Uptake of Crop Insurance among Smallholder Farmers: Insights from Maize Producers in Kenya

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Abstract:

In spite of agriculture being an important source of income growth and a potential source of investment opportunities in Kenya, farmers face numerous production risks including climate change and variability. While literature suggests that crop insurance has the potential to unlock key services that enhance farm productivity, crop insurance uptake evidence is limited, hence, this study sought to inform on ways of making crop insurance work for the smallholder producers. Data was collected from 400 maize-producing households in areas where weather index-based insurance had been promoted. Results show that uptake of crop insurance is very low and declining and, the insurance concept is also not well understood by farmers. In addition, basis risk hinders uptake of crop insurance since farmers exhibited high levels of dissatisfaction with claim payments. Furthermore, awareness and training on crop insurance, density of automated weather stations and ownership of savings account are integral factors in enhancing its uptake. Our findings therefore highlight the need to educate farmers on the principles of crop insurance and different products that exist. Similarly, designing of crop insurance products and selection of target crop enterprises should involve all stakeholders to enhance uptake.

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Keywords: crop insurance; climate change; weather-index; agricultural risks; Kenya; Africa

1. Introduction

Agriculture is the dominant sector in Sub-Saharan Africa as it accounts for a major share of key economic indicators such as value of total exports, national gross domestic product (GDP) and employment hence its potential to spur growth and reduce poverty in Africa. In Kenya, the sector is dominated by smallholder farmers who contribute over two-third of the total agricultural output (Salami et al., 2010). Despite agriculture being an important source of income growth and a potential source of investment opportunities, inherent risks have been an integral part of this sector. Rainfall variability and other weather-related hazards are an important component of risk that confront farmers due to high correlation that exist between climatic factors and performance of agricultural sector. Given the over-dependence of smallholder farms on rain-fed agriculture, climate variability and change is rapidly threatening sustained agricultural productivity, food security as well as economic development.

Smallholder farmers are increasingly faced with risk factors such as droughts, floods, diseases, pests, hailstorms, fire and theft, which impact negatively on agricultural productivity and welfare of households that depend on agriculture for their livelihood. Several studies Anderson et al., 2004; Hazell & Skees, 2005; Morton, 2007; Jones & Thornton, 2009; Thornton et al., 2011; Harvey et al., 2014) show that the frequency and severity of crop failure and livestock mortality resulting from weather related hazards is increasing and their adverse effects are becoming more rampant especially with climate change. Increased climate variability and change can have a detrimental effect on the economy by lowering investment demand in agriculture, which in turn results into reduced agricultural productivity, increased food insecurity and decreased resilience of households that depend on rain-fed agriculture (World Bank, 2005; Mahul & Stutley, 2010). Since smallholder are very vulnerable[1] to climatic risks, it is then expected that climate change will affect their agricultural productivity more in future through the resultant income and food price shocks (Morton, 2007).

Traditionally farmers had devised a diverse portfolio of risk avoidance and reduction mechanisms such as reduced input application, use of drought resistant varieties and diversification of crop or income portfolio to self-insure against agricultural risks. However, recent research (e.g. Hazell & Skees, 2005; Sina, 2012; Nnadi et al., 2013; Carter et al., 2014) show that traditional risk minimization strategies are unfavorable to some extent and that cannot adequately absorb the resultant economic shocks hence leading to a poverty trap. Therefore, risk transfer strategies in form of formal insurance is a suitable tool to: (1) transfer risk to a third-party –in this case an insurer, thereby eliminating fear of risk and encourage investment, and (2) spread covariate risks, for example drought and disease outbreaks across a wider geographical region by pooling risks that individual farmers nor the local risk sharing initiatives like farmer groups or cooperative are incapable. Overall, a well-designed agricultural insurance can help to mitigate the impact of systemic risks by providing the much needed protection and contributing to timely recovery in case a disaster strikes. This would help keep smallholders out of extreme poverty and enable them to invest for their future.

[1] Smallholders are perceived to be vulnerable to climatic risks unlike medium and large scale farms because of because of their subsistence farming orientation and the corresponding diseconomies of scale associated with small farms.

Use of agricultural insurance in Kenya to manage agricultural risks dates to 1930s in form of Guaranteed Minimum Returns (GMR) - a scheme successfully helped to mitigate agricultural risks even after independence by providing a well inter-linked system of credit, insurance and marketing services - which was later abolished in 1978 (Kerer, 2013). Since the discontinuation of GMR, the agriculture sector has lacked insurance services to manage risks. However, with the increasing awareness of climate change, the need to develop strategies for dealing with impacts of increasing climate variability particularly in the developing nations has led to a growing interest in agricultural insurance. In early 2000s, some of the leading insurance companies in Kenya ventured into livestock and crop insurance by introducing indemnity based agricultural insurance namely Named Peril Crop Insurance (NPCI) and Multi-Peril Crop Insurance (MPCI).

Although literature suggests that agricultural insurance has the potential to unlock other key services in the agricultural sector that are important in enhancing productivity, conventional indemnity-based type of crop insurance is inadequate to insure smallholders because of the associated moral hazard and adverse selection weaknesses and the confounding insurance administration costs especially when dealing with over-dispersed population of smallholders (Carter et al., 2014). Thus majority of smallholders are precluded from accessing agricultural insurance services thereby pushing them to cope with disasters using traditional risk minimization strategies yet they cannot adequately cushion them from effects of reduced productivity and income losses (Sina, 2012).

