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Subsistence versus Cash Crop Weather Index Insurance. A Willingness to Pay Study for Maize and Bean Crops in Mafeteng, Maseru and Berea Districts

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Abstract
The paper analysed the potential of weather index insurance as one of the strategies for managing climate variability in Lesotho through a Double Bounded Dichotomous Choice Contingent Valuation Method with an open ended follow up question to elicit farmers' willingness to pay. The study went further to compare willingness to pay for weather index insurance between a cash crop (Bean) and a subsistence crop (Maize). Bivariate probit model was used in the analysis. Based on data collected from 400 farmers, the results showed that majority of farmers are willing to insure their crops; maize (94.75%) and bean (92.5%) against weather perils and pay a monthly premium of M96.72 ($7.28) for maize and M101.31 ($7.63) for beans. This implies that farmers in the lowlands of Lesotho regard weather index insurance as one of the strategies for managing climate variability. The results of the t-test showed statistical significance ($p<0.1$) between maize and bean mean willingness to pay. Thus, policy and program intervention designed to address the climate variability problem in the study area should consider these preferences in the insurance product.
Keywords: Willingness to pay, weather index insurance, maize, beans

1. Introduction

Climate variability is a major threat to agricultural production in many developing countries including Lesotho due to its overreliance on rain fed production. Lesotho experienced severe weather conditions which affected agricultural production and suppressed growth in 2011 and 2012. The 2011/2012 heavy rainfall affected maize which is a staple food to 62% of the population. This disaster affected 514, 000 people who needed food assistance to survive (Government of the Kingdom of Lesotho [GoL], 2011). Although there was a modest recovery in the crop subsector and positive growth from animal farming, services and forestry in 2013 (GoL, 2013), the growth was short-lived. The country experienced yet another blow from dry spells in 2015 that forced government, United Nations and other humanitarian partners to invest in emergency and relief services to assist majority of the farmers who did not plant or harvest anything (United Nations [UN], 2016). Despite the climate variability challenge, agriculture is the main source of livelihoods for majority of rural families in Lesotho.

More than 80% of the population resides in rural areas and depends on subsistence farming and to a limited extent on pastoral production. However, only 9% of the total area is suitable for arable cultivation (GoL, 2014a). The major crops commonly grown are cereals and cash crops. Maize is the main cereal crop which covers 60% of agricultural land in Lesotho (GoL, 2014b). It is consumed in the households and used as an input in the industries for processing high value added products. Its straw is used as livestock feed for most animals. Dry bean is a very common cash crop because Lesotho's topography is suitable for dry bean production. The most common dry bean types are white and sugar beans. Dry bean is a vital and high value subsistence cash crop of smallholder farmers throughout Lesotho. Beans are high in protein, and serve as a substitute for the scarce animal and fish protein (Sefume, 2010). They are also promoted by the GoL and World Food Programme (WFP) through School Feeding Programme. However, yields have been declining for major crops in Lesotho because of factors such as low rainfall during planting time, and development stage. Area planted fluctuates between 9000 to 30000 hectares annually (World Bank, 2014). This suggests that crop production damage affects the welfare of many households.

Considering the dependence of Lesotho population on agricultural production, the irreplaceable crop production loss due to weather variability makes research and development on strategies to manage climate variability risks a priority. The current climate risk management strategies employed by farmers such as intensification, diversification, savings and borrowings may relief farmers out of smaller losses. Such measures tend to fail in the event of catastrophic shocks such as drought crisis (Heltberg & Lund, 2009; Dercon, 2002).

Transferring the risks to a third party or insurance provider is one of the options to managing climate variability (Giné & Yang, 2009). Recent studies have shown that index based insurance can assist farmers to hedge against risks and also encourage farmers to venture into high value crops with high returns (Mapfumo, 2008; Bryla & Syroka, 2007). There is a large body of literature on economics of weather index based insurance (Abebe & Bogale 2014; Ramasubramanian 2014; Makaudze & Miranda, 2010). However, no study has compared farmers demand for cash and subsistence crop despite the fact that the crops play different roles on household's welfare. This study therefore tests the hypothesis that farmers' willingness to pay (WTP) for cash crop and subsistence crop weather index insurance is different. The study went further to establish determinants of farmers' decision to participate in maize and bean weather index insurance.

