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Smallholder access to weather securities in India

Demand and impact on production decisions

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Smallholder access to weather securities in India: demand and impact on production decisions

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Abstract

Weather-based insurance products insure farmers against production risks on the basis of a weather index that is highly correlated to local yields. Indemnifications are triggered by pre-specified patterns of the index, as opposed to actual yields. This eliminates the requirement of on-field assessments for indemnification, thereby lowering administrative costs and time. Therefore, index-based insurance products have been regarded as having enormous potential to reach small farmers in developing countries. Surprisingly, the demand and take-up rates are low for weather index insurance (WII) products. One of the reasons hypothesised for the low demand and take-up of index-based insurance products is their inherent complexity, which makes it difficult for farmers to perceive the direct benefits. Hence, to encourage stronger participation, the project introduced an innovative WII product that was simple, transparent, flexible and affordable for smallholder farmers. In fact, the insurance product was a menu of very simple insurance options, each with a flat payment, but different triggers and for different coverage periods. This product was tested in three districts of Madhya Pradesh, India, during two consecutive summer agricultural seasons (known as *kharif* in India) in 2011 and 2012 among the farmers who were cultivating rainfed soya bean crop.

The main objective of this study was to assess the impact of the product (simplified WII) on the production and consumption behaviours of smallholder farmers. In addition to this, the research also investigated the responsiveness of insurance demand to a set of randomly allocated interventions among farmers who were offered insurance products. These are:

1) Exogenous variation of the distance to the weather station by installing three new weather stations, which were randomly positioned.
2) Random assignment of price discounts for the insurance offered.
3) Provision of training to all farmers being offered the insurance product, but random variation of the intensity of training across villages.

A comparison of differences in outcome variables among the baseline and a follow-up survey between control and treatment villages (through a difference in differences estimation) provided us with a test of the impact of offering WII to smallholder farmers. Empirically, we find evidence for the impact of our specific WII product, although results are not strong, arguably due to a lack of power that arose because of low take-up of the product. On the other hand, comparing take-up rates between different (randomly allocated) treatment arms allowed us to evaluate the responsiveness of insurance demand to our interventions, namely price discounts, weather station investments (a proxy to basis risk) and intensive training on insurance literacy.

Overall, the demand for our simplified WII products was quite low, at 6.9 per cent and 4.03 per cent of the sample during *kharif* 2011 and 2012, respectively. We find that the demand falls as price and distance to the weather station increase. On the other hand, the demand for WII increases as product comprehension increases. Interestingly, the intensive insurance literacy training sessions conducted in the first year seem to be of a more transient nature, with no significant impact on understanding or demand during the second year. In terms of the dynamic effects of the programme, while purchasing insurance does not have a substantial impact on demand on its own in the subsequent year/season, purchasing insurance and receiving a payout is strongly positively correlated with the decision to

purchase insurance in the subsequent season. However, observing other households in the village receiving a payout seems to have no impact on demand. This could also be explained by the low levels of trust in the product or the insurance company. This is an interesting avenue for future research.

The study seems to support the hypothesis that the purchase of WII could have influenced the farmers to use hybrid seeds or high-yielding varieties to cultivate increased areas, to cultivate new crops, to adopt improved cultivation practices and to get additional loans. However, these results are not statistically strong.

The insights gained from the study enable us to propose the following policy recommendations:

1) Thin networks of weather stations restrict the demand and scale-up of WII.
2) Provision of weather data by the weather service providers to the insurers has to happen without any time lag to enable quick indemnification.
3) Distribution and marketing channels are key to enhance take-up and scale-up of WII programmes.
4) An improved design of the WII product is key to minimise basis risk.
5) Affordability of WII insurance premiums is essential for a sustained take-up from smallholder farmers.
6) One-time WII literacy programmes have little, if any, long-lasting impact on insurance understanding and demand. This suggests that WII literacy programmes should be designed as part of a more permanent process over time so they can contribute to developing more sustainable micro-insurance markets (although more rigorous evidence of this recommendation will require longer-term research projects than this one).

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Abbreviations and acronyms

ANCOVA	analysis of covariance
ATE	average treatment effect
FGD	focus group discussion
HH	Household
IFPRI	International Food Policy Research Institute
IMD	Indian Meteorological Department
IRDA	Insurance Regulatory and Development Authority
ITT	intent to treat
km	kilometre
MDE	minimum detectable effect
NAIS	National Agricultural Insurance Scheme
WBCIS	Weather Based Crop Insurance Scheme
WII	weather index insurance

1. Introduction

Life for many farming households is risky. When this risk is uninsured, it poses a considerable cost to current welfare as unfavourable events (such as weather shocks) will reduce the production and consumption behaviours of agrarian livelihoods. Without insurance, households take inefficient actions to limit their exposure to risk, and they may pass up a profitable opportunity that is considered too risky[1] or keep a high proportion of low return/ high liquidity assets,[2] which lower their average income.

Weather-based insurance products insure farmers against production risks on the basis of a weather index (e.g. rainfall-based) that is theoretically correlated to local yields. Indemnifications are triggered by pre-specified patterns of the index, as opposed to actual yields (IFAD and WFP 2010). This eliminates the requirement of on-field assessments of average yield for a given area, thereby lowering administrative costs and time. Therefore, index-based insurance products have been regarded as having enormous potential to reach small farmers in developing countries as they can stabilise farming production without requiring farmers to make last resort sales of productive assets at a low price. Surprisingly, the demand and take-up rates are low for weather index insurance products (Cole *et al*. 2012). One of the reasons hypothesised for the low demand and take-up of traditional index-based insurance products is the inherent complexity of the products, which makes it difficult for farmers to perceive the direct benefits (Gine *et al*. 2008).

Hence, to encourage stronger participation, the project introduced an innovative weather index insurance (WII) product which was designed to address the scepticism and prejudices of the farmers against traditional insurance schemes; it was simple, transparent, flexible and affordable for smallholder farmers. This product was tested in three districts of Madhya Pradesh, India, during two consecutive monsoon/summer seasons (known as *kharif* in India) in 2011 and 2012.

The project evaluated the potential demand for this new WII product and its impact on the production and consumption behaviours of farmers. The research also investigated the barriers to the take-up of weather index insurance and also the responsiveness of insurance demand to a set of interventions, namely price discounts, new and closer weather stations (a proxy to basis risk) and training on insurance literacy.

Overall, our study found that the demand for the simplified WII products was quite low at 6.9 per cent and 4.03 per cent of the sample during *kharif* 2011 and 2012, respectively. We also found that the demand falls as price and distance to the weather station increases. On the other hand, the demand for WII increases as product comprehension increases. Interestingly, our insurance literacy training intervention seems to be of a more transient nature, with no significant impact on understanding or demand after the first year of its implementation. It was also observed from the study that the purchase of WII has influenced farmers to use hybrid seeds or high-yielding varieties to cultivate increased areas and new crops, to adopt improved cultivation practices and to get additional loans. Although the study

[1] Morduch (1991) finds that uninsured households grow low risk, low return crops.

[2] In studies on the Indian poor, Rosenzweig and Binswanger (1993) find that uninsured households hold more low-risk assets, and Fafchamps and Pender (1997) reported that they own more liquid (in unfavourable circumstances) assets.

could find empirical evidence for the impact of WII, the results are not statistically strong due to a lack of power because of low take-up of the product.

The remainder of the report narrates the methodology followed, the lessons learned and the insights gained from the study. The paper is structured as follows: the next section contains information on the study background and the current literature. Section 3 describes the interventions in detail. Section 4 contains an overview of the programme implementation. Section 5 states the randomisation method followed and the evaluation design adopted for research. Section 6 presents the results of our take-up analysis, midline survey and qualitative endline assessment. Section 7 briefly triangulates the results of our study, and Section 8 provides the conclusion and policy recommendations.

2. Context

2.1 Background

India has 116 million operational farm holdings covering 163 million hectares with a vast majority being small and marginal in size (approximately 80 per cent of farmers operate less than 2 hectares), and a significant proportion of such households are below the poverty line (World Bank and GFDRR 2011). Indian agriculture is heavily dependent on rainfall, which largely occurs due to the seasonal winds that bring rains called the monsoon. The southwest monsoon which coincides with *kharif* season (June–September) accounts for about 74 per cent of the country's total annual rainfall. It is the chief source of water supply for most of peninsular India. In India, 60 per cent of the cropped area is under rainfed agriculture, which produces 91 per cent of the coarse cereals, 90 per cent of pulses, 81 per cent of oilseeds, 65 per cent of cotton, 55 per cent of rice, and 25 per cent of wheat (Badatya 2005). Nearly two thirds of the cropped acreage in India is vulnerable to drought in different degrees. On an average, 12 million hectares of crop area are affected annually by natural disasters such as drought, floods and cyclones, severely impacting the yields and total agricultural production (GOI 2007). Normally, crop yield is influenced by the soil, topography, tillage operations, and the use of inputs, namely seed, fertiliser, pesticides and irrigation, but it has been established that in India, 50 per cent of the variations in crop yield is due to variations in rainfall (Singh 2010). In this context, one can understand that agricultural risk management products, particularly for the smallholder farmers, are of critical importance.

Weather risk is not a new phenomenon in India, and weather risk management in the broad sense has long been practised. Farmers anticipate the rains using various indicators, and time their planting and inputs based on their best estimates; they install irrigation systems if they can and they reduce risk exposure by diversifying their livelihoods as far as possible (Ellis 2000). Agricultural research has also sought ways to help manage the risk that weather presents. However, variation in weather pattern is still affecting the economies of millions of resource constrained marginal and small farmers in India. Evidence suggests that farmers often sacrifice 10 to 20 per cent of income when using traditional risk management strategies (e.g. borrowing, selling of assets and migration, among others (see Gautam *et al*. 1994). But if they can take up insurance, the picture may change.

In most areas of rural India, the only available formal insurance relating to agricultural production is the public crop insurance scheme called National Agricultural Insurance Scheme (NAIS). All farmers are required to purchase this insurance if they take a crop loan from government banks. This rule introduces adverse selection in the insurance scheme, as richer farmers (generally with lower production risk) are able to self-finance. On the other hand, payout eligibility is based on crop damage assessments relative to experimental plots, which requires a lot of resources and time. An evaluation of the traditional crop insurance programme (NAIS) reveals that 'while it has done well on equity grounds, the coverage and indemnity payments are biased towards a few regions and crops, and there are delays in settlement of claims' (Nair 2010). In this scenario, WII was considered advantageous as it insures against production risks on the basis of a weather index (e.g. rainfall) that is highly correlated to local yields. Indemnifications are triggered by pre-specified thresholds for the value of the index, as opposed to actual yield losses. This eliminates the requirement of on-field assessments, thereby lowering administrative costs and time. Interestingly, the WII sector in India has attracted private sector participation since 2002.

Nevertheless, despite a recent surge in interest among private companies and policymakers in insuring farmers through weather index products, in practice, low demand and take-up rates exist among farmers (Cole *et al*. 2012). One of the reasons hypothesised for the low demand and take-up of the WII product is the inherent complexity, which makes it difficult for farmers to perceive its direct benefits (Gine *et al*. 2008). To address this issue, this study tested a very simple, transparent and flexible WII product. The product was launched through a private insurance company called HDFC ERGO in the districts of Dewas, Bhopal and Ujjain in the state of Madhya Pradesh, India, among smallholder farmers cultivating rainfed soya bean crop during two consecutive summer agricultural seasons (*kharif*) in 2011 and 2012.

2.2 Related literature

A considerable amount of literature exists on the determinants of demand for index-based products. We draw a number of hypotheses from this literature as to the likely determinants of demand for index insurance (drawing on Hill, Hoddinott and Kumar 2011) to define predictions about the likely impact of the price, basis risk and understanding on demand.

We start by considering a model of demand for WII following Clarke (2011), which assumes well-informed individuals who make choices according to the expected utility theory. Demand for weather insurance in this case will be a function of the price, the degree of basis risk—the probability that the index triggers a payout different from the loss experienced by the farmer[3]—and the degree to which an individual is risk averse. Since WII is not the same as standard indemnity insurance, and in particular because these products contain basis risk, demand for index products will be (under a minimal set of assumptions) decreasing in basis risk and decreasing in the loading factor (the ratio of the price to the actuarially fair price of the insurance contract). This means that installing a reference weather station closer to a household's farm should, by decreasing basis risk, increase demand for the index product. Several studies analyse these questions and find results coherent with these predictions (e.g. Gine *et al*. 2008; Mobarak and Rosenzweig, 2012; Karlan *et al*. 2012; Cole *et al*. 2013).

[3] Two extreme cases are: (i) The farmer experiences the largest possible yield loss and the insurance product doesn't trigger a payout; (ii) The farmer experiences no yield loss and the insurance product triggers the largest possible payout.

Basis risk is a particularly critical problem in the context of index insurance. It arises due to an index's inadequacy to perfectly capture the individual losses of an insured farmer. This imperfect relation can be related to a number of factors. First, the weather index may be imperfectly measured because of the natural variation of weather between a measurement station and the farmer's plot. Second, a simple weather index cannot capture the full complexity of the effect of weather on a crop, which might involve the interplay of a number of weather variables (temperature, rainfall, humidity, evapotranspiration, winds), and on the crop variety, soil quality and farming practices. Third, other non-weather events may impact crop growth, such as pest attacks and diseases. Mobarak and Rosenzweig (2012) randomly assign new weather stations to different Indian villages and find that demand for WII decreases with distance to the weather station.

A critical feature of this model is the assumption of well-informed agents. However, weather insurance is, for many, a new and unknown financial product. For some farmers, an insurance purchase would represent the first time they engage with a formal financial institution, and they may have some uncertainty about how this would work and how far such an institution can be trusted. The benefits of the insurance contract itself may also not be immediately clear, as there is much to learn about the probability distribution of rainfall at the weather station, and the joint probability between rainfall at the weather station and a farmer's own yields. A farmer's perception of the distribution of benefits may be highly uncertain. As such, the decision of whether or not to purchase insurance is akin to the decision to adopt a new technology (Gine *et al.* 2008; Lybbert *et al.* 2010). An example consistent with this view is the tendency of farmers to purchase one or two units of insurance—much less than would be required for full insurance—perhaps to experiment with how well it works. This is similar to the observation that farmers experiment with new technologies or practices on small portions of their land, as would be predicted by a Bayesian model of learning about a new technology (Feder and O'Mara 1982; O'Mara 1971, 1980).

Competitively priced insurance that is designed to be risk reducing may not be perceived as such as a result of uncertainty around returns and the probability that it will pay out when needed. Consequently, although insurance is a financial product for which we would expect demand to increase with risk aversion for some, if not all, of the distribution of risk preferences, this relationship may not be observed. Technology adoption studies have long reported that risk-averse households are less likely to be early adopters of new technologies. Empirical analyses have shown that demand for insurance may decrease with risk aversion across a range of high risk aversion (Gine, Townsend and Vickrey, 2007; Clarke and Kalani 2011; Gine *et al.* 2007; Hill, Hoddinott and Kumar 2011. This is also consistent with the hypothesis that ambiguity aversion[4] constrains insurance demand; Bryan (2010) has used data collected in Malawi to test this hypothesis and finds evidence consistent with this finding.

In addition to suggesting an alternate relationship between risk aversion and adoption, conceptualising insurance as a technology adoption decision highlights the importance of subjective expectations (Adesina and Baidu-Forson 1995), and thus the role of trust in financial firms or the financial sector.

[4] Ambiguity aversion pertains to the aversion towards the uncertainty about the probability distribution over outcomes.

In this context of uncertain perceptions about the benefits and costs of index insurance, increased training about risk management and insurance may help. If this training provides farmers with an understanding that the benefits of insurance are higher than previously understood, and a higher level of trust in the financial system that will provide them with the insurance, farmers may increase their demand. However, it is also possible that training may lead farmers to believe that the benefits of insurance are lower than they had previously perceived, and as a result they may reduce their demand for insurance.

This point also relates to a strand of more recent empirical research focusing on the question of whether observed realisations of insurance payouts serve the purpose of clearing some of the uncertainty related to the adoption of new technology. In this hypothesis, observing a payout may increase trust in the insurer and in the product, and even improve understanding of the insurance product's functioning. There are a few papers that have been able to analyse the demand for index insurance over time (Cai, de Janvry and Sadoulet 2013; Karlan *et al*. 2012; Cole, Stein and Tobacman 2014).

Finally, there are other factors that affect a farmer's decision about whether or not to adopt a new technology. A large body of literature shows that wealthier, more educated households with entrepreneurial ability are more likely to be early adopters of new technologies (Feder, Just and Zilberman 1985; Schultz 1981). We may expect similar relationships to be observed among early adopters of WII (Gine *et al*. 2008). However, weather insurance will be but one element in households' portfolio of risk management activities. Others include actions that ex-ante smooth income—such as diversifying into livestock or off-farm activities—and actions to smooth consumption, such as savings and borrowing, transfers within networks to spread risk, and accumulation and decumulation of physical assets. Households with good networks and access to savings and borrowing instruments may have a lower demand for insurance than those without access to these activities, if the cost of engaging in these activities is lower than the cost of purchasing insurance, if it reduces consumption variability and if insurance is perceived as a substitute for these. The demand for WII will increase with the presence of these risk management activities where it is seen to complement existing mechanisms (Mobarak and Rosenzweig 2012).

3. Intervention and theory of change

3.1 Intervention

The primary intervention of this project was the provision of simplified weather securities (simple weather-indexed insurance products) to smallholder farmers in three districts of Dewas, Bhopal and Ujjain in the state of Madhya Pradesh, India. These WII were sold through an insurance company named HDFC ERGO. Randomly selected farmers were given the option to purchase the simplified WII from HDFC ERGO. These WII are innovative weather-index insurance products designed by IFPRI to be simple, transparent, flexible and affordable for smallholder farmers. (The details of this simple weather-indexed insurance product and its implementation process are elaborated in Section 4 and Appendix A.)

In addition to this, the project also had three other interventions: (i) variation in the provision of insurance literacy training programmes; (ii) installation of new reference weather stations in randomly selected locations; and (iii) provision of different premium subsidies. These interventions are mainly to assess its impact in take-up behaviour by the farmers. (The details of these interventions are presented in Section 4.)

With these interventions, the study intended to test the impact of having access to WII on the production and consumption behaviours of smallholder farmers. In particular, the study aimed at shedding light on some of the following questions: Do farmers switch to higher return technologies once risk is accounted for? Does their consumption pattern change in response to changes in their expected income flows? In addition, another objective of the study was to assess the determinants of product take-up by smallholder farmers. In particular, it intended to analyse the extent and importance of commonly cited demand obstacles, such as affordability of the insurance instrument, understanding of the insurance product and farmers' perception of the implicit geographic basis risk in index products.

3.1.1 The product

Weather index insurance products insure farmers against production risks on the basis of a weather index (e.g. rainfall). The weather index serves as a proxy for losses rather than the assessed losses of each individual policyholder. This eliminates in-field assessments of average yield for a given area, thereby lowering administrative costs. The key advantage of WII for the farmers is that indemnity payments get settled quickly because of no in-field assessment, and because transaction costs get lower for insurers, these reduced costs should generally be passed along to farmers themselves. In theory, at least, this makes WII financially viable for private sector insurers and the product becomes more affordable to small farmers.

Weather index insurance products have been marketed in India from 2003 onwards, but the take-up rates have been low (Cole *et al*. 2012). One of the reasons hypothesised for the low demand and take-up of WII has been the inherent complexity of the products, which makes it difficult for farmers to assess the real benefits (Gine *et al*. 2008). For example, in a WII contract for deficit rainfall, a farmer should be aware of and be able to broadly calculate the levels of rainfall deficit that affect his crops at different crop stages, an estimation of the ultimate impact of this deficit rainfall in terms of crop losses, and the correlation between rainfall at his plot and the weather station. It involves non-trivial calculations to make informed decisions about the product, which makes it complex and difficult for the farmers to understand WII.

In addition, WII products have traditionally been designed as fixed contracts with a specific payout function related to the hypothesised losses of an average farmer in the region. This type of contract generally offers a linear payout function after a certain trigger, which depends on the difference between the recorded value of the index and the trigger point. This makes the product even more difficult to understand, and takes away any flexibility for adapting the product to the heterogeneity of crops and farming practices in the region.

Hence, under the hypothesis that a simple WII product may lead to better understanding by the farmers and ultimately increase take-up rates, the project introduced an innovative simple WII product that does not involve complex calculations to estimate payouts. Instead, this product triggers a flat payment if the weather index is above a single trigger, and nothing otherwise.

Moreover, the simplified WII product included a small portfolio of different insurance contracts for different periods instead of a single WII contract for the entire crop period. In particular, the crop growth period was split into three phases (cover periods) of shorter duration, and simplified WII contracts were offered for each phase so as to enable payouts immediately after the lapse of a phase.

For each of these cover periods, there were two types of simplified WII contracts offered. One WII contract was intended to pay on the occurrence of a very low probability event representing severe yield losses (e.g. extreme deficit or excess rainfall from the optimal level; the probability of occurrence of these events is very rare and they can cause severe damages to crops). The other contract was intended to pay on the occurrence of a moderately probable event (e.g. slight deficit or excess rainfall from the optimal level; these events may occur occasionally and their impact on crop growth would be moderately detrimental). By offering products for different weather (rainfall) risk levels, we allowed farmers to choose an insurance portfolio suited to their specific combination of extreme and moderate risk. In sum, we designed very simple contracts for different coverage periods and risks levels and gave farmers the option to freely choose a combination of them.

3.2 Theory of change

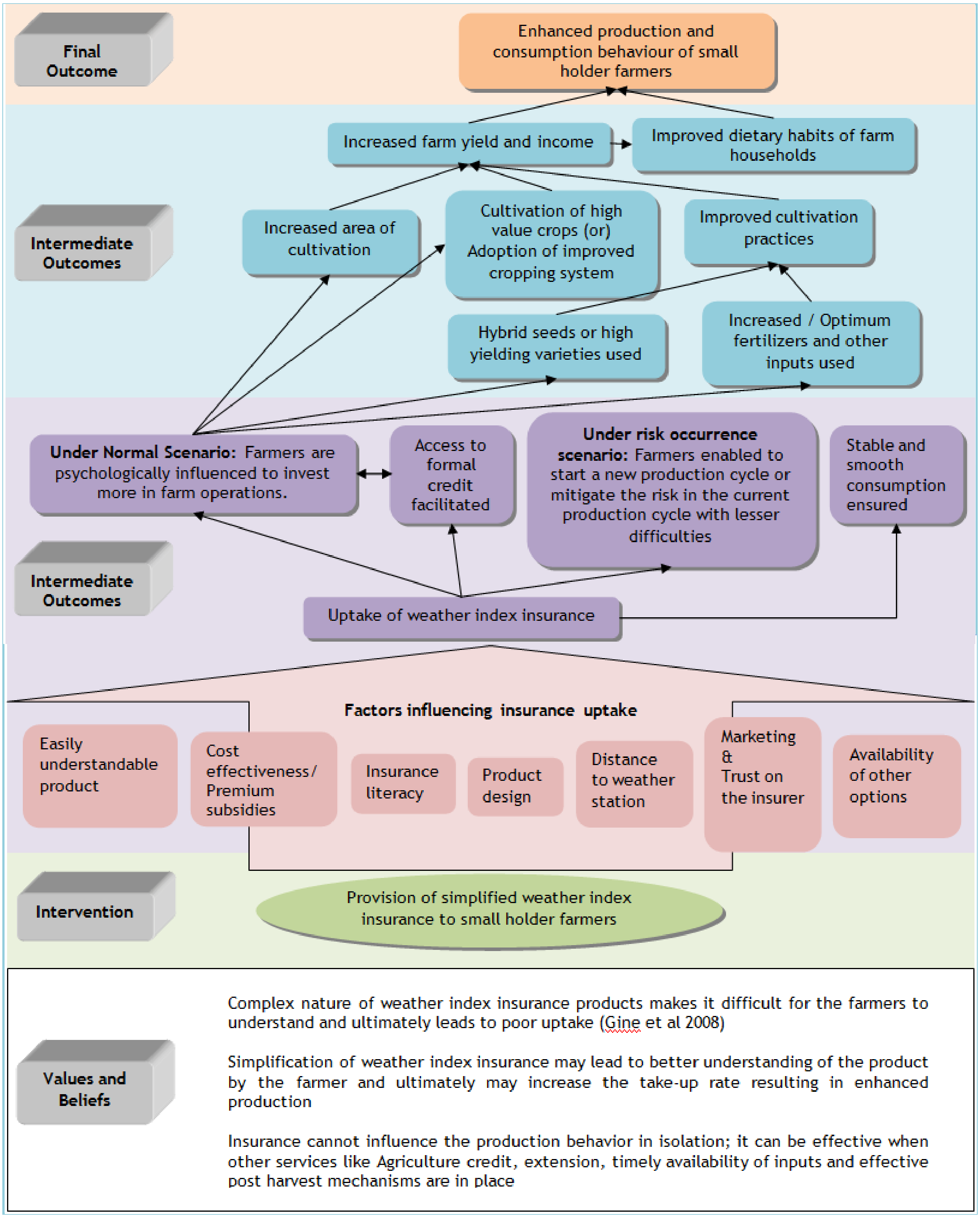
The theory of change underlying this experiment is presented in Figure 1.

