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WILLINGNESS TO ADOPT INDEX BASED CATTLE INSURANCE IN THE FACE OF CLIMATE CHANGE: EVIDENCE FROM SMALLHOLDER CATTLE FARMERS IN THE POLOKWANE LOCAL MUNICIPALITY, SOUTH AFRICA

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Abstract

This paper analysed the determinants of smallholder cattle farmers' willingness to adopt Index-Based Cattle Insurance (IBCI) being climate change adaptive strategy in the Polokwane Municipality of South Africa. A multi-stage purposive sampling procedure was employed to collect primary data using structured questionnaires from 110 smallholder cattle farmers. The results revealed that about 89% of the sampled farmers were willing to adopt IBCI, while about 11% weren't willing to adopt IBCI. The Probit regression model results revealed that marital status, farming experience, access to extension services, off-farm income and land ownership had a positive and significant influence on the willingness to adopt IBCI. However, educational level, household size, experience of cattle loss and farm size significantly influenced willingness to adopt IBCI negatively. Therefore, this study recommends workshops for raising IBCI awareness, government subsidy on insurance premiums and finally, improved market access and extension services for smallholder cattle farmers for sustainable livelihoods.

1. Introduction

Climate change and variability on a global level is one of the most serious environmental challenges which exacerbates the well-known vulnerability of smallholder farmers to a wide range of production constraints. Additionally, this global phenomenon; climate change, has been noted to have led to the deterioration of agricultural productivity across developing countries with South African production activities being no exception (Mdoda et al., 2020). Existing literature notably expresses climate change to be one of the major present challenges in the world (Malhi et al., 2021; Linn & Maenhout, 2019). Risk management plays a crucial role in farming and agricultural insurance positions itself as one of the main risk management instruments available to farmers. However, struggles of smallholder farmers in South Africa are aggravated by the inability to obtain effective insurance as a risk management option against climatic conditions. This in turn creates a concern of disruption to agriculturally based livelihoods and precludes the achievement of sustainable development (Karimi et al., 2018). Impressions brought on by climate change upon agriculture are still surrounded by uncertainty. However, notwithstanding the present uncertainty, climate change has become a broadly accepted phenomenon that creates a concern of disruption to agriculturally based livelihoods (Karimi et al., 2018).

The cattle farming sector of South Africa is dualistic in nature; this follows the co-existence of a highly commercialised system together with the subsistence-based production system on the other end (Oduniyi et al., 2020). For this country, this sub-sector is by far the largest, contributing about 25% to 30% towards the yearly agricultural output (Maltou and Bahta, 2019). In addition to this, cattle production ranks a major activity within both the smallholder and commercial farming systems (Oduniyi et al., 2020). In rural areas, this activity of cattle production is of topmost importance as rural households significantly depend upon agriculture for sustenance of livelihoods. (Fakade, 2016). Similarly, research has evidently indicated that Cattle production can be part of the solution to addressing food insecurity and enhance livelihoods in Africa's rural areas (Gwaka & Dubihlela, 2020). However, climate change risks socioeconomic stability and creates a setback upon efforts of development. As such, adaptation in which insurance can be a key tool is vital to building societal resilience to the impacts of climate change by reducing vulnerability and building both physical and financial resilience (Jarzabkowski et al., 2019).

The challenge in low-income countries is the non-existence or underdevelopment of insurance markets and also, moral hazard and/or adverse selection as problems to farm level insurance products (Tlholoe, 2016). Index-based insurance refers to a micro-insurance initiative designed to provide financial protection cover potential losses experienced by smallholder farmers as a result of climate variability (Ellis, 2017; Tlholoe, 2016). The products' indemnities are based on an index, meaning neither the policyholder nor insurer has better information on potential indemnity value making the product to not be vulnerable to moral hazard and/or adverse selection (Barnett, 2004). In line with this backdrop, insurance proves relevant seeing how climate change's increased frequency and severity of weather extremes imply a threat to the sustainability of cattle farming and livelihoods. However, rural households and small-scale systems within low-income countries rarely have access to formal insurance contracts. Additionally, the 'traditional' insurance model has long been viewed as unfeasible in this context owing to challenges associated with high transactions costs, adverse selection and moral hazard (ARID Kenya, 2018). Hence, this study intended to provide an analysis of the determinants of smallholder cattle farmers' willingness to adopt index-based Cattle insurance as a climate risk adaptation strategy in the Polokwane Local Municipality.

2. Scope of the Study

Aim of the study

The aim of this study was to analyse the determinants of smallholder cattle farmers' willingness to adopt index-based Cattle insurance as a climate risk adaptation strategy.