1.1 Study Context

Most researchers define index insurance as an insurance which compensates the insured based on the objectively observed value of an index that is correlated with the yield losses (Barnett & Mahul, 2007). The index can be in the form of rainfall data which is usually collected from local weather stations, Normalized Difference Vegetation Index (NDVI) which is collected by satellites and measures vegetation density, sea surface temperatures (SST) and cumulative temperature over a season that is strongly associated with insurable loss (Skees, 2008). The details of how the insurance works are provided by figure 1.

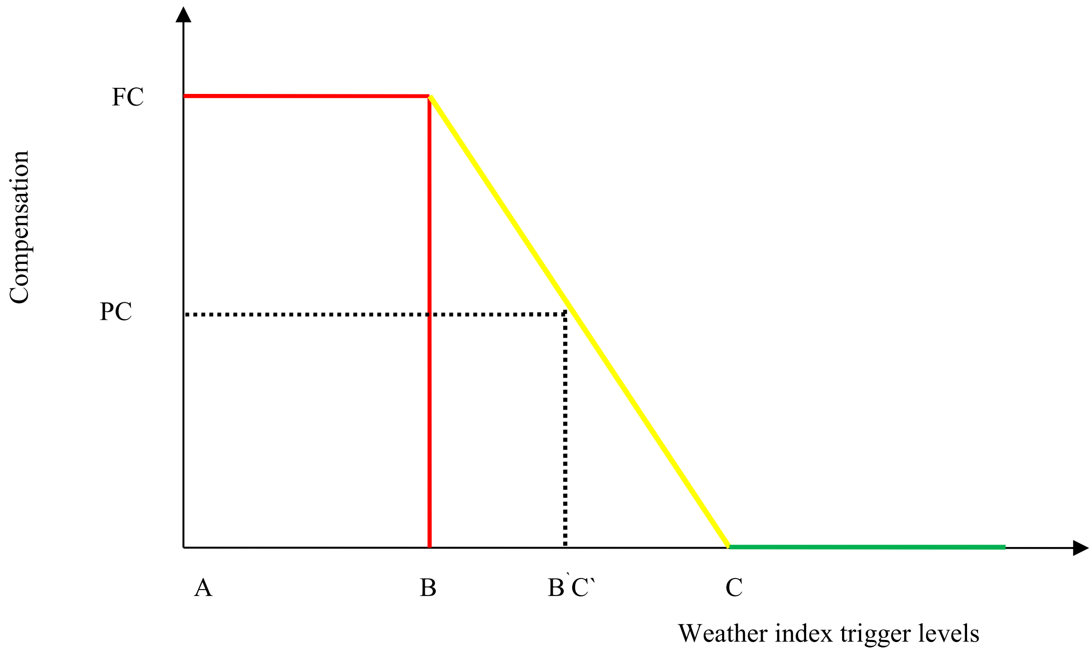

Figure 2 : Weather Index based insurance compensation and index trigger levels

Adapted from Makaudze and Miranda, 2010

Figure 1 shows that when the insurance index is triggered at point "A", the insurer will compensate the farmer "FC" which is the full payment such that the production loss is eliminated and the farmer revenue stays crop production loss free. If the index is triggered between point "A" and "B", the farmer will get full compensation. But if the index is triggered between "B" and "C", the farmer gets proportional compensation depending on the level of index. For instance, if the index is at "B`C`", the compensation will be "PC". And lastly if the index is from point "C", the index is not triggered therefore there will be no compensation.

Thus, Index insurance is free from moral hazard (farmers cannot influence the value of the index) and adverse selection (payouts are based on generally observed variables) in that the contract is standardized and there is no need to individually design the contract or verify losses which can substantially reduce the transaction costs of monitoring and verifying the insurance contracts (Barnett & Mahul, 2007; Miranda & Vedenov, 2001; Miranda, 1991). In addition, it is cheaper to administer because it does not require on-farm inspections and field loss assessments.

2 Empirical Methodology

The study used double bounded Contingent Valuation (CV) technique to elicit WTP. With double bounded format, there are four possible outcomes "yes-yes", "yes-no", "no-yes" and "no-no" responses. First, the respondent k was asked if she/he would be willing to pay a certain bid B_S (starting bid) for weather index insurance. If she/he said "yes", she/he was offered a second, higher bid, B_H where she/he either accepted or rejected. For respondents who said "no" to the initial bid, they were offered a second, lower bid, B_L where they also had a chance to reject or accept it. Following Hanemann *et al.* (1991) the four discrete outcomes are;

$$D_k = \begin{cases} 1\ if\ WTP > B_H \\ 2\ if\ B_S < WTP < B_H \\ 3\ if\ B_L < WTP < B_S \\ 4\ if\ WTP < B_L \end{cases} \quad (1)$$