Purchase decisions of WII depend on a number of farmer-level factors, which will be the main focus of this report. Among these, we can mention product understanding, affordability (price), basis risk, trust in the insurer and availability of other risk management options. By simplifying the product, as explained in the previous section, our project intends to remove some aspects of the above complexities. More specifically, we speculate that this new type of index insurance will result in easier understanding by farmers with low levels of literacy, which will also contribute to enhancing trust in the insurer. Moreover, through the installation of new weather stations, the average distance to the farmer's plot will be (exogenously) reduced, which will encourage insurance uptake. These channels have the potential to be successful in strengthening demand.

Now, uptake of WII by a farmer may influence him to invest more in his farming operation by both reducing his perceived levels of risk and by mitigating current credit constraints. Both these effects would have a positive impact in terms of investment in agricultural inputs by, for example, applying higher yielding varieties or hybrid seeds, or by encouraging the farmer to increase the area of cultivation. This could, in turn, result in a feedback loop through which more formal credits may become available.

If the risks were not to materialise, the above investments should directly impact the farmer's welfare through increased crop yields and a boost in farm income. Moreover, the latter should also have a direct bearing on consumption behaviours, both in terms of quantity and quality. Under the worst case scenario of the realisation of these weather risks, holding insurance against these would then enable the farmer to start a new production cycle or to cover his losses in the current production cycle with fewer difficulties.

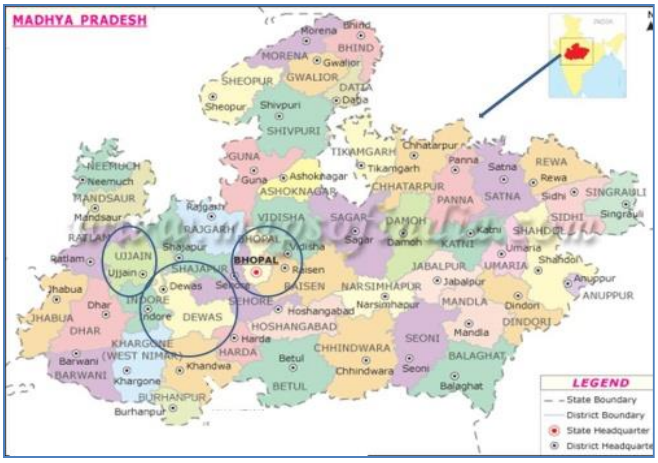
Figure 1: Theory of change



4. Implementation

According to our original project plan, we have aimed to implement the project in two states of India, namely Karnataka and Madhya Pradesh, during the cropping season *kharif* 2011. These two states presented different on-the-ground research environments. Karnataka was of great interest for the project because it is a state where the government subsidises index insurance. However, we learned that access to subsidies can occur only under two situations: (i) bundled credit insurance programme, in which insurance is mandatory, and (ii) as a stand-alone product, but in which the insurance product is designed as approved by the government. In Madhya Pradesh, there was freedom to design innovative products without having to compete with state insurance products bundled with government credit. According to this original plan, 180 villages were to be selected (90 villages in each state). Weather index insurance was to be offered in 120 of these villages, selected randomly, whilst individuals in the remaining 60 villages would form the control group. But we decided not to implement the project according to this original plan since the state government of Karnataka was not able to offer subsidies for our simplified WII product as they were subsidising only the traditional WII product. Since the design of this traditional product runs counter to our project objectives of providing simple, transparent and flexible weather securities, and also considering the limited chance of our product to compete with the subsidised government product, we have ultimately dropped the implementation of the project in the state of Karnataka. Given this limitation, we were ratified by 3ie to implement the project in the state of Madhya Pradesh alone for two cropping seasons, i.e. *kharif* 2011 and *kharif* 2012, by increasing the number of villages from 90 to 110.

Figure 2: District map of Dewas, Bhopal and Ujjain



In accordance with this, the study was implemented in the districts of Dewas and Bhopal, with the inclusion of an additional district, Ujjain, to accommodate the increased number of villages for implementation in Madhya Pradesh among the smallholder farmers cultivating rainfed soya bean crop. The districts were selected according to a number of different qualitative factors assessed during the design stage between the project team, the insurance company and local officials. Among these factors are the high rainfall risk these districts faced, coupled with the fact that they included a large number of smallholder farmers growing rainfed soya bean, the fact that these districts had not yet been notified by the government for its subsidised agricultural insurance scheme, and the availability of historical rainfall data to be used for product design. We worked with the insurance company HDFC ERGO to identify suitable villages to be included in the study. Suitable villages were defined as those that were 15 to 20 kilometres or less from a reference weather station, and those in which HDFC ERGO had a marketing presence. Additionally, it was important to select villages that were neither too small nor too large for surveying and marketing activities.

First, administrative data on the number of households within a village were used to exclude villages of less than 100 households and more than 500 households. This resulted in a list of about 120 villages in three districts. Second, 45 villages in Dewas and Bhopal and 20 villages in Ujjain, 110 villages in total, were randomly selected for inclusion in this study. In each village, 30 households were sampled for study purposes. Seventy-two out of 110 villages were selected at random (30 in Bhopal, 29 in Devas and 13 in Ujjain) and WII was offered to the sampled households in these treatment villages, while households in the remaining 38 villages formed the control group. Table 1.1 shows tests of balance across a number of characteristics between these randomly selected control and treatment villages.

Table 1.1: Comparing treatment and control villages

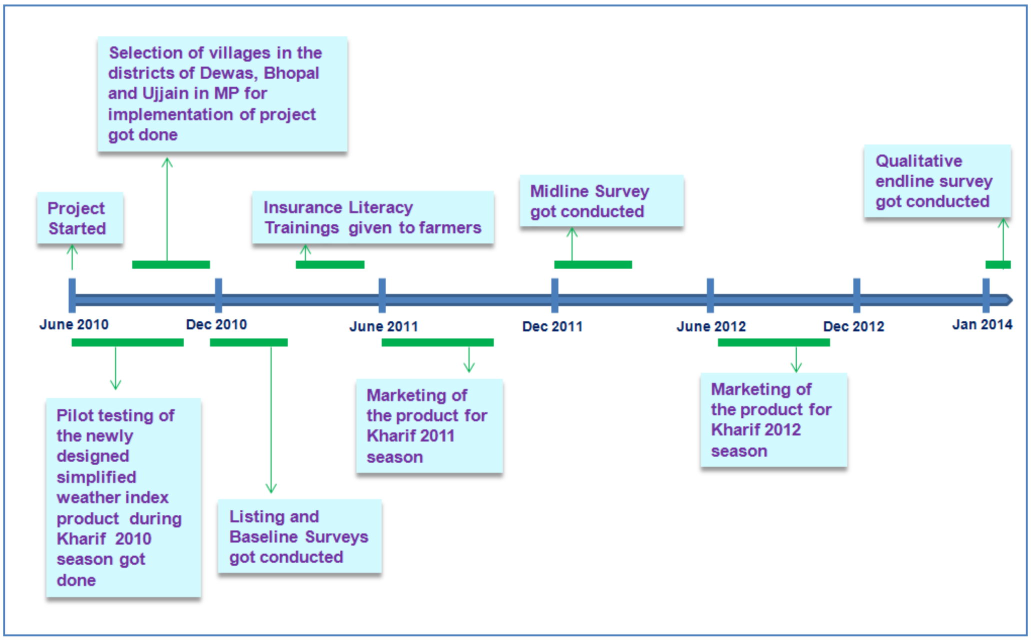
	Mean across control villages	Mean across treatment villages	T-test of difference (t-stat)
Variables from household listing			
Number of households	209.08	213.85	-0.226
Proportion of type 0 households	0.35	0.38	-0.696
Proportion of type 1 households	0.23	0.22	0.437
Proportion of type 2 households	0.23	0.22	0.797
Proportion of type 3 households	0.06	0.06	-0.032
Proportion of type 4 households	0.12	0.12	0.114
Proportion of female-headed households	0.04	0.04	-0.179
Average years of education of household head	3.70	3.84	-0.473
Proportion of SC/ST/OBC	1.11	1.13	-0.185
Average land owned (in acres)	3.26	3.16	0.299
Variables from baseline survey			
Km distance to pre-existing weather station	8.32	8.38	-0.058
Distance to market (in minutes)	45.79	46.78	-0.251
Average cultivated acreage	6.87	6.85	0.027
Proportion of land that is irrigated	0.77	0.76	0.383
Average cultivated acreage in the Rabi	6.01	5.93	0.193
Proportion of land on which wheat is grown	0.69	0.65	0.991
Proportion of land on which chickpea is grown	0.22	0.26	-1.279
Average cultivated area in the *kharif*	6.29	6.42	-0.291
Proportion of land on which soya bean is grown	0.90	0.90	0.114
Proportion of households reporting drought in the last 10 years	0.13	0.15	-0.624
Proportion of households that previously had some agricultural insurance	0.41	0.34	1.531
Proportion of households that previously had some insurance	0.59	0.57	0.543
Proportion of households with access to agricultural loans	0.94	0.92	1.212
Village belongs to Dewas district	0.43	0.40	0.295
Village belongs to Bhopal district	0.38	0.42	-0.383

Source: Listing and household survey

Note: None of the T-tests of difference between the two groups are significant at the 10% level. All comparisons are at the village level. The number of control and treatment villages is, respectively, 37 and 72. SC/ST/OBC refers to scheduled caste, scheduled tribe and other backward castes. Households are classified in types according to whether they own more (+) or less (-) than 6 acres of land, and whether the household decision maker has had more (+) or less (-) than five years of schooling. Type 0 households own no land. Type 1: Land / (-)Schooling, Type 2: (-)Land / (+)Schooling, Type 3: (+)Land / (-)Schooling, Type 4: (+)Land / (+)Schooling.

Before the initiation of the project, during *kharif* 2010 we did a pilot testing of our new simplified WII product in three villages, namely Banedia, Chander and Khajraya of Depalpur *tehsil* of Indore district in Madhya Pradesh. The main objective of this pilot was to test our simplified WII product design in a real case scenario and not to study the impact of the product on the farmer's livelihood. The learning from this pilot test was carried forward in designing the WII products during the cropping seasons of *kharif* 2011 and *kharif* 2012. We have implemented all the project interventions like conducting insurance literacy training programmes, installation of new weather stations and provision of premium subsidies well before the start of the first cropping season, *kharif* 2011. All the data collection activities like executing a listing exercise, a baseline survey, midline survey and an endline survey were done in stipulated times. This is clearly depicted in the timeline of the project presented in Figure 3, and the details of the implementation of each project activity are elaborated below.

Figure 3: Project timeline



4.1 Designing of simplified WII products

The project introduced an innovative simple WII product with a flat and easy to understand payout if the event (weather index) written on it comes true. A traditional WII product involves some calculation to determine the payout amount, which makes the product complex and difficult for farmers to understand. Moreover, the simplified WII offered provided a menu of options among different simple insurance contracts. Instead of offering one WII contract covering the entire crop period, we offered WII contracts for shorter periods. Here, the entire crop growth period was split into three phases (cover periods) of shorter duration and simplified WII contracts were offered for each phase so as to enable payouts immediately after the lapse of a phase to enable the farmer to take corrective action.

Focus group discussions (FGDs) were conducted in selected villages from the three districts of Devas, Bhopal and Ujjain. They provided information for the design of our product. Discussions with farmers enabled us to understand the perils faced by their crops, the critical periods of rainfall and the approximate crop losses during these periods. These perils, their duration and the average losses were similar across the three districts. On the basis of this information, we divided the season into three cover periods. For each cover period, we specified a type of index which we considered most appropriate, given the FGDs. Details of the periods and the coverage are provided in Table 1.2.

Our study of historical rainfall patterns in the three districts revealed that the distribution of the amount and volume of rainfall was slightly different in each district. Therefore, the product was designed in such a way that the period and perils covered were the same in all the districts, but each district had different index's trigger levels corresponding to a payout.

Table 1.2: Product design

Cover Period	Time period	Description	Index
1	Jun 25 – July 20	This period corresponds to the sowing and germination stage. Sowing usually takes place after 15 June. Farmers have the option to wait until the start of the rainy season to decide when to start sowing. After sowing and during the germination phase, the major peril is excessive rain on a single day.	Maximum rainfall on any single day during cover period
2	Jul 21 – Sep 15	This period combines the vegetative and reproductive phases. Both phases share similar perils, either excess or deficit of total rainfall during the period. During the vegetative phase rain deficit seems relatively more important, while there is an excess of rain during the reproductive phase. Given that each phase by itself is relatively short, our evaluation is that it is not practical to create securities for each phase separately.	Total cumulative rainfall during cover period
3	Sept 16 – Oct 15	This period combines the maturity phase and harvest. The major peril is excess of rainfall, especially heavy rain on a single day.	Maximum rainfall on any single day during cover period

For every peril identified in each cover period, two types of WII products were designed: one for a payout in case of a lower probability event representing severe yield losses (e.g. large deficit or excess rainfall from the optimal level; the probability of occurrence of these events is very low and if this occurs, it can cause severe damage to crop growth). And the other for the case of a moderate probability event representing moderate yield losses (e.g. slight deficit or excess rainfall from the optimal level; these events may occur very frequently and the impact level of such events on crop growth can be moderately detrimental). The intention behind this was to cover both severe and moderate losses for each peril. Farmers can freely choose the number and combination of WII they would like to purchase. The WII were priced at actuarially fair prices plus the administration costs of the insurance company. The WII designed for each district are described in Appendix A.

4.2 Marketing process

The marketing of WII was carried out by HDFC ERGO General Insurance Company in three different phases, prior to the start of each cover period during both the cropping seasons of *kharif* 2011 and *kharif* 2012. As a general marketing strategy for product promotion, van campaigns, pamphlet distribution, meeting of farmer groups and sending mass SMS messages were undertaken in all the treatment villages before the start of each cover period during both the cropping seasons. Sales of the product were conducted door to door by HDFC insurance agents (the most common modality in India for insurance products targeted at lower income populations). Farmers were also able to contact the local office of the insurance company to purchase the product; however, we did not receive any reports of this happening.

In Dewas and Bhopal during *kharif* 2011, the WII were sold only for the second and third cover periods, because during the first cover period the insurance company HDFC ERGO utilised its entire market force to sell other government insurance products in the neighbouring districts. In Ujjain, WII were marketed only for the third cover period during *kharif* 2011 as the household survey of this additional district was completed during the second cover period. This delay in Ujjain was because of its delayed inclusion in the project to increase the number of villages, as we could not implement our project in Karnataka state. Considering the issues of no marketing during the first phase and the inclusion of additional villages in Ujjain at a later stage, HDFC agents were instructed to perform door to door visits for the entire household sample during the marketing phase, and were provided with monetary incentives for each sale they brought in.

Low take-up rates were a concern during the *kharif* 2011 season and it was not clear from the midline data how much of this was due to a lack of information about the products. Consequently, we worked with HDFC ERGO to design a comprehensive marketing strategy for *kharif* 2012. To ensure that there were no capacity constraints in implementing the marketing activities (particularly the door to door sales), we hired a field-level organisation named Sigma Research and Consulting to do the door to door sales of WII on behalf of HDFC ERGO. Sigma's field staff were trained by HDFC ERGO to sell the WII product of this study.

4.3 Implementing premium subsidies

Exogenous variation in the price of the insurance products was introduced by randomly allocating price discount vouchers among treatment households. Inducing exogenous variation in the price of insurance allows us to understand and measure how insurance demand responds to price changes or, in other words, the demand price elasticity. Following a standard law of demand, our hypothesis was that holding constant other factors that might affect demand, the demand for insurance products is decreasing (or not increasing) in prices.

Discounts were introduced in absolute terms. Based on group discussions and given the level of education of targeted farmers, we concluded that absolute numbers would be more easily understood by farmers rather than percentage discounts. Four levels of discounts were selected to make them close to 15 per cent, 30 per cent, 45 per cent and 60 per cent price discounts, so that we have enough price variation along a hypothetical demand curve.

In Dewas and Bhopal districts during *kharif* 2011, the following four levels of discounts were allocated: ₹45, ₹90, ₹135 and ₹180.[5] Out of the 30 sampled households in a village, five households received a discount voucher for ₹45, five households received a discount voucher for ₹90, five households received a discount voucher for ₹135, five households received a discount voucher for ₹180 and 10 households did not received any discount vouchers. All non-sampled households in treatment villages received no discount. The lottery method was used in distributing the households with the subsidy vouchers. The HDFC insurance company decided to have a more aggressive pricing policy in Ujjain (low loading and therefore lower prices), which was included at a later stage in the third cover

[5] The market price of the product without a discount was between ₹200 to ₹350; see Appendix A.

period, and so the discounts offered in Ujjain were adjusted accordingly. In Ujjain district, the discount levels were ₹30, ₹60, ₹90 and ₹120. The distribution of different levels of price subsidies within the villages created farmer dissatisfaction and provoked prejudices which, in turn, affected the marketing process in Dewas and Bhopal. Considering these difficulties, the protocol for discount distribution in Ujjain was later modified. In Ujjain, all households (sampled and non-sampled) in treatment villages were assigned one of the following discounts: of ₹0, 30, 60, 90 and 120. Out of the 13 selected treatment villages, two villages were given a discount of ₹30, two were given a discount of ₹60, two were given a discount of ₹90, two were given a discount of ₹120, and five villages did not receive any discount.

During *kharif* 2012, unlike *kharif* 2011, uniform village-wise premium discounts were given by randomly assigning all the treatment villages with one of the following discounts: of ₹0, ₹40, ₹75, ₹115 and ₹150.

Table 1.3: Price discount allocations

	***kharif* 2011**		***kharif* 2012**
	Bhopal and Dewas treatment villages	**Ujjain treatment villages**	**Bhopal, Dewas and Ujjain treatment villages**
Premium discount allocation method followed	Random at the household level	Random at the village level	Random at the village level
Value of discount allocated	₹0: 10 sampled households and all the non-sampled households ₹45: 5 sampled households ₹90: 5 sampled households ₹135: 5 sampled households ₹180: 5 sampled households	₹0: all households in 5 villages ₹30: all households in 2 villages ₹60: all households in 2 villages ₹90: all households in 2 villages ₹120: all households in 2 villages	₹0: 6 treatment villages each in Dewas and Bhopal; 5 treatment villages in Ujjain ₹40: 6 treatment villages each in Dewas and Bhopal; 2 treatment villages in Ujjain ₹75: 6 treatment villages each in Dewas and Bhopal; 2 treatment villages in Ujjain ₹115: 6 treatment villages each in Dewas and Bhopal; 2 treatment villages in Ujjain ₹150: 6 treatment villages Bhopal, 5 treatment villages in Dewas and 2 treatment villages in Ujjain

4.4 Installing new weather stations

Proximity of weather stations to a farmer's field is a prerequisite for a successful weather index-based product. As distance to the weather station increases, the difference between rain on a farmer's field and rain recorded at the weather station also increases, and as a result, so does the degree of risk that is not covered (basis risk). Individuals facing higher basis risk are less likely to purchase WII; and when they do purchase it, these WII will be less beneficial to their production decisions and welfare.

In practice, assessing the impact of basis risk is difficult as weather stations are not exogenously located but are often located close to markets, municipal centres and other endogenous landmarks. To study the impact of basis risk, distance to the weather station was exogenously varied by installing three new randomly located weather stations among the treated villages.

The locations of the new weather stations were randomly selected in order to ensure similarity in the average characteristics between treatment villages that are to be served by a new weather station, and those that would be served by an existing weather station. In particular, three new weather stations were installed in locations selected using the following process:

(1) We excluded all treatment villages at 5 kilometres or less from an existing weather station. Out of the non-excluded treatment villages, we randomly selected one village in which to place a new weather station. All villages very close (5 kilometres or less) to this one were then excluded from further selection.
(2) Out of the remaining villages, we randomly selected a second location. All villages very close (5 kilometres or less) to this one were then excluded from further selection.
(3) Out of the remaining villages, we randomly selected a third location.

The three villages selected for new station installations using this process were Polayjagir and Talod in Dewas, and Intkhedi Sadak in Bhopal. Thirty treatment villages were then assigned to a new weather station based on closest proximity, and the remaining 42 villages were assigned to the existing station, based also on closest proximity. The full list of weather stations used in this study is given in Table 1.4

Table 1.4: Weather station assignment

Trigger weather station	Weather station with historical data used for product designing	Number of villages assigned	Number of villages covered
Dewas - Sonkatch (NCSML)	Indore (IMD)	11	9
Dewas - Polayjagir – NEW	Indore (IMD)	9	10
Dewas - Talod – NEW	Indore (IMD)	9	10
Bhopal (IMD)	Bhopal (IMD)	18	18
Bhopal - Intkhedi Sadak - NEW	Bhopal (IMD)	12	12
Ujjain-Khachrod (IMD)	Ujjain(IMD)	13	13

HDFC agents were provided with the name and location of the reference weather station assigned to the contracts in each of the treated villages. This could be either a new or an old station. In our results, we found that in six out of the 72 villages the weather station assignment had not been as per our randomised assignment. This was discovered to be the result of an error by the HDFC marketing agent in Dewas and we accounted for this in the analysis by using actual weather station assignment (thus providing intent to treat results as opposed to actual treatment to account for potential endogeneity in this deviation from protocol). The actual number of villages assigned to each station is indicated in the last column of Table 1.4. Overall, we intended to treat 30 villages with new weather stations and

42 villages with old weather stations. However, these adjustments leave us with 28 villages with new weather stations and 44 villages with old weather stations.

The key characteristics of the villages served by a new weather station were compared to treatment villages served by existing weather stations, and tests of balance between these two groups were performed. Results are presented in Table 1.5 and indicate that these key characteristics are balanced between these two treatment groups.

Table 1.4: Comparing villages with insurance offered from new and old weather stations

	Mean across old weather station villages	Mean across new weather station villages	T-test of difference (T-stat.)
Variables from household listing			
Number of households	213.3	214.4	-0.039
Proportion of type 0 households	0.43	0.38	1.048
Proportion of type 1 households	0.19	0.22	-1.228
Proportion of type 2 households	0.23	0.23	0.031
Proportion of type 3 households	0.05	0.05	-0.510
Proportion of type 4 households	0.11	0.12	-0.835
Proportion of female-headed households	0.04	0.04	-0.405
Average years of education of household head	4.56	4.27	1.128
Proportion of SC/ST/OBC	0.82	0.84	-0.329
Average land owned (in acres)	3.23	3.82	-1.525
Variables from baseline survey			
Km distance to pre-existing weather station	10.96	9.52	1.466
Distance to market (in minutes)	48.25	45.37	0.574
Average cultivated acreage	6.77	6.94	-0.307
Proportion of land that is irrigated	0.76	0.76	-0.003
Average cultivated acreage in the *rabi*	5.93	5.93	0.005
Proportion of land on which wheat is grown	0.67	0.64	0.524
Proportion of land on which chickpea is grown	0.26	0.25	0.228
Average cultivated area in the *kharif*	6.45	6.40	0.091
Proportion of land on which soya bean is grown	0.91	0.89	0.718
Proportion of households reporting drought in the last 10 years	0.15	0.10	1.132
Proportion of households that previously had some agricultural insurance	0.29	0.38	-1.533
Proportion of households that previously had some insurance	0.56	0.63	-1.554
Proportion of households with access to agricultural loans	0.93	0.95	-1.052
Village belongs to Dewas district	0.45	0.60	-1.34
Village belongs to Bhopal district	0.55	0.40	1.34

Source: Listing and household survey
Note: None of the T-tests of difference between the two groups are significant at the 10% level. All comparisons are at the village level. The number of old and new weather station villages is, respectively, 29 and 30. SC/ST/OBC refers to scheduled caste, scheduled tribe and other backward castes. Households are classified in types according to whether they own more (+) or less (-) than six acres of land, and whether the household decision maker has had more (+) or less (-) than five years of schooling. Type 0 households own no land. Type 1: (-)Land / (-)Schooling, Type 2: (-)Land / (+)Schooling, Type 3: (+)Land / (-)Schooling, Type 4: (+)Land / (+)Schooling.

4.5 Conducting insurance literacy training

Insurance literacy training was conducted by IFPRI and IFMR with the help of BASIX for all training sessions. The curriculum for this training was designed by IFPRI and IFMR. In all treatment villages, the decision makers in the sampled households were invited to two hours of basic insurance literacy training. The training was compulsory for the sampled households. If the decision maker could not attend, some other representative for the household had to attend; in this way we ensured the complete participation of sampled households. In these basic training sessions, which were also open to any other observers from the village, farmers were first introduced to the various weather-related risks that they might face and were encouraged to discuss their pre-existing coping mechanisms. After this introduction, the bulk of the remaining training focused on a general discussion of WII, how it has been tailored for their circumstances and the specifics of the product. Interactive games were played with the farmers which presented the significance of risk pooling and the costs and benefits of purchasing insurance. A final iteration of our games helped farmers understand that the ability of the insurance company to pay their claims was not dependent on the weather outcome of other farmers. This was intended to build trust between the farmers and the insurance company.