The need to offer risk hedging products for smallholder producers has led to emergence of the innovative index-based weather insurance (IBWI) in the last one decade. Since 2007, IBWI has gained attention of the government, private sector and development agencies because of its ability to overcome shortcomings of indemnity based insurance since physical inspection costs are eliminated as well as moral hazard associated with behavior of policy holders. Although several IBWI products[2] for both crop and livestock enterprises exist in Kenya, most of them are still in a piloting phase.

Despite substantial research efforts to enhance smallholder access to formal insurance services through innovation in financial derivative insurance products, emerging evidence demonstrate that the uptake of index insurance has been generally low (Binswanger-Mkhize, 2012; Cole et al., 2012; Janzen & Carter, 2013; Tsikirayi et al., 2013; Karlan et al., 2014; Carter et al., 2014; Takahashi et al., 2014; Daninga & Qiao, 2014) though there is promising results with regard to its demand and impacts on key household indicators. In the Kenyan context, (Kerer, 2013) reports that only a small percentage of smallholders has been covered, albeit the emergence of weather index-based in 2008. This remark is seemingly correct given that penetration of the overall insurance in Kenya is estimated at 3%.

[2] The most common agricultural insurance products for smallholder producers at the time of the study were: the basic "***Kilimo Salama"*** (safe farming) that focused on primary inputs namely fertilizer and hybrid seed, "Kilimo Salama" plus that incorporated labour costs in addition to basic inputs, "*Ngao ya mkulima*" (farmers' shield) for crops and "***Bima Ya Mifugo"*** (livestock cover) for dairy cattle.

Our study therefore explores trends and the drivers of crop insurance uptake and its intensity of use among smallholder maize farmers in Kenya with view of contributing to the body of knowledge on the ways of making crop insurance work for the smallholder producers. The rest of the paper is organized as follows. The next section presents the current gaps and challenges in the pro-poor agricultural insurance landscape while in section 3 we discuss materials and methods used in the analysis. Specifically, we describe the data sources, estimation strategy and the variables used. Results and discussion are outlined in section 4 while the paper closes with conclusion in section 5.

2. Current gaps and challenges

The concept of agricultural insurance is not popular in Africa except among the large-scale farmers although in the recent years, crops insurance has emerged as an important policy tool for enhancing household resilience against climatic risks. Whilst globally there is a vast body of literature that seeks to understand patterns and structure of crop insurance with respect to behavior of the farmers under risk and their attitude, embedded information asymmetry problems such as moral hazard and adverse selection and the likely outcomes on household welfare, existing literature has been seriously biased towards indemnity-based insurance products. Nonetheless, recent innovations in the derivative financial intermediaries has seen a remarkable evolution of index insurance products in developing countries, but very little has been documented with regard to the quality of indexed products (Jensen et al., 2014). Furthermore, even with numerous effort to avail formal insurance to farmers in low income rural settings through pilot programmes, to date, very little success has been achieved to move index insurance beyond the piloting phase (Cole et al., 2012) hence the uptake levels remains low.

Factors that affect uptake of crop insurance are yet to be fully understood partly because of lack of sufficient data and over-reliance on hypothetical evidence that seem to underscore theoretical viability of crop insurance yet the empirical evidence from pilot programs show mixed results on performance of agricultural insurance. Previous studies (Mohammed & Ortmann, 2005; Sundar & Ramakrishnan 2013; Falola, et al., 2013; Kwadzo et al., 2013; Aidoo et al., 2014; Daninga & Qiao 2014; Takahashi et al., 2014) have looked at determinants of crop uptake decision such as price of the insurance, knowledge of the farmers, resource endowment and rights but these studies tend to imply that insurance uptake is a binary mechanism yet there is an incremental feature that defines the intensity of uptake. Nonetheless, uptake of crop insurance draws heavily from the conventional technology adoption literature whereby the existing evidence highlight the importance role of availability and affordability of agricultural technologies and the expected benefits of adoption (Kasirye, 2013) in stimulating farmer response.

Drought and the related extreme temperatures have been the most significant cause of losses to crop and livestock production in Kenya, accounting for KSh 699 billion and KSh 121 billion in livestock and crop losses respectively between 1999 and 2011. As a result, the government spends on average Kshs 9.3 billion per year (Kerer, 2013). Based on this, the national government is considering to partner with county governments and the private sector to implement an agricultural insurance public-private partnership to protect the farmers and pastoralists against the catastrophic disasters. Given the existing index insurance knowledge gap, it's imperative to advance the understanding of index insurance uptake drivers. We therefore use data from a market-based weather index insurance to elicit trends and drivers of crop insurance uptake decision. We thus separate uptake decisions into two: 1) farmers' decision to join the crop insurance program and, 2) the decision on the amount of crop insurance purchased. We further compare insurance uptake between household in medium to high and low potential agricultural areas.

3. Materials and Methods

3.1 Data and sampling strategy

We utilize data from maize growing households of Embu and Laikipia counties in Kenya consisting both participants and non-participants in a weather index insurance program. Primary data for this study was obtained through interviews at the household level using structured questionnaires in October through November, 2014. The reference period of the survey was short rains and the long rains cropping seasons of 2013 and 2014, respectively. In addition, secondary data was synthesized from crop insurance trainers'[3] records, annual reports from the ministry of agriculture and literature reviews.