The general econometric model is then specified as;

$$WTP^*_{jk} = \mu_j + \varepsilon_{kj} \quad (2)$$

where WTP^* is the unobserved WTP for kth households and j is the household response to the first bid and second bid, μ is the mean WTP of the first and second bids, and ε is the error term with mean zero for the first and second bids. Treating the means as a function of individual covariates;

$$\mu_j = \beta X_{kj} \rightarrow WTP_{kj} = \beta X_{kj} + \varepsilon_{kj} \quad (3)$$

Equation (3) accommodates the kth respondent to first and second responses to the CV question. To construct the likelihood function we derive the probability of observing each of the two-bid response sequence (yes-yes, yes-no, no-yes, no-no). The probabilities corresponding to the above outcomes are;

$$\Pr(D = yes - yes) = \Pr(B_S \leq Max\ WTP, B_H \leq \max WTP)$$
$$\Pr(D = yes - no) = \Pr(B_S \leq Max\ WTP \leq\ B_H)$$
$$\Pr(D = no - yes) = \Pr(B_S \geq Max\ WTP \geq\ B_L)$$
$$\Pr(D = no - no) = \Pr(B_O > Max\ WTP, B_L > \max WTP)$$

The log-likelihood function then becomes;

$$\log L = \sum_{i=1}^{N}[\Pr(B_S \leq Max\ WTP, B_H \leq \max WTP) + \Pr(B_S \leq Max\ WTP \leq\ B_H) + \Pr(B_S \geq Max\ WTP \geq B_L) + Pr(B_S > Max\ WTP, B_L > max\ WTP)] \quad (4)$$

The WTP for each individual has a bivariate normal distribution with mean zero and constant variance. Thus, the bivariate probit model was estimated to determine the mean WTP.

Following Greene (2002), the bivariate probit model is specified as;

$$WTP^*_1 = \alpha + \beta X + \varepsilon_1 \quad (5)$$
$$WTP^*_2 = \theta + \varphi X + \varepsilon_2 \quad (6)$$

where WTP^*_1 and WTP^*_2 are household willingness to pay for the first bid and second bid, respectively. β and φ are parameters to be estimated for each model and $\varepsilon_1 and\ \varepsilon_2$ are model disturbance terms. The error terms are independent of each other and normally distributed with mean zero and constant variance. The Xs are explanatory variables.

Equations (5) and (6) were estimated through bivariate probit using maximum likelihood method. From the bivariate probit model, the mean willingness to pay which is the demand for weather index insurance was then estimated as;

$$MWTP_1 = -\frac{\alpha}{\beta} \quad \text{and} \quad MWTP_2 = -\frac{\theta}{\varphi} \quad (7)$$

where α and θ are parameter estimates for the constants and β and φ are parameter estimates explanatory variables (Haab & McConnell, 2002).

2.1 Study variables and their measurement

Based on the reviewed literature, socio-economic and geographical variables used in the empirical models are summarized in a table below;

Table 2.1: Variables description, units of measurement and hypothesised sign

Variable	Code	Measurement	Postulated sign	Reference
Socio-economic characteristics of the farmer				
Household monthly income	Income	Continuous	+/-	Ghazanfar *et al.* 2015; Ali, 2013
Previous exposure to risk	Lossexper	1= Yes if the farmer has been exposed to weather risk before, 0= No	+/-	Ghazanfar *et al.* 2015; McIntosh *et al.* 2013; Liu *et al.* 2015
Number of years of farming	Yearsoffarm	Continuous variable indicating number of years the farmer has been practicing farming	+/-	Zhang and Fan, 2016
Education type	Eductype	1= Formal, 0= Informal	-	Gebre, 2014
Access to climate variability information	Climateinfor	1= Yes, if the farmer owns a radio, and 0= No	+	Abebe and Bogale, 2014
Current risk management strategies	Strategyadeq	1= Adequate, 0= Inadequate	-	McIntosh *et al.* 2013
Age of the farmer	Age	Continuous variable showing number of years of the farmer	+/-	Abebe and Bogale, 2014; Zhang and Fan, 2016
Gender of the farmer	Gender	1= male, 0= female	+	Abdullah *et al.* 2014
Institutional factors				
Land Size	Landsize	Number of acres planted by the farmer, Continuous	+	Ghazanfar *et al.* 2015; McIntosh *et al.* 2013; Akter *et al.* 2009
Geographical factors				
Mafeteng	Mafeteng	This is a dummy variable that indicates whether a farmer stays in Mafeteng District or not;1= Yes, 0=No	+/-	Bendig *et al.* 2009
Maseru	Maseru	This is a dummy variable that indicates whether a farmer stays in Maseru District or not;1= Yes, 0=No	+/-	
Berea	Berea	This is a dummy variable that indicates whether a farmer stays in Berea District or not;1= Yes, 0=No	+/-	Barry *et al.* 2004; Cole *et al.*2009

