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EXPLAINING THE PERCEPTION OF SMALLHOLDERS TOWARDS WEATHER INDEX MICRO-INSURANCE ALONGSIDE RISKS AND COPING STRATEGIES

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Abstract

Many studies associate smallholders with negative attitudes towards weather index-based micro-insurance. This article analyses the perceptions of small-scale maize producers towards weather index insurance amid common risks and coping strategies. Findings do not strongly suggest a negative attitude towards weather index insurance among smallholders thus controverting hitherto studies. Rather, the study postulates that other risks facing smallholders and their risk responses disposition may distort and override farmers' attitude towards weather index insurance. Further, results of the Ordered Probit model revealed that Sex of the household head, size of the household, if a farmer experienced crop loss in the previous farming seasons, off-farm income, if a farmer received compensation, the level of education of the household head, if the household head accessed Credit and group membership had a significant influence on the perception of the smallholders towards the index-based micro insurance scheme.

Key Words: *Perception, Risk, Coping strategies, Weather index insurance*
JEL Codes: *D81, Q12, Q14, Q16*

1. Introduction and Background

Agricultural risks are associated with undesirable effects that arise due to imperfectly predictable biological and non-biological factors which are normally beyond the control of the farmers. Such may include sporadic outbreaks of new pests and diseases, adverse climatic conditions like drought, flood, storm and frost. In addition, others may include or can be classified as resource risks like lack of farm inputs, credit access, poor markets, plummeting of producer prices, un-cushioned input cost fluctuations, destruction of property and loss of lives among farming households. Thus, it is perturbing that the agricultural sector is vulnerable to many risks and uncertainties. As part of the remedy, weather index insurance (WII) is emerging to address the evolving weather perils like drought and excess rains.

Weather index-micro insurance (WII) thus is a topical subject in the present times than ever before and has subsequently stirred up discourse because of the vital role played by agriculture to humanity. Many studies reveal that agriculture is one of the most weather sensitive sectors with a substantially huge demand for financial protection against weather perils by farmers (Jerry R. Skees, 2008; Turvey, 2001; World Bank, 2011). In addition, informal insurance mechanisms commonly used by smallholders have been unsuccessful during manifestations of large covariate risks (Dercon, 1996; Rosenzweig & Binswanger, 1993; Rosenzweig, 1988; Townsend, 1994; Zimmerman & Carter, 2003). Consequently, researchers and policy makers are concerned with agricultural risks and how they can be managed using insurance (Enjolras, Capitanio, & Adinolfi, 2012).

It is noteworthy that index products that are based on cumulative rainfall, cumulative temperature, area yield, livestock mortality and satellite imagery have been developed over time for agricultural producers (Deng, Barnett, Vedenov, & West, 2007; Mahul, 2001; Martin, Barnett, & Coble, 2001; Miranda & Vedenov, 2001; J. R Skees & Enkh-Amgalan, 2002; Turvey, 2001). Progressively also research has concentrated on the potential for using index based products in low-income countries to mitigate against loss of agricultural assets that results from various climate perils (Chantarat, Mude, & Barrett, 2009; Hess, Richter, & Stoppa, 2002; Hess, Skees, Stoppa, Barnett, & Nash, 2005; Mahul & Skees, 2006; Sakurai & Reardon, 1997; J. Skees, Barnett, & Hartell, 2005; J. Skees, Gober, & Varangis, 2001; J. Skees, Hazell, & Miranda, 1999; J. R Skees & Enkh-Amgalan, 2002; J. Skees, Varangis, Larson, & Siegel, 2005; Jerry R. Skees, 2000; Varangis, Skees, & Barnett, 2002). Index based insurance products have also been developed for a number of crops such as maize and cotton growers respectively (Daninga & Qiao, 2014b; Osgood et al., 2007) and the scope is expanding so as to include more crops. In this study index insurance refers to a financial product linked to an index that is highly correlated to the local yields and its contracts are written against specific perils or events that are defined and recorded at regional levels (Hazell et al., 2010). In addition, Hazell et al. affirm that pay-outs are triggered by pre-specified patterns of the index, and not necessarily the actual yields that are obtained. Hazell et al. also explain that the insurance product is based on an independently verifiable index, which can be re-insured, thus allowing insurance companies to transfer part of their risk to international markets.

A plethora of literature in crop insurance exists that focus on the analysis of factors influencing crop insurance uptake (Cole et al., 2013; Daninga & Qiao, 2014b; Gine, Townsend, Vickery, & Take-up, 2008; Sakurai & Reardon, 1997; Smith & Baquet, 1996; Velandia, Rejesus, Knight, & Sherrick, 2009). This uptake of insurance products in the agricultural sector though, remains low Leblois and Quirion (2013) whereas in other commercial sectors like mining, motor vehicle, the services and industrial sectors it continues to thrive. Likewise, implementation of index based insurance has been slow and subsequent uptake by both potential insurance providers and beneficiaries is still low (Cole, Bastian, Vyas, Wendel, & Stein, 2012). Conversely, in a country like the USA where agricultural insurance is heavily subsidised, agricultural insurance uptake is high (Goodwin & Smith, 2013). Some studies suggests negative attitude towards insurance (Daninga & Qiao, 2014a) or limited willingness to pay for the insurance services or products (Enjolras et al., 2012; Hill, Hoddinott, & Kumar, 2013; Mahul & Stutley, 2010) as some of the factors that influence up-take. According to World Bank (2011) certain behavioural and institutional reasons are also causes of the slow uptake of index based insurance because of farmers pursuing other informal risk sharing arrangements. Others reasons are attributed to significant basis risk[1], limited perils, lack of technical capacity, expertise, and data (International Fund for Agricultural Development and World food programme, 2011).

