmer acquired, three would be needed to feed the family, and the farm would accumulate two white disks (0.5 tons of maize or MK 10,000). However, the farm with the basis risk insurance contract would only receive four white disks, reflecting the "bad luck" of the basis risk draw, and accumulate only one white disk. The traditional practices farm would lose one of its two endowment white disks because under traditional practices maize yields would be only 0.5 tons (2 white disks) while the family's subsistence consumption needs would still be 0.75 tons (3 white disks).

Other draws would result in different outcomes (for example, the selection of a red ball followed by an orange ball would not affect outcomes for traditional practices and ideal insurance contract farms, but generate an additional MK 10,000 or two white disks for the basis risk insurance contract farm). By tracking the accumulation (or reduction) of white and yellow disks on each farm's table, a group quickly gained an appreciation of how basis risk affected outcomes and the performance of the different alternatives.

The third step was to provide the group with experiential learning about the relative impacts of the cash payment, fertilizer, ideal insurance, and traditional practices alternatives. In this and subsequent games, white disks worth MK 5,000 and yellow disks worth MK 1,000 were utilized. For the purposes of this game, farmers were now told that poor rains occurred about once every five years (the actual rate for drought over the previous thirty years in the study area) and so the "weather bag" would now contain eight green balls but only two red balls. Four tables were set up and farmers volunteered to sit behind each table (effectively choosing one of the four options).

In this game (game 2), the ideal insurance indemnity was again set at MK 5,000 and the guaranteed cash payment was set at MK 1,000 (the expected value of the insurance indemnity). At least a 50 kilogram bag of fertilizer is typically required to fertilize a hectare of land for maize production (as noted above, the typical farm size in the study area). At the time of the data collection effort, these bags were priced at about MK 4,000. Hence, in the game, the farmer received a 50 percent fertilizer subsidy of MK 2,000 (comparable to previous subsidy levels). Each farmer was again given half a ton of maize as their initial endowment.

At the beginning of each round (growing season), the farmer with the cash payment option received one yellow disk (the guaranteed cash payment) but the farmer with the fertilizer option gave up two yellow disks because he was required to pay half the cost of the fertilizer the farm had to use. All farmers required to adopt conservation agroforestry also gave up the equivalent of five yellow disks to cover their ACP expenses. After the draw of a green or red ball from the "weather bag", as in the previous game, farmers gave up or received the requisite white and/or yellow disks. Again, the effects of each strategy or option on each farmer's wealth could be tracked by the group from one year to the next.

The Choice Elicitation Experiment (CEE)

The experiential education program required approximately two and a half hours of each group's time. Farmers were then provided with a break, drinks and snacks (worth approximately half a day's wages for manual labor) and an opportunity to discuss the education program informally.[12] Each farmer was then asked by an enumerator to come to a separate room or hut where, in isolation from all other farmers, the choice elicitation experiment was carried out and, subsequently, the detailed household survey was administered. When the survey instrument was completed, the farmer was thanked and asked to leave. No contact was allowed with other farmers who had not yet participated in the experiment or the survey. [13]

In administering the CEE, enumerators were instructed to show the respondent sixteen choice sets in a predetermined order and record their responses to each choice set. The enumerator could explain the bare bones of each option in a choice set (for example, to meet the needs of non-readers and non-numerate respondents) or respond to any clarification questions (for example, about the size of a cash payment or fertilizer subsidy) but were prohibited from giving any guidance about choices. After the CEE had been administered, the farmer completed the household survey which was then stapled to the CEE response record.

The CEE Choice Sets

Farmers responded to sixteen choice sets, each of which included three mutually exclusive options. Altogether, the sixteen choice sets included five general options (table 2): Option A, continue traditional practices; Option B, a guaranteed cash payment (that varied among choice sets); Option C, an ideal insurance instrument in which the indemnity is always set at MK 5,000; Option D, a fertilizer subsidy (that varied among some choice sets); and Option E, a 50 percent basis risk insurance instrument (with varying indemnity levels). As discussed above, options B-E required the farmer to adopt CA practices.

The order in which the choice sets were presented was held constant across all farmers in all villages and consisted of four blocks. In all sixteen choice sets, the farmer was provided with option A (continuing traditional farming practices). Block 1 consists of choice sets 1-5, which included Option C, the ideal insurance instrument, and five different versions of Option B, a guaranteed annual cash payment with values of MK 800, MK 1,000, MK 1,300, MK 1,800 and MK 2000. However, to ensure that a farmer could not guess which cash payment value was coming next, the order of the five cash payment values was adjusted to appear random (as shown in table 2).

Cash payments included values lower than, higher than, and equal to the expected value (MK 1,000) of the ideal insurance contract indemnity (an indemnity of MK 5,000 which occurred with a twenty percent probability). Less than two percent of all respondents chose traditional farming practices and, therefore, the cash payment in each choice set effectively represented the opportunity cost of the insurance contract. A guaranteed cash payment of MK 1,000 represents the actuarially fair premium rate for the ideal insurance contract (its expected value), a cash payment of MK 1,300 represents the lower bound of any reasonable estimate of the commercial cost of delivering a weather index or area yield index product to relatively large farmers (a 30 percent overhead charge), while MK 1,800 and MK 2,000 can be taken to represent estimates of the commercial cost of delivering index insurance to smallholder operators (an 80 percent overhead charge) and individual yield insurance to larger (but not very large) farmers.

Block 2 also consisted of five choice sets (choice sets 6-10) which included Option B, in which the same five cash payments were used, and Option D, a fertilizer subsidy of MK 2,000 (a fifty percent subsidy). Block 3 consisted of three choice sets (choice sets 11-13) and included Option C, the ideal insurance instrument with a fixed indemnity of MK 5,000, and Option D, the fertilizer subsidy, with three different levels of subsidy (MK,1500, MK 2,000 and MK 2,500).

The last block (Block 4) consisted of three choice sets (choice sets 14-16) that include Option C (the ideal insurance contract with an indemnity of MK 5,000) and Option E, a fifty percent basis risk insurance contract with three different levels of indemnity – MK 6,000, MK 10,000 and MK 14,000, with respective expected values of MK 3000, MK 5000 and MK 7000.

Sample Respondent Risk Attitudes

The choice sets in Block 4 were designed to elicit information about farmers' risk preferences using the following criteria, under the assumption that each farmer understands the difference between the no basis risk contract and the basis risk contract.

- Only a risk loving farmer would choose the basis risk contract with an MK 6000 payout and conditional (on poor rains occurring) expected value of MK 3000 over a no basis risk contract with a guaranteed pay out of MK 5000.
- A farmer selecting a MK 10,000 fifty percent basis risk insurance contract over an MK 5000 ideal insurance contract would either have to be risk neutral or risk loving.
- Risk averse farmers would not accept either of the MK 6000 or MK 10,000 fifty percent basis risk contracts but could accept a fifty percent basis risk contract with a payout of MK 14,000 (and an expected value of MK 7000) over a guaranteed MK 5000 payout contract.
- Farmers who refused all three contracts would also be risk averse and, other things being equal, more risk averse than farmers who accepted the MK 14,000 basis risk contract but not the other two basis risk contracts.

The three choice elicitation questions in Block 4 were therefore used to place farmers in four risk preference categories: risk loving (choose a MK 6000 basis risk contract), risk loving/risk neutral (chose an MK 10,000 basis risk contract but not a MK 6000 basis risk contract), risk averse (choose an MK 14,000 basis risk contract, but not the other two contracts), and "extremely" risk averse (never select a basis risk contract). A few farmers switched between the two insurance options in ways which indicated inconsistent or intransitive choices. For example, a farmer might have chosen a basis risk contract with an MK 6,000 pay out but have rejected an MK 10,000 basis risk contract. These farmers were allocated to a fifth "intransitive" category.