3 Data and Sampling

400 farmers were face to face interviewed using structured questionnaires in the three districts of Lesotho: Mafeteng, Maseru and Berea in 2016. The questionnaire was structured using National Oceanic and Atmospheric Administration (NOAA) guidelines for conducting CV surveys. The first part of the questionnaire consisted of farmers' perception on climate variability and its effects on their farms. The second part looked at the current strategies and their weaknesses in managing ex-ante climate variability risks. The third part described the CV scenario and lastly the final part looked at the socio-economic characteristics of the farmers. Before the implementation of the study, a pilot study was conducted to establish starting bids and also to pre-test the questionnaire for modifications.

4 Results and Discussion

4.1 Descriptive statistics

The study results as summarised in table 4.1 show that out of 400 smallholder farmers interviewed, 95% were willing to participate in the weather index insurance for Maize and 93% were willing to pay for weather index insurance for beans. This implies that most farmers are willing to insure their crops based on weather derivatives. The average household monthly income for each household is M1293.88[1]. The primary source of income was stated by most farmers as farming (48.60%), self-employed (25.19%), employed (21.12%) and lastly pension was stated by 5.09% of the farmers as their primary source of income. On average each household had access to 5.51 acres of agricultural land. Most of the land was owned by the farmers, few stated that they rented and share cropped. The results of the survey further showed that farmers have been practising farming for a long time. Further 75.43% of the farmers stated that they had suffered production loss due to climate variability in the previous years. Climate variability information help farmers to prepare against weather hazards before they occur and 97.24% of the smallholder farmers indicated that they have access to climate variability information in the country through radio, television set, newspapers and cell phones. Majority of the farmers (75.9%) stated

[1] 1US$=M13.28. www.exchange-rates.org.Accessed on 22/09/2017

that they perceive more extreme weather conditions to prevail in the country in the next 10 years. This suggests that farmers are aware of the climate variability situation and the fact that it is not over yet. Farmers have their own indigenous climate variability risk management strategies, however few of the farmers 42.61% stated that their risk management strategies are adequate. This implies that more farmers 57.39% feel that their current coping mechanisms are lacking. Out of the sampled respondents, 58.39% were men while 41.61% were women. This is not surprising since after retrenchment from the South African mines, most men had to venture into farming so as to make living while majority of the women worked at the factories. In line with the national statistics, majority of the sampled farmers have attended formal schooling. Thus they have basic reading, writing and calculation skills. They can therefore weigh options which is important when making decision whether to take part in agricultural insurance or not.

Table 4.1: Summary statistics of variables

Variable	Mean
WTPMAIZE (yes = 1)	0.947468
WTPBEANS (yes = 1)	0.924812
Household monthly income	1293.885
Land size in acres	5.514286
Age of the farmer	44.88722
Number of years of farming	19.96684
Number of years of schooling	8.876574
Previous exposure to risk (yes= 1)	0.754386
Access to climate variability information (yes= 1)	0.9724311
Forecast severe weather conditions in the future (yes= 1)	0.7593985
Current risk management strategy adequate (yes= 1)	0.4260652
Gender of the farmer (Male=1)	0.5839599
Education type (Formal= 1)	0.9348371

Source: Survey, 2016

4.2 Farmers WTP distribution by crop type, location and Reasons for not willing to pay

Majority of farmers (94.75%) are willing to pay for maize weather index insurance (see Figure 4.1). Likewise, majority of farmers (92.5%) are willing to pay for bean weather index insurance (see Figure 4.2). The results are consistent with Abebe and Bogale (2014). Abebe and Bogale (2014) found that majority of farmers were willing to pay for rainfall insurance in central Rift valley, Ethiopia. Similarly, Gebre (2014) and Ramasubramanian (2014) found that many farmers were willing to pay for insurance. This implies that farmers regard weather index insurance as one of the strategies that can be adopted on their farms for managing climate variability risks.