The study adopted multiple sampling approaches to select both the area of study and category of farmers. Embu and Laikipia were purposively selected for the study since they were the only identifiable areas with a significant number of farmers who had taken up crop insurance. Using a multi-stage sampling procedure, a total of 400 households were selected for the analysis and out of which 60 percent were target (participants) households. Simple random sampling was utilized to draw a pool of target households from a sampling frame of both farmer groups and list of group members obtained from the local insurance trainers while random-walk technique was applied when selecting farmers who had never taken up insurance within the neighborhood of the target farmers. The random-walk involved random counting of 6 households, then picking the 7th household. This step was then followed by establishing if the household had ever taken any agricultural insurance and if the household had not, it qualified as a control group, otherwise, the same process was repeated until a suitable sample was obtained.

We further zoned farmers with respect to the agricultural potential of the region whereby low agricultural potential areas (Matanya and Mbeere) were receiving less than 650 mm annual rainfall and the mid-high potential areas (Kalalu, Manyatta and Runyenjes) were receiving annual rainfall of more than 700mm. The selected households were mapped by their respective weather stations as shown in table 1.

(Table 1)

[3] There was a group of farmer trainers who offered insurance-related extension services to the farmers through the farmer groups. The trainers also doubled as sales and marketing representatives given their close contact with the farmers.

3.2 Estimation strategy

The conceptualization of this study is embedded in the realm of random utility modelling which falls under the utility maximization framework to explain the behavior of farmers under discrete choice. During uptake of crop insurance, farmers are faced with mutually exclusive discrete choices of either to adopt crop insurance or not. In this regard, choice taken depends on the expected utility in their farm operations. The utility of a commodity comprises of two facets namely: deterministic element (U_{ik}) that is observable and the random error (ε) which is unobservable (Jabbour et al., 2003; Yang, 2014). Given utility that a household derives with and without crop insurance in its farming activities is U_i and U_k respectively, the nth household will adopt crop insurance only if U_i>U_k. Consequently, the probability that nth household will take-up crop insurance can be expressed as:

$$P_{nth} = (U_i + \varepsilon_i > U_k + \varepsilon_k) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots . (1)$$

We adopt both descriptive and econometric analytical strategies to show trend of uptake and estimate covariates that influence the household decisions as follows:

3.2.1 Descriptive analysis

We use descriptive analysis to generate frequencies, proportion and means of trends and patterns insurance uptake over the years. Student t-test of difference of means have also been used to compare the control (non-insurance users) and the target (insurance users) samples where applicable.

3.2.2 Econometric model

To assess factors that influence households' decision to use crop insurance and its intensity, we adopt a two-step approach based on the discrete choice framework where an assumption is made such that two – decision levels are made i.e. choice to participate or not and then the extent of participation – in this case measured by the amount of premiums paid. Various studies have employed the censored regression models such as Tobit and Double hurdle to study household participation (Sigelman & Zeng, 1999; Moon et al., 2004; Bellemare & Barrett, 2006; Wodjao, 2007; Ground & Koch, 2008; Komarek, 2010; Mignouna et al., 2011) but in our case, we employ the sample selection model of Heckman (1978) to overcome the problem of missing data in the outcome equation as a result of incidental truncation arising from responses in the selection equation. Tobit assumes that the participation and intensity decisions are determined by the same variables and parameters hence it is limited in its ability to separate the two participation hurdles.

Unlike the corner solution models such as double hurdle that accounts for participation and intensity decisions by allowing the regressors to vary between the two hurdles, the Heckman model is most suitable because of its ability to account for non-random nature of the sample such that it computes a selection term in the first equation which is then included as one of the regressor in the second stage to correct for self-selection (Olwande & Mathenge, 2012).

3.2.3 Specification of Heckman selection model

While establishing the factors that influence adoption of crop insurance and the extent of adoption, the first stage involves a discrete choice model (Probit) where a correction factor (probability of participation for those who did not participate) also known as the inverse Mill's ratio (IMR) is computed. The second hurdle involves an OLS model where the generated IMR is included as one of the regressor. The two-step model therefore is represented as follows;

Participation decision equation;

$$\boldsymbol{z_i^*} = \alpha\, \boldsymbol{w_i} + \boldsymbol{\mu_i} \quad \ldots \ldots \ldots \ldots \ldots \ldots \quad \mathbf{2)}$$

$$\boldsymbol{Z_i} = 1 \text{ if } \boldsymbol{z_i^*} > 0, \text{ and otherwise if } \boldsymbol{z_i^*} = 0 \quad \ldots \ldots \ldots \ldots \ldots \ldots \quad \mathbf{3)}$$

Outcome/intensity equation;

$$\boldsymbol{y_i^*} = \beta\, x_i + \lambda + \boldsymbol{\varepsilon_i} \quad \ldots \ldots \ldots \ldots \ldots \ldots \quad \mathbf{4)}$$

$$\boldsymbol{Y_i} = \boldsymbol{y_i^*} \text{ if } \boldsymbol{y_i^*} > 0 \text{ and } \boldsymbol{z_i^*} > 0, \text{ otherwise } \boldsymbol{Y_i} = 0 \quad \ldots \ldots \ldots \ldots \ldots \ldots \quad \mathbf{5)}$$

Where $\boldsymbol{z}^*$and $\boldsymbol{y}^*$are unobserved latent variables determining the household's decision to adopt crop insurance and the premiums paid, **Z** and **Y** are the observed decision (to use crop insurance or not) and the amount of crop insurance bought by a household respectively, $\boldsymbol{w_i}$ and $\boldsymbol{x_i}$ are vectors of explanatory variables that influence household participation and intensity decisions in the crop insurance scheme and $\boldsymbol{\lambda}$ is the **inverse Mill's ratio**. The explanatory variables are presumed to be uncorrelated with their respective error terms ($\boldsymbol{\mu}$ and $\boldsymbol{\varepsilon}$).