Research further shows that households with low incomes and limited wealth do not choose to adopt risky, but high return activities (Jerry R. Skees, 2008) or to invest in improved agricultural technology and market opportunities thus encouraging precautionary strategies over activities that are more profitable on average (Barrett et al., 2007; Hansen, Mason, Sun, & Tall, 2011). In effect a vicious cycle of low incomes and poverty results, hence impeding adoption of technology as well as innovative tools for managing agricultural risks like WII among smallholders. Presently, more than 100 countries are carrying out crop insurance programmes (Mahul & Stutley, 2010) so as to minimize the effects of adverse weather conditions on farmers. In Africa, for example, WII programs have been piloted widely in several countries such as South Africa, Nigeria, Ethiopia, Kenya, Malawi and Tanzania (Barnett, Barrett, & Skees, 2008; Cole et al., 2013; Daninga & Qiao, 2014b; Hess & Hazell, 2009; Meherette, 2009).

Generally, in practice traditional insurance is an expensive measure of risk mitigation, particularly to smallholders given the costs associated with the assessment of damages and subsequent verifications of individual claims in named-peril or multiple-peril insurance contracts (Jerry R. Skees, 2008). In addition, traditional agricultural insurance schemes face financial challenges because of high administrative and operational costs, adverse selection and moral hazard problems (Kang, 2007) that are caused by the prevalence of asymmetric information. According to Skees (2008) the impact of weather risks on agricultural enterprises and rural households is real, however individuals suffer because development of insurance is hampered by enormous transactional costs and information asymmetry. Index based insurance thus provides an alternative risk-reducing tool with the potential to alleviate the financial effects of adverse weather (Banerjee & Berg, 2012) which to a large extent affect the smallholder farmers attitudes towards agricultural insurance. The index-based insurance though, is subject to salient limitations like basis risk, however, it can provide a less-costly and more-transparent risk management option than other alternative products, hence enabling farmers to make more-productive investments and better manage consumption risk (Cole et al., 2012).

Therefore, against this backdrop, this article examines factors that influence perception towards WII amid common risks and risk coping strategies, following the case of the *Kilimo Salama* (safe Agriculture in Kiswahili) insurance scheme farmers in Kenya. The weather index crop insurance scheme was established in the year 2008. The insurance was designed for maize and wheat farmers. The scheme protects farmers’ investment in farm inputs such as seed, fertilizer and chemicals and against extreme weather risk of drought or excess rainfall. The project is a partnership between the Syngenta Foundation for Sustainable Agriculture, UAP Insurance, and telecoms operator Safaricom Limited. The scheme uses solar powered weather stations to monitor rainfall and mobile phone payment technology to collect premiums and make payments to farmers respectively. Every time farmers purchase inputs (seeds, fertilizer or chemicals) from authorized dealers, they pay an extra 5% in addition to the price as premium. The insurance scheme is distributed by Agro-dealers. These Agro-dealers register the farmer using a camera-phone to scan a bar code on every input that is sold.

[1]Basis risk depicts the mismatch between the index-triggered pay-outs and the actual losses suffered by the smallholders/policy holders. This means that it is possible for farmers/policy holders to receive a pay-out even when they have suffered no losses, and conversely, policyholders may not receive a pay-out when they have actually suffered a loss.

Then a text message confirming the policy instantly goes to farmer's cell phone. The Syngenta Foundation for Sustainable Agriculture has set up automated weather stations to monitor the insurance. If a station reports at the end of the season that the local rainfall has been insufficient, farmers in affected area receive a payout via Safaricom M-PESA money transfer service. The scheme modernized manual rain gauges with solar powered and computerized gauges send out data on rainfall levels, sun and temperatures every 15 minutes. The index insurance policy is offered with respect to the nearest weather station that is within 20 kilometers from where the farm land is located. If the weather station indicates that the rainfall was insufficient early in the growing season, or too much late in the maize season, all farmers in that area receive an automatic payout. And if the rainfall was only slightly off, farmers get a small payment and if the weather was extreme enough to destroy their whole harvest, they get full compensation as prescribed. We further attempt to show how multiple common risks facing smallholder farmers may influence the perception and possibly disadvantage the uptake of index insurance. This study, therefore, contributes to the growing body of literature on WII. Survey data from smallholder maize producers are assessed to give policy implications for nurturing WII.

2. Materials and methods

2.1 Description of study area, sampling and data

The study was carried out in Embu County in Kenya. A sample of 401 smallholder farmers was obtained following Multi-stage sampling technique. Smallholder farmers are defined on the basis of land cultivation that is less than 5 acres. In the first stage, Embu County was purposively selected because of the WII programme. In the second stage, purposive sampling was also used to select maize farmers around the five weather stations (Embu Divisional Agricultural office, Ishiara Agriculture farm; Runyenjes Agricultural Office; Siakago Rural Technology Development Unit; Gachoka DO Office) because *Kilimo Salama* index insurance targeted maize farmers. In the third stage, systematic random sampling was done to identify the farmers who participated in the WII. The final stage involved selection of the non-participants following the simple random sampling.