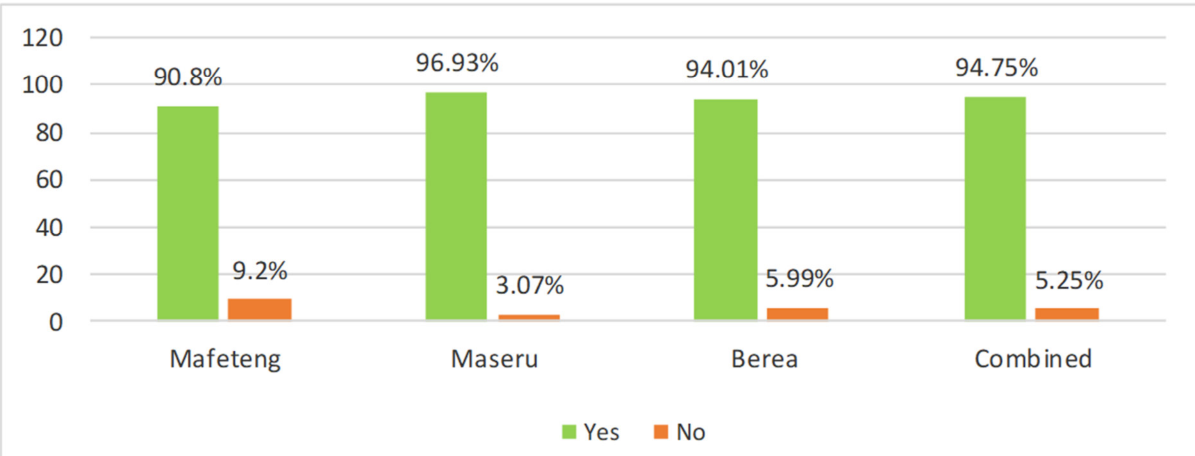

Figure 4.1: WTP distribution for maize weather index insurance
Source: WTP Survey, 2016

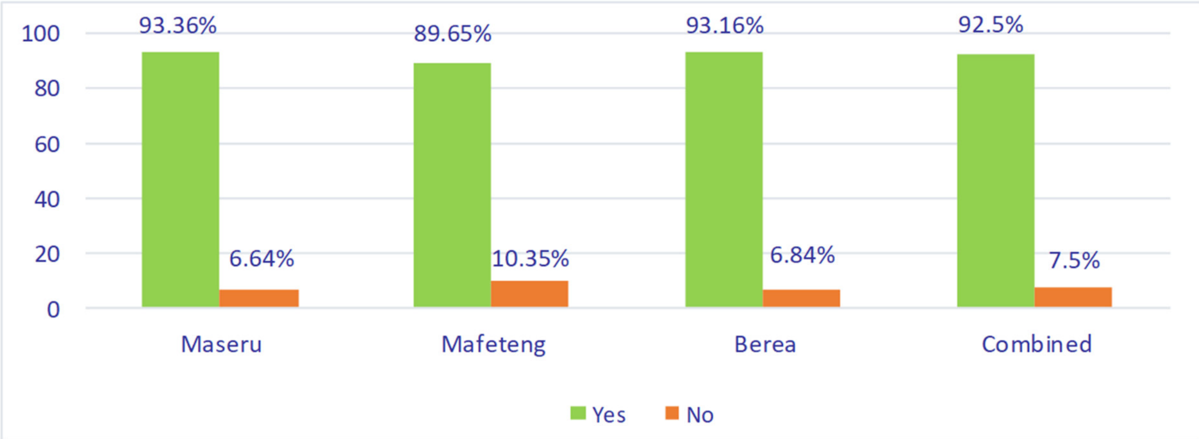

Figure 4.2: WTP distribution for bean weather index insurance
Source: WTP Survey, 2016

Few farmers are not willing to pay for maize and bean weather index insurance. The reasons are provided in Table 4.2

Table 4.2. Reasons for not willing to pay for insurance

	Maize model				Bean Model			
Reason for not WTP	**Mafeteng (N=8)**	**Maseru (N=6)**	**Berea (N=7)**	**ALL (N=21)**	**Mafeteng (N=9)**	**Maseru (N=13)**	**Berea (N=8)**	**ALL (N=30)**
Cannot afford insurance	59%	21%	20%	28%	34%	30%	36%	29%
Current risk management strategies are enough	0%	45%	55%	17%	0%	0%	100%	10%
Lack of information about insurance	41%	34%	25%	55%	39%	27%	34%	61%

Source: WTP Survey, 2016

Table 4.2 shows that the major reason for not willing to pay for both maize and bean weather index insurance is lack of information about the insurance. This is consistent with Sadit *et al.* (2010) who indicated that farmers' knowledge of advantages and disadvantages of rainfall insurance have positive impact on their propensity to accept insurance.