The distribution of farmers between these five risk attitude categories is presented in table 3. Less than 8 percent of the respondents made intransitive or inconsistent choices. This suggests that over 92 percent of the farmers had a reasonably good or very good understanding of the basis risk insurance contract and the ideal insurance contract. Over fifty percent of the sample were "highly" risk averse and consistently selected the ideal (no basis risk) contract. Eight percent were risk averse, requiring up to a forty percent higher expected payout before they were willing to accept a 50 percent basis risk contract. By themselves, these results suggest that weather index products, which typically have around a fifty percent basis risk, are likely to be unattractive to many subsistence households unless they are heavily subsidized. This is especially the case, given that, as discussed below, insurance contracts with no basis risk were selected by relatively few households when the opportunity cost was equal to or greater than the expected indemnity.

In contrast, approximately twenty five percent of farmers in the sample are categorized as risk-loving and another nine percent are risk neutral or risk-loving; that is, about one third of the farmers appeared not to be risk averse. This result is not inconsistent with findings reported by Binswanger (1980), and Maertens, Just and Chari (2011) for subsistence farmers in India.

Descriptive Results

A primary objective of this study is to identify the determinants of farmer preferences for three different policy instruments that provide incentives for the adoption of conservation practices that include agroforestry.   In choice sets 1-5 (Block 1) and choice sets 6-10 (Block 2), first an ideal insurance contract and then a 50 percent fertilizer subsidy were compared to the same set of five different cash payments (effectively the opportunity costs of those two incentive programs).

Figure 1 shows the proportions of the sample selecting the ideal insurance contract at each cash payment. In figure 1, at a cash payment of MK 800, only forty percent of the sample was willing to choose the ideal insurance instrument, even though the expected value of the indemnity payment, MK 1,000, was twenty five percent higher. At a cash payment of MK 1,000, only 32 percent of the sample selected the ideal insurance alternative (slightly fewer than the number of farmers in the sample categorized as risk loving or risk neutral). Thirty one percent opted for the insurance option when its opportunity cost increased to MK 1,300 (implying a 30 percent overhead charge); at MK 1800 about 27 percent still selected the ideal insurance contract, and at MK 2,000 that proportion fell to about 25 percent.

In the previous section, we reported that over half the farmers in the sample would not choose a basis risk insurance product over an ideal insurance product even when the basis risk contract offered a 40 percent risk premium. This suggests that fewer farmers in the sample would have chosen a basis risk insurance contract at each of those opportunity costs. The initial results also indicate that substantial subsidies would be needed to encourage many farmers to choose either an ideal insurance contract or a basis risk contract in return for adopting agroforestry based conservation practices, even though those practices substantially improve yields. The findings highlight the fact that even a heavily subsidized ideal insurance contract involves one form of risk. The subsistence farmer has to give up cash (which is otherwise held with certainty) to obtain an uncertain indemnity return, even though the timing of that indemnity reduces risk associated with the household's real income stream from farming.

Figure 2 shows the proportions of the sample selecting an MK 2,000 fertilizer subsidy at each of the same five cash payments. While the proportion of the sample selecting the fertilizer subsidy declines from 93% to 90% as the cash payment increase from MK 800 to MK 2,000, the changes are minimal. The reason follows from the information in table 4, in which statistical distributions are presented for the outcomes of all of the options used in the first 13 choice sets (including different levels of cash payments or fertilizer subsidies. In each case, the distributions are binomial (what happens when good rains occur and what happens when poor rains occur) and expected values are the sums of the outcomes in the two states of the world multiplied by the probabilities of those states (good rains and poor rains).

The information in table 4 shows that the binomial distribution for the MK 2,000 fertilizer subsidy first order stochastically dominates each of the binomial distributions for the five cash payments (that is, returns from the fertilizer subsidy option are better in both states of the world and its expected value is higher in choice sets 6-10). Regardless of their attitude to risk, therefore, no "rational" farmer should have selected a cash payment in any of the choice sets in Block 2, and overwhelmingly, most farmers in the sample did not. These results imply, not surprisingly, that farmers would have to receive a cash payment in excess of the fertilizer subsidy before selecting the cash payment option. The question is, how much more they would need, as a farmer could always use a cash payment as if it were a fertilizer subsidy to obtain the yield gains associated with fertilizer use, but would also incur substantial additional out-of-pocket costs to acquire the fertilizer.

Figure 3 provides information on responses to the three choice sets in Block 3, in which farmers had to choose between the ideal insurance contract (with an indemnity of MK 5,000) and three levels of fertilizer subsidy (MK 1,500, MK 2,000 and MK 3,000). As the fertilizer subsidy increased from MK 1,500 to MK 2,500, the proportion of farmers selecting the insurance contract declined from 12 percent to 7 percent. Again, table 4 provides insights as to why this is the case. While the fertilizer subsidy does not first order stochastically dominate the insurance contract, (the insurance option is superior by about eight to ten percent in monetary terms in years when rains are poor), the expected value of fertilizer subsidy is about sixteen to nineteen percent higher overall.

Further Empirical Analysis: Data and Estimation Models

The data obtained from the choice experiments were combined with data from the household survey to examine the determinants of choices between the ideal insurance contract and cash payments, the MK 2,000 fertilizer subsidy and cash payments, and the ideal insurance contract and three alternative levels of fertilizer subsidy. As described above, each respondent's risk preferences were assigned to one of five categories (risk loving, risk loving/risk neutral, risk averse, "highly" risk averse and intransitive). As also discussed above, only five of 276 respondents choose the traditional practices option in any of the choice sets and these observations were omitted from the data set. Hence, responses to choice sets 1-5 by each individual indicated their preferences between an ideal insurance instrument and five different guaranteed cash payments. These responses were used to construct an indicator variable that takes on the value of 1 if the farmer chooses the insurance contract and zero otherwise, resulting in five observations for each farmer (one for each cash payment) and a total of 1355 observations on insurance-cash payment choices among the 271 participating farmers.

Similarly, responses from choice sets 6-10, which examined a farmer's preferences between cash payments and an MK 2,000 fertilizer subsidy, were used to construct an indicator variable with a value of 1 if the farmer chooses the fertilizer subsidy (yielding 1355 observations). Responses from choice sets 11-13 are also used to construct an indicator variable that takes on a value of 1 if a farmer chooses the ideal insurance contract over a fertilizer subsidy that ranges from MK 1,500 to MK 2,500 (yielding 813 observations). In addition, four indicator variables were also constructed to represent the five cash payment levels (MK 800 is the omitted cash payment) and two indicator variables were constructed to represent the three fertilizer subsidy levels (MK 1,500 is the omitted subsidy).

Responses to the household questionnaires provided information on each respondent's gender and age; household size and composition by gender and age; household cash income from farm sales and off farm labor by month, and monthly per capita food expenditures; the value of household farm and non-farm fixed assets and distance in time from the nearest trading center; and farm structure and operation characteristics, including livestock assets, and the frequency with which various farming practices were used, including frequency of use over the previous five years of conservation practices, agroforestry, soil conservation, fertilizer, and manure. A more detailed description of the survey instrument is presented in Appendix A. These responses were used to create a series of household and farm characteristics variables. Variable definitions for the indicator, household characteristic, and farm characteristic variables are presented in table 5. Descriptive statistics (means, maximums, minimums and standard deviations) are presented in table 6.