3.3 Variables used in the analysis

Our model utilizes two dependent variables namely; the discrete choice to participate in crop insurance scheme (a yes or no response) in the first step and the amount of crop insurance purchased (expressed in terms of premiums paid in Kenya shillings by a household) in the second step. We use premiums paid as a proxy for the value of crop insurance insured simply since we could not establish the value of maize crop that a household had insured. Furthermore, premiums paid are a good proxy for value of crop insured because they (premiums) were directly computed as a percentage of the value of inputs purchased. The second decision relating to the extent of participation in the crop insurance program can only be observed for the individuals that choose to take-up the insurance and vice-versa. Table 2 outlines the explanatory variables used to model crop insurance uptake decisions.

(Table 2)

4. Results and discussion

4.1 Household characteristics

We analyzed the socio-economic and demographic attributes of the insured households with the non-insured (control) to establish whether they were in any way different in terms of their characteristics. Results in Table 3 indicate that characteristics of the insured households were not statistically different from their counterparts without insurance except in terms of age and education level of the head, income levels, size of land owned, distances to the nearest weather station and market for farm produce, membership in farmer groups, credit access, ownership of savings account with banking institutions and use of hired labour in farm activities. The insured household heads were on average older by about three years and had significantly more years of formal schooling than the control household heads with a mean of 9.09 and 7.46 years, respectively. Similarly, insured households recorded on average higher incomes than non-insured. For all income categories except crop income, the difference between the two categories of farmers (insured versus non-insured) was statistically different. Size of the land owned also differed significantly between the samples. On average, plots held by the insured households were relatively larger by about 1.2 acres compared to their un-insured counterparts.

(Table 3)

Geographic proximity is a key factor influencing both transaction costs and the basis risk for households under a weather-index insurance contract. Therefore, a comparison of households' proximity to the output market and the weather stations revealed that insured households faced shorter distances to the produce market unlike the control households. Conversely, insured households lived far away from the weather stations when compared with the non-insured households who recorded an average distance of 5.3km. Descriptive statistics also reveal that majority of insured households had access to banking services, greater success in credit access, use of hired labour and participating in farmer organizations as well.

4.2 Insurance uptake and payout trends

We further analyzed trends of insurance uptake since 2009 using farmer recall[4] data and the results in Figure 1 shows that the number of households buying insurance per year increased sharply from 2.4% in 2009 to about 36% in 2012 but dipped to a low of 4.6% in 2014. When asked reasons for dropping out of the insurance scheme, 23% of the farmers cited failure to be compensated despite suffering losses (basis risk) as the main reason while an almost equal proportion discontinued purchase of insurance because their expectations were not met (which could imply little payout compared to the actual losses suffered) or because the insurance was no longer available within their locality.

(Figure 1)

We sought to establish payout trends to justify farmers' complaint of non-compensation and our analysis show that proportion that were unsuccessful to receive a payout increased from 27% in 2009 to over 90% by year 2014. This could partly be because of escalating crop losses that could not measure up with the total amount of premiums collected by the underwriter. At the same time, while the payout is triggered by precipitation index based on the reference weather stations data, registration of the farmers was done remotely via mobile phone and there were no systems for verifying the location of the corresponding plots that were planted with the insured inputs. Inadequacy of verification mechanism could have affected the correlation between precipitation index and the reality on the farms.

[4] The farmers' recall data on historical purchase of insurance was supplemented by data derived from the local insurance trainers' records to increase its reliability.

Majority (49%) of non-adopters on the other hand attributed their non-participation in the insurance scheme to lack of understanding on how crop insurance works, another 20% alluded that crop insurance service was not readily available in their locality whereas 14% felt that the crop insurance premiums were expensive beyond their purchasing ability. However, only 17% of non-adopters did not require crop insurance in their farm activities despite a good number having reported to have experienced weather-related shocks within the last 5 years prior to the survey.

(Figure 2)

4.4 Determinants of crop insurance uptake

4.4.1 Decision to adopt crop insurance

The results of factors influencing crop insurance uptake in Table 4 indicate that factors that significantly influenced the decision to buy crop insurance were: training on crop insurance, ownership of a savings account, exposure to drought shocks, size of land allocated to maize production, family (household) size, proximity to both the nearest farm produce market and the weather station and altitude (elevation above sea level). These covariates had the expected sign of influence on adoption of crop insurance except the proximity to relevant weather station.