Cross sectional data were collected by administering a pre-tested interview schedule to the smallholder maize farmers. The interview schedule captured information pertaining to the farm characteristics, social-economic, institutional factors and WII technology characteristics, others include input-output market access, household size, the age, sex and education level attained by a household head, various sources of income, membership to a formal and or informal organizations, participation and frequency of contact with extension personnel, land size, access to credit, distance from home to weather station, years of farming experience and access to weather forecast information. In addition, data on common risks faced by farmers, the risk coping strategies used by farmers, source of information about the WII scheme and perception of farmers towards index insurance were collected. Moreover, the respondents were asked to rank the commonly experienced risks on a scale of 1-8 and the risk coping strategies they use using a scale of 1-10. The scales used in the ranking of risks and risk management strategies vary because the risk management strategies used were not specific or limited to the types of risk experienced.

2.2 Modelling strategy

The perception towards weather index insurance was obtained using a five point Likert scale as follows; 0= poor, 1= fair, 2= average, 3= good, 4= excellent. The mean scores were then determined. An Ordered Probit model was used to evaluate the relationship between perception and factors that were hypothesized to influence it. The suitability of this model derives from the assumption that there is a latent continuous metric underlying ordinal response observed (Jackman, 2000). The latent continuous variable $y^*$is a linear combination of some predictions, *X* and a disturbance term that has a standard normal distribution:

$$y^*_i = X_i\beta + \varepsilon_i,\ \varepsilon_i \sim \text{N } (0, 1),\ \forall=1\ldots\text{N} \qquad (1)$$

Where, y_i^* is the observed ordinal variable that takes on values 0 through m according to the following scheme:

$$y_i = n \Leftrightarrow \mu_{n-1} < y^*_i \leq \mu_n$$

Where, *n*=0....m

The Ordered Probit explicitly shows how changes in the predictors translate into the probability of observing a particular ordinal outcome. The Ordered Probit is appropriate because it identifies the relationships between explanatory variables e.g. socio-economic and institutional factors and a dependent variable (perception of weather index insurance). The model estimates the statistical significance and direction of the relationship each explanatory variable has on each rank of perception, as well as marginal effects (Winship & Mare, 1984). The marginal effects show the probabilities that a farmer would rank the index insurance scheme in the five categories given a set of farmer characteristics and farm attributes. The sign in the parameter estimates and their statistical inference indicates the direction of the relationship (Verbeek, 2004). The Ordered Probit can be expressed in the form:

$$y^* = \beta' X + \varepsilon \qquad (2)$$

Where y^* is the dependent variable (perception) that takes the values 0= poor, 1= fair, 2= average, 3= good, 4= excellent); β' is a vector of estimated parameters and *X* is the vector of explanatory variables; ε is the error term assumed to be normally distributed with a mean of zero and unit variance). It has a cumulative distribution denoted by Φ(.) and a density function on individual falls in category *n* if μ_n-1 <y^* <μ_n. The perception data y_1 are related to underlying latent variable y^* through thresholds μ, where, *n*= 0...4 as shown on the following probabilities.

$$pro(y = n)\phi(\mu_n - \beta' X) - \phi(\mu_{n-1} - \beta' X),\ \text{n=0...4} \qquad (3)$$

where, μ=0 and $\mu=+\infty$ and $\mu_0<\mu_1<\mu_2<\mu_3<\mu_4$ are defined as five thresholds within which the categorical responses are estimated. The estimation of this model is simple and the likelihood function can be derived easily (Mckelvey & Zavoina, 1975). The threshold μ shows the range of the normal distribution associated with specific values of the response variable. The parameter β shows the effect of change in explanatory variable on the underlying scale. The marginal effect of factors *X* on the underlying perception index can be evaluated as shown:

$$\partial prob(y = n)\partial X = -[\mu_n - \beta' X) - \phi(\mu_{n-1} - \beta' X)]\beta,\ \text{n=0...4} \qquad (4)$$

In addition, a measure of goodness of fit can be obtained by calculating:

$$\rho^2 = 1 - [InL_b / InL_o] \qquad (5)$$

where, InL_b is the log likelihood at convergence and InL_o is the log likelihood computed at zero. If all the coefficients are zero, the goodness of fit will be zero. Normally, the goodness of fit cannot be equal to one. However a value that is approaching one indicates a very good fit (Duncan, Khattak, & Council, 1998).