The theoretical framework presented in section 2 implies that choices between the pairs of strategies will be affected by household and farm characteristics, including attitudes towards risk, as well as the relative benefits and opportunity costs of those strategies. Probit specifications are utilized for each of three general estimation models for the dichotomous choices between (a) the ideal insurance contract and a cash payment, (b) the MK 2,000 fertilizer subsidy and a cash payment, and (c) the ideal insurance contract and a fertilizer subsidy. In each case, the choice variable is estimated as a function of household socio-economic characteristics, farm characteristics, a set of indicator variables for different levels of cash payments or (in the choice between an insurance contract and a fertilizer subsidy) different levels of fertilizer subsidies, risk attitude indicator variables, and a regional indicator variable (as the villages were located in two districts. Interactions between risk attitude variables and cash payment levels or fertilizer subsidy levels were examined but were generally found not be statistically significant.

Estimation Results

Representative regression results for the ideal insurance contract and cash payments are presented in tables 7(a) and 7(b). Table 7(a) contains parameter estimates and standard errors for two specifications (model 1, which excludes the regional dummy variable, and model 2, which includes the regional dummy along with interaction terms between the regional dummy and the indicator variables for levels of cash payments or fertilizer subsidies). Table 7(b) reports marginal effects for the main explanatory variables using a representative or base case farm household. Similar regression results and marginal estimates are reported for the cash-fertilizer choice model in tables 8(a) and 8(b), and for the ideal insurance-fertilizer subsidy choice model in tables 9(a) and 9(b) using essentially the same base case.[14] In each dichotomous choice model, parameter estimates were robust with respect to changes in model specifications,[15] In addition, logit models yielded similar results.

The impact on a household's choice of policy instruments of changes in the relative values of those policies is a central focus of this study. An issue of particular interest is the consequences of changes in cash payments on farmers' decisions to purchase an ideal insurance contract and, by implication index insurance contracts with basis risk. The parameter estimates presented in table 7(a) and the related probability and marginal effects presented in table 7(b) are consistent with the raw data on the proportions of farmers selecting an ideal insurance contract at each cash payment level discussed above.

The omitted (base case) indicator in the regression models for choice sets 1-5 is the lowest cash payment of MK 800. *A priori*, as cash payments are increased, farm households would be expected to become less likely to select the ideal crop insurance contract. As the dependent variable equal one if the household chooses the insurance contract, the coefficients on the four cash payment indicator variables – MK 1,000, MK 1,300, MK 1,800 and MK 2,000 – are expected to be negative and increasing in absolute size. In table 7(a), all four cash payment coefficients are negative, statistically significant and increase in absolute size, ranging from – 0.243 for a cash payment of MK 1,000 to – 0.472 for a cash payment of MK 2,000. The marginal effects of these variables on the probability of purchasing insurance are calculated by computing the base case probability, reported as 40 percent (0.40) in table 7(b), and subtracting it from the probability obtained by setting the indicator variable for a given cash payment equal to 1 (instead of zero, as in the base case).

The estimated marginal effect of increasing the cash payment from MK 800 to MK 1,000 is to reduce the probability of selecting the ideal insurance contract by 9 percent (-0.09) to 31 percent. A cash payment of MK 2,000 reduces the probability of selecting the insurance by an additional 7.1 percent to 23.3 percent. These findings are very similar to, and consistent with, the data on the proportions of all respondents in the total sample selecting the insurance option presented in figure 1(a). They confirm that a majority of farmers are reluctant to obtain an ideal insurance contract even when its expected value is 25 percent higher than its opportunity cost, especially among highly risk averse farmers (the base case) who constituted 50 percent of the sample.

The regression results also indicate that moderately risk averse farmers (7.7% of the sample) are even less likely to select an ideal insurance contract under those conditions. The coefficient for the "moderately risk averse" indicator variable is negative, statistically significant, and larger in absolute size than the coefficient for the "highly risk averse" indicator variable. The estimated effect of shifting from a highly risk averse to moderately risk averse household is to reduce the probability of selecting the insurance instrument by 23 percent (-0.232) to about 17 percent. In contrast, risk loving and risk neutral farmers (about 34 percent of the sample) were more likely to select the insurance contract, but among those groups no more than 62 percent selected the insurance contract when its expected value (MK 1,000) exceeded the MK 800 cash payment by twenty five percent.

As discussed above, the relatively low selection rate for an ideal insurance contract, even when the actuarially fair premium is effectively subsidized, indicates that index insurance contracts with basis risk are even less likely to be accepted. In a developing country context, one potential explanation for low acceptance of even ideal insurance contracts may be lack of liquidity. Households who received income from sales in nine or months of the year were statistically significantly more likely to select the insurance contract while an increase in household size had a statistically significant negative effect (and increasing the household size by one person reduced the probability of choosing insurance by 2.5 percent). Both these results provide evidence in support of the hypothesis that liquidity constraints have some effect on very poor households' willingness to participate in insurance schemes. But the quantitative effects do not appear to be large enough to explain why so many farmers are reluctant to choose an insurance alternative that appears to be more attractive (because of no basis risk) than the weather based index products that have been piloted in countries like Peru, Kenya, and Mongolia.

A farm household's previous experience with agroforestry and other conservation practices appears to have no effects on farm household choices between ideal insurance and cash payments. Nor, as illustrated in model 2 in table 7(a), do regional effects, or effects related to a household's distance from trading centers have any impacts. However, farmers who have used fertilizer and/or manure more frequently in the past are more likely to select the insurance option over a cash payment. An additional year of fertilizer use increases the probability of selecting insurance by 3.1 percent and an additional year of manure use increases that probability by 1.2 percent (the effects are small but parameter estimates are positive and statistically significant).

The choice between a fertilizer subsidy and cash payments is not statistically significantly affected by changes in the level of cash payment (tables 8(a) and 8(b)), almost surely because, as discussed above, the fertilizer subsidy first order stochastically dominates each of the five alternative cash payments offered to farmers in choice sets 6-10 and there is very little change in the probability that the fertilizer option will be selected (in the base case the estimated probability of selecting an MK 2,000 fertilizer subsidy is 97.6%). Nor do risk attitudes have any statistically significant effects. However, previous experience with new technologies (fertilizer) and some conservation farming practices do have statistically significant but relatively small effects on the fertilizer subsidy – cash payment choice. More frequent previous use of fertilizer reduces the probability of selecting the fertilizer subsidy (an extra year of fertilizer use relative to the mean reduces the probability of selecting the fertilizer subsidy by just under one percent), perhaps because of slightly less need for nutrients like nitrogen and phosphate and lower expected yield gains. More frequent use of soil conservation practices increases the probability of selecting the fertilizer subsidy (an extra year of soil conservation relative to the mean increases the probability of selecting the fertilizer subsidy by 0.2 percent).

In the regression model of the choice between the ideal insurance contract and a fertilizer subsidy (tables 9(a) and 9(b)), in the base case, when the fertilizer subsidy is set at MK 1,500, the estimated probability that a highly risk averse household would select the insurance contract is five percent. An increase in the fertilizer subsidy to MK 2,500 has a statistically significant negative effect on the likelihood that the insurance contract will be selected, with an estimated marginal effect of – 2.9 percent (a smaller increase in the subsidy to MK 2000 has a negative but not statistically significant effect). Risk attitudes also have a statistically significant effect. Risk loving and risk neutral farmers are three or four times more likely (with estimated probabilities of 14.7 percent and 25 percent) to prefer insurance over an MK 1,500 fertilizer subsidy than a base case highly risk averse farmer.