4.3 Farmers' WTP Responses Distribution by Geographical District and Crop Type

In double bounded method, initial bids were randomly distributed to respondents. The initial bids were obtained from the pilot study of 10 randomly chosen respondents in the areas not targeted for the study. Each initial bid was doubled when the respondent answered yes to the initial bid and halved if the respondent answered no to it. The initial bid is represented by Bid1 and the follow up bid by Bid2 (Table 4.3). The double bounded CV yields four outcomes (No-No, No-Yes, Yes-No and Yes-Yes) (Haab & McConnell, 2002:118).

Table 4.3. Summary of discrete responses to maize double bounded questions

Bid 1	Bid2	No-No	No-Yes	Yes-No	Yes-Yes
20	10	2	1	-	-
20	40	-	-	4	62
40	20	6	4	-	-
40	80	-	-	23	51
60	30	9	18	-	-
60	120	-	-	44	36
80	40	7	21	-	-
80	160	-	-	44	5
100	50	13	22	-	-
100	200	-	-	25	3
Total		37	66	140	157
Percentage (n = 400)		9.25	16.5	35	39.25

Source: WTP Survey, 2016

Table 4.4. Summary of discrete responses to bean double bounded questions

Bid 1	Bid2	No-No	No-Yes	Yes-No	Yes-Yes
50	25	7	7	-	-
50	100	-	-	16	51
80	40	9	15	-	-
80	160	-	-	48	15
100	50	9	20	-	-
100	200	-	-	36	8
120	60	46	61	-	-
120	240	-	-	47	5
Total		71	103	147	79
Percentage (n=400)		17.75	25.75	36.75	19.75

Source: WTP Survey, 2016

The farmers were asked to respond to bid questions based on their monthly household income. Since income is constant, as the bid value increased the number of definitely willing to pay responses dropped. The result supports the theory of demand which states that the price of a good influences the demand for that particular good (Nicholson & Snyder, 2008:182; Varian, 1992:145). This also implies that weather index insurance is a normal good.

a. Mean willingness to pay for maize and bean weather index insurance

Table 4.5. Mean WTP for maize and bean weather index insurance by district and crop type

		Full model			Mafeteng			Maseru			Berea		
	Variable	Coef.	Std. Err.	P>z	Coef.	Std. Err.	P>z	Coefficient	Std. Err.	P>z	Coeff.	Std. Err.	P>z
Maize crop	Bid1mz	-0.022	0.003	0.000***	-0.025	0.006	0.000***	-0.024	0.005	0.000***	-0.019	0.006	0.001***
	Cons	2.060	0.212	0.000***	1.765	0.417	0.000***	2.422	0.348	0.000***	1.980	0.389	0.000***
	Bid2mz	-0.013	0.001	0.000***	-0.011	0.003	0.001***	-0.016	0.002	0.000***	-0.010	0.003	0.000***
	Cons	1.264	0.138	0.000***	0.911	0.268	0.001***	1.707	0.221	0.000***	1.002	0.250	0.000***
	MWTP1	93.47			69.95			99.18			104.23		
	MWTP2	99.98			85.53			107.07			98.70		
Bean Crop	Bid1Bean	-0.021	0.003	0.000***	-0.017	0.005	0.001***	-0.028	0.004	0.000***	-0.014	0.005	0.002***
	Cons	2.150	0.266	0.000***	1.383	0.511	0.007***	2.954	0.460	0.000***	1.752	0.448	0.000***
	Bid2beans	-0.008	0.001	0.000***	-0.005	0.002	0.017**	-0.009	0.001	0.000***	-0.010	0.002	0.000***
	Cons	0.832	0.130	0.000***	0.496	0.241	0.040**	1.058	0.192	0.000***	0.760	0.265	0.004***
	MWTP1	103.02			82.53			103.72			123.55		
	MWTP2	99.61			101.69			117.41			75.22		

Key: ***, and ** represents 1% and 5% level of significance respectively. MWTP1 and MWTP2 represents the mean willingness to pay for the initial bid (first bid) and mean willingness to pay for follow up bid (second bid).
Source: WTP survey, 2016