Additionally, 37 of the treated villages that received the two hours of basic insurance literacy training were randomly selected and given an additional two-hour training. These villages were selected using a simple random draw within blocks defined by whether or not the village was being serviced by a new weather station. Equality of selected village-level characteristics between the group receiving basic and intensive training were tested to ensure that these characteristics were equal across these two groups. These results are presented in Table 1.6, and show that the two training treatment groups are also balanced.

In the second training, our household sample was again actively encouraged to attend the meeting and all villagers were allowed to participate. As in the case of basic training, even in the second level of training we ensured the full participation of sampled households. In this additional training session, the basic concepts were reiterated and any questions and concerns that the farmers had were addressed. Our hypothesis is that this extra training session will enhance understanding of the product through repetition and give those household decision makers who could not attend the first session a second chance to participate. We anticipate that extra training will have a greater impact on those with lower levels of education, and thus on female-headed households.

4.6 Data collection

A baseline survey, a midline survey and an endline survey were executed to collect data. The baseline survey was conducted before launching the weather insurance product in *kharif* 2011. The midline survey for assessing the impact of the product was done after the *kharif* 2011 cropping season, and the endline survey was done after the completion of the *kharif* 2012 cropping season. The baseline and the endline surveys were elaborative and quantitative in nature, whereas the endline survey was a comprehensive but targeted qualitative endline assessment using various relevant methodologies.

The household decision maker was the respondent for all our household surveys. The decision maker was defined as the one who took the major economic decisions in the household and was not just the oldest person in the household. If the household decision maker could not be found, another household member knowledgeable about the agricultural production decisions of the household was interviewed. A face-to-face interview approach during house-to-house visits was used to collect data. To reduce reporting biases, interviews were conducted privately so that the other members of the household or neighbours could not overhear or intervene. As with all cross-sectional surveys, this survey is subject to response and recall biases. The survey responses on knowledge, attitude and behaviour questions may be influenced by the perceived desirability of answers to the experimenters. This was limited as far as possible by framing questions on past behaviour in a neutral manner: for example, leading questions were avoided. However, some recall bias will remain, and we henceforth indicate any specific questions where we think it was overly influential. Some questions were not answered by some households because the respondents were not willing to disclose the information, and this was a right clearly explained to them during the process of informed oral consent.

Table 1.5: Balance between villages offering intense and basic insurance literacy training

	Mean across intensive treatment villages	Mean across basic treatment villages	T-test of difference (T-stat.)
Variables from household listing			
Number of households	212.68	215.09	-0.1
Proportion of type 0 households	0.39	0.37	0.35
Proportion of type 1 households	0.23	0.22	0.49
Proportion of type 2 households	0.21	0.23	-0.7
Proportion of type 3 households	0.06	0.06	-0.52
Proportion of type 4 households	0.12	0.12	-0.48
Proportion of female-headed households	0.04	0.04	0.43
Average years of education of household head	4.17	4.29	-0.47
Proportion of SC/ST/OBC	0.81	0.82	-0.11
Average land owned (in acres)	3.77	3.82	-0.13
Variables from baseline survey			
Km distance to pre-existing weather station	8.15	9.06	-0.67
Distance to market (in minutes)	47.34	48.03	-0.15
Average cultivated acreage	6.85	6.8	0.09
Proportion of land that is irrigated	0.71	0.74	-0.82
Average cultivated acreage in the *rabi*	5.65	5.65	0
Proportion of land on which wheat is grown	0.63	0.6	0.8
Proportion of land on which chickpea is grown	0.28	0.29	-0.27
Average cultivated area in the *kharif*	6.4	6.22	0.38
Proportion of land on which soya bean is grown	0.9	0.93	-1.13
Proportion of households reporting drought in the last 10 years	0.16	0.13	0.72
Proportion of households that previously had some agricultural insurance	0.3	0.38	-1.59
Proportion of households that previously had some insurance	0.58	0.57	0.19
Proportion of households with access to agricultural loans	0.93	0.92	0.37
Village belongs to Dewas district	0.32	0.49	1.40
Village belongs to Bhopal district	0.49	0.34	-1.23

Source: Listing and household survey; Note: None of the T-tests of difference between the two groups are significant at the 10% level. All comparisons are at the village level. The number of villages with intensive and basic treatment is, respectively, 37 and 35. SC/ST/OBC refers to scheduled caste, scheduled tribe and other backward castes. Households are classified in types according to whether they own more (+) or less (-) than six acres of land, and whether the household decision maker has had more (+) or less (-) than five years of schooling. Type 0 households own no land. Type 1: (-)Land / (-)Schooling, Type 2: (-)Land / (+)Schooling, Type 3: (+)Land / (-)Schooling, Type 4: (+)Land / (+)Schooling.

The baseline and the midline surveys were done in collaboration with a professional survey company named SIGMA consulting. In the baseline survey, 3,339 households were visited across 110 villages. In the follow-up midline survey, 3,267 households were successfully revisited. Therefore, only 72 households (or 2 per cent) were unreachable in any of the minimum three visits by enumerators. As the endline survey was a targeted qualitative assessment through in-depth interviews and FGDs, this was executed by our own data collection team in IFMR Research. Apart from these household surveys, to analyse the farmers' take-up behaviours with regard to insurance, we collected the insurance purchase and payout data from the MIS database of the HDFC ERGO insurance company.

4.7 Weather shocks registered and the payouts made

During both years of implementation, only in the district of Dewas did farmers experience mild weather shocks due to excess rainfall. The indemnification paid by WII was ₹1,000 per contract. There were no weather-related shocks in the districts of Bhopal and Ujjain. The details of the weather shocks registered and the payouts made are listed in Table 1.7.

Table 1.6: Weather shocks registered and the payouts made

Season	Cover period	Weather shock registered	Intensity of weather shock registered	Payout made (₹)	No of farmers received
Kharif 2011	II (June 21 to Sep 15)	Excess cumulative rainfall (>850mm but <1250mm)	Mild or Moderate	1,000	14
Kharif 2012	I (June 25 – July 20)	Maximum rainfall on any single day (>120mm but <200mm)	Mild or Moderate	1,000	18
Kharif 2012	II (June 21 to Sep 15)	Excess cumulative rainfall (>700mm but <960mm)	Mild or Moderate	1,000	10

5. Methodology: Randomisation and evaluation design

5.1 Randomisation of insurance provision

Farmers who purchase insurance are a highly self-selected group. Current research in India indicates that farmers more likely to buy insurance have higher levels of education and fewer liquidity constraints (Cole *et al*. 2012). They may also differ in unobservable characteristics, such as a tendency to buy new products. The behaviour of these farmers with respect to the outcome variables of interest (identified in Evaluation Questions) is likely to be quite different from those who do not purchase insurance. Simply comparing farmers with and without WII will thus not tell us much about their impact, as preexisting underlying differences are likely to confound the impact of receiving insurance. Farmers who were offered WII and chose not to buy are thus not the appropriate counterfactual for those farmers who chose to buy.

To ensure the appropriate comparability between insured and uninsured farmers, we worked with HDFC ERGO to randomly select villages to offer our product. As our product was not at the stage of large-scale roll out, this approach was acceptable to the insurance company. Randomising at the village level reduced the probability of contaminating the sample: if randomisations were at the household level and a non-selected household wanted to purchase insurance, it would have been difficult for HDFC ERGO marketing agents to exclude them. Therefore, randomisation at the village level also mitigated the impact of spillover effects on the estimates. Accordingly, a total of 110 villages were selected, and our simplified WII products were offered in 72 of these villages selected at random, whilst individuals in the remaining 38 villages formed the control group. More treatment villages than control villages were selected, given the multiple treatment arms in this study. Villages in Bhopal and Dewas were allocated to treatment and control categories using a random draw with no stratification or blocking. Ujjain villages were allocated to treatment and control categories separately, on account of the later inclusion of this district. As such, there was stratification of the villages along district lines, and we include district dummies in all regression analysis.

To ensure that the random selection of villages was successful, and thus treatment and control villages did not differ statistically on the basis of observable characteristic existing data sources (such as census data) were used to validate similarities on characteristics such as distance to a nearby town, distance to the weather station, education, caste and household-level socio-economic factors.

5.2 Randomisation of treatments

The 72 selected treatment villages were further categorised into different treatment categories. The following two treatments were randomised at the village level:

- Weather station: Thirty villages from Bhopal and Dewas were selected to be offered insurance that has payments triggered by a weather station installed by the study team. The remaining 29 villages (30 villages were originally chosen, but one was dropped because its distance from the weather station was more than 20 km) from these districts were offered insurance with payments triggered by pre-existing weather stations in the corresponding district. This was done in order to exogenously vary the degree of basis risk faced by households in the study villages. Only villages in Dewas and Bhopal were eligible for this treatment, meaning that the 13 Ujjain villages that received insurance used pre-existing reference stations.

- Insurance literacy training: Thirty-seven villages were selected to receive intensive insurance literacy training. The other 35 villages received the basic insurance literacy training. This was done in order to exogenously vary the understanding of the insurance product in the study villages.

There are thus four categories of treatment villages, as summarised in Table 2.1. The number of villages in each category is given in brackets. Given the small number of villages in each cell, interactions between the interventions will not be assessed.[6]

Table 2.1: Randomisation of treatment villages into four categories

Existing weather station (E) and basic training (B) = 20 villages	Existing weather station (E) and intensive training (I) = 22 villages	E = 42
New weather station (N) and basic training (B) = 15 villages	New weather station (N) and intensive training (I) = 15 villages	N = 30
B = 35	I = 37	

5.3 Selection of sample households

A listing exercise was conducted in all the selected villages (110 villages) before survey work, training and insurance sales began. The listing exercise collected basic information on each household's characteristics. It collected information on age, gender and education of the household head, caste, housing structure, landownership and main crop of production in the rabi (winter) season.

The listing survey provided two important contributions to the study. Much of the randomisation within this study was conducted at the village level, so aggregation of data collected in the listing survey allowed us to calculate accurate village-level statistics in order to ensure balanced treatments. Second, given that purchase rates of insurance tend to be quite low, it was important for us to focus our energies on households that would be naturally predisposed to purchase insurance. The information from the listing questionnaire allowed us to identify these households and over-sample them.

Studies of insurance demand in India suggest that those who purchase weather index insurance have larger landholdings and higher education levels than those who do not (Gine *et al*. 2007). Data on education of the household decision maker and landholding of the household that was collected in the listing survey was used to classify households into five categories. Households in the first category, type 0 households, were those that did not own any land. Weather insurance cannot be purchased by these households, so they were not included in either the survey sample or in the training and marketing activities. Households that owned land were further categorised into four types:

[6] It was our initial intention to utilise the randomly allocated interventions described in this section as instruments in IV approach to assess the consumption and production impacts of purchasing insurance. Since purchasers of insurance are generally different in terms of a number of unobservable characteristics, this is one strategy to obtain random variation in insurance purchase decisions. Given the very low take-up rates encountered, however, we had to abandon this initial idea.

- Type 1 households own less than or equal to 6 acres of land and have a household decision maker with less than five years of schooling;
- Type 2 households own less than or equal to 6 acres of land and have a household decision maker with greater than or equal to five years of schooling;
- Type 3 households own more than 6 acres of land and have a household decision maker with less than five years of schooling; and
- Type 4 households own more than 6 acres of land and have a household decision maker with greater than or equal to five years of schooling.

On an average, the proportion of type 4 households is much lower than the proportion of type 0, 1 or 2 households. However, it is type 4 households that are most likely to buy insurance, so we oversampled these households for inclusion in our study.

In each village, 30 households were selected. We designed the sampling strategy such that the proportion of type 4 households in the sample selected from each village would be 0.5. Three type 1 households were randomly selected from all type 1 households, and six type 2 households, six type 3 households and 15 type 4 households. A summary is provided in Table 2.2.

Table 2.2: Household types, based on education and landownership of household decision makers

	Less than 5 yrs of schooling	Greater than or equal to 5 yrs of schooling
Greater than 0 acres of land, less than or equal to 5 acres of land	Type 1 (3 included in activities)	Type 2 (6 included in activities)
Greater than 5 acres of land	Type 3 (6 included in activities)	Type 4 (15 included in activities)

5.4 Evaluation design

A baseline survey was conducted before launching the weather insurance product in *kharif* 2011; this was followed by a midline survey for assessing the impact of the product, which was conducted after the completion of the *kharif* 2011 cropping season. The baseline and midline surveys were conducted for 30 households in each of the 38 control and 72 treatment villages. A comparison of differences in outcome variables between the baseline and midline survey of control and treatment villages (difference in difference estimation) provided us with a test of the impact of offering our simplified WII to the farmers.

On the other hand, the product take-up rate by the farmers during *kharif* 2011 was very low (6 per cent of sample). Since only a low proportion of households in the sample purchased our WII, the power of tests on the impact of our product was lower than what the initial power calculations indicated. Similarly, the same trend of low take-up rate (4 per cent) of our product prevailed during the subsequent cropping season of *kharif* 2012. Considering the fact that the quantitative impact of the interventions addressed through the project’s midline study (limited by a very low take-up rate) would not have been much different from the results of a quantitative endline study, we modified the project approach to conduct instead a comprehensive, targeted qualitative endline assessment. This provided us with further scope to learn the determinants of simplified WII product take-up and its influence on production and consumption behaviours through qualitative means. Moreover, this exercise led to some deep insights in terms of key policy issues for the way ahead, in particular with regard to the governance and regulatory improvements needed to develop a better WII market.

The qualitative data collection for the endline was done after the completion of the second cropping season. In-depth interviews and FGDs were conducted among a group of purposively sampled households from our treatment villages. These included:

a. Farmers who purchased insurance only in the first year;
b. Farmers who purchased insurance only in the second year;
c. Farmers who purchased insurance in both the first and the second year;
d. Farmers who never purchased insurance;
e. Farmers who received a payout in the first year and bought the insurance in the second year;
f. Farmers who received a payout in the first year and did not buy the insurance in the second year; and
g. Farmers who received a payout in the second year.

Purposive sampling was done to garner opinions from all these categories of farmers in our treatment groups. Sixty-two in-depth surveys and six FGDs were executed among the categories of farmers listed above. More in-depth interviews were executed because we considered that the conventional method of FGD would not allow the farmers to express their individual views in a complex heterogeneous scenario like this. On the other hand, apart from the farmers, key players from the insurance company were also interviewed to understand supply-side perspectives on the determinants of take-ups.

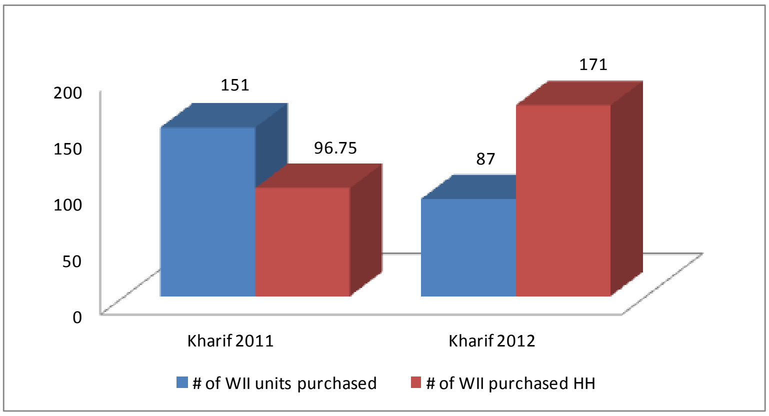
6. Impact analysis and results

6.1 Analysis of product take-up

Simplified WII products were sold during *kharif* 2011 and *kharif* 2012 seasons to all treatment households in the 72 treatment villages. In this section, we compare the take-up pattern of the product during both seasons, focusing on the impact of the three arms of our intervention namely, price discounts, insurance literacy training and degree of basis risk.

6.1.1 Take-up pattern

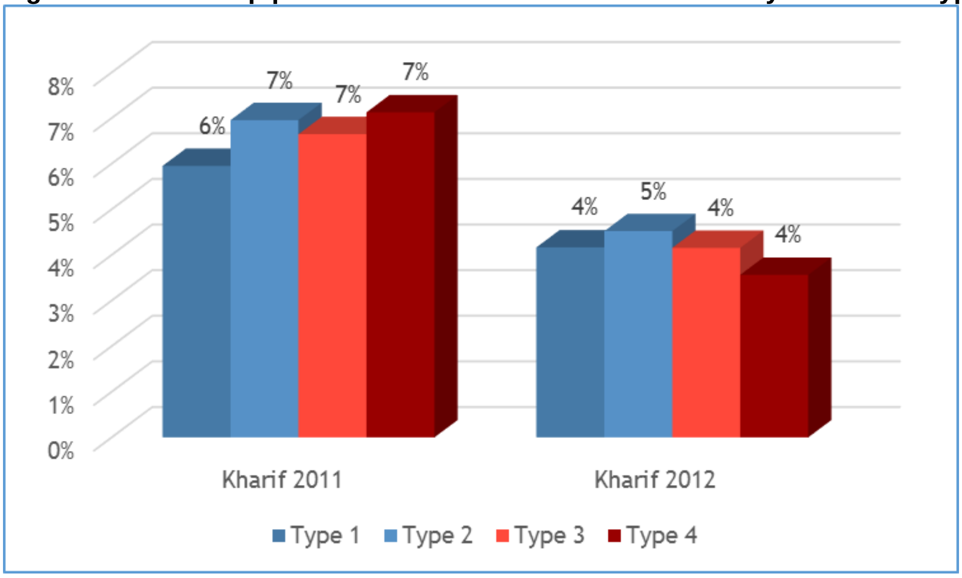
Figure 4: WII take-up pattern in *kharif* 2011 and *kharif* 2012



The overall take-up rates recorded were 6.9 per cent and 4.03 per cent of sample households during *kharif* 2011 and 2012, respectively. This is in line with the take-up rates found in several WII in India. Gine *et al.* (2008) report a lower than 5 per cent take-up rate of WII in Andhra Pradesh. Although our product was simplified when compared to other WII products, there seems to be no enhanced take-up due to the simplified design. Figure 4 provides a comparison of the take-up for the two seasons. The number of households purchasing insurance was lower in 2012 compared to 2011, although the number of units of WII sold was higher in the second year. In 2011, approximately half of the sampled households purchased less than one unit of WII, i.e. they insured less than one acre of land. However, in 2012, all the contracts purchased were for one acre and above.

Now, recall from Section 5 that we oversampled households of type 4 (with larger landholdings and higher education level of the household head) due to the belief (rooted in the existing literature) that these households would be more inclined to purchase insurance. It is interesting to observe whether this presumption materialised in practice. Figure 5 shows the percentage of households within each type (see Table 2.2) that purchased insurance in either season. We can see that there was no differential uptake by household type (something that is implicit in the lack of effect of education and landholdings variables in the uptake analyses, including covariates, in Section 6.1.6). It thus seems that the general lack of interest in the product manifested across all household types, which undermined our initial intention to encourage demand for the product.

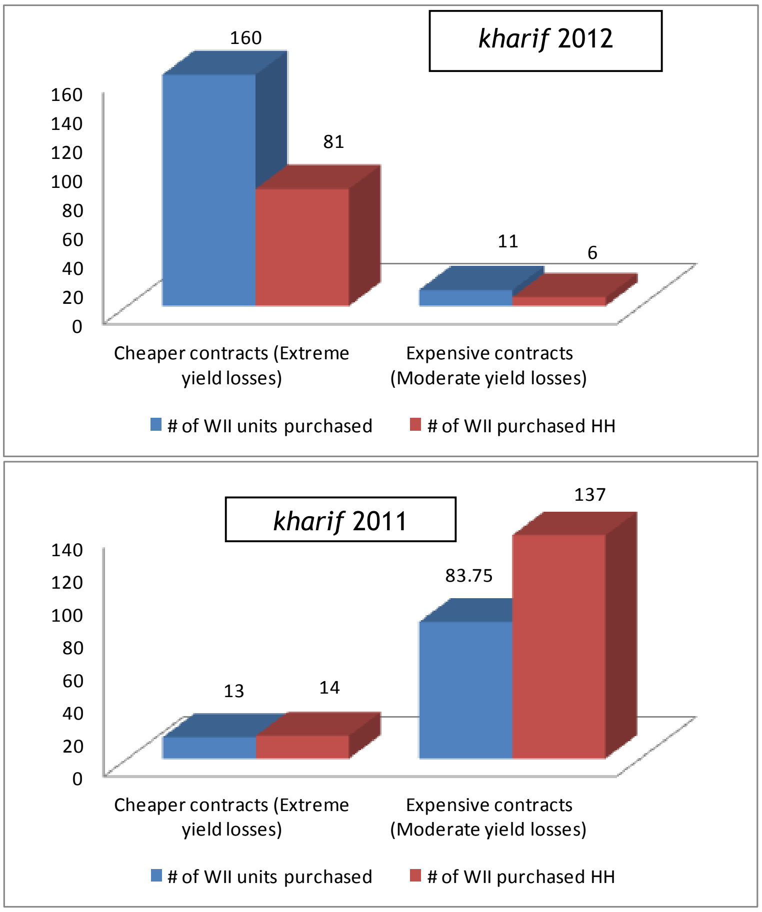
Figure 5: WII take-up pattern in *kharif* 2011 and *kharif* 2012 by household type



6.1.2. Contract preference

As described in Section 4.1, there were two types of contracts offered for each peril identified under every cover period. One security would pay on the occurrence of a very low probability event representing severe yield losses, and the other security would pay on the occurrence of a moderately probable event representing moderate and severe yield losses. The objective behind this was to allow farmers to choose an insurance portfolio suited to cover their specific combination of extreme and moderate risk. Naturally, the cost of the contract for the low probability event was cheaper than the contract for the moderately probable event. Interestingly, farmers' preferences to insure against extreme or moderate yield losses are quite different when we compare 2011 and 2012 data (Figure 6). During *kharif* 2011, 87 per cent of farmers who purchased insurance bought the expensive contract (i.e. they insured against moderate yield losses), whereas in *kharif* 2012, 94 per cent of farmers who bought insurance preferred the cheaper contracts (i.e. they insured against extreme yield losses). Moreover, a large proportion of the farmers who bought insurance during *kharif* 2011 did not repurchase insurance in *kharif* 2012, except for a handful of 11 farmers.

Figure 6: Farmers preference for cheaper vs expensive WII contracts

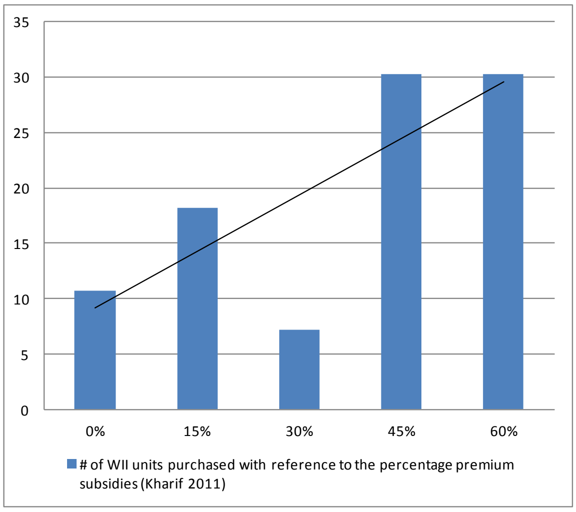


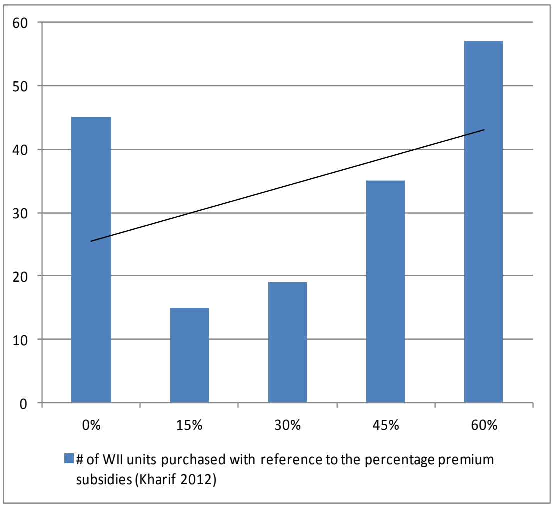
6.1.3 Premium discounts

As elaborated in Section 4.3, four levels of discounts were given to the treatment households which were approximately close to 15 per cent, 30 per cent, 45 per cent and 60 per cent of the premium amount of the product offered to them during *kharif* 2011 and *kharif* 2012 cropping seasons.