There is also some evidence that farm households who receive income more frequently during the year have a higher probability of selecting an ideal insurance contract (the coefficient for the variable indicating farmers received income from farm sales in nine or more months is positive and statistically significant). Finally, farmers with more experience using manure were also more likely to opt for the insurance contract, while farmers who more frequently practiced soil conservation were more likely to prefer the fertilizer subsidy (as was the case when offered choices between cash payments and fertilizer subsidies).

Conclusion

This study uses a framed choice experiment to examine Malawi smallholder farmers' preferences among four major policy options that provide incentives for adopting agroforestry based conservation practices: cash payments, an ideal crop insurance instrument, a crop insurance instrument with a fifty percent basis risk and fertilizer subsidies. Most farmers in the sample had relatively little schooling, limited numeracy and literacy skills, and very little or no experience with financial instruments such as insurance. Therefore, prior to the choice elicitation experiments, a relatively complex protocol based on dynamic learning games was utilized to enable farmers to understand and appreciate the dynamic implications of crop insurance contracts cash payments and fertilizer subsidies.

The first major set of findings concerns the results from the analysis of the choice sets in in which farmers had the option of an ideal insurance contract or a guaranteed cash payment. Even when the expected value of the ideal insurance contract's indemnity was 25 percent higher than the cash payment, 60 percent of the sample preferred the cash payment and only forty percent the insurance contract. As the cash payment was increased to reflect the commercial costs of delivering a basis risk insurance (involving an overhead charge of between 30 percent for larger farms and likely closer to 80 percent for very small farms with one hectare of land because of fixed costs associated with insurance contracts), less than 27 percent of the farmers in the sample selected the ideal insurance contract.

An ideal insurance contract effectively implies that yields and/or rainfall shortfalls on the farm itself are being insured. Such contracts are widely viewed as infeasible in settings that involve very small farms producing very small amounts of crops. Basis risk contracts that utilized area rainfall indexes or area yields maybe more feasible, but the evidence from the choice sets indicates that about 50 percent of farmers in the sample would reject a basis contract in favor of an ideal contract even when the basis risk contract has an expected value that is 40 percent higher, and 60 percent of farmers prefer the ideal insurance contract when the two insurance contracts have the same expected value. Hence, while care must be taken in interpreting the choice elicitation experiment results, far fewer farmers appear likely to accept basis risk insurance contracts than ideal insurance contracts when they are identical in terms of expected values and opportunity costs. These results are consistent with most of the findings reported in previous studies of the willingness to pay and demand for crop insurance.

Second, this study provides some evidence that cash flow or liquidity constraints limit some farmers' willingness to use crop insurance as a risk management tool. Evidence from probit models of the choice between cash payments and the ideal insurance contract indicates that farmers in the sample with more frequent income from the sale of crops and livestock products were more likely to select the ideal insurance product. Similarly, *ceteris paribus*, a decrease in household size (and a corresponding implied increase per capita household income and assets) also had a significant positive effect on the probability of selecting an insurance instrument.

Third, almost no farmer opted to use traditional farming practices when confronted with cash payment, insurance contract, and/or fertilizer subsidy based incentives for the adoption of conservation agriculture. This suggests that the scope for such incentive programs is substantial. However, those incentives may not be cheap, at least from the perspective of a developing country's government. For example, a per hectare annual cash payment of MK 800, the lowest incentive offered in the choice experiments, is equivalent to approximately $5.50. Ignoring discounting issues, a five to seven year commitment for an annual payment at that level required total funds of between $28 and $39 dollars per hectare. If the government established a goal of attracting one million hectares (about 40% all arable land in Malawi) into agroforestry based conservation practices, the annual budget would be close to $28-39 million (approximately $6-8 million per year) over a five to seven year commitment in total outlays. Using an ideal insurance instrument with an indemnity of MK 5000 and an expected value of MK 1,000 would be at least 25 percent more expensive (with an annual cost of about $8.0 million and a five year commitment cost of about $40.0 million).

The fourth major result of the study is that over 60 percent of the sample of farmers exhibited risk averse behavior while about 33 percent appeared to be risk loving or risk neutral, at least with respect to the options with which they were confronted. These findings are relatively consistent with results recently reported by Maertens, Just and Chari (2011) for smallholder farmers in Ethiopia and raise questions about assertions that an overwhelming majority of very poor farmers are highly risk averse. It is also worth noting that only seven percent of the sample of farmers made inconsistent or intransitive choices when confronted with the ideal insurance/basis risk insurance choice set, suggesting that, as a result of the dynamic learning games protocol, most farmers in the sample understood basis risk and how insurance contracts worked.

This study has not examined farmers' minimum reservation prices for adopting agroforestry based conservation in terms of the minimum values of alternative policy instruments required to encourage them to use those practices. The data on yield gains associated with agroforestry, especially when combined with fertilizer use, suggests that those reservation prices may be quite low. An important "next step" would be to carry out additional studies in which framed choice elicitation experiments considered wider and lower ranges of values for the policy innovations being considered. These might include "one time" incentives of the sort suggested by Barrett (2007) to overcome fixed costs associated with adopting new production practices. However, it should be noted that conservation practices also require continuous additional outlays of farm household labor and major yield increases tend to occur after the first year of adoption, suggesting that multi-year incentive programs may be required. The evidence from this study suggests that indexed based crop insurance contracts in which basis risks are substantial are probably not the least cost instruments for achieving that objective.

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Table 1. Farm Maize Yields Under Alternative Farming Practices

Farming Practice	Yield in "Good Rain" Years	Yield in "Poor Rain" Years
	Tons/ha	
Traditional	1	0.5
Conservation Agriculture (CA)	2	1
CA & Fertilizer	2.5	1.25

Table 2. Choice Set Alternatives

Choice Set Block 1	Option A Traditional practices with no incentives	Option B Cash payments (with adoption of conservation agroforestry)	Option C "Ideal" insurance contract indemnity (with conservation agroforestry)
1	No incentives	MK 800	MK 5000
2	No incentives	MK 2000	MK 5000
3	No incentive	MK 1300	MK 5000
4	No incentives	MK 1000	MK 5000
5	No incentives	MK 1800	MK 5000
Choice Set Block 2	**Option A Traditional practices**	**Option B Cash payments ((with adoption of conservation agroforestry)**	**Option D Fertilizer subsidies ((with adoption of conservation agroforestry)**
6	No incentives	MK 800	MK 2000
7	No incentives	MK 2000	MK 2000
8	No incentives	MK 1300	MK 2000
9	No incentives	MK 1000	MK 2000
10	No incentives	MK 1800	MK 2000
Choice Set Block 3	**Option A Traditional practices**	**Option C "Ideal" insurance contract indemnity (with adoption of conservation agroforestry)**	**Option D Fertilizer subsidies (with adoption of conservation agroforestry)**
11	No incentives	MK 5000	Mk 2000
12	No incentives	MK 5000	MK 1500
13	No incentives	MK 5000	MK 2500
Choice Set Block 4	**Option A Traditional practices**	**Option C Ideal" insurance contract indemnity (with adoption of conservation agroforestry)**	**Option E Insurance indemnity with 50% Basis Risk (with adoption of conservation agroforestry)**
14	No incentives	MK 5000	MK 10,000
15	No incentives	MK 5000	MK 6,000
16	No incentives	MK 5000	MK 14,000