Crop insurance training at the household level had positive and significant (at 1%) influence on the decision to buy crop insurance. Our results are consistent with Dercon et al. (2014) in that households which receive regular training on how insurance works and its benefits are more likely to incorporate crop insurance in their farm production activities. Hill et al. (2010) argue that complexity of crop insurance products has been contributed to the low uptake of agricultural insurance products. This pattern could be explained by the fact that the perceived complexity make it difficult for the farmers to perceive direct benefits taking insurance hence they view insurance as an expense rather than a factor of production. Therefore, this result signifies the importance to training farmers not only about the insurance products but also the importance of insurance as a factor of production. Since risk mitigation with crop insurance is a new concept for smallholders, training helps to influence their attitude and perception towards agricultural insurance as well as their degree of risk aversion. Integrating crop insurance workshops with initiatives that build awareness on climate change among farmers can help to bridge the gap between climate scientists and the users (who are mainly farmers) by empowering them with the relevant knowledge and skills that aid in making informed decisions on ways of confronting climate risks as a way of building their resilience.

Ownership of a savings account with a formal financial institution also positively influenced decision to take up crop insurance. Results indicate that households with a savings account are more likely to adopt crop insurance. Since weather index insurance is a form of financial derivative through which farmers can hedge against climatic risk, ownership of savings account was used to capture two aspects of insurance and financial intermediaries namely; trust towards insurance and liquidity access from formal financial institutions. Ownership of a bank account is associated with financial literacy which is an important component when evaluating insurance product (Cole et al., 2012) and therefore, households with savings account are perceived to have trust with financial intermediaries hence they are better placed to be receptive to insurance concept. In addition, ownership of savings account can serve as pathway to build liquid wealth in a households (Rhine et al., 2014), which can ease financial constraints when making farm investment.

The household experience with drought risks measured in terms of number of drought incidents that a household has experienced is negatively related with the willingness to adopt crop insurance product to insure against drought risk at the household level. Result show that even when a household recognizes that it has suffered repetitive crop loss due to drought, it is less likely to take up the cover to insure against it. Explanation for this finding is that a repetitive shock may prompt a household to devise 'safe' mechanism to cope with the resultant shocks without crop insurance despite having suffered losses to the same shock in the past.

Land allocated to maize production was also found to be positively related with adoption of crop insurance. Increase in the proportion of land allocated to maize, increases the likelihood of a household to take-up crop insurance. Land is an important factor of production and therefore a household can only increase proportion of land to produce a particular crop when it is important to them (Kassie et al., 2012). This implies that such a household would as well take an extra step to insure against threats of insurable risks.

Distance to the nearest farm produce market influence insurance adoption negatively. The negative coefficient suggests that as distance to the market increases, likelihood of insurance uptake in a household declines. Proximity to the market has economic implication on the household farm and market activities. Distance to the market is a key indicator of the relative effect of transaction costs that influence household participation in the market. The result show that increase in distance to the produce market decreases the probability of uptake of crop insurance for maize. The decreased motivation to take-up insurance perhaps could be as a result of cost of market access which may render maize production as unattractive enterprise due to the reduced expected earnings. In addition, since the insurance was based on hybrid seeds, majority of farmers in remote rural areas with poor road infrastructure especially those from resource constrained household may opt to plant local varieties which may not be insured hence rather than spend extra funds to obtain the insured varieties. Interactions with farmers revealed that the insured varieties were distributed by appointed agro-dealers who were mainly located at specific locations which were most likely not convenient to all potential clients.

(Table 4)

Regarding proximity to the reference weather station, results show unexpected sign which is contrary to our expectation. While the effectiveness of weather derivative insurance is hindered by basis risk including geo-location basis risk resulting from deviations of weather conditions between the reference weather station and the insured farm (Ritter *et al*. (2012), coefficient of distance to reference weather station in our model is positively associated with decision to take up crop insurance. This means that as the distance to the reference weather stations increases, probability of households to buy crop insurance increases. Existing literature (Gine et al., 2012; Gommes & Kayitakire, 2013) consider a distance of not more than 20 km from reference weather station to the insured field as acceptable for weather derivative insurance without affecting correlation of indices with insured risk. A plausible explanation for the negative coefficient is that since no system was in place to verify location of the farm from the reference weather stations, farmers may possibly have insured crop fields outside the recommended radius to increase the chance of being compensated.

Results in table 4(a) also show that family size matters in insurance uptake at the household level. Coefficient of the household size was statistically significant at 10 percent and negatively influenced the probability of a household to take up crop insurance. The findings corresponds with (Okoffo et al., 2016) who finds similar result among cocoa farmers in Ghana. In Nepal, household with one more member was also found to undermine uptake of weather-index insurance by 0.8 – 1.1 percent (Guo, 2015). Large households are often faced with complex expenditure priorities hence low disposable incomes hinders households with high number of dependents to adopt agricultural insurance as a risk management instrument. Furthermore, (Rahut & Micevska Scharf, 2012) argue that farm households with large families and small farms are disposed towards non-farm diversification strategies activities against risks hence in this case, crop insurance would be less preferred.

Altitude is a key determinant of weather parameters such as temperature and relative humidity which have greater importance towards crop growth and therefore it is a good parameter[5] for agro-ecological potential. We find that at higher altitude, similar to adoption of productivity enhancing technologies such as seed and fertilizer (Shadi-Talab 1977; Hassan & Karanja, 1997; Gamba et al. 2003; Munyua et al. 2010) farmers are more receptive to the concept of insurance and thus are more likely to adopt agricultural insurance faster as part of inputs in crop production compared to their counterparts in low altitude areas. This finding suggest that design of insurance products should be region specific (rather than a universal product) that is built within the context of end users needs and expectations and this can be attained if their needs are well understood.