Table 1. Description of factors influencing smallholders' perception of weather index insurance and the expected Sign

Variable	Variable Description	Measurement of Variable	Expected sign
SEXHHH	Sex of household head	Dummy(Male=1, Female =0)	+/-
LANDSIZE	Land size	Continuous (acres)	+/-
OFFFARMINC	off-farm Income	Continuous (Ksh)	+/-
AGE	Age of household head	Continuous Variable	+
COMPENSATED	If farmer received indemnity	Dummy (Yes=1, No=0)	+/-
PREMIUM	Premium paid	Continuous (Kenya shillings)	-
EDUC	Education level	Level of education	+/-
HHSIZE	Household size	Number of persons	+/-
EXTEN	Access to extension	Dummy (Yes=1, No=0)	+
GROUP	If farmer is member of group	Dummy (Yes=1, No=0)	+
CREDIT	If farmer accessed credit	Dummy (Yes=1, No=0)	-
DISTMKT	Distance to the market	Continuous (Kilometres)	-
FORECASTS	If accessed forecast information	Dummy (Yes=1, No=0)	+/-
DISTWSTN	Distance to weather station	Continuous (Kilometres)	-
YEARSEXP	Years of farming experience	Continuous (Years)	+
EXPCRPLOS	If experienced crop loss	Dummy (Yes=1, No=0)	+

As shown in Table 1, we use sex of household head as a dummy variable with 1 to represent male and 0 to represent the female. According to Tangka, Jabbar, & Shapiro (2000) critical farm resources (e.g land, labor, and capital) and access to institutional credit and extension services affect female's participation in dairy production and markets. In this study, we postulated that male farmers are more likely to participate in WII because they are more endowed with, and have more control over farm resources compared to their female counterparts. It was expected that those smallholder farmers who have access to credit would be in a better position to take up new technology. A dummy variable was introduced to capture access to credit. Smallholder farmers may need credit services to acquire inputs (e.g seeds, fertilizer and chemicals). Availability of credit enhances the farmers' capacity to purchase agricultural inputs, hence, participation in the WII scheme. The expected sign of the coefficient of access to credit variable is negative. Extension services are provided by the ministry of Agriculture and thus may act as a major source of information about WII.

Kaufmann (2007) showed that agricultural extension agents are required to deliver and implement agricultural-related goods and services to farmers and therefore it was expected that access to extension service, especially on WII, would influence the perception of the household head positively.

Off-farm income refers to that part of the income measured in Kenya shillings that is earned from non-farm activities. Such income may enable the farmers to purchase farm inputs. As a result off-farm income was expected to positively influence participation in WII. Similarly off-farm income would have a negative effect where farmers spend more time away from the farm to earn it. Regarding the effect of age of household head, we assume that age is positively correlated with the uptake of WII on the basis that older farmers are likely to have accumulated more capital that would lessen the risk effects associated with the adoption of new technology. Age can also be used as a proxy of farming experience and exposure to production technologies in addition to higher physical and social capital. This agrees with Staal et al. (2006) who found that investment level and experience are highly correlated with age. We assume that older farmers may have expertise through their own experience as compared to the younger ones and therefore they are more likely to evaluate and adopt new technologies such as a WII. Education level is considered as a categorical variable that captures various levels of the farmers' education. We postulate that household heads with higher levels of education may have better access to non-farm income and hence, are able to participate in WII. Educated farmers may also be aware of the benefits of modern technologies, have a greater ability to access new information and may understand the complexities associated with WII thus enhancing a positive perception. To the contrary, better educated household heads may pursue more of off-farm employment and less of the farming activities, hence a negative effect on the WII.

Mostly, household size has been positively associated with adoption of new agricultural technologies through provision of labour (Faturoti, Emah, Isife, Tenkouano, & Lemchi, 2006) which is a limited perspective. The household size variable is defined as the total number of household members measured in adult equivalent. It is likely that in a big household, the head may diversify on crops and livestock so as to effectively cope with the common risks hence a negative perception on WII. Land size is an indicator of wealth and is assumed to influence the perception of WII positively or negatively. It was also expected that ownership of smaller parcels land would encourage a positive perception towards WII among farmers because WII concept primarily targets small-scale producers.

Membership to an organization is used as a dummy in the study. Group membership as a form of social network was expected to affect perception towards technology uptake. Farmers who are engaged in informal and/or formal organizations would be in a better position, compared to those who are not in terms of access to information and possibly access to both the input and output markets. It was hypothesized that membership to an organization would positively influence perception towards WII. Concerning distance to the market, it was assumed that ease of access to the market would readily influence the perception of the smallholders towards WII; hence it was expected that distance to the market would have a negative effect. Similarly, since every farmer who buys insurance is linked to the nearest weather station not more than 20 kilometres from where the farm land is located, it was postulated that this would have a negative effect on the perception as distance from the weather station increases. Previous experience of maize crop loss due to extreme weather changes by farmers was expected to positively influence the household head's perception of WII. This is because the WII scheme aim is to cushion farmers against drought or excess rains that subsequently damage maize crop leading to losses. It was also assumed that the insurance premium paid would have a negative effect on the perception of the WII. This assumption holds because when farmers purchase inputs (seeds, fertilizer or chemicals) they pay an extra

5% in addition to price as an insurance premium hence increasing the costs of inputs to the farmers. Compensation or indemnity in the event of suffering a loss is very important in insurance (Vaughan & Vaughan, 2014). It was anticipated to positively influence the perception of farmers towards WII. Likewise, insurance pay-out may have a negative influence to perception, especially in WII due to basis risk. Access to weather forecast information was captured as a dummy variable with 1 representing access and 0 otherwise. We assumed that access to forecast information by the smallholders would either influence their perception towards WII positively or negatively.