Table 3. Risk Preference Categories

Farmer Risk Preference Category	Farmer Selects MK 6000 Basis Risk Insurance Contract	Farmer Selects MK 10,000 Basis Risk Insurance Contract	Farmer Selects MK 14,000 Basis Risk Insurance Contract	Numbers of Sample Respondents in Each Risk Category	Proportion of Sample Respondents in Each Risk Category
Risk Loving	Yes	Yes	Yes	69	25.5%
Risk Loving/Risk Neutral	No	Yes	Yes	24	8.9%
Risk Averse	No	No	Yes	21	7.7%
"Highly" Risk Averse	No	No	No	137	50.5%
Indeterminate	Respondents making inconsistent or intransitive choices in responding to choice sets 14-16			20	7.4%
	TOTAL			**271**	**100%**

Table 4: Payoffs from Choice Alternatives

Incentive Program	Poor Rains Yield (tons/ha)	Good Rains Yield (tons/ha)	Poor Rain Payoff (000 MK)	Good Rain Payoff (000 MK)	Expected Value of Program (000 MK)
Traditional Farming	0.5	1	10.0	20.0	18.0
Cash Payment (and CA)					
MK 800	1	2	20.8	40.8	36.8
MK 1000	1	2	21.0	41.0	37.0
MK 1300	1	2	21.3	41.3	37.3
MK 1800	1	2	21.8	41.8	37.8
MK 2000	1	2	22.0	42.0	38.0
Insurance Contract and CA					
Indemnity of MK 5000	1	2	25.0	40.0	37.0
Fertilizer Subsidy					
Subsidy = MK 1500	1.25	2.5	22.5	47.5	42.5
Subsidy = MK 2000	1.25	2.5	23.0	48.0	43.0
Subsidy = MK 2500	1.25	2.5	23.5	48.5	43.5

Table 5. Variable Definitions

Variable	**Definition**
Cash-insurance choice	Indicator variable = 1 if participant picked insurance in choice sets 1-5.
Cash-fertilizer subsidy choice	Indicator variable = 1 if participant picked fertilizer subsidy in choice sets 6-10.
Insurance-fertilizer subsidy choice	Indicator choice variable = 1 if participant picked insurance in choice sets 11-13.
Gender of household head	Indicator variable = 1 if participant is male.
Age of household head	Age of head of household in years
Regularity of farm income	Indicator variable = 1 if farm income was received for less than 3 months in the previous 12 months
	Indicator variable = 1 if farm income was received for more than 3 but less than 6 months in the previous 12months
	Indicator variable = 1 if farm income was received for 6 or more but less than 9 months in the previous 12 months
	Indicator variable = 1 if farm income was received for more than 9
Education level of household head	Indicator variable = 1if household head had no formal education
	Indicator variable = 1 if household head had at most some primary schooling
	Indicator variable = 1 if household if household head had at most some secondary schooling
	Indicator variable = 1 if household if household head had at least post-secondary schooling
Value of all farm equipment owned ('000 MK)	The resale value of all farm implements and equipment owned by household
Value of all livestock owned ('000 MK)	The minimum sale value of all livestock owned by household
Household size (Persons)	Number of persons in household
Per capita monthly food expenditure ('000 MK)	Food expenditure per person in a month (based on the 3 months prior to survey)
Distance to trading center	Travel time (in hours) to local trading center by households most common travel mode
Years of fertilizer use	Number of years over the past five years (immediately) prior to the survey) in which fertilizer was used on farm
Years of manure use	Number of years over the past five years (immediately) prior to the survey) in which manure was used on farm
Years of agroforestry practices	Number of years over the past five years (immediately) prior to the survey) in which agroforestry practices were implemented on farm
Years of soil conservation practices	Number of years over the past five years (immediately) prior to the survey) in which soil conservation practices were implemented on farm

Table 5 (cont'd)

Years of conservation agriculture (CA) practices	Number of years over the past five years (immediately) prior to the survey) in which conservation agriculture was used on farm
MK1000 cash Dummy	Indicator variable for a cash payment of MK 1000 offered in a choice experiment (=1, 0 otherwise)
MK1300 cash Dummy	Indicator variable for a cash payment of MK 1300 offered in a choice experiment (=1, 0 otherwise)
MK1800 cash Dummy	Indicator variable for a cash payment of MK 1800 offered in a choice experiment (=1, 0 otherwise)
MK2000 cash Dummy	Indicator variable for a cash payment of MK 2000 offered in a choice experiment (=1, 0 otherwise)
MK2000 fertilizer subsidy Dummy	Indicator for fertilizer subsidy level of MK 2000 used in choice experiment (=1, 0 otherwise)
MK2500 fertilizer subsidy Dummy	Indicator for fertilizer subsidy level of MK 2500 used in choice experiment (=1, 0 otherwise)
Risk Loving	Dummy variable = 1 if household is risk loving as defined in Table X3
Risk Neutral	Dummy variable = 1 if household is risk neutral as defined in Table X3
Risk averse (moderate)	Dummy variable = 1 if household is moderately risk averse defined in Table X3
Risk averse (high)	Dummy variable = 1 if household is highly risk averse as defined in Table X3
Intransitive choices Dummy	Dummy variable =1 if household choice was intransitive as defined in Table X3
Participation in game protocol Dummy	Dummy variable=1 if respondent participated in the game protocol
District Dummy	Indicator variable for district from data was collected. Ntcheu=1, Dedza=0

Table 6. Descriptive Statistics (Mean, minimum, maximum and standard deviation)

Variable	Mean	Min	Max	SD
Gender of household head	0.74	0.00	1.00	0.44
Age of household head	43.00	18.00	76.00	13.78
Farm income was received for less than 3 months in the previous 12 months	0.44	0.00	1.00	0.50
Farm income was received for more than 3 but less than 6 months in the previous months	0.43	0.00	1.00	0.50
Farm income was received for 6 or more but less than 9 months	0.08	0.00	1.00	0.27
Farm income was received for more than 9	0.06	0.00	1.00	0.23
Household head has no formal schooling	0.16	0.00	1.00	0.37
Household head has at most primary schooling	0.66	0.00	1.00	0.47
Household head has at least some secondary schooling	0.17	0.00	1.00	0.38
Household head has at least post-secondary schooling	0.004	0.00	1.00	0.06
Value of all farm equipment owned ('000 MK)	11.48	0.00	116.90	16.63
Value of all livestock owned ('000 MK)	16.31	0.00	511.00	38.17
Household size (Persons)	5.60	3.00	11.00	1.79
Pa capita monthly food expenditure ('000 MK)	0.78	0.19	18.63	0.57
Distance to trading center	0.29	0.02	2.00	0.48
Years of fertilizer use	3.82	0.00	5.00	1.43
Years of manure use	2.35	0.00	5.00	1.74
Years of agroforestry practices	0.18	0.00	5.00	0.58
Years of soil conservation practices	3.81	0.00	5.00	1.54
Years of conservation agriculture (CA) practices	0.76	0.00	5.00	1.68
Participation in game protocol	1.00	1.00	1.00	0.00
Risk Loving	0.26	0.00	1.00	0.44
Risk Neutral	0.09	0.00	1.00	0.29
Risk averse (moderate)	0.08	0.00	1.00	0.27
Risk averse (high)	0.52	0.00	1.00	0.50

Table 7(a). Probit estimates of Cash-Insurance choices in choice sets 1-5 (insurance = 1)