It can be observed from Figure 7 that the highest proportion of the total contracts purchased by the treatment households were with the maximum discount during both the cropping seasons of *kharif* 2011 and *kharif* 2012. This, together with the fact that these discount levels were allocated in equal proportions, seems to imply that higher discounts lead to increases in take-up, as expected.

Figure 7: Number of WII units purchased with reference to the premium subsidies

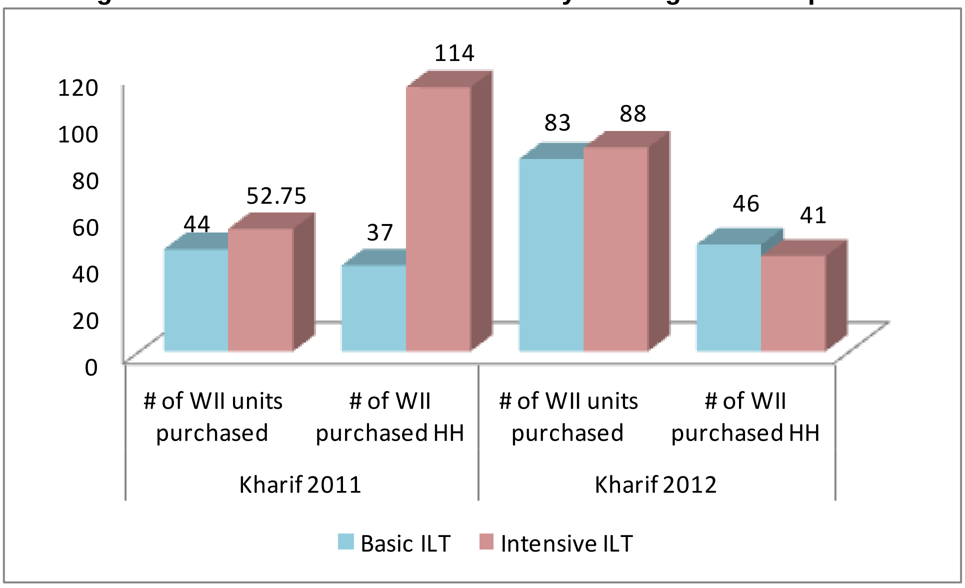




6.1.4 Insurance literacy training

Insurance literacy training was provided before the first season (*kharif* 2011), but was not repeated during the second season (*kharif* 2012). The training was provided to all sampled households in the treatment villages. There were two levels of insurance literacy training, with 50 per cent of the sampled households given a basic level of insurance literacy, and the other 50 per cent given intensive training.

Figure 8: Influence of insurance literacy training on take-ups



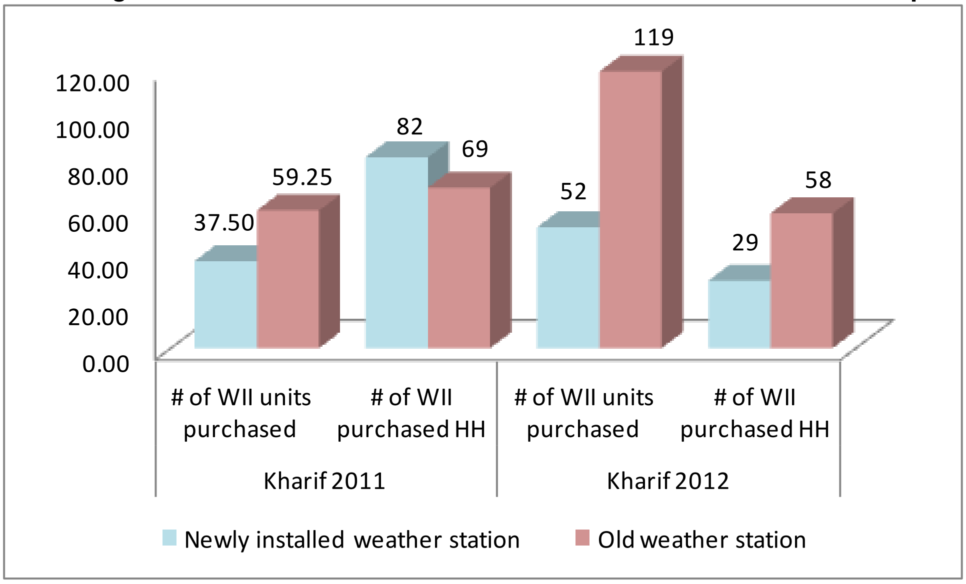
Take-up of the product for *kharif* 2011 indicates that the proportion of sampled households that purchased insurance was three times higher in the intensive literacy training group (75.50 per cent) when compared to the households that received a basic level of training. In contrast, during *kharif* 2012, there does not seem to be a clear correlation between take-up and the levels of insurance literacy provided in 2011. This seems to imply that the differential level of insurance literacy training provided in 2011 did not carry through to the *kharif* 2012 season.

6.1.5 Weather stations

The simplified WII contracts were issued with reference to six weather stations, out of which three stations were installed for the purpose of the project in randomly selected locations. This was done in order to assess the influence of distance to the weather station (spatial basis risk) on take-up.

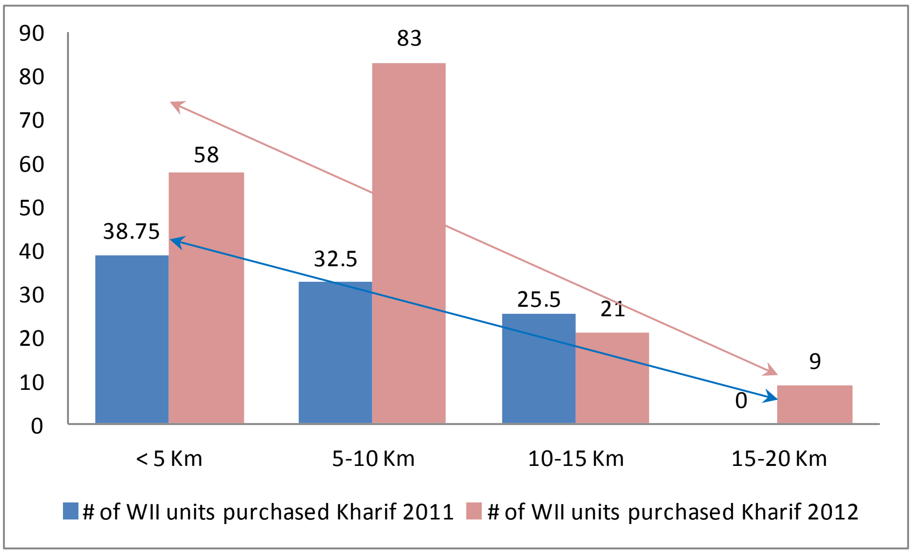
Nearly one third of the total contracts purchased (39 per cent in *kharif* 2011 and 30 per cent in *kharif* 2012) were referenced to the weather stations newly installed for the project. In terms of households that took up the product, 54 per cent and 33 per cent purchased products referenced to the newly installed weather stations during *kharif* 2011 and *kharif* 2012, respectively. This shows that there were no clear disparities in farmers' perceptions between new and old weather stations, and that farmers seemed to accept the newly installed weather stations as much as the preexisting ones.

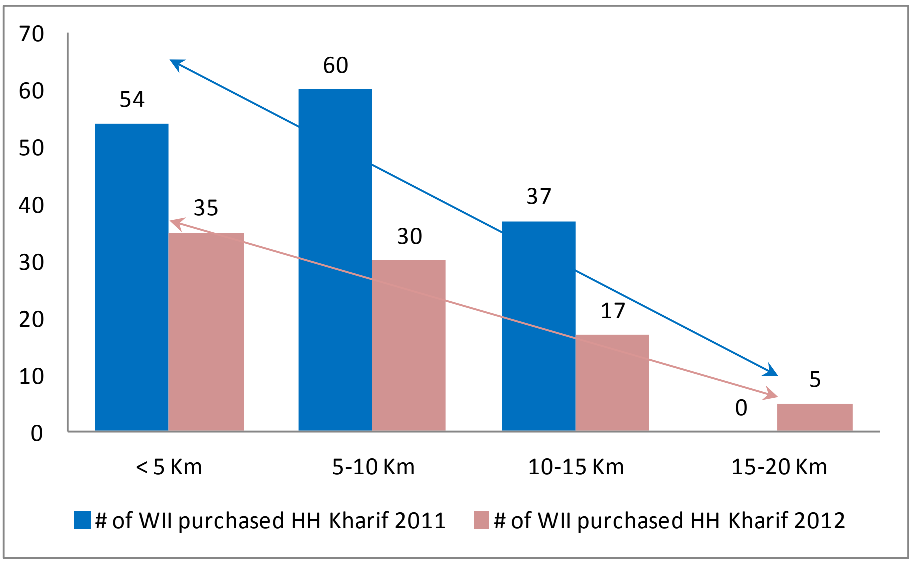
Figure 9: Influence of new and old weather stations on WII take-up



Now, an appropriate measure to assess the relevance of basis risk on demand would be to consider the actual distance of a household/household's farm from the reference weather station used in the offered product. By comparing the GPS coordinates of households and those of the weather stations (both new and old), we calculated the distance between each sampled household and their corresponding reference weather station. This exercise reveals that 74 per cent (in *kharif* 2011) and 82 per cent (in *kharif* 2012) of contracts were purchased by the households located at a distance that was less than 10 kilometres from the weather station, with take-up rates falling considerably beyond 10 kilometres. This seems to point to a significant impact of spatial basis risk on index insurance take-up. The next section formalises this analysis by introducing distance to the reference weather station into an econometric model of the household's decision to purchase insurance.

Figure 10: WII take-up with reference to the distance from weather station





6.1.6 Further analysis on the impact of interventions on take-up

We carried out an in-depth econometric analysis of take-up and found that the results are in line with our descriptive analysis of take-up data. In this section, we begin with the analysis of the *kharif* 2011 insurance purchasing season. In particular, we test the village-level interventions formally by estimating the intent to treat effect (ITT) as follows:

$$dij = \alpha + \beta t \, tj + \varepsilon ij \qquad (6.1)$$

Where d_{ij} is a measure of insurance demand for individual i in village j and t_j indicates the treatment that the village received. We test the impact of price discounts formally by estimating the ITT as follows:

$$dij = \alpha + \beta_p p_{ij} + \varepsilon ij \qquad (6.2)$$

Where p_{ij} indicates the price discount that individual i in village j received. Given the orthogonality of each treatment to the other treatments, we can estimate the impact of each treatment on demand separately. When we consider the impact of basis risk on demand, we also use the following estimation strategy. We instrument distance to weather station using allocation to a new weather station as an instrument. Specifically, the estimation strategy used is:

$$d_{ij} = \alpha + \beta_{dist}\widehat{dist_{ij}} + \varepsilon ij \qquad (6.3)$$

Where $\widehat{dist_{ij}}$ is the estimate derived from the following equation (where t_j in this case refers to whether or not insurance was triggered by a newly placed weather station):

$$dist_{ij} = \alpha + \beta_t t_j + \varepsilon ij\,. \qquad (6.4)$$

In Tables 6.1 and 6.2, we present results on the impact of our three interventions—price discounts, weather station investments and training—on insurance demand.[7] Table 3.1 presents results using a dependent variable that takes the value of 1 when a household purchased insurance. In Table 3.2, the dependent variable is the log of the amount of land insured. Columns 1 to 4 look at each of the interventions separately, whilst in the last two columns, we simultaneously estimate the impact on all of the interventions. Given that each intervention was randomly allocated and we tested that the weather station and intensive training intervention were orthogonally allocated, we should not observe any difference from considering the impact of all treatments at the same time.

First, we note that the proportion of households purchasing insurance is significantly higher among sample households in Bhopal than in Dewas or Ujjain. This may be possibly related to the higher level of marketing effort and organisation in Bhopal than in the other districts. As discussed earlier, marketing in Dewas suffered some setbacks for the late season policies. Ujjain was a new district for HDFC, and insurance literacy training and marketing followed each other closely in this district, perhaps leaving farmers little time to decide whether or not they would buy insurance.

Second, we look at the impact of being offered a price discount. Discounts varied from ₹0 to ₹180 in Bhopal and Dewas, and ₹0 to ₹120 in Ujjain. The independent variable on discounts in Table 3.1 is the ratio of the discount value to price of the cheapest policy. The price of this policy is ₹265 in Bhopal and Dewas and ₹165 in Ujjain. Since the ratio of the price of expensive to inexpensive policy is constant across all districts, this ratio is a good measure

[7] In all of the subsequent analyses, standard errors are clustered at the village level, since this is the main level at which we conduct the random assignment of our treatments. Nevertheless, best practice indicates that, when using the random assignment of weather stations in our analysis, standard errors should be clustered at this level. The first problem with doing so is that we have an extremely low number of clusters (six weather stations in total), which is far from enough for achieving any asymptotic properties of the estimator for the standard errors. Second, this type of concern arises from the possibility of common error components across study units within a given cluster. This is of course reasonable when the cluster is a village, a district, or other economic aggregate sharing common social and economic factors. In our case, however, the aggregate unit is only created artificially by taking into consideration an arbitrary threshold of geographic proximity to randomly-placed weather stations. Given this, we expect these common components in the error term to be of much lower importance than in other cases of randomised assignment. This said, we did run the analyses clustering at the weather station level and find, as expected, that standard errors increase substantially, rendering all coefficients in the tables statistically insignificant.

of the discount value for all policies. Receiving a price discount had a substantial effect, encouraging a household to purchase insurance. A discount of 50 per cent[8] (roughly corresponding to a voucher of ₹135 in Bhopal and Dewas and ₹90 in Ujjain) led to a 12.9 percentage point increase in take-up. The independent variable on discounts in Table 3.2 is the log of the discounted price that faced each farmer. As such, results in Table 3.2 provide a direct measure of the elasticity of demand. We find significant price sensitivity with an elasticity of 0.58, not substantially different to the price elasticity of 0.66 to 0.88 estimated by Cole *et al*. (2013) for WII in other states in India.

Table 3.1: Take-up among sampled households

	(1) OLS	(2) OLS	(3) IV	(4) OLS	(5) OLS	(6) IV
Discount (% of price)	0.259***				0.260***	0.254***
	(0.060)				(0.060)	(0.059)
New reference station		0.053*			0.052*	
		(0.03)			(0.03)	
Distance to reference station			-0.011*			-0.011*
			(0.006)			(0.006)
Intensive training				0.049**	0.052**	0.050
				(0.024)	(0.030)	(0.025)
Dewas	-0.004	-0.036	-0.063	-0.001	-0.027	-0.025
	(0.025)	(0.029)	(0.045)	(0.022)	(0.030)	(0.030)
Bhopal	0.113***	0.090**	0.074	0.108***	0.089**	0.103
	(0.038)	(0.038)	(0.046)	(0.036)	(0.038)	(0.037)
Constant	-0.048*	0.025	0.154*	-0.001	-0.075**	0.025
	(0.025)	(0.022)	(0.08)	(0.021)	(0.029)	(0.061)
Observations	2,183	2,183	2,183	2,183	2,183	2,183
R-squared	0.122	0.06		0.061	0.140	

Standard errors adjusted for clustering at village level are in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Households in villages with new, closer weather stations were significantly more likely to purchase insurance (by 5 per cent) than households in villages with preexisting weather stations (column 2 of Table 3.1), but no significant difference is observed when considering the amount of insurance purchased (column 2 of Table 3.2). A better measure of the impact of basis risk on demand would be to consider the distance of a household to the weather station that they had been allocated to. Using the GPS coordinates of households and those of the weather stations (new and old), we calculate the distance between each sample household and the reference weather station. However, this distance cannot be assumed exogenous for households that were not assigned a new weather station. Therefore, we instrument distance with the randomly assigned allocation to a new weather station. On an average, households with new reference weather stations were 6 kilometres closer. The IV estimates are presented in column (3) and indicate that distance significantly reduces uptake. Each kilometre from the weather station reduces take-up by 1 percentage point. Households that were offered intensive training modules had significantly higher insurance uptake. Take-up among those offered intensive training was about 5 per cent higher than among those offered basic training only. The amount of insurance purchased was also significantly higher among those that had received the intensive training.

[8] And a decrease in the more expensive/comprehensive contract by 40 per cent.

All treatments appeared to have the expected effect on take-up, although the effect on the amount of insurance purchased is much weaker in each case. We estimate the effect of all treatments on take-up simultaneously and present these results in columns (5) and (6) of Tables 3.1 and 3.2. The same results hold, although training is no longer significant in column (6) of Table 3.1 once the distance to weather station is instrumented. The results are also robust to including household-level covariates presented in Tables 3.3 and 3.4. This is as expected, given that the tests of balance indicate no significant differences in characteristics between the treatment groups.

Table 3.2: Log of area of land insured among sample households

	(1) OLS	(2) OLS	(3) IV	(4) OLS	(5) OLS	(6) IV
Log of price of cheaper contract	-0.582***				-0.585***	-0.571***
	(0.133)				(0.133)	(0.135)
New reference station		0.140			0.136	
		(0.110)			(0.108)	
Distance to reference station			-0.029			-0.028
			(0.022)			(0.022)
Intensive training				0.167*	0.174*	0.170
				(0.091)	(0.092)	(0.092)
Dewas	0.285**	-0.086	-0.157	0.011	0.232*	0.232*
	(0.110)	(0.119)	(0.158)	(0.098)	(0.121)	(0.119)
Bhopal	0.656***	0.307**	0.266	0.352**	0.592***	0.621***
	(0.172)	(0.152)	(0.170)	(0.137)	(0.170)	(0.162)
Constant	-1.770**	-4.497***	-4.155***	-4.586***	-1.851***	-1.655**
	(0.671)	(0.095)	(0.285)	(0.088)	(0.656)	(0.718)
Observations	2,183	2,183	2,183	2,183	2,183	2,183
R-squared	0.100	0.040		0.043	0.112	

Standard errors adjusted for clustering at village level are in parentheses; *** p<0.01, ** p<0.05, * p<0.1

The diverse set of covariates allows us to briefly discuss how take-up varies with a number of other household characteristics. From the covariate results in Tables 3.3 and 3.4, we see that loss-averse households are more likely (at a 5 per cent significance level) to purchase HDFC's product and insure more of their land. This makes sense, given that the language of the training material referred to bad weather payouts as losses. Other covariates do not seem to systematically affect the demand for insurance. Weakly significant results seem to point towards households having previously purchased weather insurance being more likely to buy insurance and insure more of their land, and household previously able to access loans to cope with the last drought being less likely to purchase insurance, indicating perhaps that credit and insurance are seen as substitutes.

While we cannot compute a rigorous measure of cost-benefit analysis of each of our interventions with the results in this section, we can compare the cost of each of these in increasing take-up rates by 10 percentage points. The per person amount that was spent on the intensive insurance literacy training was $10.40, and this increased take-up by 5 percentage points. Increasing take-up rates by 10 percentage points using this strategy alone would cost $20.80 per person. However, as we see in the 2012 take-up analysis, this is not a long-term effect. The per person amount that was spent on reducing basis risk by installing new trigger weather stations was $6.67. This also increased take-up by 5 percentage points. Increasing take-up rates by 10 percentage points using this strategy alone would cost $13.34 per person. This is more cost-effective than insurance literacy training. The results in Table 3.1 suggest that to increase take-up rates by 10 percentage points, a discount of ₹115 or about $2.30 per policy is needed. In Bhopal and Dewas, we also spent $2.97 distributing vouchers to each farmer, but this is because we were randomising the price within a village. In Ujjain, the cost of administering the discount was non-existent as it was just a matter of the HDFC agent telling farmers. Either way, this strategy for increasing purchases of insurance is the most cost-effective of the three.

Table 3.3: Sample households, take-up (adding covariates)

	(1) OLS	(2) OLS	(3) IV	(4) OLS	(5) OLS	(6) IV
Ratio of discount to price	0.264***				0.267***	0.261***
	(0.061)				(0.061)	(0.061)
New reference station		0.050*			0.051*	
		(0.030)			(0.029)	
Distance to reference station			-0.007**			-0.010*
			(0.004)			(0.006)
Intensive training				0.052**	0.056**	0.050**
				(0.024)	(0.024)	(0.024)
Dewas	-0.007	-0.036	-0.039	-0.002	-0.033	-0.037
	(0.028)	(0.033)	(0.033)	(0.026)	(0.033)	(0.034)
Bhopal	0.111***	0.089**	0.098***	0.103***	0.086**	0.096**
	(0.040)	(0.038)	(0.035)	(0.033)	(0.038)	(0.037)
Years of schooling	0.002	0.002	0.001	0.002	0.002	0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Head is a male	-0.004	-0.002	0.013	0.001	0.007	0.021
	(0.030)	(0.029)	(0.029)	(0.030)	(0.029)	(0.030)
Household is SC, ST or OBC	0.017	0.026*	0.023	0.024*	0.013	0.011
	(0.014)	(0.015)	(0.016)	(0.014)	(0.014)	(0.015)
Head holds official village position	-0.004	0.009	0.012	0.013	0.003	0.006
	(0.027)	(0.029)	(0.029)	(0.028)	(0.027)	(0.027)
Member of cooperative	-0.010	-0.008	-0.008	-0.007	-0.016	-0.016
	(0.016)	(0.016)	(0.016)	(0.017)	(0.015)	(0.015)
Acres of land owned	0.002	0.002	0.002*	0.002	0.002	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Log of total assets	-0.001	-0.003	-0.004	-0.001	-0.000	-0.002
	(0.005)	(0.006)	(0.005)	(0.006)	(0.005)	(0.005)
Owns a bank account	-0.007	-0.010	-0.013	-0.012	-0.007	-0.010
	(0.013)	(0.014)	(0.014)	(0.014)	(0.012)	(0.012)
Can obtain ₹20,000 for emergency	0.004	0.005	0.002	0.005	0.009	0.006
	(0.015)	(0.014)	(0.014)	(0.015)	(0.014)	(0.014)
Bought insurance before	0.016	0.009	0.010	0.011	0.017	0.017
	(0.016)	(0.017)	(0.016)	(0.016)	(0.016)	(0.015)
Trust in private insurance	-0.004	-0.001	-0.005	-0.006	0.000	-0.003
	(0.012)	(0.013)	(0.013)	(0.012)	(0.013)	(0.013)
Expected government aid for crops	-0.007	-0.005	-0.002	-0.007	-0.013	-0.009
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Took out loan for last drought	-0.022	-0.019	-0.023	-0.024*	-0.024	-0.028*
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
Insurance knowledge score(/5)	0.004	0.002	0.003	0.003	0.000	0.001
	(0.006)	(0.006)	(0.005)	(0.006)	(0.005)	(0.005)
RA game, chose option 2	0.017	0.015	0.008	0.017	0.024	0.016
	(0.018)	(0.018)	(0.022)	(0.018)	(0.017)	(0.021)
RA game, chose option 3	0.013	0.003	-0.006	0.005	0.018	0.009
	(0.022)	(0.022)	(0.024)	(0.022)	(0.021)	(0.023)
RA game, chose option 4	0.004	-0.002	-0.010	-0.001	0.011	0.003
	(0.018)	(0.017)	(0.021)	(0.018)	(0.016)	(0.020)
RA game, chose option 5	-0.004	-0.005	-0.011	-0.006	-0.003	-0.009
	(0.021)	(0.021)	(0.024)	(0.022)	(0.020)	(0.023)
Ambiguity averse	0.013	0.014	0.006	0.015	0.014	0.006
	(0.014)	(0.015)	(0.018)	(0.014)	(0.014)	(0.018)
Loss averse	0.024**	0.023**	0.033***	0.022**	0.023**	0.033***
	(0.010)	(0.011)	(0.013)	(0.011)	(0.010)	(0.012)
Constant	-0.083	0.007	0.132	-0.047	-0.127	0.006
	(0.088)	(0.103)	(0.123)	(0.100)	(0.090)	(0.114)
Observations	2,164	2,164	2,164	2,164	2,164	2,164
R-squared	0.134	0.070	0.005	0.072	0.153	0.082

Standard errors adjusted for clustering at village level are in parentheses. Risk aversion (RA) choices are from a hypothetical Binswanger lottery survey question, where choice 1 is the least risk averse option. *** p<0.01, ** p<0.05, * p<0.1

Table 3.4: Sample households, log of area insured (adding covariates)