3. Results and discussion

3.1 Perception and selected risks and coping strategies

In order to determine the perception of farmers towards the common risks that affect agriculture in the study area, we identified common risks such as drought, excess rains, floods, frost, crop pests and diseases, input costs, marketing difficulties and price volatility. The smallholder farmers were then asked to rank these risks on a scale of 1 to 8 where 1 represents most important risk. Out of this, the most important risks to smallholder farmers were drought (1.29), input costs (3.55) and crop pests and diseases (3.63) respectively. The least ranked risks in the same order of importance were excess rains (5.53), floods (6.60) and frost (7.86) as shown in Table 2. The introduction of WII scheme is a deliberate effort to create a sustainable, effective tool for farmers to manage climate risks commonly associated with rainfall variability and drought that directly affect livelihoods by damaging farmers' harvest and inhibiting the prospects of recovery and continuity of smallholders farming activities in the future seasons. Proceeds from sales of farm produce are the main sources of income for majority of the small-scale farmers in developing countries. Thus when the adverse effects of weather perils harm and the reduce quantity and quality of crop yield, farmers end up with limited food and crop incomes. The latter implication further drives farmers who are low resource users to meagre spending on the farm inputs in the successive season. This means an arduous season would have consequential spiral effects for several seasons where formal risk mitigation measures are limited. Though, as earlier pointed out, agricultural insurance coverage for small-scale producers is not widely available in many developing countries. Thus, establishing and widely scaling-up of WII schemes is vital because of the fundamental risks facing farmers today. The input costs (3.55), crop pests (3.63) and market difficulties (3.71) revealed a clustered trend in the ranking of risks affecting the smallholders as given by the means of the respective scores. This implies that farmers perceive they are entangled in an array of perils and exposed to multiple threats where a singular approach to addressing risks may not necessarily be sufficient. Therefore, an indifferent attitude towards weather index based innovations may result, especially if they are perceived to be incapable of addressing a range of threats.

Furthermore, the analysis sought to determine the farmers' most preferred strategies that are used to cushion them against weather related risks. These include; household engagement in off-farm work, household savings, undertaking crop diversification, reliance on food aid, measures such as stopping children from attending school, borrowing from banks, taking up WII policy, selling of livestock, reducing consumption and borrowing from relatives. Similarly, farmers were asked to rank the various risk coping strategies on a scale of 1-10 where, 1 represent most important and often used strategy and 10 the least important and rarely used risk coping strategy among the smallholders. The results show that the smallholder farmers ranked engagement in off-farm work (2.01), use of household savings (3.26) and crop diversification (3.71) as the most important strategies of coping with drought and hunger.

Borrowing from banks (7.04), food aid (7.27) and stopping children from attending school (8.36) were ranked the least important strategies (Table 2). Notably, in the study was the use of savings as a coping strategy which poses a conundrum because farmers who are low resource users may not always be able to amass sufficient wealth to cover their losses in the event of crop damages and loss that result from weather variations. This would be observed more when covariate risks occur. Hazell et al. (2010) asserts that loss of productive assets can push households into poverty, from which it may be difficult to recover in the subsequent years. In addition, literature shows that informal risk coping mechanisms that depend on neighbours for example, are not effective in the case of covariate shock such as drought because many households within a certain region suffer simultaneously (Dercon, Hoddinott, & Woldehanna, 2005; Harrower & Hoddinott, 2005). Eventually this leads to a persistent pattern of reduced consumption thus agreeing with our argument that savings can be regarded as a frail option that may not sustain coping with the risks substantively. Thus, it is more likely that individuals result in immediate liquidation of assets such as livestock, which is a form of savings to smallholders for resilience after shock. In effect this might as well exhaust the resources that are required to obtain farm inputs for the subsequent seasons. Moreover, it has been observed that climate shocks precipitate effects such as children withdrawing from school and causes a decline in household productivity, asset accumulation and income growth (Dercon & Hoddinott, 2005; Dercon & Krishnan, 2000; Hoddinott & Kinsey, 2001; Hoddinott, 2006).

As explained, drought can literally deprives farmers off the capacity to save for the future. Equally, excess rain at the time of crop establishment or harvest too is hazardous and can subject farmers to the misery of incurring massive crop losses (Kibui, 2015). This is due to the physical crop and yield damage before harvest as well as lack of proper storage facilities which leads to wastage of farm produce. In such circumstances, sustainable remedies like the innovative WII that can ultimately compensate the farmers (except for the crop that has been already harvested) are most appropriate.

Strikingly, the results indicate that WII was ranked seventh in the order of preference as a risk coping strategy by the farmers. This is critical in an effort to understand and curb weather related risks because it's a pointer to existing perception challenges. Innovations in index-based insurance may still present challenges, however, Ke, Qiao, Kimura, & Akter (2015) affirm that crop insurance programs benefits are quantifiable and that they improve the welfare farmers. Similarly, Ali (2013) found that in the rain-fed areas of Pakistan farmers considered index based insurance as an important risk management strategy.