4.4.2 Intensity of crop insurance use

Table 4(b) shows the covariates that affect the intensity of crop insurance use in terms of the amount of premiums purchased and these includes: the age of the head, use of hired labour in farm activities, group membership, family size, maize farming system practiced by the household and the, altitude and agro-ecological dimensions of the farm. The positive and significant coefficient of the farmers' age indicate that relatively older farmers are more likely to invest in risk management by purchasing more insurance premium and vice-versa. Usually, majority of young and fresh farmers are not only inexperienced but they are also characterized by greater risk due to their relatively low wealth levels. Therefore, high collateral demand

[5] Crop performance is affected by factors beyond amount of precipitation. While rainfall received could be a measure for agro-ecological potential, we find that within the same local region, there is high variations in terms of received precipitation hence altitude is taken into consideration since it takes into account key parameters such as temperature, humidity all together.

deprives them financial opportunity to investment in risk management. Although our findings corroborates Cao & Zhang (2011), they argue that from insurance demand and supply perspective, overconfidence among the farmers (derived from farming experience) may impede insurance purchases.

The rising demand for food against declining farm productivity, coupled by an ageing farm population has necessitated new drive to engage youths in agriculture. Youths are viewed as an important force for transforming the agricultural sector due to their affinity to modern technologies and creativity. However, negative correlation of age to intensity of use suggest that while efforts to make agriculture appealing to the youths through various incentives to enhance access to land and capital are necessary, preference for risk management is vital in making their investment viable. Therefore extra mile of support in risk transfer mechanism through insurance should form a key component of such initiatives.

Participation in farmers' organization is also positively associated with intensity of crop insurance use. The results concur with (Suresh et al., 2011) that participation in farmer organizations has the capacity to encourage intensive purchase of crop insurance premiums in a household. On one hand, social organizations provide pathway for information acquisition through training and peer to peer learning about agricultural insurance. On the other hand, farmer organizations may help to alleviate liquidity constraint through informal credit lending (Hellin, Lundy, & Meijer, 2007) which can in turn empower the resource constrained households to afford insurance premiums.

Use of hired labour in crop production had positive and significant effect (at 1%) on the insurance premium purchases. As an indicator for commercialization, households using hired labour are more risk conscious compared to subsistent units hence, commercially oriented farmers are more likely to invest in insurance instruments to hedge against risks. Farm labour forms the bulk of crop production especially where mechanization is under-developed. Hence it is worthwhile to shield expected returns on investment (from such costs) from vagaries of weather among other risks by increasing the level of insurance cover to minimize possible losses. Implication of this result is that while implementation of index-based insurance is viewed from pro-poor lens, poor and subsistence producers are unlikely to tap the full benefits of insurance partially due to lack of motivation (among other factors) to insure against losses. Kahan (2013) argues that elimination of risks has a component of reducing potential profits hence, risk must be sufficiently large enough to warrant the management strategy. This implies that market orientation is equally important in uptake of insurance. Hence, poor subsistent farmers should be supported to reorient their farm activities to unlock the need for risk management using insurance based instruments.

Results also indicate that household size positively and significantly influenced the intensity of insurance use. While the large households were less likely to use crop insurance, second stage regression estimates in table 4(b) suggest that, among those that adopted insurance, households with more members are more likely to intensively purchase crops insurance against vagaries of weather compared with smaller family sizes.

Use of mixed cropping system had negative and significant influence on the amount of premiums purchased. Mixed-cropping of maize with other crops acts as a self-insuring strategy to diversify risks. This finding implies that farmers are more receptive to less costly risk management mechanism hence, integration of crop insurance together with farm-level risk reduction measures holds potential of cushioning farm households against crop-loss related income shocks.

Although farmers in high altitude areas were more likely to adopt crop insurance faster, we find that altitude negatively and significantly influenced the intensity of insurance cover purchases. Given the link between agro-ecological performance of land and altitude, households producing maize at higher altitude are less vulnerable to drought risk (often precipitated by precursors such as temperature and rainfall variations) hence farmers in such areas would be less inclined to intensively buy insurance.

5. Conclusion

In the face of escalating climate variability and change, smallholders need crops insurance more than ever before to manage weather related risk to enhance their resilience against income shocks. Our study therefore assessed trends of crop insurance uptake and drivers of adoption at the household level. Findings suggest that even though awareness of crop insurance is a key precursor for its uptake, only a few understands how it works thereby prohibiting their ability to make decision regarding its uptake decisions. Similarly, affordability of premiums and inaccessibility of crop insurance services especially because of distribution challenges have also hindered its uptake. As a result, only a small fraction of farmers is insured.

Furthermore, results show that factors that influence smallholder maize farmers to use insurance include age of the farmer, awareness and training on crop insurance, density of weather stations, proximity to market, ownership of savings account, proportion of land allocated to maize production and frequency of drought incidences among other factors. Selection of the enterprise to target with crop insurance play greater role in farmer acceptance of the insurance product. For instance, despite indication of the results that maize crop is highly regarded as important enterprise, its economic contribution to the household income needs were insignificant thereby arousing possibility of displeasure to insure the enterprise.