	(1)		(2)	
Variable	**Coefficient**	**SE**	**Coefficient**	**SE**
Gender of household head	-0.110	0.077	-0.126	0.078
Age of household head	0.000[A]	0.000[a]	0.000[a]	0.000[a]
Household head has at most primary schooling	-0.109	0.105	-0.147	0.107
Household head has at least some secondary schooling	-0.296**	0.135	-0.339**	0.138
Farm income was received for between 3 but and 5 months	0.153*	0.084	0.158*	0.085
Farm income was received for between 6 and 9 months	0.138	0.199	0.122	0.201
Farm income was received for more than 9 months	0.274*	0.148	0.275*	0.148
Value of all farm equipment owned ('000 MK)	-0.006**	0.003	-0.006**	0.003
Value of all livestock owned ('000 MK)	-0.002*	0.001	-0.002*	0.001
Household size	-0.071***	0.024	-0.069***	0.024
Pa capita monthly food expenditure ('000 MK)	0.078	0.054	0.086	0.055
Distance to trading center	-0.058	0.085	-0.054	0.085
Years of fertilizer use	0.066**	0.030	0.077**	0.031
Years of manure use	0.051**	0.024	0.053**	0.024
Years of agroforestry practices	-0.051	0.071	-0.063	0.072
Years of soil conservation practices	-0.031	0.028	-0.041	0.028
Years of conservation agriculture (CA) practices	-0.017	0.024	-0.016	0.024
MK1000 Dummy	-0.243**	0.115	-0.346**	0.168
MK1300 Dummy	-0.279**	0.116	-0.374**	0.169
MK1800 Dummy	-0.363***	0.117	-0.451***	0.170
MK2000 Dummy	-0.472***	0.118	-0.580***	0.173
Risk neutral	-0.234	0.154	-0.250	0.155
Moderately risk averse	-1.290***	0.185	-1.301***	0.186
Highly risk averse	-0.551***	0.091	-0.553***	0.091
Intransitive choices	-0.120	0.173	-0.134	0.174
District Dummy			-0.035	0.165
District X MK1000 Dummy			0.194	0.231
District X MK1300 Dummy			0.178	0.232
District X MK1800 Dummy			0.166	0.234
District X MK2000 Dummy			0.202	0.237
Constant	0.466*	0.247	0.499*	0.263
	1,320		1,315	

[a] The coefficients are zeros until the fourth decimal place, but not statistically significant.

Table 7(b). Predicted probabilities in the Cash-insurance choices in choice sets 1-5 (insurance = 1)

Experiment	Probabilities	Marginal Effects [b]
Base Case [a]	**0.400**	
Household size	0.374	-0.025
No schooling	0.655	0.256
Secondary schooling	0.333	-0.067
Years of fertilizer	0.430	0.031
Years of manure	0.411	0.012
Years of agroforestry	0.371	-0.028
Years of soil conservation	0.395	-0.004
Years of conservation agroforestry	0.392	-0.008
Cash level of MK 1,000	0.309	-0.090
Cash level of MK 1,300	0.297	-0.103
Cash level of MK 1,800	0.268	-0.132
Cash level of MK 2,000	0.233	-0.166
Risk loving	0.623	0.224
Risk neutral/loving	0.525	0.125
Moderately risk averse	0.168	-0.232
Intransitive risk choices	0.347	-0.053

[a] The base case farm household used to estimate probabilities and marginal changes in those probabilities has the following characteristics. The head of household is a highly risk averse male with some primary education and the household has five members. Models that included separate variables for the numbers of adults and children yielded almost identical results and parameter estimates for the two variables were very similar. Values are set at the sample means for per capita monthly food expenditure, livestock value, equipment value, and years of fertilizer use, manure use, agroforestry, soil conservation, and conservation agroforestry practices, and the base case level of cash payments is MK 800.

[b] Marginal effects are computed by increasing variables defined as "years of" by 1year above their mean values. Marginal effects are computed for the indicator variables by setting the variable equal to 1 and all other indicator variables in its set to zero. Household size is increased by 1 from its sample mean to compute its marginal effect.

Table 8(a). Probit estimates of Cash-fertilizer subsidy choices in choice sets 6-10 (fertilizer subsidy = 1)

	(1)		(2)	
Variable	**Coefficient**	**SE**	**Coefficient**	**SE**
Gender of household head	-0.086	0.126	-0.117	0.132
Age of household head	0.008*	0.005	0.009*	0.005
Household head had at most primary schooling	0.393***	0.146	0.310**	0.152
Household head had at least some secondary schooling	1.199***	0.277	1.110***	0.286
Household head had at least post-secondary schooling	0.000	0.000	0.000	0.000
Farm income was received for more than 3 but less than 6 months	0.202	0.132	0.270*	0.138
Farm income was received for 6 or more but less than 9 months	0.802*	0.469	0.787	0.491
Farm income was received for more than 9	-0.038	0.244	-0.008	0.250
Value of all farm equipment owned ('000 MK)	0.020***	0.006	0.012*	0.006
Value of all livestock owned ('000 MK)	-0.001	0.002	-0.001	0.001
Household size	-0.087**	0.036	-0.077**	0.037
Pa capita monthly food expenditure ('000 MK)	-0.000	0.000	0.000	0.000
Distance to trading center	-0.005	0.120	-0.000	0.124
Years of fertilizer use	-0.149***	0.049	-0.128**	0.052
Years of manure use	0.072*	0.038	0.094**	0.040
Years of agroforestry practices	-0.065	0.106	-0.098	0.108
Years of soil conservation practices	0.131***	0.039	0.125***	0.041

Table 8(a) cont'd

Years of conservation agriculture (CA) practices	-0.006	0.037	0.010	0.039
MK1000 Dummy	-0.040	0.198	-0.051	0.250
MK1300 Dummy	-0.167	0.192	-0.229	0.241
MK1800 Dummy	-0.132	0.194	-0.240	0.240
MK2000 Dummy	-0.297	0.186	-0.179	0.243
Risk neutral	-0.171	0.232	-0.307	0.241
Moderately risk averse	-0.075	0.243	-0.102	0.247
Highly risk averse	0.202	0.153	0.166	0.158
Intransitive risk choices	-0.433*	0.254	-0.519*	0.266
District Dummy			0.511	0.311
District X MK1000 Dummy			0.034	0.426
District X MK1300 Dummy			0.190	0.418
District X MK1800 Dummy			0.376	0.438
District X MK2000 Dummy			-0.312	0.389
Constant	1.159***	0.411	0.864**	0.439
	1,320		1,315	

Table 8(b). Predicted probabilities in the Cash-fertilizer subsidy choices in choice sets 6-10 (fertilizer subsidy = 1)

Experiment	Probabilities	Marginal Effects [b]
Base Case [a]	**0.976**	
Household size	0.971	-0.005
No schooling	0.950	-0.025
Secondary schooling	0.997	0.021
Years of fertilizer	0.968	-0.008
Years of manure	0.979	0.003
Years of agroforestry	0.975	-0.001
Years of soil conservation	0.978	0.002
Years of conservation agroforestry	0.976	0.000
Cash level of MK 1,000	0.979	0.003
Cash level of MK 1,300	0.965	-0.010
Cash level of MK 1,800	0.975	-0.001
Cash level of MK 2,000	0.952	-0.023
Risk loving	0.973	-0.003
Risk neutral/loving	0.939	-0.037
Moderately risk averse	0.959	-0.016
Intransitive risk choices	0.924	-0.052

[a] The base case farm household used to estimate probabilities and marginal changes in those probabilities has the following characteristics. The head of household is a highly risk averse male with some primary education and the household has five members. Models that included separate variables for the numbers of adults and children yielded almost identical results and parameter estimates for the two variables were very similar. Values are set at the sample means for per capita monthly food expenditure, livestock value, equipment value, and years of fertilizer use, manure use, agroforestry, soil conservation, and conservation agroforestry practices, and the base case level of cash payments is MK 800.