Analogous to the ranking of risks in the study, ranking of the risk coping strategies revealed that selling of livestock (5.39), Reduce consumption (5.60) and weather index insurance (5.71) were clustered too. It can thus be said that WII is preferred, just as much as the other coping strategies, even though in absolute terms the strategies are distinctly ordered. This buttress the explanation that given the average clustered scores where WII is embedded, perception towards insurance does not necessarily suggest a strong negative connotation in isolation. Rather, it qualifies that multiple-risks play a role in the orientation that farmers have about coping strategies in addition, the risks response disposition of the farmers may distort and override farmers' attitudes towards the WII. The ranking of index insurance on an average basis reveals that farmers possibly have certain inherent reservations to the use of WII. This is exercised when farmers' meagre resources are split and allocated among several risk coping strategies, including WII to mitigate possible risks. In the likely circumstances that most smallholders are low resource users the multiple divisions of resources infers that not a single strategy gets the requisite financial support sustainably. As a result, farmers remain exposed to risks, including where technology is advancing solutions like in WII. Ultimately, farmers may tend to exude negative perceptions when they shun WII products because they are uncertain about relying upon the index insurance to cushion them against devastating crop losses due to the numerous risks that they encounter.

Table 2. Order of importance of risks and coping strategies as perceived by smallholder farmers

RISKS	Order of Importance	N	Mean	Std Error	RISKS COPING STRATEGIES	Order of Importance	N	Mean	Std Error
Drought	1	401	1.29	0.073	off-farm work	1	401	2.01	0.123
input costs	2	401	3.55	0.124	HH savings	2	401	3.26	0.116
Crop pests	3	401	3.63	0.089	Diversification	3	401	3.71	0.176
market difficulties	4	401	3.71	0.096	borrow from relatives	4	401	4.97	0.121
Price volatility	5	401	4.81	0.112	sell livestock	5	401	5.39	0.128
Excess rain	6	401	5.53	0.100	Reduce consumption	6	401	5.60	0.145
Flood	7	401	6.60	0.113	Index insurance	7	401	5.71	0.116
Frost	8	401	7.86	0.123	borrow from banks	8	401	7.04	0.109
					Food Aid	9	401	7.27	0.104
					stop children schooling	10	401	8.36	0.001

Source: Survey data 2015, Embu County

3.2 Determinants of perception towards rating the effectiveness of index-based weather insurance

Table 3 presents the coefficients and marginal effects of the Ordered Probit model of the various factors influencing producers' perceptions towards WII. The marginal effects were estimated because the interpretation of coefficients as shown in table 3 alone is not sufficiently informative. The marginal effects (partial derivatives) depict the probabilities and impacts of a change in an explanatory variable on the predicted probabilities denoted by columns dy/dx_0 (poor), dy/dx_1 (fair), dy/dx_2 (average) dy/dx_3 (good) dy/dx_4 (excellent). The findings suggest that both socioeconomic and institutional characteristics are vital in shaping the households' head perceptions. The R^2 value indicates that 16.7% variation in the dependent variable was due to the independent variables included in the model. The LR χ^2 was significant at 1% level, indicating the robustness of the variables used.

The Sex of the household head was significant with a positive marginal effect in rating the effectiveness of WII of 5.39%. Both male and female genders participate in rural household small-scale farming activities as well as in technology uptake. This may suggest differences in the way household heads reveal perception towards WII technology due to the diversity of household decision making. Studies show that men and women exhibit different characteristics, in terms of their willingness to take risks and to trust people with women tending to make less risky choices (Eckel & Grossman, 2008). Likewise, others argue that

WII and other rural financial products are mostly designed for men, and they hardly account for gender-specific needs and constraints (Fletschner & Kenney, 2014). In addition (Akter, Krupnik, Rossi, & Khanam, 2016) found significant insurance aversion among female farmers, irrespective of the attributes of the insurance scheme under consideration.

Table 3. Coefficients and Marginal Effects of the Ordered Probit Model of Farmer Perceptions towards Weather Index Insurance