Our findings also show that age and experience of the farmers are paramount in adoption of agricultural innovations such as crop insurance. While there are concerted efforts to make agriculture appealing to the youths through incentive schemes, risk management instruments are still-out of their reach due to an array of confounding barriers. Insurance is a useful tool to stabilize incomes and provide a fallback recovery mechanism after crop failure. To transform rural agriculture into agribusiness through the youths will therefore entail a paradigm shift from the traditional risk management practices which have been unable to keep pace with rapid weather changes.

Overall lessons that emerge from the finding of this study is that the number of household taking crop insurance are marginally small and declining. This pattern is complicated by the fact that majority of households do not understand insurance concept, partially because of the complexity nature of insurance or because there isn't sufficient awareness to enlighten the farmers. This implies that awareness on insurance is not sufficient to promote crop insurance uptake but rather rigorous training to inculcate culture of insurance into agricultural production. Insurance focused a single crop enterprise thereby limiting farmer preference on what to insure. Also, there is less involvement of smallholder to provide feedback regarding the nature of insurance products of their interest.

Therefore, we recommend: 1) Engagement of all stakeholders including farmers in the design of derivative insurance products. This can be achieved by developing of feedback mechanism to promote conception and formation of practical and result oriented approaches to adapt to climate change. Participatory approach helps in designing insurance products that would take into the varying socio-economic conditions of the farmers and targeting economically viable enterprises to enhance acceptance whilst accelerating uptake. 2) Continued training of farmers on crop insurance in addition to other sustainable risk reduction and transfer measures reduce impact of the climate change on household livelihood. Therefore, crop insurance should not be promoted in isolation with other risk management techniques. 3) Government should be in the frontline to support crop insurance initiatives with relevant legislations that promote growth of micro-insurance sector as well as providing key investment infrastructure to the involved private sector partners. Government should also develop safety net program aimed at providing smart subsidies that are targeted to the poor and vulnerable population groups of farmers to accelerate insurance uptake. 4) We encourage bundling of crop insurance with other services like credit to entice farmers to buy more insurance while ensuring they get value for their investment. 5) Finally, approaches that help to lower basis risk should be put into account when the index is being developed. These include use of multiple and robust trigger, increasing density of weather station as well as investment in equipment that would enhance detection of correlation between insured risk and the relevant weather phenomena.

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Table 1: Distribution of sample by county and weather station

County	Weather station	Sample (n)	Insured %	Uninsured %	Overall %
Embu	Siakago	76	44.4	28.9	19.1
	Nthagaiya	37	18.8	18.1	9.3
	Tenri	28	12.8	15.7	7.0
	Runyenjes	24	12.0	12.0	6.0
	Ishiara	21	10.3	10.8	5.3
	Embu Met	14	1.7	14.5	3.4
Laikipia	Kalalu	125	61.4	64.4	31.3
	Matanya	70	35.7	33.9	17.5
	Airbase Laikipia	5	2.9	1.7	1.2
	Overall	**400**	**100**	**100**	**100**

Table 2: Variables used in the analysis

Variable	Description	Unit of measurement	Sign
insure	If participated in crop insurance scheme or not	Dummy : 1=yes 0=no	
premium	Premiums paid for the crop insurance cover	Amount paid in Kenya shillings	
age	Age of household head	Number of years	+
gender	Gender of household head	Dummy: 1=male, 0= female	+
heduc	Education level of household head	Number of years of schooling	+/-
hhsize	Household size	Number of households members	+/-
acre_maiz	Land allocated for maize production	Acres	+
htrain	If household received training on crop insurance	Dummy: 1=yes, 0=no	+
aware	If household is knowledgeable/ or understanding of agricultural insurance	Dummy: 1=yes, 0=no	+
freq_d	Frequency of drought episodes faced by the household	Number of drought incidents in the last 20 years	+/-
hlabour	If household used hired farm labour	Dummy : 1=yes 0=no	+
group	Membership in farmer group	Dummy : 1=yes, o=no	+
bnkaccnt	If household owns a savings account	Dummy: 1=yes, 0=no	+
mktkm	Distance to the nearest market	Distance in kilometers	-
wstkm	Distance to the nearest weather station	Distance in kilometers	-
region	Agricultural potential by geographical region	Dummy:1=medium-to-high, 0=low	+
yfarm	Farming experience	Number of years	+
fsystem	Maize farming system practiced	Dummy: 1=inter-crop, 0=mono-crop	-
watersys	Main watering systems	Dummy: 1=intercrop, 0=pure stand	-
altitude	Plot elevation	Meters above sea level (MASL)	+

Table 3: Household characteristics

Variable	Overall (N=400)		Test of difference	
	Insured	Uninsured	T-stat	Sig.
Education level of head (mean)	9.09	7.46	-2.78	0.01***
Household size (mean)	4.63	4.54	-0.44	0.66
Adult equivalent	4.00	3.87	0.74	0.46
Dependency ratio	0.74	0.81	0.85	0.39
Proportion of land under maize	0.48	0.44	-0.76	0.44
Total land owned (acres)	3.22	2.43	-1.77	0.00***
Distances (km)				
Farm produce market	4.87	5.59	1.69	0.09*
Motorable road	0.32	0.09	-1.21	0.23
Extension service provider	5.61	5.79	0.28	0.77
Weather station	8.46	5.23	-4.81	0.00***
Group membership (1=yes)	0.81	0.64	-3.79	0.00***
Watering systems (1=rain-fed)	0.94	0.93	-0.66	0.51
Hired labour use (1=yes)	0.89	0.67	-5.51	0.00***
Credit access (1=yes)	0.53	0.36	-3.28	0.00***
Saving account (1=yes)	0.94	0.77	-4.99	0.00***
Gender (1=male)	0.88	0.85	-0.94	0.35
Age of head (mean)	53.26	50.64	-1.89	0.06*
Altitude MASL	1700	1657	0.26	-1.12
Household incomes (Ksh)				
Share of maize income to total income	0.05	0.04	2.0	0.04**
Off-farm income	214,743	134,714	-3.07	0.00***
Farm income	115,631	194381	-3.59	0.00***
Total income	412,304	251,239	-4.17	0.00***