The results show that the hypothesis that the mean WTP for farmers in the lowlands of Lesotho is zero is rejected and the study concludes that the mean WTP is different from zero; farmers are willing to pay M103.12 in Maseru, M101.46 in Berea and M77.74 in Mafeteng per month. In general, farmers' WTP for maize weather index insurance is M96.72. On a monthly basis, farmers are willing to pay M110.56 in Maseru as opposed to M99.38 in Berea and M92.11 in Mafeteng District for bean weather index insurance. Table 4.5 further shows that farmers' mean WTP for bean weather index insurance is M101.31 across districts implying that the monthly mean WTP is higher for bean than for maize. This is expected because bean is a cash crop and therefore holds a higher value than maize. The three districts have different mean WTP with Maseru District having the highest, Berea District the second and Mafeteng District the least. The differences in the mean WTP in the three districts is due to variations in soil quality and expected yield. The results contradict Barry *et al.* (2004) who found that farmers with high expected yield have a higher expected income, therefore will pay more. However, the results are consistent with Cole *et al.* (2009), who indicated that the more risk averse an individual is, the less likely he/she is willing to pay for insurance.

4.5 Determinants of farmers' decision to participate in maize and bean weather index insurance

Determinants of farmers' decision to participate in maize and bean weather index insurance were estimated using the probit model. The probit model estimates do not have economic meaning and therefore average partial effects which showed changes in the probability of a farmer participating in maize and bean weather index insurance were computed. The results are presented in Table 4.6.

Table 4.6. Determinants of farmer's decision to pay for maize and bean weather index insurance

	APE after probit Maize weather index insurance			APE after probit bean weather index insurance		
Variable	APE	Std. Err.	P>z	APE	Std. Err.	P>z
Lossexper	0.0480	0.0218	0.0270**	0.0515	0.0278	0.0640*
Eductype	0.0515	0.0351	0.1420	0.0943	0.0408	0.0210**
Yearsfarm	0.0017	0.0011	0.0980*	0.0013	0.0013	0.3370
Income	0.0000	0.0000	0.9210	0.0000	0.0000	0.2040
strategyadeq	-0.0585	0.0217	0.0070**	-0.0210	0.0258	0.4150
Climateinf	0.0821	0.0399	0.0390**	0.1070	0.0563	0.0570*
Gender	0.0118	0.0211	0.5750	0.0087	0.0262	0.7380
Age	0.0097	0.0046	0.0340**	0.0083	0.0058	0.1520
Landsize	0.0095	0.0049	0.0540*	0.0109	0.0055	0.0480**
Maseru	0.0542	0.0261	0.0380**	0.0287	0.0323	0.3730
Berea	-0.0087	0.0301	0.7730	-0.0016	0.0395	0.9680
Agesquare	-0.0001	0.0000	0.0240**	-0.0001	0.0001	0.1540

Key: *,**,*** represent significance level at 10%, 5% and 1%. APE is the average partial effect after probit

Crop production loss has a positive and significant influence on farmer's decision to join both maize and bean weather index insurance. This implies that farmers who have experienced crop production loss due to weather variability are more likely to insure their maize and bean crops than those who have not because they have knowledge of effects of weather changes in maize and bean production. Similar results were reported by Ghazanfar *et al.* (2015). McIntosh *et al.* (2013) however, found that previous exposure to loss adversely affects willingness to pay for crop insurance while Liu *et al.* (2015) found no significant difference between farmers who had previously experienced floods on their farms and those who did not in China.

Farmers' decision to insure their bean crop is positively and significantly affected by the type of education attended by farmers implying that farmers with formal education on agricultural practices are more likely to insure their bean crop than farmers with informal education. Similarly, Paulos (2002) found that education type positively influenced farmers' demand for crop insurance.

The number of years a farmer has been practicing farming has a positive and significant effect on maximum amount to pay for maize weather index insurance only. This is because farmers have experience of the farming business and risks and opportunities associated with. Thus, farmers with more years of farming will be willing to pay for maize index insurance. Sadit *et al.* (2010), also observed that if a farmer spends more years in farming, then there is a high likelihood of him/her paying for index insurance since he/she tends to understand the farming problems and opportunities better.

The average partial effect results show that farmers' decision to insure their maize crop is negatively and significantly influenced by adequacy of current weather variability risk management strategies. This means that farmers with limited resilience to climate variability effects are more likely to insure their maize crop than those with adequate strategies (McIntosh *et al.* 2013). This is expected because low resilient farmers see insurance as their next best option for protecting their crop production from fluctuating.

Access to climate variability early warning information assists farmers to prepare in advance for any changes that may happen in their production. The results show that access to this kind of information has a positive and significant effect on farmers' decision to insure both maize and bean crops. Abebe and Bogale (2014) reported that farmers with access to weather variability early warning information resources such as radio are more likely to insure their crop than their counterparts.