variable	Coefficients	dy/dx_0	dy/dx_1	dy/dx_2	dy/dx_3	dy/dx_4
Sex of household head	-4.3112 (2.2163)*	0.3484 (0.3922)	0.0539 (0.2550)*	0.0629 (0.0912)	-0.6215 (0.4207)	-0.3295 (0.4945)
Land size	0.7713 (0.5191)	-0.0100 (0.0164)	-0.1752 (0.1404)	-0.0825 (0.0739)	0.2549 (0.1849)	0.0128 (0.0308)
logoff-farm income	3.4682 (1.4704)**	-0.0448 (0.0692)	-0.0807 (0.3501)**	-0.3710 (0.2885)	0.0410 (0.4620)**	0.0575 (0.1341)
Age of household head	0.1436 (0.0959)	-0.0019 (0.0030)	-0.0326 (0.0205)	-0.0154 (0.0149)	0.0475 (0.0298)	0.0024 (0.0058)
Compensated for loss	-2.4077 (1.3646)*	0.1133 (0.1542)	0.0028 (0.2179)**	-0.0643 (0.2261)*	0.1136 (0.0829)	-0.0734 (0.1384)
Premium paid	0.6560 (0.7376)	-0.0085 (0.0152)	-0.1490 (0.1813)	-0.0702 (0.0860)	0.2168 (0.2513)	0.0109 (0.0264)
Education level	-1.4960 (0.9524)*	0.0193 (0.0300)	0.3398 (0.2103)	0.1601 (0.1486)	-0.1443 (0.2893)*	-0.0248 (0.0611)
Household size	1.9490 (0.7139)**	-0.0251 (0.0391)	-0.0046 (0.1760)**	-0.2085 (0.1572)	0.0640 (0.2293)***	0.0323 (0.0751)
Access to extension	0.4999 (1.2929)	-0.0095 (0.0356	-0.1258 (0.3501)	-0.0474 (0.1079)	0.1763 (0.4695)	0.0063 (0.0213)
Group membership	-1.4063 (1.9714)*	0.0112 (0.0212)	0.2217 (0.2039)	0.1369 (0.1553)	-0.0991 (0.1623)*	-0.0706 (0.2694)
Access to credit	-2.4537 (1.3982)*	0.1186 (0.1715)	0.0264 (0.2054)**	0.1123 (0.0830)	-0.0014 (0.2404)***	-0.0659 (0.1316)
Distance to market	-0.2323 (0.1450)	0.0030 (0.0049)	0.0528 (0.0340)	0.0249 (0.0228)	-0.0768 (0.0477)	-0.0038 (0.0092)
Forecast information	-0.8766 (1.8080)	0.0054 (0.0100)	0.1377 (0.1690)	0.0934 (0.1693)	-0.1997 (0.1919)	-0.0368 (0.1666)
Distance to weather station	0.0868 (0.0734	-0.0011 (0.0019)	-0.0197 (0.0167)	-0.0093 (0.0099)	0.0287 (0.0232)	0.0014 (0.0037)
Years of farming experience	-0.1331 (0.0600)**	0.0017 (0.0028)	0.0302 (0.0149)**	-0.0142 (0.0113)**	-0.0440 (0.0196)	-0.0022 (0.0053)
Experienced crop loss	3.7249 (1.3227)	-0.4288 (0.2963)	0.0842 (0.2274)	-0.0241 (0.0503)	0.0093 (0.1769)	0.1079 (0.1764)
Predicted probabilities						
Prob(Y=0|X)	0.0044					
Prob(Y=1|X)	0.1523					
Prob(Y=2|X)	0.1419					
Prob(Y=3|X)	0.6955					
Prob(Y=4|X)	0.0058					

NOTE ***, **, * means significant at 1%, 5% and 10% probability levels, respectively, LR chi2 (15) = 41.71, Prob > chi2 = 0.000, Pseudo R2 = 0.167, Log likelihood = -135.9741, N=401

Credit access influenced perception about the effectiveness of WII in two fold. Firstly, the results show that credit access has a probability of 2.64% to positively influence perception regarding effectiveness of WII as fair. Secondly, credit has a probability of 0.14% to negatively influence the rating of index insurance as being good when credit changes by one unit. This can be explained that credit is an important variable that could improve the perception of farmers when accessed by the rural farming households who normally do not obtain it from formal institutions. The negative influence implies that farmers may access credit and expend it on other purposes other than farming activities like the WII. Ordinarily just like in non-farming activities, individual farmers seek credit when hard pressed by other special domestic (e.g dowry, medical, school fees) needs hence they may not give insurance policy (added cost) a priority. Nonetheless, access to credit is a major challenge to most rural smallholder farmers due to lack of collateral, lack of bankable projects and high risk of agricultural credit to farmers (Munyambonera, Nampewo, Adong, & Mayanja, 2012). Studies examining the effects of bundling index insurance with micro-credit have assumed that small-scale farmers already have access to credit, and therefore, focused on how insurance affects farmer demand for loans (Carter, Cheng, & Sarris, 2011). In reality, one of the reasons of low adoption of WII products among rural farm households in many developing countries is linked to poor access to credit, implying that farmers often have difficulty finding enough money when they are supposed to make these purchases (Mcintosh, Sarris, & Papadopoulos, 2013) . Therefore, access to credit may allow farmers who want but cannot afford WII an opportunity to insure their crops.

Contrary to expectation, the membership to a group variable had a negative effect on the ratings of the WII effectiveness. The probability thus declines by 9.91% where a smallholder farmer participates in the local social groups. Both formal and informal groups are used as important avenues for trainings; farmer field schools (FFS), extension demonstrations and dissemination of information by various organs in the rural setup. This enhances ease of information and knowledge sharing about WII among group members. Thus the finding suggests that farmers used the groups much more on other social and cultural activities (e.g weddings, funerals) other than agricultural related where WII uptake is one. A study by (Kumar et al., 2011) showed that farmer's participation in social and community-based organization increased the probability of being aware about crop insurance scheme.

It was noted that farmers' education levels significantly influence perception towards WII. The probability of education level reducing the chance of rating WII as good was found to be 14.43%. An increase in the level of education thus implies that education makes individuals more versatile and enhances the way individuals perceive, understand, interpret and respond to issues. In addition, better educated farmers may consider pursuing other economic activities other than agriculture thus the negative effect. A study by (Murage et al., 2011) affirms that educated farmers were more flexible in acquisition of information sources and would consult depending on the prevailing circumstances to meet their needs.