	(1) OLS	(2) OLS	(3) IV	(4) OLS	(5) OLS	(6) IV
Log of price of cheaper contract	-0.594***				-0.602***	-0.589***
	(0.137)				(0.138)	(0.138)
New reference station		0.130			0.134	
		(0.110)			(0.108)	
Distance to reference station			-0.026			-0.027
			(0.022)			(0.022)
Intensive training				0.178*	0.194**	0.180**
				(0.090)	(0.091)	(0.091)
Dewas	0.270**	-0.095	-0.104	-0.003	0.211	0.198
	(0.119)	(0.139)	(0.134)	(0.113)	(0.135)	(0.131)
Bhopal	0.652***	0.297**	0.320**	0.328**	0.586***	0.608***
	(0.173)	(0.149)	(0.136)	(0.129)	(0.168)	(0.160)
Years of schooling	0.006	0.005	0.003	0.005	0.004	0.002
	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)
Head is a male	0.007	-0.004	0.033	0.009	0.043	0.079
	(0.106)	(0.103)	(0.103)	(0.107)	(0.104)	(0.106)
Head is SC, ST or OBC	0.042	0.080	0.074	0.074	0.030	0.025
	(0.054)	(0.056)	(0.058)	(0.052)	(0.052)	(0.054)
Head holds official village position	0.024	0.075	0.083	0.091	0.048	0.055
	(0.117)	(0.123)	(0.123)	(0.121)	(0.115)	(0.115)
Member of cooperative	-0.029	-0.017	-0.018	-0.017	-0.048	-0.048
	(0.057)	(0.057)	(0.055)	(0.061)	(0.054)	(0.052)
Acres of land owned	0.011	0.020	0.023	0.017	0.012	0.015
	(0.041)	(0.041)	(0.041)	(0.040)	(0.039)	(0.039)
Log of total assets	0.006	0.002	-0.002	0.008	0.009	0.004
	(0.025)	(0.026)	(0.024)	(0.027)	(0.024)	(0.023)
Owns a bank account	-0.019	-0.031	-0.039	-0.036	-0.020	-0.028
	(0.046)	(0.049)	(0.049)	(0.048)	(0.042)	(0.042)
Can obtain ₹20,000 for	0.022	0.025	0.017	0.029	0.039	0.030
	(0.055)	(0.055)	(0.054)	(0.054)	(0.052)	(0.051)
Bought insurance before	0.100	0.071	0.074	0.078	0.104	0.106*
	(0.064)	(0.067)	(0.065)	(0.065)	(0.065)	(0.063)
Trust in private insurance	-0.017	-0.011	-0.021	-0.024	-0.007	-0.017
	(0.052)	(0.057)	(0.053)	(0.053)	(0.056)	(0.053)
Expected government aid for	-0.031	-0.015	-0.008	-0.024	-0.048	-0.039
	(0.043)	(0.044)	(0.043)	(0.044)	(0.042)	(0.041)
Took out loan for last drought	-0.080	-0.072	-0.083	-0.089	-0.091	-0.102*
	(0.060)	(0.057)	(0.058)	(0.057)	(0.059)	(0.059)
Insurance knowledge score	0.011	0.010	0.012	0.010	0.001	0.004
	(0.021)	(0.022)	(0.022)	(0.023)	(0.022)	(0.021)
RA game, chose option 2	0.086	0.081	0.062	0.088	0.108	0.088
	(0.067)	(0.069)	(0.076)	(0.070)	(0.066)	(0.074)
RA game, chose option 3	0.055	0.017	-0.005	0.026	0.071	0.047
	(0.080)	(0.080)	(0.082)	(0.079)	(0.077)	(0.079)
RA game, chose option 4	0.023	-0.003	-0.023	0.001	0.044	0.023
	(0.069)	(0.066)	(0.075)	(0.068)	(0.064)	(0.073)
RA game, chose option 5	-0.003	-0.011	-0.026	-0.013	0.001	-0.014
	(0.076)	(0.077)	(0.083)	(0.078)	(0.073)	(0.079)
Ambiguity averse	0.021	0.027	0.007	0.031	0.023	0.002
	(0.059)	(0.062)	(0.066)	(0.060)	(0.060)	(0.066)
Loss averse	0.104**	0.101**	0.127***	0.097**	0.100**	0.126***
	(0.042)	(0.044)	(0.045)	(0.044)	(0.041)	(0.042)
Constant	-1.968**	-4.706***	-4.389***	-4.887***	-2.074***	-1.766**
	(0.778)	(0.470)	(0.522)	(0.453)	(0.753)	(0.815)
Observations	2,164	2,164	2,164	2,164	2,164	2,164
R-squared	0.110	0.048	0.023	0.052	0.123	0.094

Standard errors adjusted for clustering at village level are in parentheses. Risk aversion (RA) choices are from a hypothetical Binswanger lottery survey question, where choice 1 is the least risk averse option. *** p<0.01, ** p<0.05, * p<0.1

6.2 Midline impact analysis

The midline survey provides us with an array of data on which we can test the impact of the *kharif* 2011 intervention. First, we can measure the impact of offering insurance—ITT effect—on a set of household characteristics. Second, since we have information on which households actually bought insurance products, we are also interested in measuring the effect of actual insurance purchase on their farming outcomes and decisions. While answering these two questions may require different econometric strategies, we begin by using ANCOVA to analyse both sets of questions.

Given that we have data on household characteristics for two time periods, baseline and midline, we can either use ANCOVA, estimate differences between treatment and control in the period post intervention, or implement a difference-in-differences estimator. If there is correlation between the midline and baseline household characteristics, the ANCOVA estimator is strictly more efficient and hence more statistically powerful than the post-intervention estimator alone. Furthermore, the ANCOVA estimator is weakly more efficient and hence more statistically powerful than the difference-in-differences for all levels of autocorrelation in the variable of interest (McKenzie 2011). Due to this statistical superiority, we prefer the ANCOVA approach for both: an estimate of ITT of offering insurance and the impact of purchasing insurance. The general regression specification is presented in (6.5) and the estimator of interest is approximated in (6.6), where Y is one variable of interest (e.g. income from soya bean production) that takes values across two different time periods 0 and 1, and $TREAT_{i,1}$ takes a value of 1 if household i received a specific treatment, e.g. intensive training, and 0 if it did not.

$$Y_{i,1} = \alpha + \gamma TREAT_{i,1} + \theta Y_{i,0} + \varepsilon_{i,1} \quad (6.5)$$

$$\gamma = \left(Y_1^T - Y_1^C\right) - \hat{\theta}(Y_0^T - Y_0^C) \quad (6.6)$$

Equations (6.5) and (6.6) also present, respectively, the specification and the estimator of the ITT effect of being offered insurance, where $TREAT_{i,1}$ takes a value of 1 if insurance was offered to household I, and 0 otherwise.

For the set of variables we are interested in, we have calculated the minimum detectable effect (MDE) of a test on the statistical significance of the coefficient gamma in equation (6.5). Here, the minimum detectable effect is defined as the true ITT, which gives us a statistical power of at least 0.8 in a two-sided test of the null hypothesis that the ITT is equal to zero[9]. We would like to have a minimum detectable effect that is as small as possible in order to detect true population effects (through the estimated gamma) in our random sample. Table 3.5 shows the MDE of our ITT regressions. The first column presents the average of the variable in the control group. The second column shows the minimum difference from the control mean that would be possible to detect by a test on gamma with a power of more than or equal to 0.8 (and thus a probability of type II error less than or equal to 0.2). For example,

[9] In order to calculate the MDE, we estimate sample means and standard deviations (adjusted by the intra-cluster correlation of the errors at the village level) for both control and treatment group, and an overall autocorrelation coefficient between baseline and follow-up. These, together with the total sample sizes of both groups, are then used as inputs into the sampsi command in STATA, which uses a variance for the estimated gamma coefficient like the one discussed in McKenzie (2011).

if the population's true (ITT) effect of insurance on the log of total acres sowed with soya bean were less than 0.11, a statistical test of the significance of the gamma coefficient in equation (6.5) would incorrectly fail to reject the null (thus claiming no effect when in fact it exists) in more than 20 per cent of the draws of a random sample from the population (keeping constant the probability of type I error at 5 per cent). In other words, and with our current sample size, in order to keep the type II error probability below 20 per cent (power above 80 per cent) and thus identify an effect when this truly exists, the true (population) average impact of providing insurance on the log of total acres sowed with soya bean would need to be larger than 0.11 acres per farmer.

Equations (6.7) and (6.8) below present the second and first stage of the main ATE (average treatment effect) regression in our subsequent analysis. In order to calculate the average treatment effect of purchasing insurance, we instrument insurance purchase with the exogenous variations in our study: assignment of weather station, price discount vouchers and intensive training:

$$Y_{i,1} = \alpha + \gamma PURCHASE_{i,1} + \theta Y_{i,0} + \varepsilon_{i,1} \quad (6.7)$$

$$PURCHASE_{i,1} = \beta + \beta_1 TRAINING_{i,1} + \beta_2 STATION_{i,1}\gamma + \beta_3 VOUCHER_{i,1} + \beta_4 Y_{i,0} + \mu_{i,1} \quad (6.8)$$

We present estimates of the MDE of gamma in regression (6.7) in Table 3.6. In this case, the MDE constitutes an MDE calculation for an un-instrumented endogenous variable. Therefore, the approximations in Table 3.6 should be taken with caution. When we compare Tables 3.5 and 3.6, we see that the intervals are generally much higher for Table 3.6, those applicable to the ATE regressions. The first reason is that the sample is restricted and only includes households that were offered insurance—otherwise the interpretation of the gamma coefficient is not the intended ATE of insurance purchase over not purchasing insurance when insurance is offered. The smaller sample size thus increases the standard deviations used in our MDE calculations. Furthermore, only 151 households purchased insurance. Therefore, the standard error for the treatment group, i.e. those who were offered insurance, is much larger and thus contributes to a higher MDE. Finally, while in our ITT analysis we have a relatively balanced ratio of treatment to control observations (1.92 with a total of 3,228 observations), the ratio of treatment to control observations in our analysis of the uptake of insurance is only 0.08, with a total of 2,123 observations. In conclusion, the larger MDE for our ATE estimations implies that we would need to face a much higher population effect (in comparison to the ITT estimations) in order to be able to achieve the same amount of power. In other words, these MDE calculations imply that it will be very hard for us to find statistically significant effects from holding insurance on different production variables unless the true effect of insurance were implausibly large.

Table 3.5: Minimum detectable effect of the comparison between average of treatment and control in ANCOVA for ITT regressions

	Average of Control	Minimum Detectable Effect (+/-)		Averag e of Contro	Minimu m Detectab
Log acres of soya bean land	2.004	0.1093	*interest of biggest loan*	21.113	3.1324
Acres soya bean land / acres cultivated land	0.956	0.0271	*interest of agricultural input loan*	19.012	3.5537
Log of acres soya bean and fert land	1.978	0.1227	*used for inputs*	0.656	0.0968
Acres fert and soya bean land /acres soya	0.961	0.0294	*used for health*	0.074	0.0356
log of acres soya bean and irrig land	1.785	0.1399	*used for tools*	0.066	0.0403
Acres irrig and soya bean land / acres soya	0.806	0.0597	*log of other income: wages, business*	5.047	0.8485
Log of acres soya bean and early sowed land	1.810	0.1915	*number of months employed*	4.262	0.9011
Acres early sowed and soya bean land / acres	0.883	0.0703	*log of total value of transfers*	6.627	1.3978
Log of value of soya bean sold in kharif	9.717	0.3212	*number of months transfers received*	1.998	0.4512
Log of fert expenditures on soya bean	8.214	0.3827	*log of guarantee income*	0.519	0.4663
Soya bean fertiliser expenditures / fert	0.943	0.0352	*number of months guarantee income received*	0.108	0.0993
Log of pesticide expenditures	0.667	0.0160	*employment August and September*	0.085	0.0223
Pesticide expenditure / total expenditure	0.120	0.0198	*employment October and November*	0.111	0.0269
Log of hybrid expenditure	0.287	0.0661	*log of value transfer, August and September*	0.810	0.4819
Hybrid exp. / total exp.	0.065	0.0205	*log of value transfer October and November*	0.357	0.2580
Log of non-hybrid exp.	0.495	0.0671	*dummy guarantee scheme in August and September*	0.009	0.0089
Non-hybrid exp. / total exp.	0.020	0.0135	*dummy guarantee scheme October and November*	0.005	0.0083
Log of labour cost	0.601	0.0368	*insurance knowledge score*	3.020	0.1752
Labour cost / total exp.	0.141	0.0245	*basis risk comprehension*	0.781	0.1115
Log of oxen exp.	0.166	0.0967	*payout comprehension*	0.918	0.0624
Oxen exp. / total exp.	0.002	0.0017	*timing of insurance purchase comprehension*	0.932	0.0598
Log of tractor exp.	0.636	0.0347	*exposure to millimetres*	0.301	0.0692
Tractor exp. / total exp.	0.107	0.0148	*comprehension of millimetres*	0.043	0.0322
Log of irrig. Exp	0.030	0.0320	*trust in government insurance*	0.931	0.0516
Irrig exp. / total exp.	0.004	0.0055	*trust in private insurance*	0.191	0.0834
Dummy: took out a loan	0.897	0.0589	*weather station is a good measure of rain on own field*	0.136	0.0746
Number of loans	1.909	0.2593	*resilience in demand given no payout in first year*	0.762	0.0919
Log of biggest loan if loan taken	9.361	0.6749	*resilience to demand given basis risk occurs*	0.270	0.1137
Log of input loan, biggest	10.341	0.2313			

Table 3.6: Minimum detectable effect of the comparison between average of treatment and control in ANCOVA for ATE regressions

	Average of Control	Minimum Detectable Effect (+/-)		Average of Control	Minimum Detectable Effect (+/-)
Log acres of soya bean land	1.955	0.1752	*interest of biggest loan*	20.336	5.1712
Acres soya bean land / acres cultivated land	0.958	0.0669	*interest of agricultural input loan*	18.360	5.6090
Log of acres soya bean and fert land	1.924	0.1652	*used for inputs*	0.667	0.1559
Acres fert and soya bean land /acres soya bean land	0.952	0.0527	*used for health*	0.070	0.0497
Log of acres soya bean and irrig land	1.698	0.2510	*used for tools*	0.068	0.0681
Acres irrig and soya bean land / acres soya bean land	0.782	0.1353	*log of other income: wages, business*	4.981	1.5204
Log of acres soya bean and early sowed land	1.713	0.2602	*number of months employed*	3.939	1.6421
Acres early sowed and soya bean land / acres soya bean	0.857	0.0820	*log of total value of transfers*	6.497	1.5367
Log of value of soya bean sold in kharif	9.561	0.6505	*number of months transfers received*	2.214	0.4586
Log of fert expenditures on soya bean	7.961	0.7024	*log of guarantee income*	0.709	0.4864
Soya bean fertiliser expenditures / fert expenditures	0.928	0.0696	*number of months guarantee income received*	0.127	0.1054
Log of pesticide expenditures	0.665	0.0377	*employment August and September*	0.075	0.0502
Pesticide exp. / total exp.	0.112	0.0226	*employment October and November*	0.103	0.0446
Log of hybrid exp.	0.267	0.1179	*log of value transfer, August and September*	0.888	0.5475
Hybrid exp. / total exp.	0.066	0.0488	*log of value transfer October and November*	0.632	0.4855
Log of non-hybrid exp.	0.491	0.1266	*dummy guarantee scheme in August and September*	0.005	0.0170
Non-hybrid exp. / total exp.	0.021	0.0310	*dummy guarantee scheme October and November*	0.005	0.0192
Log of labour cost	0.603	0.0635	*insurance knowledge score*	3.139	0.1727
Labour cost / total exp.	0.142	0.0288	*basis risk comprehension*	0.817	0.1580
Log of oxen exp.	0.156	0.0675	*payout comprehension*	0.961	0.0421
Oxen exp. / total exp.	0.002	0.0017	*timing of insurance purchase comprehension*	0.934	0.0951
Log of tractor exp.	0.629	0.0359	*exposure to millimetres*	0.307	0.1167
Tractor exp. / total exp.	0.108	0.0183	*comprehension of millimetres*	0.051	0.0654
Log of irrig. exp.	0.019	0.0203	*trust in government insurance*	0.940	0.0554
Irrig exp. / total exp.	0.002	0.0039	*trust in private insurance*	0.249	0.1534
Dummy: took out a loan	0.849	0.1420	*weather station is a good measure of rain on own field*	0.125	0.1648
Number of loans	1.817	0.4656	*resilience in demand given no payout in first year*	0.767	0.1657
Log of biggest loan if loan taken	8.852	1.5488	*resilience to demand given basis risk occurs*	0.320	0.2171
Log of input loan, biggest	10.416	0.2956			

6.2.1 Understanding variations in take-up: changes in attitudes and perceptions

The provision of a new product to a target population that is unfamiliar about its key characteristics can largely hinder its demand. As mentioned above, during the first year of implementation, we encountered a low take-up for the product. However, as the introduction of a new insurance product can take time to take root in a rural population like the one in our sample, a significant impact on the knowledge and attitudes of farmers towards insurance can be indicative of a potential future impact on demand. In this section, we thus investigate the impact of offering insurance and of the three randomised treatments (new weather station, intensive training and distribution of price discount vouchers) on different measures of knowledge about insurance, attitudes towards various aspects of our product such as basis risk and trust in insurance providers.

Table 3.7 provides the results from a series of regressions measuring the impact of (i) offering insurance (ITT) and (ii) purchase of insurance (ATE), on a set of trust and knowledge variables of interest. Each row corresponds to one variable, and each column corresponds to a different regression with the same dependent variable. For example, the first variable, insurance knowledge score, is the subject of two regressions: the ITT impact of offering insurance on the insurance knowledge score, and the ATT impact of insurance purchase on this score. The relevant coefficients from these two regressions are shown in columns 1 and 3, respectively, followed by their standard errors and corresponding number of observations. All regressions use an ANCOVA estimator.[10]

The insurance knowledge score takes a value from 0 to 5, depending on the number of individual questions that a respondent answered correctly. These questions are shown as the next five variables (rows) in Table 3.7, and range from comprehension of the properties of basis risk to comprehension of the concept of millimetres, each of which takes a value of zero or one. The rest of the variables are also binary. The last two variables are based on hypothetical questions on whether a household would buy insurance, given that no payouts were made in the first year. In the first case, a value of one indicates that a household would do so in the most basic scenario. In the second, a value of one indicates that a household is still willing to purchase insurance even if it received poor rain.

The results in Table 3.7 indicate that the offer of insurance had a significant effect on knowledge and trust, while the purchase of insurance increased comprehension of only certain aspects of our knowledge tests. Now, the ITT effect of offering insurance actually captures the average effect of a set of various treatments. Therefore, we want to understand the specific mechanisms through which certain treatments can increase knowledge, positive attitudes towards the product and trust in the provider. Specifically, we want to know how each different arm of our treatments influenced households. Furthermore, we wish to examine if the interaction of certain treatments created an added incentive to the households to learn from the training modules.

In Tables 3.8a and 3.8b, we examine the ATE impact of each treatment arm on six of the dependent variables presented in Table 3.7. In Table 3.8a, the treatments are new weather

[10] As a word of caution, the F statistic in the first stage of the ATE specifications is not very high (of around 5, depending on the specification), which hints at a weak instrument problem. This is to be expected since uptake was very low, which leads into the low power issue discussed above.

stations, intensive training and distribution of price discount vouchers. In Table 3.8b, we instrument distance from the weather station (to account for potential endogeneity of distance to the pre-existing weather stations) and include, instead of the absolute price discount, the ratio of the insurance premium covered by the discounts (and thus the variable now takes values from 0 to 1). Our results show that provision of a new weather station has a positive impact on the comprehension of insurance payouts and timing, greater satisfaction with the weather station and higher trust in private insurers. Also, a higher price discount has a positive impact on the overall insurance knowledge score. In both tables, we find that intensive training has no significant impact on the knowledge score, satisfaction with the weather station, or trust in private insurers.

Table 3.7: Impact of insurance on knowledge and trust

Results of ANCOVA regressions of either the offer of insurance (column 1) or instrumented uptake of insurance (column 3) on series of dependent variables (rows).

	ITT of insurance	N	ATE of	N
Insurance knowledge score	0.117*	3,237	-0.291	2,130
	(0.061)		(0.435)	
Basis risk comprehension	0.035	3,309	-0.416	2,183
	(0.040)		(0.262)	
Payout comprehension	0.043*	3,309	0.126	2,183
	(0.022)		(0.113)	
Timing of insurance purchase comprehension	0.000	3,309	0.338*	2,183
	(0.021)		(0.202)	
Exposure to millimetres	0.010	3,229	-0.151	2,124
	(0.023)		(0.208)	
Comprehension of millimetres	0.009	3,309	0.036	2,183
	(0.011)		(0.102)	
Trust in government insurance	0.011	3,234	0.120	2,127
	(0.018)		(0.124)	
Trust in private insurance	0.060**	3,231	-0.317	2,126
	(0.029)		(0.268)	
Weather station is a good measure of rain on own field	-0.003	3,209	0.133	2,111
	(0.026)		(0.187)	
Resilience in demand given no payout in first	0.007	3,235	0.170	2,128
	(0.032)		(0.246)	
Resilience to demand given basis risk occurs	0.056	3,232	-0.160	2,125
	(0.040)		(0.391)	

Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 3.8a: Specific OLS regression results of impact of interventions on knowledge and trust

VARIABLES	1 Insurance knowledge score	2 Comp. of insurance payouts	3 Comp. of insurance timing	4 Satisfaction with weather station	5 Trust in government insurance	6 Trust in private insurance
New weather station	-0.097	0.017*	0.034*	0.108***	0.001	-0.032
	(0.062)	(0.010)	(0.019)	(0.036)	(0.020)	(0.041)
Intensive training	-0.083	0.005	0.014	-0.044	0.014	-0.031
	(0.059)	(0.011)	(0.020)	(0.032)	(0.019)	(0.038)
Discount was received	0.069*	0.008	0.027*	0.002	0.009	-0.010
	(0.037)	(0.010)	(0.014)	(0.014)	(0.011)	(0.024)
Constant	2.921***	0.957***	0.908***	0.116***	0.904***	0.262***
	(0.067)	(0.016)	(0.024)	(0.025)	(0.023)	(0.038)
Lag of dependent variable	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,130	2,183	2,183	2,111	2,127	2,126
R-squared	0.023	0.003	0.008	0.030	0.003	0.008

Table 3.8b: Specific IV 2SLS regression results of impact of interventions on knowledge and trust

VARIABLES	1 Insurance knowledge score	2 Comp. of insurance payouts	3 Comp. of insurance timing	4 Satisfaction with weather station	5 Trust in government insurance	6 Trust in private insurance
Distance from new ws	0.020	-0.004*	-0.007*	-0.000	0.007	-0.022***
	(0.014)	(0.002)	(0.004)	(0.004)	(0.009)	(0.008)
Intensive training	-0.083	0.005	0.014	0.014	-0.031	-0.045
	(0.066)	(0.011)	(0.021)	(0.019)	(0.039)	(0.035)
Ratio of price discounted by voucher	0.167**	0.018	0.042	0.008	-0.042	0.005
	(0.073)	(0.016)	(0.025)	(0.018)	(0.038)	(0.034)
Constant	2.729***	0.993***	0.980***	0.909***	0.201**	0.337***
	(0.130)	(0.018)	(0.036)	(0.043)	(0.080)	(0.073)
Lag of dependent variable	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,130	2,183	2,183	2,127	2,126	2,111
R-squared			0.002	0.003		

Notes: Robust standard errors in parentheses.
Distance from new ws is instrumented by assignment to new ws.
*** p<0.01, ** p<0.05, * p<0.1

We find evidence in Tables 3.8a and 3.8b that the provision of vouchers and a larger ratio of price discounted by the voucher increased the understanding of insurance. There can be two reasons for this. First, the provision of a voucher created higher incentives to pay more attention during the training session. Second, people who received vouchers were more likely to purchase insurance and therefore were able to learn about insurance through this process, the so-called learning-by-doing.[11] Some suggestive evidence of this effect can be seen in Table 3.7, where we find that households who purchased insurance had a higher comprehension of a number of components in our score. In Tables 3.8a and 3.8b, we further find this effect amongst the households with new weather stations and closer distance to a weather station. We also find that households that had insurance referenced to a new weather station were significantly more satisfied with how their rain was measured. Furthermore, households that were further away from weather stations had significantly lower comprehension of insurance payouts and timing and lower trust in private insurance.

In addition, we want to better understand why intensive training was not beneficial in increasing insurance understanding in our sample. We must not forget, however, that intensive training was in fact an additional two hours of training on top of an initial two-hour basic training session provided to all households who were offered insurance. Unfortunately, we do not have the ability to measure the exact impact of this basic two-hour training as it perfectly correlates with the offering of insurance (all households that were offered basic training were at the same time offered insurance). In Table 3.9, we present a set of regressions on the same set of dependent variables, where the relevant independent variables are the offer of insurance, and the offer of insurance interacted with other treatments (intensive training, a new weather station, or insurance price discount). The first coefficient is the marginal effect of just offering insurance without any further treatments, while the second coefficient captures the additional effect of providing the other treatments. The problem with this is that in the context of selling such a product, knowledge can be increased by simply offering insurance if the target sample sought out information to make a purchase decision. While we cannot directly measure how much effort a household put into gathering information outside of training, the overall demand for households who did not receive any other treatments is very low. Therefore, we speculate that the impact of marketing on seeking out information explains a small fraction of what we see. Specifically, we see that the overall knowledge score was significantly higher when basic training was offered with insurance than when neither was provided. The size of the effect is higher than that of an offer of a price discount voucher presented in row three of Table 3.8a. Therefore, we take this as weak evidence to point out that while extra training is not helpful, basic training might be impacting knowledge about insurance. Again, however, this effect is unfortunately technically indistinguishable from the marketing effect, so these results need to be seen with caution.