[b] Marginal effects are computed by increasing variables defined as "years of" by 1year above their mean values. Marginal effects are computed for the indicator variables by setting the variable equal to 1 and all other indicator variables in its set to zero. Household size is increased by 1 from its sample mean to compute its marginal effect.

Table 9(a). Probit estimates of Insurance-fertilizer subsidy choices in choice sets 11-13 (insurance = 1)

	(1)		(2)	
Variable	**Coefficient**	**SE**	**Coefficient**	**SE**
Gender of household head	-0.126	0.144	-0.104	0.146
Age of household head	0.001	0.000	0.001	0.000
Household head had at most primary schooling	-0.235	0.183	-0.217	0.184
Household head had at least some secondary schooling	-0.288	0.244	-0.229	0.246
Household head had at least post-secondary schooling	0.000	0.000	0.000	0.000
Farm income was received for more than 3 but less than 6 months	-0.034	0.153	-0.046	0.154
Farm income was received for 6 or more but less than 9 months	0.000	0.000	0.000	0.000
Farm income was received for more than 9	0.477*	0.245	0.464*	0.246
Value of all farm equipment owned ('000 MK)	-0.010*	0.006	-0.007	0.006
Value of all livestock owned ('000 MK)	0.001	0.002	0.001	0.002
Household size	0.021	0.042	0.017	0.042
Pa capita monthly food expenditure ('000 MK)	0.173*	0.095	0.151	0.095
Distance to trading center	0.080	0.144	0.076	0.145
Years of fertilizer use	0.037	0.054	0.023	0.055
Years of manure use	0.148***	0.046	0.144***	0.046
Years of agroforestry practices	-0.272	0.185	-0.252	0.184
Years of soil conservation practices	-0.127**	0.049	-0.128**	0.050
Years of conservation agriculture (CA) practices	-0.015	0.043	-0.016	0.042
MK2000 fertilizer subsidy Dummy	-0.260	0.160	-0.305	0.200
MK2500 fertilizer subsidy Dummy	-0.425**	0.169	-0.468**	0.207
Risk loving/risk neutral	0.328	0.246	0.378	0.250
Moderately risk averse	-0.596**	0.289	-0.614**	0.292
Highly risk averse	-0.650***	0.167	-0.621***	0.168
Intransitive choices Dummy	-0.208	0.309	-0.152	0.310
District Dummy			-0.296	0.227
District X MK2000 fertilizer subsidy Dummy			0.109	0.282
District X MK2500 fertilizer subsidy Dummy			NA	NA
Constant	-0.842**	0.420	-0.662	0.436
	762		759	

Table 9(b). Predicted probabilities for Insurance-fertilizer subsidy choice sets 11-13 (insurance = 1)

Experiment	Probabilities	Marginal Effects[b]
Base Case [a]	**0.050**	
Household size	0.051	0.001
No schooling	0.083	0.032
Secondary schooling	0.049	-0.002
Years of fertilizer	0.053	0.003
Years of manure	0.060	0.010
Years of agroforestry	0.023	-0.028
Years of soil conservation	0.047	-0.004
Years of conservation agroforestry	0.049	-0.001
Subsidy level of MK 2,000	0.029	-0.021
Subsidy level of MK 2,500	0.020	-0.030
Risk loving	0.147	0.097
Risk neutral/loving	0.250	0.200
Moderately risk averse	0.052	0.002
Highly risk averse	0.125	0.074

[a] The base case farm household used to estimate probabilities and marginal changes in those probabilities has the following characteristics. The head of household is a highly risk averse male with some primary education and the household has five members. Models that included separate variables for the numbers of adults and children yielded almost identical results and parameter estimates for the two variables were very similar. Values are set at the sample means for per capita monthly food expenditure, livestock value, equipment value, and years of fertilizer use, manure use, agroforestry, soil conservation, and conservation agroforestry practices, and the base case level of cash payments is MK 800.

[b] Marginal effects are computed by increasing variables defined as “years of” by 1year above their mean values. Marginal effects are computed for the indicator variables by setting the variable equal to 1 and all other indicator variables in its set to zero. Household size is increase by 1 from its sample mean to compute its marginal effect.

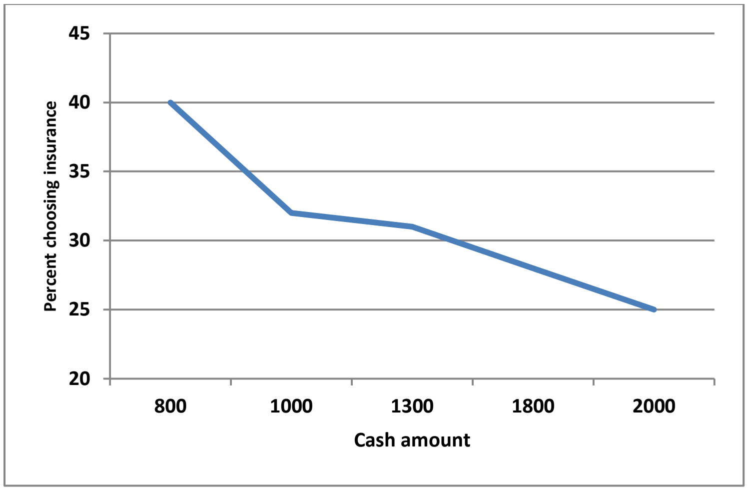

Figure 1. Percent choosing ideal insurance against various cash amounts (Cash-insurance choice)

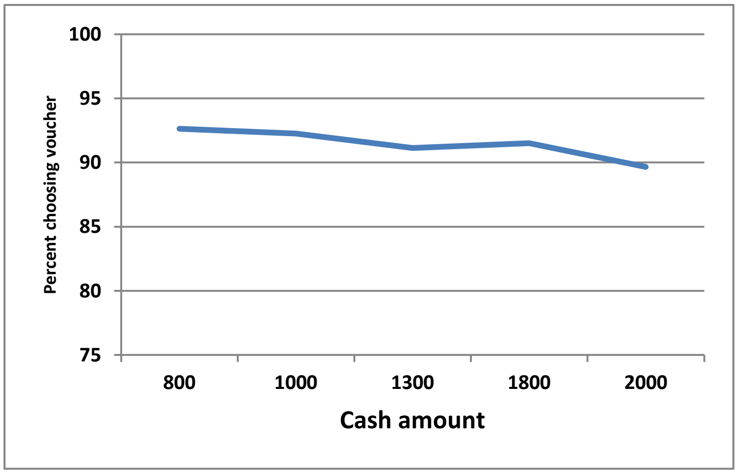

Figure 2. Percent choosing fertilizer subsidy against various cash amounts (Cash-fertilizer subsidy choice)