Age of the farmer positively and significantly affects farmer decision to pay for Maize weather index insurance. However, age-squared variable shows a negative relationship between age and willingness to pay. Thus, farmers have an increasing WTP up to a specific age, before the WTP for insurance decreases due to higher incentives to protect their families from certain hazards the age of the farmer follows a u-shape (Bendig and Arun, 2011).

The coefficient for land size is positive and significant for both maize and bean crops weather index insurance models. This implies that farmers with more land are more likely to take maize and bean insurance. This is expected because farmers with more land lose more in terms of inputs used in planting their fields or opportunity cost of not planting in case planting is skipped due to weather changes (Ghazanfar *et al*. 2015; Akter *et al.* 2009; McIntosh et al. 2013). Barry *et al.* (2004) also found that farmers with larger land size have greater managing capacity and utilize economies of scale, therefore they will be willing to pay for insurance.

The results further indicate that farmers in Maseru District are more likely to participate in maize insurance markets than farmers in Mafeteng. This is shown by the positive and significant effect of Maseru District dummy variable on WTP decision for maize weather index insurance. This result might be due to the differences in the average household incomes of farmers between the districts. The descriptive statistics have shown that farmers in Mafeteng have higher average monthly income than farmers in Maseru. Therefore, higher income functions as an endogenous risk management capability of the farmer to buy grain in case their crop fails (McIntosh *et al.* 2013). Furthermore, Mafeteng is a high risk area as it has very low rainfall. Bendig *et al.* (2009) indicated that households which assume that they are more vulnerable to risk opt not to use any financial services at all and are especially unlikely to use insurance on top of other services. This explains the low WTP for farmers in Mafeteng District.

5. Conclusion and Recommendations

The purpose of this study was to determine the mean WTP for maize and bean weather index insurance and to test the hypothesis that the mean WTP for maize and bean weather index insurance is different in Mafeteng, Maseru and Berea Districts. The mean WTP was estimated for the full model and at district levels. The study has shown that majority of farmers are willing to pay for bean and maize weather index insurance estimated at 94.75% for maize and 92.5% for bean. The district with the highest percentage of farmers willing to pay for both maize and bean weather index insurance is Maseru. The mean WTP for maize weather index insurance is M103.12 in Maseru, as opposed to M101.46 in Berea and M77.74 in Mafeteng Districts. For bean weather index insurance, mean willingness to pay in Maseru is M110.56 as opposed to M99.38 in Berea and M92.11 in Mafeteng District. The results have shown that the monthly mean WTP for maize weather index insurance is M96.72 and M101.31 for beans. Thus, farmers are willing to pay a higher amount for bean than maize weather insurance.

This study rejects the hypothesis that mean WTP for maize and bean crop insurance in the lowlands of Lesotho is the same. The study therefore concludes that the mean WTP differs by crop type and geographical location (district). Further the study concludes that there are some factors that have significant effect on farmer's decision to join MWI such as loss experienced, adequacy of applied current risk management strategies access to climate variability information, age of the farmer, land size, and being located in Maseru district. The study further concluded that loss experienced, education type, access to climate variability information, and land size positively influenced farmers' decision to participate in BWI whilst adequacy of current risk management strategies have a negative effect.

The study recommends that since farmers are willing to pay for maize and bean weather index insurance, there is a need for policy makers and stakeholders to establish maize and bean weather index insurance program in Lesotho. However, the policy and program intervention should consider differentiating the insurance product by crop type and location and also consider the following;

- Access to climate variability information significantly influenced farmers' decision to participate in weather index insurance and majority of the farmers had access to this information. Therefore, continued provision of climate variability early warning information is likely to increase the demand for weather index insurance for both crops. Thus, broadcasting of this information is advocated.
- Lack of knowledge of weather index insurance is identified as the main reason for not willing to join insurance. Extension services through awareness programs on the long term impacts of the existing informal risk coping strategies and how these measures may fail in certain circumstances is recommended to help households re-think their risk coping portfolio. Enlightening households on how formal insurance works and how they can cater to catastrophic shocks by pooling risks across larger geographies may encourage them to invest in market-based formal risk management techniques such as weather index insurance to deal with shocks in the long run.
- The study focused only on the demand side of weather index insurance, therefore further study is recommended on the supply side of weather index insurance to determine if the amount farmers are willing to pay is an actuarially fair insurance premium.

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