[11] The effects we observe could be potentially driven by a behavioural response of the recipients to receiving a voucher, where the voucher may serve as a reminder that repeatedly draws the individual's attention to the topic of insurance. Unfortunately, our design does not allow us to separate this effect from the learning-by-doing mentioned above.

Table 3.9: Investigation into the effect of basic training

VARIABLES	1 Insurance knowledge score	2 Comp. of insurance payouts	3 Comp. of insurance timing	4 Satisfaction with weather station	5 Trust in government insurance	6 Trust in private insurance
Insurance was offered (+ basic training)	0.098**	-0.072*	0.071*	-0.047	0.002	0.111
	(0.046)	(0.039)	(0.039)	(0.030)	(0.050)	(0.091)
Other treatment was offered	-0.070**	0.080**	-0.069*	0.049*	0.005	-0.061
	(0.035)	(0.034)	(0.035)	(0.028)	(0.045)	(0.087)
Constant	0.769***	0.915***	0.246***	0.138***	0.722***	0.269***
	(0.033)	(0.031)	(0.021)	(0.020)	(0.027)	(0.032)
Lag of dependent variable						
Observations	3,309	3,309	3,229	3,209	3,235	3,232
Lag of dependent variable	0.005	0.007	0.031	0.002	0.004	0.004

Notes: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Even though extra training has no significant impact, it is possible that it has a complementary effect with reduced distance and size of discount. We therefore examine the interaction of intensive training with these variables. Tables 3.10 and 3.11 present the results. In Table 3.10, we find no significant interaction between intensive training and distance from a weather station. However, in Table 3.11 we do find a negative effect of offering a larger voucher and intensive training on comprehension of the timing of insurance. While we hypothesised that a larger voucher might provide higher incentives to understanding the product (since the voucher makes it more attainable for the household), it is also possible that there is a disincentive for the same reason: too high a discount makes some households less likely to increase their information about the product since they will not be as negatively impacted by purchasing a poor product as those households who have to pay the full cost. Ultimately, we do not find strong evidence of a possible incentive effect of an improved product on understanding from training.

Finally, we speculate that there are two reasons for the surprising positive effects of decreased basis risk and price that we found in Tables 3.8a and 3.8b, a similar incentive effect of seeking out information and learning-by-doing. It is important to note that these two reasons are not disproved by Tables 3.10 and 3.11. While we find no incentive effect to information in intensive training, there could very well be such an effect in basic training. However, as mentioned earlier, we have no means by which to test this. Since we find that basic and intensive training are very likely to have different impacts on knowledge and attitudes, we suspect that basic training might interact with the offer of lower basis risk and price of insurance.

Table 3.10: Specific regression results of impact of intensive training, basis risk, and their interaction

Distance from weather station is instrumented with weather station assignment.

VARIABLES	1 Insurance knowledge score	2 Comp. of insurance payouts	3 Comp. of insurance timing	4 Satisfaction with weather station	5 Trust in government insurance	6 Trust in private insurance
Intensive training	-0.283	-0.019	-0.017	-0.188	0.015	-0.192
	(0.224)	(0.032)	(0.060)	(0.128)	(0.066)	(0.155)
Distance from weather station	0.008	-0.005	-0.009	-0.031***	-0.000	-0.003
	(0.016)	(0.003)	(0.006)	(0.010)	(0.006)	(0.013)
Interaction	0.025	0.003	0.004	0.018	-0.000	0.020
	(0.028)	(0.004)	(0.008)	(0.015)	(0.008)	(0.018)
Constant	2.861***	1.009***	1.005***	0.407***	0.911***	0.271**
	(0.132)	(0.022)	(0.043)	(0.085)	(0.056)	(0.113)
Lag of dependent variable	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,130	2,183	2,183	2,111	2,127	2,126
R-squared			0.002	0.017	0.003	

Notes: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.11: Specific regression results of impact of intensive training, voucher, and their interaction

VARIABLES	1 Insurance knowledge score	2 Comp. of insurance payouts	3 Comp. of insurance timing	4 Satisfaction with weather station	5 Trust in government insurance	6 Trust in private insurance
Intensive training	-0.137*	-0.012	-0.016	-0.040	0.016	-0.017
	(0.069)	(0.010)	(0.013)	(0.038)	(0.023)	(0.049)
Ratio of total price covered by a discount	0.051	0.034	0.099***	0.029	0.013	-0.020
	(0.090)	(0.026)	(0.033)	(0.054)	(0.028)	(0.061)
Interaction	0.206	-0.029	-0.105**	-0.024	-0.008	-0.050
	(0.128)	(0.031)	(0.044)	(0.065)	(0.037)	(0.077)
Constant	2.919***	0.960***	0.913***	0.152***	0.906***	0.249***
	(0.062)	(0.016)	(0.023)	(0.031)	(0.023)	(0.036)
Lag of dependent variable						
Observations	2,130	2,183	2,183	2,111	2,127	2,126
R-squared	0.021	0.002	0.006	0.005	0.003	0.008

Notes: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6.2.2 The impact of insurance on production and welfare

A key motivation of this study is to understand the impact of the purchase of weather insurance on household economic decisions. Cole *et al*. (2011) provide a recent contribution to this question. They provide treatment households with free insurance and measure its impact on subsequent production decisions. They find evidence supporting this hypothesis, with households offered free insurance subsequently sowing more of their land with a cash crop—a riskier decision—and purchasing more inputs for these crops. Another, more recent, example is Karlan *et al*. (2013), who randomly distributed both cash and insurance grants to farmers in Ghana. They found a significant increase in agricultural investment (chemical inputs and sowed land) for farmers in the insurance grant group, although not for the cash grant group. They interpret these results as indicative of binding risk constraints, but non-binding liquidity or credit constraints. Like many other relevant studies, such as Lybbert *et al*. (2010), Gine *et al*. (2008) and Cole *et al*. (2011), we posit that insurance will help protect farmers against the increased risk of higher yield investments and thus make them more attractive to the risk averse.

While we are interested in understanding the changes to production decisions in the manner of Cole *et al*. (2011) or Karlan *et al*. (2013), we are also interested in assessing how other ex post coping mechanisms such as transfers, employment and credit respond to the adoption of an ex ante coping mechanism such as weather insurance. In particular, we would expect that for those households who purchase WII (weather index insurance) and receive a payout when negatively impacted by a weather shock to rely less on loans and informal transfers to cope with crop losses. However, we also consider it possible that due to basis risk households that purchased WII might not receive payouts when facing a negative weather shock and therefore are more likely to take out loans and rely on transfers and other sources of employment to cope with crop losses.

In Table 3.12, we present the results of our analysis of the impact of insurance on production decisions. We display these results in a similar fashion to those of Table 3.7. For each dependent variable in a row, we provide the key results of ANCOVA regressions on the ITT of insurance and the treatment effect of purchasing the product (ATE). The latter regression is instrumented with the exogenously-varied treatment assignments. We present a very complete set of variables, from size and proportion of land cultivated under cash crops (soya bean), fertilised, irrigated and early sowed, to the value and proportion of inputs in total expenditures. Given that we are conducting statistical testing over a large number of hypotheses (one per variable and method), we correct the p-values for sequential testing using a simple Bonferroni correction based on the number of variables considered within each family of variables.[12]

The low impact on production decisions such as fertilisers, cash crop cultivation and hybrid seed purchases do not support evidence by other authors, such as Cole *et al*. (2011).[13] However, before we consider these results, it is worth mentioning that Cole *et al*. (2011)

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[12] To conduct this correction, we divide the p-value for the treatment coefficient in each of the specifications by the total number of variables for which we are conducting tests in that table (25 for Table 3.12, six for Table 3.13, and 15 for Table 3.15).

[13] This is, however, not surprising, given the very low power of our tests following the low take-up rates, as discussed at the beginning of Section 6.1.

gave away insurance that covered, on an average, 1 hectare of land, while an insured household in our sample purchased, on an average, coverage for only half an acre (about a fourth of a hectare). Furthermore, the average cultivated land of the sample of Cole *et al*. (2011) was 5 acres, while it was a little over 8 acres in our sample. Therefore, the insurance purchased in our sample constitutes no more than a test-run for households, while the insurance given by Cole *et al*. (2011) to their sample covered a significant proportion of their agricultural production. Hence, while the mechanism of insurance is similar, one should not necessarily expect to have similar results.

Table 3.13a gives an indication of the impact of insurance offer and purchase on credit decisions. Our module on credit asked households whether they took a loan, how many loans they took and a few specifics about their largest loan such as size, interest rate and purpose. We find that the offer of insurance did not have a detectable impact over any of these credit measures.

However, we do find that the purchase of insurance resulted in the taking of more loans (as measured by the ATT specification). We do not have data on the exact timing, type or size of these loans, which makes it hard to draw conclusions about the exact mechanisms behind this effect. Regardless, the increase in the number of loans for households that purchased insurance is interesting. It is possible, for example, that households that purchased insurance took out very small loans to pay for it. If this were the case, we speculate that the number of loans should vary with the cost of insurance. In column 1 of Table 3.13b, we add a variable on the total amount of money spent on insurance by a household to the ATE regressions shown in Table 3.13a and report the regression results for only this additional variable. We do not find any significant effects. Another possibility is that, since very few households that purchased insurance received payouts (14 out of 151), some households may have needed to take out loans to deal with negative basis risk. To test for this, we add a dummy variable indicating whether a payout occurred to the ATE specifications in Table 3.13a and report only these additional results (in column 3 of Table 3.13b). We find no support for our hypothesis, although we should again note the power limitations discussed above.

In the districts of Bhopal, Ujjain and Dewas, the purchase of government insurance is tied to government loans for inputs. Therefore, it is possible that households taking government loans satisfy totally or partially their demand for insurance as government insurance comes with the loans.[14] Therefore, in Table 3.14 we present results on the impact of insurance offer (ITT) and purchase (ATE) on the demand for insured government loans and on the demand for stand-alone insurance. While the offer of insurance does not have a significant effect, households that do purchase insurance are less likely to take out government loans with insurance. One possibility is that households that purchase insurance are taking smaller loans for inputs, as opposed to one larger government-insured loan. In any case, this substitutability between government loans and the HDFC product is to be expected. However, since we ask households about how many government loans they took out in the past 12 months in January 2012, we cannot strongly conclude whether the substitutability happened during *kharif* 2011 or during the dry season of 2012.

[14] As shown in Table 1.1, the proportion of households with access to agricultural loans is more than 90 per cent, with presumably a large number of cases being subsided loans linked to government insurance.

In Table 3.15a, we consider the impact of insurance on household transfers and other sources of income such as wage labour. We label as guarantee scheme the national income scheme that provides cash for labour to impoverished households. Furthermore, we define transfers as either educational transfers, donations, gifts, inheritance and dowry from family members, village members, or local, state and federal entities. We find that households that were offered insurance received significantly more total transfers in October and November after the end of the harvest.

Looking at the size of the ATE coefficients of insurance purchase, which are also positive and of a relatively high magnitude (although not statistically significant), we wondered if this variable was just capturing HDFC payouts, which would be the case if payouts were reported by the households as part of transfers. However, out of the 14 households who received payouts, the reported transfers were not close in value to the HDFC payouts. An alternative explanation would be that households that received payouts were more willing to send gifts and donations to other households. A naïve test for such a hypothesis could be to see whether households in villages where payouts were made were more likely to receive transfers. In Table 3.15b, we test this by including a dummy equal to one if a household was in a village where payouts were made, and report the coefficient for this added variable. We find no statistically significant effect on any of the dependent variables in Table 3.15a.

In terms of other potential mechanisms at play, it could be possible that offering insurance, with its many training events that brought the village together to discuss overall coping mechanisms, made each household more aware of the risks of other households and, in turn, increased transfers to those in need in the aftermath of the rainy season. Alternatively, the offering of insurance may have given rise to other informal insurance arrangements between households. However, as we do not count with any evidence or statistical power to properly distinguish between any of these mechanisms, this discussion is only speculative.

Table 3.12: Impact of insurance on *kharif* production

Results of ANCOVA regressions of the effects of either the offer of insurance (column 1) or instrumented uptake of insurance (3) on a series of dependent variables (rows).

	ITT of insurance	N	ATE of insurance	N
Log of acres of soy land	0.003	3,228	-0.021	2,123
	(0.028)		(0.232)	
Acres soy land / acres cultivated land	0.000	3,228	-0.088	2,123
	(0.008)		(0.064)	
Log of acres soy and fert land	-0.010	3,095	0.474	2,029
	(0.037)		(0.309)	
Acres fert and soy land /acres soy land	-0.011	3,095	0.068	2,029
	(0.010)		(0.095)	
Log of acres soy and irrig land	-0.009	3,095	-0.297	2,029
	(0.041)		(0.430)	
Acres irrig and soy land / acres soy land	-0.013	3,095	-0.178	2,029
	(0.020)		(0.220)	
Log of acres soy and early sowed land	-0.067	3,095	-0.206	2,029
	(0.067)		(0.644)	
Acres early sowed and soy land / acres soy land	-0.023	3,095	-0.192	2,029
	(0.025)		(0.251)	
Log of value of soy sold in *kharif*	-0.068	3,134	-1.873	2,057
	(0.150)		(1.147)	
Log of fert expenditures on soy	-0.234	3,237	-0.942	2,130
	(0.115)		(0.979)	
Soy fertiliser expenditures / fert expenditures	-0.017	3,237	-0.082	2,130
	(0.011)		(0.096)	
Log of pesticide expenditures	-0.002	3,237	-0.011	2,130
	(0.006)		(0.054)	
Pesticide expenditures / total expenditures	-0.004	3,237	0.040	2,130
	(0.006)		(0.047)	
Log of hybrid expenditures	-0.017	3,235	-0.004	2,128
	(0.023)		(0.220)	
Hybrid expenditures / total expenditures	0.003	3,235	0.053	2,128
	(0.007)		(0.066)	
Log of non-hybrid expenditures	-0.004	3,236	-0.016	2,129
	(0.023)		(0.192)	
Non-hybrid expenditures / total expenditures	0.003	3,236	0.094	2,129
	(0.005)		(0.044)	
Log of labour cost	0.006	3,237	0.038	2,130
	(0.013)		(0.107)	
Labour cost / total expenditures	0.000	3,237	-0.012	2,130
	(0.008)		(0.056)	
Log of oxen expenditures	-0.016	3,234	-0.120	2,128
	(0.031)		(0.223)	
Oxen expenditures / total expenditures	-0.000	3,234	-0.000	2,128
	(0.001)		(0.005)	
Log of tractor expenditures	-0.004	3,237	0.043	2,130
	(0.012)		(0.113)	
Tractor expenditures / total expenditures	0.000	3,237	-0.065	2,130
	(0.005)		(0.041)	
Log of irrig. expenditures	-0.012	3,227	0.050	2,123
	(0.011)		(0.080)	
Irrig expenditures / total expenditures	-0.002	3,228	0.005	2,124
	(0.002)		(0.011)	

Notes: Robust standard errors in parentheses. p-values are corrected for sequential testing using a simple Bonferroni correction based on the number of variables considered in the table.
*** p<0.01, ** p<0.05, * p<0.1

Table 3.13a: Impact of insurance on credit

Results of ANCOVA regressions of the effects of either the offer of insurance (column 1) or instrumented uptake of insurance (3) on a series of dependent variables (rows).

	ITT of insurance	N	ATE of insurance	N
Dummy: took out a loan	-0.044	3,235	0.040	2,128
	(0.020)		(0.180)	
Number of loans	-0.088	3,216	2.332*	2,115
	(0.090)		(0.920)	
Log of biggest loan, if loan taken	-0.440	3,199	-0.229	2,103
	(0.222)		(2.014)	
Input loan taken 2	0.019	2,306	0.130	1,463
	(0.036)		(0.428)	
Log of input loan, biggest	0.157	788	-0.237	496
	(0.079)		(0.967)	
Interest of biggest loan	-0.878	2,217	23.390	1,400
	(1.096)		(15.001)	
Interest of agricultural input loan	-0.437	764	18.941	479
	(1.250)		(12.759)	

Notes: Robust standard errors in parentheses. p-values are corrected for sequential testing using a simple Bonferroni correction based on the number of variables considered in the table.
*** p<0.01, ** p<0.05, * p<0.1

Table 3.13b: Impact of insurance on credit

Results of ANCOVA regressions of the effects of the addition of log of units purchased and receiving a payout variables into the ATE regressions of Table 3.13a. Only the coefficient estimates for the added variable is shown. 'Payout was received' was instrumented by treatment assignment.

	From regression of ATE on insurance		From regression of ATE on insurance	
	Money spent on insurance	**N**	**Payout was received**	**N**
Dummy: took out a loan	-1.072	2,128	0.294	2,128
	(1.534)		(2.234)	
Number of loans	-8.026	2,115	0.179	2,115
	(8.195)		(11.561)	
Log of biggest loan, if loan taken	-6.839	2,103	9.666	2,103
	(17.338)		(24.237)	
Input loan taken 2	-0.501	1,463	-4.711	1,463
	(3.758)		(4.791)	
Log of input loan, biggest	13.472	496	1.904	496
	(10.664)		(10.459)	
Interest of biggest loan	-142.938	1,400	-56.005	1,400
	(168.607)		(97.325)	
Interest of agricultural input loan	-120.071	479	-197.862	479
	(136.726)		(296.478)	

Table 3.14: Full regression results from the impact of offer and purchase of weather index insurance on government insurance demand

	1	2	3	4
VARIABLES	Purchase of government insurance with credit	Without credit	With credit	Without credit
Insurance	-0.056	0.012		
	(0.039)	(0.009)		
Uptake			-0.516*	0.111
			(0.278)	(0.073)
Constant	0.646***	0.019***	0.632***	0.022***
	(0.032)	(0.006)	(0.023)	(0.005)
Observations	3,235	3,235	3,235	3,235
R-squared	0.003	0.001		0.006

Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 3.15a: Impact of insurance on transfers, employment and other sources of income

Results of ANCOVA regressions of the effects of either the offer of insurance (column 1) or instrumented uptake of insurance (3) on a series of dependent variables (rows).

	ITT of insurance	N	ATE of insurance	N
Log of other income: wages, business	-0.141	3,237	0.591	2,130
	(0.273)		(2.559)	
Number of months employed	-0.308	3,237	0.444	2,130
	(0.306)		(2.884)	
Log of total value of transfers	-0.012	3,237	5.499	2,130
	(0.487)		(4.140)	
Number of months transfers received	0.215	3,237	1.398	2,130
	(0.155)		(1.460)	
Log of guarantee income	0.098	3,237	-1.161	2,130
	(0.146)		(1.393)	
Number of months guarantee income received	0.006	3,237	-0.193	2,130
	(0.033)		(0.288)	
Employment August and September	-0.009	3,237	0.109	2,130
	(0.008)		(0.064)	
Employment October and November	-0.008	3,237	-0.004	2,130
	(0.009)		(0.068)	
Log of value transfer, August and September	0.092	3,237	0.436	2,130
	(0.166)		(1.148)	
Log of donations and gifts, August and September	-0.008	3,237	-0.218	2,130
	(0.045)		(0.327)	
Log of educational transfers, August and September	-0.005	3,237	1.139	2,130
	(0.157)		(0.959)	
Log of value transfer, October and November	0.258*	3,237	1.248	2,130
	(0.091)		(1.058)	
Log of donations and gifts, October and November	0.125	3,237	0.952	2,130
	(0.046)		(0.705)	
Log of educational transfers, October and November	0.041	3,237	0.805	2,129
	(0.059)		(0.568)	
Dummy guarantee scheme in August and September	-0.005	3,237	0.019	2,130
	(0.003)		(0.024)	
Dummy guarantee scheme in October and November	-0.001	3,237	0.016	2,130
	(0.003)		(0.033)	

Notes: Robust standard errors in parentheses. p-values are corrected for sequential testing using a simple Bonferroni correction based on the number of variables considered in the table.
*** p<0.01, ** p<0.05, * p<0.1

Table 3.15b: Impact of insurance on transfers, employment and other sources of income

Results of ANCOVA regression of the effects of the addition of a dummy variable capturing whether a payout was made in the village of a household into the ATE regressions of Table 3.15a. Only the coefficient estimate for the added variable is shown. 'Dummy, payouts made in the village' is instrumented by the treatment assignment.

	From regression of ATE on insurance	
	Dummy, payouts made in the village	**N**
Log of other income: wages, business	-3.812	2,130
	(5.040)	
Number of months employed	-3.948	2,130
	(5.066)	
Log of total value of transfers	3.343	2,130
	(6.751)	
Number of months transfers received	-2.785	2,130
	(3.044)	
Log of guarantee income	-0.138	2,130
	(1.954)	
Number of months guarantee income received	-0.048	2,130
	(0.398)	
Employment August and September	-0.187	2,130
	(0.206)	
Employment October and November	-0.084	2,130
	(0.148)	
Log of value transfer, August and September	-3.866	2,130
	(4.127)	
Log of donations and gifts, August and September	0.643	2,130
	(0.821)	
Log of educational transfers, August and September	-2.638	2,130
	(2.806)	
Log of value transfer, October and November	-4.553	2,130
	(4.381)	
Log of donations and gifts, October and November	-1.097	2,130
	(1.412)	
Log of educational transfers, October and November	-1.333	2,129
	(1.464)	
Dummy guarantee scheme in August and September	-0.026	2,130
	(0.042)	
Dummy guarantee scheme in October and November	-0.008	2,130
	(0.031)	

6.3 The longer run impact of offering insurance on demand

We now turn to the effect of the marketing interventions on take-up in 2012, the second season of sales for the index insurance product. As described above, in 2012 we again offered price discounts, randomised at the village level (to sampled and non-sampled households), but left the other treatments unchanged: no new weather stations were installed and no additional training sessions were conducted.

Table 3.16 presents ITT regression specifications for the second season of index insurance sales. The price of the insurance policy is again strongly significant in predicting demand. The distance to the weather station is also strongly associated with purchases in the subsample of villages served by new stations, though only weakly associated with demand in the full sample, arguably due to a lack of power from low take-up. Interestingly, the effect of training seems to fade over time: although receiving intensive training significantly increased demand in the season immediately following training, it had no significant effect on demand in 2012. This confirms the finding in the previous section that insurance literacy training did not seem to have a lasting effect on knowledge about the insurance product during the midline survey.

In Table 3.17, we include the discount received in 2011 as an additional control, but find no effect on demand. This is surprising given the results in previous sections, which suggested that households that had received a subsidy had a much better understanding of the insurance product. Also, this result does not seem to support the existence of a discouragement (encouragement) effect of having received a higher (lower) discount in the past season. In sum, the results suggest that insurance literacy training and subsidies have an immediate, but not a sustained, effect on demand.

In Table 3.18, we test the relationship between an individual's experience with weather insurance in 2011 and demand in 2012. We find that prior experience of insurance is a strong predictor of demand. While purchasing insurance in 2011 has a small but significant impact on the demand in 2012 on its own, purchasing insurance in 2011 and receiving a payout is strongly positively correlated with the decision to purchase insurance in the subsequent season. However, there seems to be no impact on demand of observing other households in the village receiving a payout.[15],[16]

[15] These results are unreported and are available on request.

[16] This pattern closely resembles that found by Stein (2011), and is in contrast to the work of Cole, Stein and Tobacman (2014) who find that experiencing a payout in the village is the only relevant predictor of future demand, regardless of individually receiving a payout, and that of Karlan *et al*. (2012), who find individual as well as social network spillover effects.