Note *, ** and***, represents significance levels at 10%, 5% and 1% respectively. Exchange rate at the time of survey 1 US Dollar ($) = Kenya Shillings (KSh) 90.

Table 4: Determinants of crop insurance use and amount purchased

Variable	Coefficient	Robust Std. Err.
(a) Insurance uptake decision (1=yes)		
Age of HH head	0.00849	[0.00791]
Education level (years)	-0.00271	[0.0245]
Gender (1=male)	0.0547	[0.278]
Trained (1=yes)	1.981***	[0.265]
Ownership of savings account (1=yes)	0.975***	[0.279]
Exposure to drought (n times)	-0.0741*	[0.0369]
Membership in farmer group (1=yes)	-0.0327	[0.214]
Land allocated to maize (acres)	0.376**	[0.118]
Household size	-0.106*	[0.0475]
Distance to market (KM)	-0.105***	[0.0254]
Distance to reference weather station (KM)	0.0744***	[0.0167]
Plot altitude (MASL)	0.000799**	[0.000308]
Maize farming sys (1=intercrop, 0=pure stand)	-0.1	[0.204]
Main watering systems (1=rain fed, 0=irrigated)	0.588	[0.359]
Constant	-3.050***	[0.829]
(b) Intensity decision (log premiums in Ksh)		
Age of HH head	0.0177*	[0.00724]
Education level (years)	-0.0162	[0.0238]
Gender (1=male)	-0.0923	[0.303]
Hired labour use (1=yes)	0.811***	[0.239]
Ownership of savings account (1=yes)	0.205	[0.299]
Exposure to drought (n times)	-0.0258	[0.0384]
Membership in farmer group (1=yes)	0.575*	[0.227]
Household size	0.135**	[0.0490]
Distance to market (KM)	0.00518	[0.0274]
Distance to reference weather station (KM)	-0.0105	[0.0153]
Plot altitude (MASL)	-0.00114***	[0.000314]
Maize farming sys (1=intercrop, 0=pure stand)	-0.428*	[0.209]
Main watering systems (1=rain fed, 0=irrigated)	0.378	[0.317]
Constant	5.345***	[0.970]
Rho	-0.603	0.196
Sigma	1.292	0.077
Lambda	-0.778	0.277
Observations	331	
Wald test of independence	Chi(2) = 2.43	P value= 0.1189

Note: *, ** and***, represents significance levels at 10%, 5% and 1% respectively. Standard errors are in parentheses.

Figure 1: Insurance uptake patterns

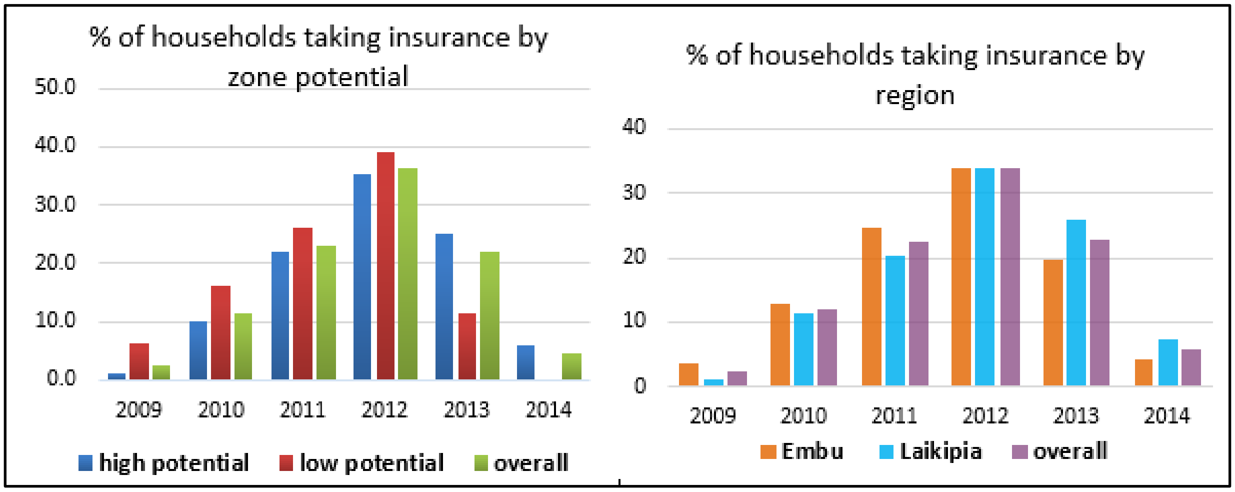

Figure 2: Reasons for non-adoption of crop insurance