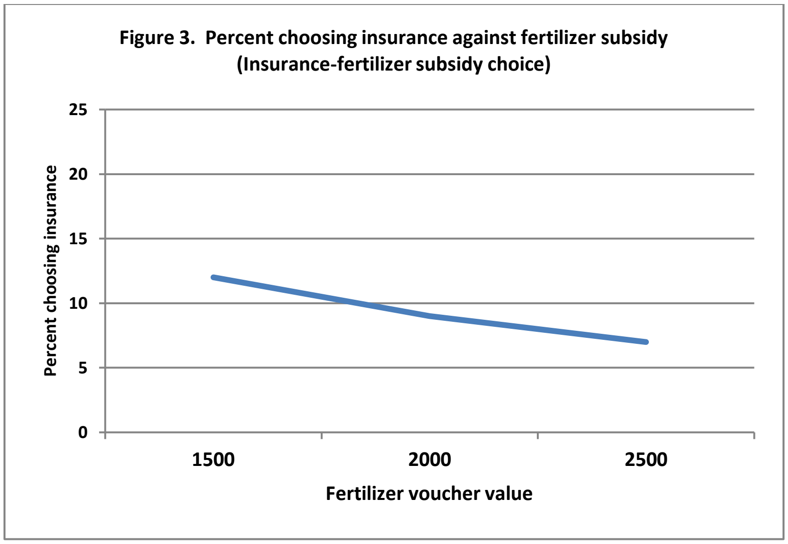

Figure 3. Percent choosing ideal insurance against various fertilizer subsidy (Insurance-fertilizer subsidy choice)

Appendix A

The household questionnaire included nine brief sections. A cover sheet requested data on the household's location (district and village name). The first main section consisted of a table on which a census of household members was entered. There was space to enter six adults and the age, gender, education and income information for each adult. The number of children under 17 years of age was also entered (but with no other details). The next three sections (section 2-4) collected data on length of residency of household in the village and whether the household members were native to the village or immigrants. A table on group membership of the household head and the spouse was also completed. In section five, the respondents filed out a table that listed all the farm implements smallholder operations were likely to use. The number of each type of implement was entered and the respondent was asked to state the minimum resale value the implements could fetch if they were to be sold. These responses were used to estimate the value of the farm's assets (other than land). Section 6 was designed to obtain an inventory of the livestock types owned by the farm and the minimum price at which ach livestock type could be sold.

In section seven, the respondents completed a table identifying various food categories by recording the annual the amounts of each food type consumed from purchases and own production. The respondents were asked to summarize the information based on a three month recall period prior to the survey to avoid zeros being recorded for categories of food that were purchased on a regular basis. These data were used to construct estimates of monthly per capita food consumption by each farmer. In section eight, respondents were asked about their experience with manure, soil conservation agroforestry, conservation agriculture and fertilizer use and how frequently (on an annual basis) they had used these practices in the previous five years.

Endnotes/Footnotes

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[1] In agriculture, conservation techniques are complex and often defined in the context of specific agronomic conditions. The term conservation agriculture is defined as a system of cultivation characterized by the following practices: mitigating soil disturbance by practicing minimum tillage, maintaining soil cover through crop residue retention, and incorporating agroforestry trees into the crop field. In this study we use the term agroforestry based conservation practices (ACP) to refer to this set of agricultural practices

[2] Vargas Hill and Viceisza (2011) describe an ideal insurance contract as one with no basis risk that also provides no moral hazard or adverse selection incentives. The ideal insurance contract considered here also has no basis risk and, given that farmers are confronted with the same binomial yield distribution and indemnities driven by weather events beyond their control, does not have any apparent adverse selection or moral hazard incentive associated with it. The other contract does have downside basis risk, but similarly provides no moral hazard or adverse selection incentives.

[3] One of the fundamental justifications for non-separable models is that smallholder households operate in environments where some markets are incomplete or missing. For example, Fabella (1989) shows that even when commodity markets exist and function effectively, non-separability may still hold because of the absence of risk related and other contingent claims markets.

[4] Along these lines, Barrett (2007) has proposed a “one-off subsidies of adoption of improved production technologies so as to obviate credit constraints”. One example is food for work schemes tied to yield increasing investments in soil and water conservation structures that have resulted in higher levels of adoption by cash and credit constrained smallholder farmers (Holden, Barrett, and Hagos 2006).

[5] See also Skees and Collier (2008), Goodwin and Smith (1995), Sarris, Karfkis, and Christriaensen (2006), Skees et al. (2007) for discussions of the potential role of insurance in reducing financial constraints facing small holder farmers.

[6] Antle has also emphasized that providing payments for environmental services which are tied to the adoption of specific technologies helps to address negative externalities by resolving some of the coordination failures that are inherently associated with the adoption of land management practices such as conservation agriculture and agro-forestry (FAO 2007, Antle and Diagana 2003).

[7] The agronomists were specifically asked to provide estimates of likely yields from each practice when they were used by smallholder farmers on their own farms, not on experimental plots.

[8] Here, the term conservation agroforestry indicates that a farm utilizes agroforestry in its portfolio of conservation practices, which also include practices such as minimum tillage and, where needed, some form of terracing.

[9] In our sample of 271 smallholder farmers, no respondents had any tertiary education.

[10] Enumerator training included three days of classroom education and discussion led by the protocol designers, simulated education and choice elicitation sessions with farmers in the vicinity of Bunda College, where the enumerators were enrolled in masters degree programs, and two days of protocol pre-testing with groups of 12 to 15 farmers drawn from villages in the study area (although no data from these villages were used in the analysis). At the end of each pre-testing session, the enumerators shared their experiences and challenges with the project leader, and, where necessary, changes were made to the education protocol and the implementation

procedure for the choice sets. During the first two weeks of actual data collection, the enumerators and the project director also met at the end of each day to discuss the enumerators' experiences and address any further difficulties in presenting the education programs and carrying out the choice elicitation experiments.

[11] In the study area, while in practice on average drought occurs about once every five years, to ensure that farmers grasped the concept of an insurance indemnity, in this part of the education program drought was assumed to be much more frequent

[12] Many experimental economics studies involving risk provide participants with rewards tied to the outcomes of their choices or compensate participants for their time. In this framed choice elicitation experiment, to ensure a random sample, the authors were advised not to offer cash payments or rewards that might encourage village leaders to put forward individuals who had not been identified in the random sampling procedures. A second concern was that cash payments might generate subsequent problems within the villages and between village and local authorities about who had been allowed to participate in the program.

[13] Farmers remained isolated with a team member until an enumerator came to get them. No enumerator had to carry out more than three experiments and surveys in any given day because the group sizes were limited to between 12 and 18 farmers, which limited interviewer fatigue and improved recording accuracy.

[14] The base case farm household used to estimate probabilities and marginal changes in those probabilities has the following characteristics. The head of household is a highly risk averse male with some primary education and the household has five members. Models that included separate variables for the numbers of adults and children yielded almost identical results and

parameter estimates for the two variables were very similar. Values are set at the sample means for per capita monthly food expenditure, livestock value, equipment value, and years of fertilizer use, manure use, agroforestry, soil conservation, and conservation agroforestry practices. The base case level of cash payments is set at MK 800 (the omitted cash payment indicator variable) in the cash-insurance and cash-fertilizer choice models and the base level of the fertilizer subsidy is set at MK 1,500 in the insurance-fertilizer choice model.

[15] Models analyzing choice elicitation experiment data often include random effects, frequently because of lack of information about each respondent. Here, the household survey provided substantial amounts of information about each respondent. Alternatively, fixed effects may be included to account for differences among sub groups (for example, different villages). However, as is well known, fixed effects cannot meaningfully be incorporated in probit models (Greene 2002). Moreover, the villages were drawn from only two districts with very similar climates, topologies, and cultures.