Table 3.16: Take-up among sampled households, *kharif* 2012

	(1)	(2)	(3)
	IV	OLS	IV
Log (price)	-0.028*	-0.055**	-0.093***
	(0.015)	(0.021)	(0.042)
Log (distance to weather station)	-0.002	-0.020**	-0.181
	(0.015)	(0.007)	(0.137)
Intensive training	0.003	0.023	
	(0.012)	(0.017)	
Log (distance) * log (price)			0.038
			(0.028)
Sample	Full	Only new station	Full
Observations	2,183	848	2,183

Table 3.17: Take-up among households, *kharif* 2012, including price in *kharif* 2011

	Take-up	Take-up
	IV	IV
Log (price, 2012)	-0.028*	-0.094**
	(0.015)	(0.042)
Log (price, 2011)	0.002	-0.002
	(0.010)	(0.010)
Intensive	0.003	
	(0.012)	
Log (distance)	-0.002	-0.184
	(0.015)	(0.138)
Log (distance) * log (price, 2012)		0.039
		(0.028)
Observations	2,183	2,183

Table 3.18: Take-up among sampled households, *kharif* 2012, including uptake and payouts in *kharif* 2011

	Take-up IV	Take-up IV	Take-up IV	Take-up IV
Log (price)	-0.026*	-0.082*	-0.026*	-0.075
	(0.015)	(0.045)	(0.015)	(0.048)
Bought insurance in 2011	0.053**	0.049*	0.022	0.019
	(0.025)	(0.024)	(0.019)	(0.018)
Had a payout in 2011			0.287***	0.284***
			(0.071)	(0.071)
Intensive	0.000		0.004	
	(0.012)		(0.012)	
Log (distance)	0.001	-0.152	-0.002	-0.137
	(0.015)	(0.142)	(0.015)	(0.148)
Log (distance) * log (price)		0.032		0.029
		(0.028)		(0.030)
Observations	2,183	2,183	2,183	2,183

6.4 Endline qualitative assessment

This section elaborates on the findings of the qualitative assessment to determine the various causes that have resulted in the low take-up of our simplified weather index insurance, and also the influence of the product on the production and consumption behaviours of smallholder farmers.

6.4.1 Determinants of weather index insurance take-up

The overall take-up rates recorded were 6.9 per cent and 4.03 per cent of sample households during *kharif* 2011 and 2012, respectively. Several factors come into play when trying to understand the determinants of weather index insurance take-up. Table 3.19 highlights the reasons for low take-up of the product, and the subsequent write-up elaborates the various determinants for WII take-up in a lucid manner, as observed in the qualitative assessment.

Table 3.19: Reason for non-purchase of insurance

Reason	Response in Percentage
No one came for marketing / Did not hear about the product	67
Did not get a payout in 2011, hence did not buy in 2012 (farmers are preferring some return for the investment in purchasing an insurance, even if there are no weather-related crop losses)	10
Do not trust the product /insurer	10
Cannot afford	2
Do not want to experiment with a new practice. Never had an insurance before for crops	2
When the marketing people came, I had no money, but I promised them that I will purchase and asked them to come again in few days' time. They did not turn up the second time	2
Payout received in 2011 is not sufficient, and hence did not buy in 2012	2
Do not understand about insurance	2
Refused to respond	4

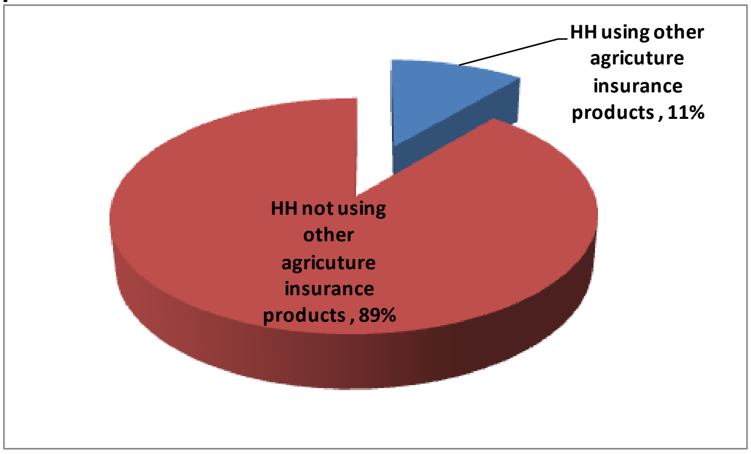
Insurance marketing

The major reason for the poor take-up of this product might be a result of the low level of product awareness among the target households due to a lack of marketing effort. Sixty-seven per cent of the respondents have stated this during the in-depth interviews. But in reality, as a part of marketing activities, van campaigns, pamphlet distribution, advertisements through wall paintings and posting bulk SMS text messages were carried out, apart from the door to door sales process. We took special interest in incentivising the sales agents to visit all treatment households to sell the product.

It was found during the FGDs and in-depth interviews with farmers that most of them had not heard about the product and also said that no one visited their house for marketing. Considering this, we understand that a single visit taken up for door to door sales during each cover period is not sufficient to reach out to the farmers. We also found that some of the sales agents said that they were not able to reach all the heads of the households in a village in just a single visit. Moreover, during our qualitative survey, there were a few farmers who said that they had requested the sales agents to come back later, as they did not have the money on the day of the house visit to pay the sales agents and purchase the product. Hence, it can be understood that for better sales to take place, the agents have to make repeated house visits. Considering the cost-benefit ratio from a business perspective, no insurance company in India has the required manpower or resources to reach out to all farmers in every village repeatedly to sell the WII products. Therefore, it is important for insurance companies to explore alternative delivery channels for marketing these products.

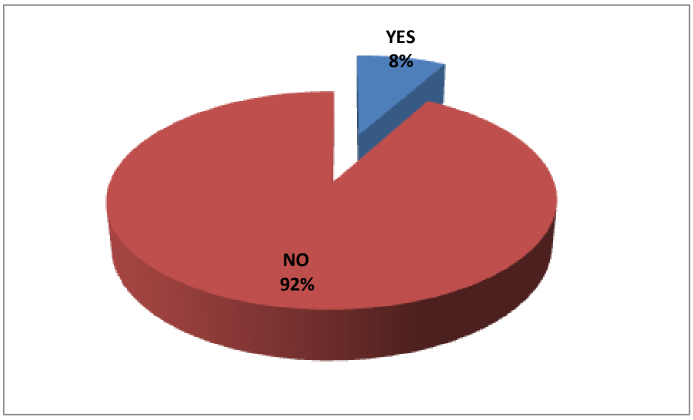
Familiarity with Insurance

Figure 11: Households using other agriculture insurance products



Weather index insurance or the crop insurance market has not been well-developed among the farmers in our selected districts. The habit of insuring crops as a risk management measure has not been a regular practice in agrarian livelihoods. This is clearly evident from Figure 11, which indicates that 85 per cent of the surveyed sampled households are not using any agriculture insurance product at all. Even the insured 11 per cent of households have not bought crop insurance purposefully as a risk management tool; rather, they are just a bundled product along with their crop loans.

Figure 12: Awareness level of household about WBCIS



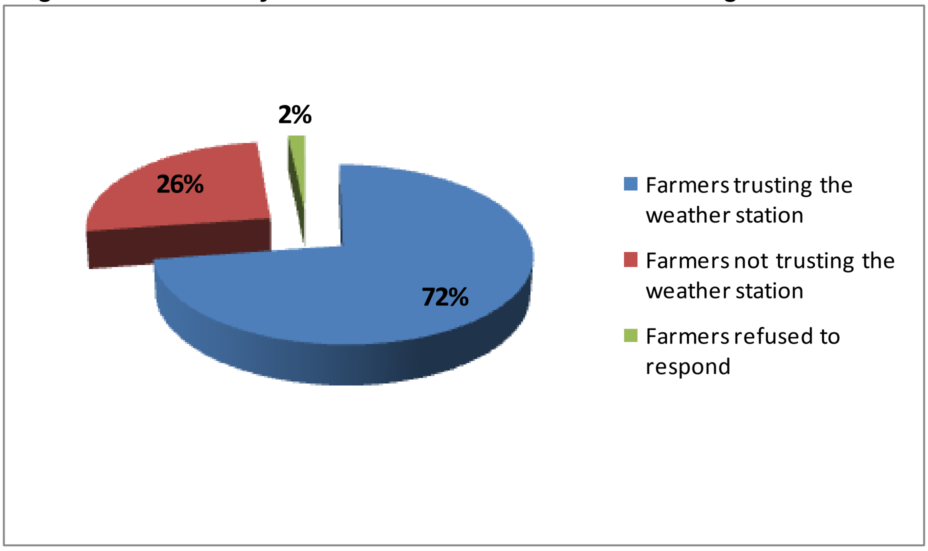
On the other hand, the awareness about the traditional weather index insurance product was also very low (Figure 12), with only 8 per cent of surveyed households knowing about the much heralded government's Weather Based Crop Insurance Scheme (WBCIS).

In this scenario, one can clearly conclude that the insurance literacy rates among farming households are very minimal. Although some farmers are aware of the insurance (Table 3.19) mechanism, they look for some kind of return for every purchase of insurance. This mindset prevents the farmers from taking insurance if they do not get a payout. Apart from this, 94 per cent of the surveyed households admitted that insurance literacy training is needed for farmers to understand weather index products and their features. Seventy-four per cent of the households insisted that insurance literacy training should happen periodically, once or twice per season, so as to enable farmers to understand insurance as well as the product features. Hence, for the development of the weather insurance market in India, one of the foremost criteria to be addressed is insurance literacy.

Weather station

For the development of the WII market, the presence of weather stations at proper distances is needed. Although all our treatment villages were in a 15–20 kilometre radius from the weather stations, the farmers do not seem to have faith in the recordings of weather stations. It was observed from the qualitative survey (Figure 13) that 26 per cent of farmers do not trust the weather station recordings. This could also have been a factor in the low take-up of our product.

Figure 13: Reliability levels of weather station for farming households



For the development of the WII market, 97 per cent of surveyed sample households prefer to have a greater number of weather stations, and 87 per cent of farmers prefer to have a weather station in every village (Table 3.20). Moreover, 77 per cent of households mentioned that access to the recordings of weather stations through SMS, regardless of the purchase of insurance, will build trust in the weather stations among farmers.

Table 3.20: Factors influencing the take-up of WII with reference to weather station

Factors influencing the take-up with reference to weather station	Response in Percentage
Greater number of weather stations are needed	97
A weather station in every village is needed	87
Access to the recordings of weather stations through SMS (regardless to the purchase of insurance)	77

Product design

The farmer's opinion about the product design is presented in Table 3.21. It was found that nearly 81 per cent of respondents who have purchased the WII product stated that the product is simple and easily understandable. But the critical point to be considered is the basis risk; nearly 53 per cent of the respondents who have bought the product expressed their displeasure in saying that they suffered losses due to the weather and did not receive a payout. This is something we have to critically review: was this due to the distance from the weather station, or due to the lack of correlation between crop growth/yield parameters and rainfall level. Most farmers do not bother with WII if there is no proper correlation between crop and weather in the product design.

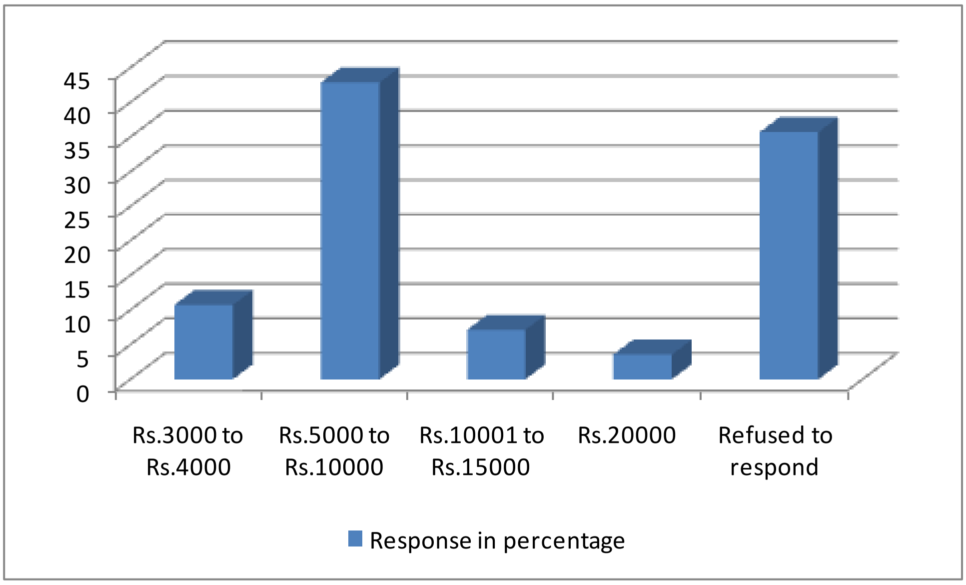
Table 3.21: Farmers' opinion about the WII product design

Farmers' opinion about the product	Response in Percentage
Easily understandable product / simple product	81
Useful product	69
Covered all the expected weather risks	65
Experienced basis risk (suffered loss due to weather, but did not get a payout)	53

On the other hand, through our FGDs we found that the farmers are expecting more risks to be covered by a simple WII product like this one. This is also evident from Table 3.21, where only 65 per cent of the respondents reported that the product covered all the expected weather risks. This was mainly because of the lack of understanding about the weather index insurance product.

Similarly, most farmers expressed the view that the payout level was very minimal, which deterred many farmers from purchasing the insurance. Figure 14 projects the farmer's view about the payout level.

Figure 14: Farmers' expectations for the product's payout

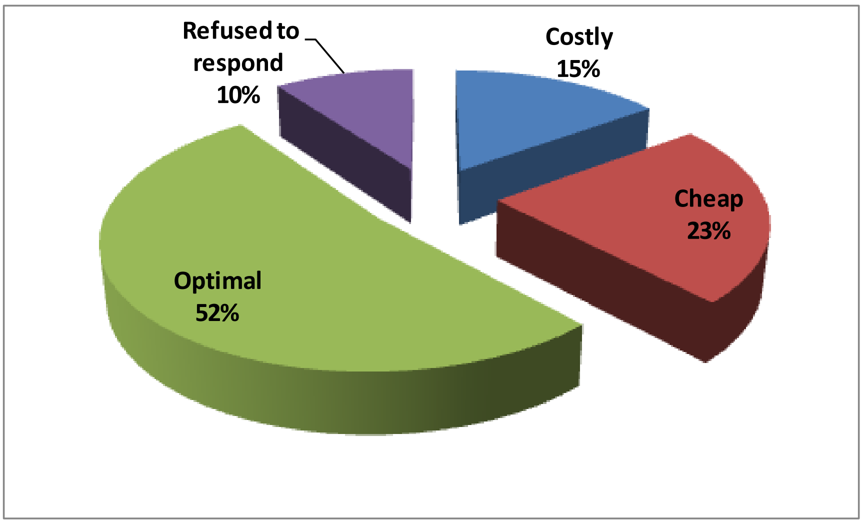


Only 11 per cent of the respondents opted for a realistic actual payout for one insurance product of ₹3,000 to 4,000. A product of minimal cost (premium of ₹200 to 300) with huge returns (payouts of ₹10,000 to ₹20,000) would definitely enhance take-up, but is of course commercially unviable without large amounts of subsidies. These results perhaps point to a failure in the training provided to farmers. As explained above, one of the key characteristics in the design of the specific insurance products offered is to target heterogeneous farmers by serving as a sort of building block towards a portfolio of insurance policies. Thus, farmers expecting higher payouts, given unfavourable weather events, would have the possibility of purchasing a greater number of insurance policies to cover any desired amount (within certain limits imposed by the insurance company). Farmers expecting a payout for their total operational costs by purchasing only one insurance policy are then showing a lack of comprehensive understanding of the characteristics of the insurance product being offered to them. Moreover, farmers should understand with reference to WII that crop production depends not only upon rainfall, but also upon multiple factors like good agronomic practices, other weather factors like temperature and humidity, and pests and diseases. Hence, we infer that this issue with respect to low payout is once again due to a lack of insurance literacy among the farmers.

Product cost

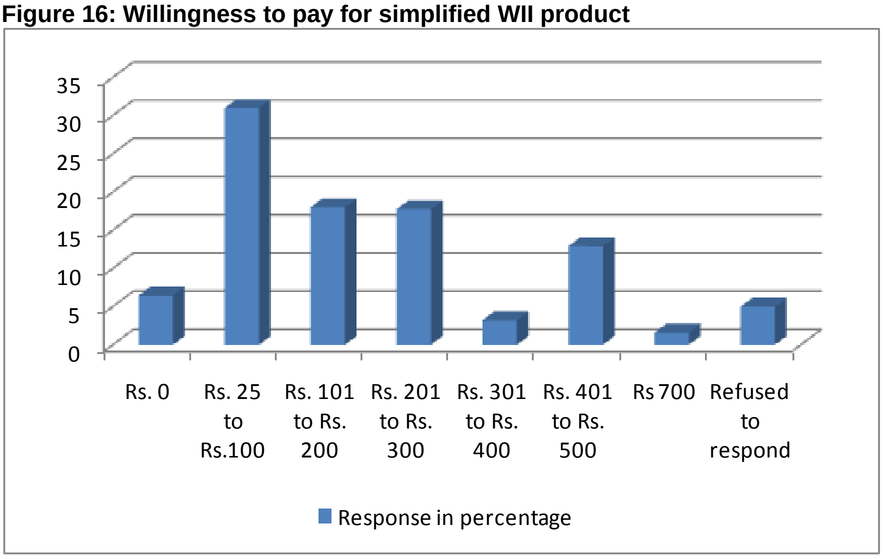
The farmer's opinion about the cost of the product is presented in Figure 15. It was found that nearly 52 per cent of the respondents find the premium level to be optimum, and only 15 per cent of farmers find this costly.

Figure 15: Farmers' opinion about the cost of the product



Interestingly, when asked about the discounts that farmers prefer for this product, 81 per cent of the respondents stated that they do not need any further discounts. This implies that for such products, a premium of ₹200 to ₹350 is easily affordable for smallholder farmers. Figure 16 indicates the willingness of farmers to pay for this product. There is only a minimum of 6 per cent respondents who have said they cannot pay for this product.

Figure 16: Willingness to pay for simplified WII product



Trust in the insurer

The level of farmers' trust in the insurance company (HDFC ERGO) is presented in Table 3.22. It was found that 40 per cent of farmers who bought the WII and 30 per cent of farmers who did not have trust in the insurance company. Another interesting observation that one could infer from this is that, although trust influences take-up, trust alone is not a major deciding factor in insurance take-up. It is clearly evident that 70 per cent of the respondents in the no purchase group trusted the insurer, and 40 per cent of the respondents in the purchase group did not trust the insurer. Moreover, one should also consider that private insurance companies have started operating in India only recently, and they are just over 10 years old. Hence, it may take people some time to understand the credibility of private insurers. If private insurers can gain the confidence of people in the case of motor insurance or health insurance, then they can also fare well with farmers/WII insurance.

Table 3.22: Farmers' trust in the insurer

	Farmers who bought WII	Farmers who did not buy WII
Trust the insurer	60%	70%
Do not trust the insurer	40%	30%

On the other hand, the reasons for not trusting the insurer are presented in Table 3.23. One of the important reasons that require attention is that the insurer should have a good permanent local presence in the area where the product is sold. At the moment, the product is being sold by contractual agents who seldom visit the field after marketing. This was stated by 29 per cent of the farmers who have bought the product, and 75 per cent of farmers who have not bought the product. The insurers can overcome this by joining with partners such as companies involved in contract farming or agricultural input supply, or with community-based organisations in order to take advantage of their existing links with farmers to market WII effectively.

Table 3.23: Reasons for not trusting the insurer

Reason for not trusting the insurer	Farmers who bought WII	Farmers who did not buy WII
Did not get the payout	62%	0%
The insurance company people visit us only once for marketing, and after that they vanish. Insurance company doesn't have a local office, permanent staff or contact address to share our grievances or ask our doubts	29%	75%
HDFC ERGO is a new and private company (will trust only government insurance company)	10%	25%

Peer experience

It was found during the qualitative assessment that almost all the take-ups have happened because of peer influence among the farmers in the village. Most of the take-ups have been among relatives, friends and people of the same caste. If one farmer has a good understanding of the product, his presence influences others in the neighbourhood to adopt the new product. However, the insurance literacy levels of these farmers taking up the insurance product because of peer influence continues to be very low.

6.4.2 Influence of WII on the production and consumption behaviour of farmers

The impact of WII on production behaviours of farmers is presented in Table 3.24. It was found that the impact of purchasing the WII product in 2011 or 2012, or both, was quite low. Thirty-two per cent of the sampled surveyed farmers who have purchased WII said that WII influenced them to purchase a higher quality or hybrid seeds, 11 per cent said that they cultivated a larger area, 23 per cent said that they cultivated new or high-value crops, 17 per cent said they saw some improvement in their yield or income through the adoption of improved cultivation practices, and 3 per cent said that WII influenced them in getting additional loans.

Table 3.24: Impact of WII on production behaviours of farmers

Impact of WII	Response of farmers who bought WII
Used hybrid seeds or high-yielding varieties because of WII	32%
Increased the area of cultivation because of WII	11%
Cultivated new crops or high-value crops because of WII	23%
Adopted improved cultivation practices because of WII	17%
Got additional loan because of WII	3%

On the other hand, although the responses were favourable in assessing the impact of the product, it remains inconclusive on further qualitative probing. It seems that most of these farmers had already planned to try using hybrid seeds or new crops or improved cultivation practices, or to increase the area of cultivation. Since they had been planning this for a long time and the introduction of our WII product occurred recently and in an unexpected manner, there always remains the possibility that these farmers would have tried these production practices even without WII. Moreover, we believe that a clear impact could be assessed only when this risk management practice (of WII) becomes a regular part of the livelihood practices of these farmers over a period of time. There were also some positive indicators, e.g. a farmer who had taken WII said that they have intentionally bought the product just to add strength to their being able getting a cattle loan to buy a buffalo.

The influences of WII payout on production and consumption behaviours are presented in Table 3.25. It was found that 28 per cent of farmers who have received the payout have mitigated the risk in crop production and managed a normal level of consumption. Although these figures support the impact, on the other hand a larger proportion—72 per cent—of farmers who have also received the payout mentioned that since the payout took place two to three months later, they had to mitigate the risk through their savings or by local lending.

Table 3.25: Influence of WII payout on production and consumption behaviours

Impact of WII payout	Response of farmers who received payout
Risk mitigated in crop production in time with the help of payout	28%
Managed normal level of consumption because of payout	28%

Nevertheless, it has to be understood that during both the years of our piloting (*kharif* 2011 and 2012), farmers experienced only moderate weather risk in their crop production. From a research perspective, we feel that the impact of the WII product could have been measured better had farmers experienced an extreme weather shock.

Benefits of Insurance would be realised better only in the situation of extreme events:

In a normal year, Fool Singh Lodi used to harvest a yield of around 5 quintals of soya bean per acre. The average cost of cultivation for him would be around ₹5,000 per acre, and he would approximately receive an income of around ₹10,000 to ₹12,000 per acre by selling his produce at the end of a normal season. Fool Singh's crop suffered a moderate shock during *kharif* 2011 and *khari*f 2012 due to excessive rainfall, resulting in a yield of around 4 quintals per acre with an income of ₹8,000 to 9,000 per acre. He received a payout of ₹1,000 per acre during both seasons and managed to compensate his moderate yield loss to some extent through weather index insurance. According to Fool Singh, the weather shock experienced by his crop was moderated during *kharif* 2011 and 2012. He feels that he could have lost his entire crop if the rainfall had been extreme, and shared that the insured farmer would experience the full benefit of WII only during such extreme situations where he would receive a maximum payout of ₹4,000 per acre to be saved from total loss.

Fool Singh Lodi's uninsured neighbouring farmers also experienced a reduction in yield during *kharif* 2011 and 2012 due to excessive rainfall during the vegetative phase of the crop. Since the reduction in the yield of the crop did not bring a negative cash flow, they were not able to appreciate the benefit of weather index insurance to its full extent.

Moreover, crop yield is determined by complex factors like the adoption of good agronomic practices, incidence of pests and diseases, and other environmental factors like light, temperature, humidity and rainfall. We cannot authentically justify that the moderated variation in yield was a result of a moderate variation in rainfall alone. Hence, the full benefit of a WII can be appreciated only in the case of severe yield loss scenarios due to the occurrence of any extreme event.

7. Triangulation of the results

In this section, we triangulate the results of the product take-up analysis, midline analysis and the endline qualitative assessment on the impacts of the three types of interventions, namely price discounts, insurance literacy training and weather station on the demand for WII. Apart from this, it also triangulates the study results on the impact of the simplified weather index on the smallholder farmer's welfare by affecting their production and consumption behaviours.

7.1 Price discounts

It was found from the take-up analysis that higher price discounts have led to an increase in the take-up of WII. This is in accordance with the findings of Craig *et al*. (2013). Cole *et al*. (2013) also reported a fall in the demand for WII as price increases. Furthermore, the results of the midline analysis revealed that the provision of price discounts increases insurance literacy as well, which we attribute to either an incentive effect of paying more attention to training as the offered insurance products were now more appealing, or a learning-by-doing effect of being more likely to purchase insurance once discounts were distributed. While we hypothesised that a higher discount might provide a higher incentive to understand the product since it is more attainable for the households; it is also possible that there is a disincentive for the same reason. A higher discount sometimes makes households less likely to increase their information about the product since they will not be as negatively impacted by purchasing a poor product as those households that have to pay the full cost. Our midline analysis did not find any definitive evidence to support either of these claims. On the other hand, our qualitative endline assessment showed that a premium of ₹200 to ₹350 is easily affordable for smallholder farmers and there is no need for any further discount in the product price.