Just like other forms of insurance where compensation or indemnity is vital in the event of suffering a loss (Vaughan & Vaughan, 2014), it is equally important in agricultural insurance. We find that compensation due to crop loss variable led to positive rating of the WII as fair with a probability of 0.28%. Conversely, the rating of the WII had a probability of 6.43% with a negative effect. This implies that although pay-out was done, possibly it did not cover the full losses as experienced by the farmers. This is called downside basis risk, where a farmer pays for an insurance contract, the year turns out to be bad and no pay-out is made following the difference between the index and actual rainfall record on the field. Thus, having knowledge and understanding of whether payment will be made or not when the peril operates is vital. As mentioned, index insurance is based on local e.g rainfall indexes that are closely related with the yields in the region. So that when the payment threshold is met farmers automatically receive payment without a costly process of estimating their losses. Normally farmers will expect full compensation in the event of loss. In addition, the weather index concept holds that farmers may also receive pay-out even when they have actually not suffered a loss as long as the index triggers payment due to the differences recorded between the farm and the reference weather station. Such varied occurrences may wield potential to influence the perception that small-scale farmers hold about WII.

Further, the effect of household size was positive and significant. This reveals that an increase in size of household by one member reduces the probability of rating the effectiveness as fair by 0.46% while it also increases the probability of a good rating by 6.40%. These observations can be explained differently; firstly, a big household may have diversified on crops, livestock and income to effectively cope with the common risks. Secondly, in positively increasing the probability these empirical results suggest that an increase in the size of the household impelled the household to view other innovative measures such as WII as appropriate in cushioning against crop loss. In addition, a bigger household size may imply diversity in opinions, exposure to new knowledge, information or ideas as shared by different members that could affect how the household head makes decisions. Mostly a big household size has been associated with adoption of new agricultural technologies through provision of labour (Faturoti et al., 2006).

The number of years of farming experience was significant in the study and a change in the years of farming led to a fair and average rating of the effectiveness of the WII by 3.02% and 1.42% respectively. The negative sign on the average rating imply that those farmers with more years of farming experience were less likely to rank WII as average and more likely to rank it as fair. According to (Isaboke, Mshenga, Mutai, & Saidi, 2012) increase in years of experience leads to a better understanding of farming by way of learning new skills and appreciating new knowledge thus leading to an increase in the extent of adoption of technology. Similarly, (Oluoch-Kosura, Marenya, & Nzuma, 2001) affirmed that experienced farmers often have better technical knowledge and are better placed to assess risks and possible returns on investment of a technology.

The Household head's off-farm income was also significant and it negatively influenced the probability of perceiving WII as fair. This implies that an increase in off-farm income by one unit reduced the probability of rating the scheme by 8.07%. This is probably because of the fact that farmers who were involved in off-farm activities and other formal employment engaged limited time in pursuit of other on-farm activities and measures of risk mitigation such as WII. It is also possible that farmers who participate more in off-farm activities tend to earn higher income which allows a household to easily smooth consumption; as a result farmers would view WII as just a fair coping strategy. Contrary, it was also observed that an increase in off-farm income by one unit would increase the probability rating of WII as good by 4.10%. This can be explained that off-farm income may have been used to some extent to meet farm expense requirements such as any extra costs coming with the new innovation of WII like the premium load on the price of inputs (seeds, fertilizer and pesticides) at the start of a planting season. Other empirical studies show that off–farm income may provide income for the purchase of inputs, thus enhancing uptake of new technology since that addresses the risk in trying out new technologies (Mathenge & Tschirley, 2007)

4. Conclusion and policy implications

Smallholder farmers face multiple risks in their farming activities. Studies also show that agriculture is one of the most weather sensitive sectors and farmers' demand for financial protection against weather perils is huge. In order to address this situation an innovation platform and research beyond classical agricultural insurance has led to development of WII products. Smallholders who are the ultimate beneficiaries on the other hand, however are non-exuberant and slow in embracing such innovations. This continues to be a major setback towards adoption and advancement of suitable technologies that could enhance smallholders' productivity and smoothing of agricultural incomes. Literatures also reveal that farmers have a negative perception towards WII without extensive prodding the effects of other risks that farmers face. This research sought to determine the perception of smallholder farmers towards WII amid common risks and risk coping strategies. The study generally established that farmers do not rank WII as the most preferred risk coping strategy. Instead, involvement in off-farm activity, drawing from savings or investments and crop diversification provide an alternative cushion against risks. Furthermore, the findings do not strongly suggest a negative attitude towards the use of WII among smallholders thus controverting hitherto studies. In addition, the study rather postulates that other risks facing smallholders and their risk responses disposition may distort and override farmers' attitude towards WII. Thus leaving farmers uncertain regarding the extent to which they can rely upon WII in cushioning against devastating crop losses due to the occurrence of multiple risks.

The output of the Ordered Probit model further reveal that Sex of the household head, size of the household, if a farmer experienced crop loss in the previous farming seasons, off-farm income, if a farmer received compensation/indemnity, the level of education of the household head, if the household head accessed Credit and group membership had a significant influence on the perception of the smallholders towards the WII. The findings reveal the ranking of WII as largely fair and good at the same time with respect to various independent variables, thus signifying potential for success of such a tool of risk mitigation. We recommend the use of farmers' perceptions as an important entry point for enhancing crop insurance research and dissemination of WII information to the ultimate consumers and policy framework development. Further studies on the role of gender and collective action in enhancing WII are also recommended. It is important, however to note that index insurance is a financial product and not a physical product like in other innovative crop or animal technologies. It is rather conceptual but has observable benefits occasionally thus due diligence is paramount in the totality of processes that would make WII functional as well as in scaling it-up among smallholder farmers.

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