7.2 Insurance literacy training

Insurance literacy training was provided before the first season (*kharif* 2011), but was not repeated during the second season (*kharif* 2012). There were two levels of insurance literacy training, with 50 per cent of the sampled households given a basic level of insurance literacy, and the other 50 per cent given intensive training. It was found that the intensive literacy training had influenced three times the take-up when compared to the basic level of training during *kharif* 2011. But during *kharif* 2012, there does not seem to be any clear influence of the levels of insurance literacy provided in 2011 on the take-up of the product. This seems to imply that the impact of the differential level of insurance literacy training provided in 2011 did not carry through to *kharif* 2012.

On the other hand, our midline analysis revealed that the intensive training had no effect on the comprehension of the insurance product, or on the other attitude-related questions that households were asked. This suggests that, to the extent that intensive training had an impact on demand, it did not come about as a result of a sustained increase in insurance literacy. It could be that households had forgotten what they had learned by the time of the survey (about six months later), or it could be that the additional training served more of a marketing purpose than providing additional knowledge about the insurance itself. This is confirmed by our qualitative endline assessment as well, where we observed that insurance literacy among farming households was very minimal. We found from our qualitative assessment that periodic insurance literacy training needs to be imparted to all farming households on a regular basis, so as to enable them to understand the insurance and WII product features. Hence, for the development of a weather insurance market in India, one of the foremost criteria to be addressed is insurance literacy.

7.3 Weather station

From the take-up analysis, it was found that more than two thirds of the contracts purchased during both cropping seasons were by households located at a distance of less than 10 kilometres from the weather station, while the take-up rates fell considerably beyond this distance from the weather station. This indicates the significant impact of the spatial basis risk on index insurance take-up. Mobarak and Rosenzweig (2012) also find that the demand for a WII product decreases with increase in distance to the weather station. We found further evidence from our midline analysis that the households located closer to the newer weather stations were significantly more satisfied with the weather station operations. Furthermore, households located away from the weather stations had significantly lower comprehension of insurance payouts and timing, and less trust in the insurance/insurer.

On the other hand, from our qualitative endline assessment we found that for the development of a WII market, a weather station is needed in every village. It was also found that access to the recordings of weather stations through SMS, regardless of the purchase of insurance, will build trust in the weather stations among farmers.

7.4 Impact of the simplified WII on production and consumption behaviours

Our midline analysis during *kharif* 2011 showed that the offer of insurance (ITT) decreased fertiliser expenditures in soya bean crop cultivation. Furthermore, the purchase of insurance (ATE) resulted in a higher share of non-hybrid seeds to total input costs. The other production impacts of WII observed during *kharif* 2011 are:

- The offer of WII decreased the likelihood of farming households taking a loan; however, when an agricultural loan was taken, it was significantly larger.
- There was a positive impact in the number of smaller loans for households that purchased insurance. However, we do not have a fully consistent explanation of our ITT result, which shows a negative impact on the purchase of fertiliser and farmers taking larger loans.
- Households that purchased our WII were much less likely to take out government loans with insurance, suggesting a substitution effect.
- Households that were offered insurance received significantly more total transfers, specifically in the form of gifts and donations in September and October and after the end of the harvest, although it is not clear to us what might explain this.

Similarly, our qualitative endline study also gave us results like WII positively influencing farmers to use hybrid seeds or high-yielding varieties, to cultivate an increased area, to cultivate new crops, to adopt improved cultivation practices and to get additional loans. Although these results were in line with the findings of other relevant studies such as Lybbert *et al*. (2010) and Cole *et al*. (2011), we found that our results were very inconclusive.

Through further qualitative probing, we found that most of the farmers who have tried newer or improved practices had already planned to implement them even before they came to know about our WII. Since they had been planning this for a long time, and the introduction of our WII product took place in an unexpected manner through our project, there remains some doubt as to whether these farmers would have tried these production practices even without our WII. Moreover, we believe that a very clear impact of WII could be assessed only if this risk management practice of using WII becomes a regular part of the livelihood practices of these farmers over a period of time.

On the other hand, that WII payouts influence the production and consumption behaviours of farmers remains a bit inconclusive through our qualitative study. It was found that that since the payout was done two to three months after the occurrence of risk, in a real time situation the farmers had to mitigate their risk through their savings or by local lending. Nevertheless, it has to be understood that during both years of our piloting (*kharif* 2011 and 2012), farmers experienced only moderate weather shocks in their crop production. From a research perspective, we feel that the impact of the WII product could have been measured more accurately had farmers experienced extreme weather shocks.

8. Conclusions and policy implications

8.1 Conclusion

This report presents our impact evaluation study to assess the potential of our simplified WII in satisfying the insurance demands of smallholder farmers in India. The study was carried out for two cropping seasons with the original intention to evaluate the impact of our WII product on the production and consumption behaviours of smallholder farmers cultivating rainfed soya bean crop. Unfortunately, due to the low levels of take-up faced, we were not able to carry out this intended analysis. Nevertheless, we were able to investigate the barriers to the take-up of WII together with the responsiveness of WII demand to a set of interventions, namely price discounts, proximity of weather stations (a proxy for basis risk) and the intensity of training on insurance literacy. We find the following empirical evidence, with different levels of statistical significance.

The main findings from our empirical work are:

- After controlling for a large set of socio-economic covariates, the proportion of households purchasing insurance in Bhopal district was higher than that in Dewas or Ujjain districts. We have anecdotal information stating that it was precisely in Bhopal that the insurance company was able to implement a better and on-time marketing campaign, and therefore we speculate that this is a potential explanation. In this project, we had little control over marketing activities as it was carried out by the insurance company and as a learning experience we recommend: (i) incorporate in the design of similar projects some degree of control over such activities, and (ii) collect specific information to measure marketing activities when surveying households.

- We find that take-up is sensitive to price variations which were randomly introduced. We estimate a price elasticity of 0.58, which is not substantially different from the price elasticity estimated by others in other states in India.

- As expected, distance to a weather station is a relevant factor in explaining the demand for WII. As one can expect, the location of existing weather stations is not random, and is probably correlated with where certain types of farms are located. In this project, we installed new weather stations to properly estimate the impact of distance on WII take-up. Our estimates indicate that distance significantly reduces uptake, and that each kilometre from the weather station reduces take-up by 1 percentage point.

- We found that households that were offered intensive training on insurance literacy had significantly higher insurance uptake than those that were given basic training. Take-up among those offered intensive training was about 5 per cent higher than among those that were offered basic training only.

- All random treatments (price variation, distance to weather station, training) appeared to have the expected effect on take-up, although the effect on the amount of insurance purchased (or number of acres insured) is much weaker in each case. Our results are robust to including household-level covariates.

- We studied the impact of a set of household characteristics on WII take-up and found that only a few of them showed at least some evidence of such impact. We see that loss-averse households are more likely (at a 5 per cent significance level) to purchase HDFC's product and insure more of their land. Weakly significant results seem to point towards households having previously purchased weather insurance (before project implementation) also being more likely to buy insurance and insuring more of their land, and households previously able to access loans to cope with the last drought being less likely to purchase insurance, indicating perhaps that credit and insurance are seen as substitutes.

- A simple computation (using our 2011 estimates) of a measure of cost-benefit analysis of our three exogenous interventions shows that: (i) Increasing take-up rates by 10 percentage points by insurance literacy training (which has a short-term lasting effect) would cost $20.80 per person; (ii) Increasing take-up rates by 10 percentage points by reducing the distance to a weather station (and installing new stations) would cost $13.34 per person; and (iii) that to increase take-up rates by 10 percentage points by providing discounts, $2.30 per policy is needed. Therefore, providing discounts seems to be the most cost-effective treatment to increase index insurance take-up.

- We studied the impact of offering and purchasing insurance on the basis of trust in the insurance company and on knowledge about the product. The offer of insurance has a significant effect on knowledge and trust, while the purchase of insurance increased the comprehension of only certain aspects of our knowledge indicator. To understand better the mechanisms of these effects, we analysed the impact of each treatment arm on trust and knowledge. Our results show that reducing the distance to a weather station has a positive impact on the comprehension of insurance payouts and timing, greater satisfaction with the weather station and greater trust in the private insurer. Also, a higher price discount has a positive impact on our overall insurance knowledge score. We find some evidence to support two mechanisms for this result: (i) the provision of a voucher created greater incentives to pay more attention during the training session; and (ii) people who received vouchers were more likely to purchase insurance and therefore were able to learn about insurance through this process (learning-by-doing). On the contrary, intensive training has no significant impact on our knowledge score, satisfaction with the weather station or trust in the private insurer.

- When we analyse the impact of offering insurance and purchasing insurance on farmers' production decisions (among them size and proportion of land cultivated under cash crops, fertilised, irrigated and early sowed, and value and proportion of inputs in total expenditures), we do not find conclusive evidence of such an impact, and a non-significant impact on decisions such as the application of fertilisers, cash crop cultivation and hybrid seed purchases do not support the evidence of other studies. We claim that this lack of empirical evidence is in part explained by the low take-up and therefore the low statistical power of our estimators. Likewise, we find no detectable impact on the likelihood of taking a loan and the size of the largest loan across all loans.

- While analysing the impact on loans, we find that the offer of insurance does not have a detectable impact on any of the following credit measures: taking a loan, the number of loans, and some specifics about the largest loan such as size, interest rate and purpose. However, we do find that the purchase of insurance resulted in the taking of more loans, although we cannot provide evidence on why this happens. In the particular case of government loans (which are linked to government insurance), we find some evidence that households that purchase insurance are less likely to take out government loans with government insurance. This indicates a certain degree of substitutability between government loans and the HDFC product, as expected.

- We also consider the impact of insurance on household transfers and other sources of income such as wage labour. We find that only households that were offered insurance received a significantly greater number of total transfers, specifically in the form of gifts and donations in September, October and November, and after the end of the harvest. We also tested whether households in villages where payouts were made were more likely to receive transfers, but did not find anything to support this hypothesis.

- When we looked at the second season of index insurance sales, we confirmed that price variations and distance to the weather station were also strongly associated with purchases (especially in the subsample of villages served by new stations). Interestingly, the effect of training seems to fade over time: although receiving intensive training significantly increased demand in the season immediately following training (2011), it had no significant effect on demand in 2012.

- Also there is no evidence that the discount received in 2011 had any impact on the 2012 demand, which is somehow surprising, given that we found that households that had received a subsidy had a much better understanding of the insurance product. In sum, the results suggest that insurance literacy training and subsidies have an immediate, but not sustained, effect on demand.

- Finally, we found evidence that purchasing insurance in 2011 and receiving a payout is strongly positively correlated with the decision to purchase insurance in the subsequent season. However, observing other households in the village receiving a payout seems to have no impact on demand.

8.2 Policy implications and recommendations:

We derive some policy implications and recommendations from this project:

- During the implementation of this project, we were able to validate that weather risk is a big source of uncertainty and concern for farmers in the districts where we have worked. Despite the low take-up for the specific product we have tested, the majority of farmers expressed interest in having an instrument that helps them insure against weather and production risks. Therefore, keeping an active policy for piloting, testing and improving micro-insurance products for small farmers is advisable.

- This project's intention was to shed light on the specific characteristics that an insurance product should have to make farmers move from simply showing an interest in WII to taking more concrete action and purchasing it. We proposed a new product which we claim is simple to understand and which gives farmers a range of options to choose from according to their own risk profile. The evidence gathered from purchasing behaviour apparently indicates that these two features were not appealing enough to encourage a sizeable share of farmers to purchase the product. However, as our qualitative assessment shows, there are other factors that can potentially explain the low take-up among farmers (among them a better marketing strategy). The farmers' perception was that the product offered was not complex or difficult to comprehend. Also, we observed that the most preferred product changed from one season to the next, validating to some extent the importance of giving farmers a menu of product options to choose from. Therefore, we propose that having an explicit policy in favour of simple and flexible products is more beneficial than detrimental.

- Given the low take-up of the product and the small fraction of land insured among those who actually purchased the product, it has not been possible to provide evidence on the impact of insurance purchase on production and consumption decisions, and ultimately on farmers' welfare. In fact, only a few pilot programmes have been able to provide some of this evidence, and additional and conclusive evidence is needed. This is important from a policy perspective because only with conclusive evidence can those government agencies in charge of promoting agricultural micro-insurance markets have a greater chance to permanently prioritise the topic within the government and find the fiscal resources to implement more aggressive and ambitious rural micro-insurance programmes. Therefore, we suggest policies that promote pilot programmes and ensure high take-up rates. This will enable us to measure the impact on farmers' welfare. This project has contributed additional evidence to show that demand for WII is sensitive to prices, distance to weather stations and an understanding of the product. Hence, these three instruments can be used, at least in subsamples of the target population, to achieve high take-up rates in pilot programmes. And the relevant government agency (i.e. the Ministry of Agriculture) should invest resources in these three instruments while piloting and gathering evidence. This implies the provision of important discounts, a dense network of weather stations in piloting regions and periodic training and information activities.

- One important learning experience from this project is to give priority to marketing activities, which should include proper delivery channels. Most agricultural micro-insurance pilot programmes in India and elsewhere are usually designed and led by economists, financial experts, impact evaluators or development consultants, and less attention is probably given to marketing experts. One lesson from this project is that a proper marketing strategy is a key element in piloting new insurance products and can become a crucial constraint when marketing is the weak link. This requires bringing in marketing experts from the time the project is being designed and during pilot implementation. Our qualitative assessments clearly show that a large proportion of farmers have no recollection of the product offered, that some farmers were not able to purchase the product because the insurer had no presence in their villages, and that those who purchased the product were expecting some return, no matter what. Marketing should perhaps be conceptualised as a permanent process rather than as a few specific activities that take place at specific points in time; again, marketing experts should play a large role in the project design and in formulating a comprehensive marketing strategy.

- With respect to marketing activities, it might be the case that some activities are not cost-effective from an individual business perspective, e.g. no insurance company in India has the required manpower or resources to reach out to all farmers in every village repeatedly to sell WII products. Therefore, it is important to explore alternative delivery channels for marketing WII products and exploit economies of scale. For this purpose, it is worth considering building partnerships among insurers and other companies, such as those involved in contract farming or agricultural input supply, or community-based organisations or microfinance institutions in order to take advantage of their existing links with farmers to market WII effectively. When using local institutions, this will also enhance the farmers' trust in the insurer.

- Timely provision of weather data to the insurers is important as it enables quick indemnification. Although theoretically WII can trigger a payout immediately at the end of the cover period, it takes longer, as has been the case in this project. It was found that there has been a delay of approximately two to three months on the part of the insurance company in making the final payout to the beneficiaries. This is mainly because of the delay in receiving the weather data officially from the weather stations. Such a delay in indemnity settlement has a great impact when the cover period of WII is split into smaller phases during the crop cycle. In such a situation, the weather-affected insured farmers will expect payouts immediately after the end of the cover period for taking corrective action. A delay in the settlement of indemnity will spoil one central advantage of WII contracts, which should be exploited to make these products more appealing to farmers. Moreover, delays in indemnity settlement create an adverse attitude among farmers vis-à-vis purchasing WII contracts for the subsequent phases of crop growth. On the other hand, it was also observed from our qualitative study that access to the recordings of weather stations through SMS, regardless of the purchase of insurance, might be considered part of a comprehensive marketing strategy as it helps build trust in the weather stations. Hence, institutional arrangements have to be worked out between the weather service providers and insurers so as to reduce the delay in officially providing weather data for WII. The Insurance Regulatory and Development Authority (IRDA) in India should be more active in enforcing regulatory measures so as to avoid these administrative delays.

- Our project shows that an insurance literacy training intervention has a short-term impact on demand, but with no significant impact on understanding or demand after a year of its implementation. Hence, it is worth exploring the implementation of a strategy in which training and insurance literacy are part of a permanent process (at least for some initial years), rather than a one-time activity. We propose to consider insurance literacy trainings that are imparted through existing agriculture extension programmes in India; the incremental costs should be minimal, and the potential medium/long-term benefits could be important (although rigorous evidence of this is lacking and would require a longer-term research project).

- Our qualitative assessment study tells us that basis risk is a real factor that farmers take into account when showing satisfaction or dissatisfaction with a WII product. We found that nearly 53 per cent of the respondents who have bought the product expressed their displeasure by saying that they suffered losses due to the weather but did not receive a payout. This is something that needs to be critically reviewed; was this due to the distance from the weather station or due to the lack of correlation between crop growth/yield parameters and rainfall level? The bottom line is that high quality WII products are a precondition for a sustained demand, as in any other industry. And in this case, a high quality product is one with no or minimal basis risk. We know that this depends on establishing an accurate correlation between productivity levels (yields) and weather variations, as well as with other factors. However, one key input to come up with improved, low basis risk and affordable products is accurate information. So far, the proportion of yield loss due to weather indices has not been quantified by any sound agricultural study in India. Here there is scope for an active role for the government and research institutions in the country to improve access to all relevant (current and historical) information and conduct rigorous studies to establish the best indices that correlate with yield loss, ultimately leading to the design of high-quality WII products.

- Affordable premiums have been proven in this and other studies to impact take-up rates for WII products In this project in particular, by offering products with low sums insured, most farmers have found that premiums between ₹200 and ₹350 are affordable, although some might not have had the full understanding that comes precisely with a low sum insured. However, outside of this project is a perception that premium rates for WII are high and largely unaffordable for small farmers. This is in part explained by insurers' administrative costs and re-insurance costs. The latter will probably stay or become even more costly in the scenario of climate change and global warming. To keep premiums affordable for small-scale farmers, there is need for the micro-insurance industry, reinsurers and the government to look jointly at cost structures and together find alternatives to keep premiums low, rather than simply asking the government to provide subsidies.

Appendix A

I. Details of simplified weather index insurance products sold during *kharif* 2011 and 2012 in the districts of Bhopal, Dewas and Ujjain

The design of the simplified WII product implemented during *kharif* 2011 and 2012 is provided in a tabular format. These are simple contracts because, unlike traditional WII projects, they do not involve any mathematical calculation to determine the payout. On the other hand, these are smaller contracts as well, because the entire crop period has been split into three cover periods of smaller duration, rather than one contact for the whole crop period.

For every cover period, two types of products were designed: pay for a lower probability event representing severe yield losses, and in case of a higher or moderate probability event representing moderate yield losses. Through the acquisition of these products, farmers can hedge against extreme and moderate yield losses due to suboptimal rainfall availability. Farmers can freely choose the number and combination of products they would like to purchase. These products are priced actuarially, plus the administration costs.

Bhopal (*kharif* 2011)

Security	Cover period	Index	Strike (mm)	Exit (mm)	Payout 1 condition	Payout 2 condition	Premium (₹)
					(₹1,000)	(₹4,000)	
1	25 June–20 July	maximum rainfall on any single day	95	200	Index > strike	Index > exit	352
2	25 June–20 July	maximum rainfall on any single day	120	200	Index > strike	Index > exit	265
3	21 July–15 Sep	Total cumulative rainfall	280	130	Index < strike	Index < exit	265
4	21 July–15 Sep	Total cumulative rainfall	340	130	Index < strike	Index < exit	352
5	21 July–15 Sep	Total cumulative rainfall	635	960	Index > strike	Index > exit	352
6	21 July–15 Sep	Total cumulative rainfall	700	960	Index > strike	Index > exit	265
7	16 Sep–15 Oct	maximum rainfall on any single day	70	160	Index > strike	Index > exit	352
8	16 Sept–15 Oct	maximum rainfall on any single day	85	160	Index > strike	Index > exit	265

Bhopal (*kharif* 2012)

Security	Cover period	Index	Strike (mm)	Exit (mm)	Payout 1 condition (Rs 1,000)	Payout 2 condition (Rs 4,000)	Premium (Rs)
1	25 June–20 July	maximum rainfall on any single day	95	225	Index > strike	Index > exit	300
2	25 June–20 July	maximum rainfall on any single day	115	225	Index > strike	Index > exit	200
3	21 July–15 Sep	Total cumulative rainfall (Deficit Rainfall)	425	200	Index < strike	Index < exit	300
4	21 July–15 Sep	Total cumulative rainfall (Deficit Rainfall)	350	200	Index < strike	Index < exit	200
5	21 July–15 Sep	Total cumulative rainfall (Excess Rainfall)	850	1250	Index > strike	Index > exit	300
6	21 July–15 Sep	Total cumulative rainfall (Excess Rainfall)	900	1250	Index > strike	Index > exit	200
7	16 Sep–15 Oct	maximum rainfall on any single day	65	170	Index > strike	Index > exit	300
8	16 Sep–15 Oct	maximum rainfall on any single day	85	170	Index > strike	Index > exit	200

Dewas (*kharif* 2011)

Security	Cover period	Index	Strike (mm)	Exit (mm)	Payout 1 condition (₹1,000)	Payout 2 condition (₹4,000)	Premium (₹)
1	25 June–20 July	maximum rainfall on any single day	95	225	Index > strike	Index > exit	352
2	25 June–20 July	maximum rainfall on any single day	115	225	Index > strike	Index > exit	265
3	21 July–15 Sep	Total cumulative rainfall	350	200	Index < strike	Index < exit	265
4	21 July–15 Sep	Total cumulative rainfall	425	200	Index < strike	Index < exit	352
5	21 July–15 Sep	Total cumulative rainfall	850	1250	Index > strike	Index > exit	352
6	21 July–15 Sep	Total cumulative rainfall	900	1250	Index > strike	Index > exit	265
7	16 Sep–15 Oct	maximum rainfall on any single day	65	170	Index > strike	Index > exit	352
8	16 Sep–15 Oct	maximum rainfall on any single day	85	170	Index > strike	Index > exit	265

Dewas (*kharif* 2012)

Security	Cover period	Index	Strike (mm)	Exit (mm)	Payout 1 condition (Rs 1000)	Payout 2 condition (Rs 4000)	Premium (Rs)
1	25 June–20 July	maximum rainfall on any single day	95	200	Index > strike	Index > exit	300
2	25 June–20 July	maximum rainfall on any single day	120	200	Index > strike	Index > exit	200
3	21 July–15 Sep	Total cumulative rainfall (Deficit Rainfall)	340	130	Index < strike	Index < exit	300
4	21 July–15 Sep	Total cumulative rainfall (Deficit Rainfall)	280	130	Index < strike	Index < exit	200
5	21 July–15 Sep	Total cumulative rainfall (Excess Rainfall)	633	960	Index > strike	Index > exit	300
6	21 July–15 Sep	Total cumulative rainfall (Excess Rainfall)	700	960	Index > strike	Index > exit	200
7	16 Sep–15 Oct	maximum rainfall on any single day	70	160	Index > strike	Index > exit	300
8	16 Sep–15 Oct	maximum rainfall on any single day	85	160	Index > strike	Index > exit	200

Ujjain (*kharif* 2011)

Security	Cover period	Index	Strike (mm)	Exit (mm)	Payout 1 condition (Rs 1,000)	Payout 2 condition (Rs 4,000)	Premium (Rs)
1	16 Sep–15 Oct	maximum rainfall on any single day	50	240	Index > strike	Index > exit	221
2	16 Sep–15 Oct	maximum rainfall on any single day	66	240	Index > strike	Index > exit	165

Ujjain (*kharif* 2012)

Security	Cover period	Index	Strike (mm)	Exit (mm)	Payout 1 condition (₹1,000)	Payout 2 condition (₹4,000)	Premium (₹)
1	25 June–20 July	maximum rainfall on any single day	82	181	Index > strike	Index > exit	300
2	25 June–20 July	maximum rainfall on any single day	99	181	Index > strike	Index > exit	200
3	21 July–15 Sep	Total cumulative rainfall (Deficit Rainfall)	353	95	Index < strike	Index < exit	300
4	21 July–15 Sep	Total cumulative rainfall (Deficit Rainfall)	247	95	Index < strike	Index < exit	200
5	21 July–15 Sep	Total cumulative rainfall (Excess Rainfall)	634	1235	Index > strike	Index > exit	300
6	21 July–15 Sep	Total cumulative rainfall (Excess Rainfall)	816	1235	Index > strike	Index > exit	200
7	16 Sep–15 Oct	maximum rainfall on any single day	44	239	Index > strike	Index > exit	300
8	16 Sep–15 Oct	maximum rainfall on any single day	66	239	Index > strike	Index > exit	200

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Weather index insurance (WII) has had low demand and uptake among farmers despite a recent surge in interest among private companies and policymakers. One of the reasons for the low demand is the complexity of insurance schemes. This study evaluated the impact of a simple, transparent and flexible WII product among smallholder farmers cultivating rain-fed soybean crop in the state of Madhya Pradesh in India.

The study found that the overall demand for the simplified weather index insurance products was low. In fact, there was a fall in demand as price and distance to the weather station increased. Interestingly, intensive insurance literacy training sessions conducted in the first year seemed to have no significant impact on the understanding or demand during the second year.

While purchasing insurance did not have a substantial impact, receiving a payout had a positive impact on the decision to purchase insurance in the subsequent season. However, there was no impact on demand of observing other households in the village receiving payouts. This could also be explained by low levels of trust in the product or the insurance company.

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