The objectives of this study were to:

Profile the socio-economic characteristics of smallholder cattle farmers in the Polokwane Local Municipality.

Explore smallholder cattle farmers' level of perceptions towards IBCI and components of climate change.

Analyse the determinants of willingness to adopt IBCI among smallholder cattle farmers in the Polokwane Local Municipality.

Research Hypotheses

There is no difference in the level perceptions among smallholder cattle farmers towards IBCI and components of climate change.

Determinant factors do not have a significant influence upon the smallholder cattle farmers' willingness to adopt IBCI in the PLM.

3. Research Methodology

3.1. Description of the study area

The study was conducted in the Polokwane Local Municipality (PLM). The municipality is located in the Capricorn district within South Africa's northern province of Limpopo with a semi-arid climate and shares borders with 5 other districts of the province. It is divided into, Aganang, City, Molepo/Chuene/Maja Dikgale/Sebayeng, Mankweng, Moletji and Seshego Clusters. Geographically, the PLM is located 23°54'00" S, 29° 27'00'' E in the province of Limpopo and covers an area of approximately 3766 km^2 which is about 3% of the total surface area of Limpopo (Leso et al., 2017).

Figure 1. Study Area

3.2. Sampling techniques

A multi-stage purposive sampling procedure was used in the selection of the surveyed clusters in the Polokwane Local Municipality (PLM). In all, 110 smallholder cattle farmers where interviewed per cluster as follows; Aganang (12), Mankweng (75), Molepo/Chuene/Maja (22) and Sebayeng/ Dikgale cluster with only one (1) farmer willing to participate in the study.

3.3. Data collection procedure

This study used survey research design, wherein a cross-sectional survey (through face-to face and telephonic interviews) on smallholder cattle farming households was carried out in the Polokwane Local Municipality.

3.4. Data analysis and analytical procedures

Profile the socio-economic characteristics of smallholder cattle farmers in the Polokwane Local Municipality.

To achieve the first objective of this study, descriptive statistics such as the mean, frequency and percentages were used to describe the socio-economic characteristics of the smallholder cattle farmers in the study area. To further elicit the demographics and description of the sampled farmers, the study adopted the use of pie charts, bar graphs as well as frequency tables.

Determinants of willingness to adopt IBCI among smallholder cattle farmers in the PLM

With respect to the third objective for this study, Contingent Valuation Method (CVM) was used to investigate the willingness to adopt IBCI among the smallholder cattle farmers in the study area. The contingent valuation method (CVM) is an appraisal technique which entails the approximation of a value placed upon goods or services by an individual. Furthermore, the technique is a direct approach to measuring the willingness to pay (WTP) that many researchers have produced tangible results and predictions in relation to non-market goods (Oduniyi et al., 2020). Table 1 below depicts Willingness to adopt IBCI framework.

i. If index-based insurance was to be introduced as a climate risk management strategy such that whenever there is rainfall deficit or lack of forage, the insurance will protect you against any loss. Would you adopt it (the insurance) and obtain a policy to cover 100% of your Cattle? Yes [ ] No [ ]

ii. If No to "i", please state reasons.

iii. If "YES" to "i". Should the premium increase by 10%, would you still be willing to pay insurance cover for 100% of your stock? Yes [ ] No [ ]

iv. If "NO" to "i". Would you accept if the government offers to pay for the 10% premium increase, allowing you to pay insurance for 90% of the value of your animal stock? Yes [ ] No [ ]

Source: (adopted from Tlholoe, 2016)

It is therefore through responses of the cattle farming households to the above questions (Table 1) that we were able to come up with the following classification for the dependent variable (Y_i^*);

Y_i = 0 indicates the farmer is not willing to adopt IBCI
Y_i=1 indicating less willingness, where a farmer is willing to adopt IBCI but not cover 100% of their stock
Y_i= 2 indicates moderate willingness to adopt IBCI as the farmer aims to 100% of their stock and lastly,
Y_i = 3 indicates more willing, where the farmer is willing to adopt IBCI and cover 100% of their cattle even if the premium was to be increased by 10%.

For the purpose of analysis with the probit model, the outcomes; Y_i=1, Y_i=2 and Y_i=3 where all considered as Y_i=1 to indicate willingness to adopt index-based Cattle insurance. Thus, having estimated the willingness to adopt IBCI by the farmers, it is necessary to know the factors which are likely to influence farmers' decision to adopt IBCI. We assume that the willingness

of the i^th smallholder cattle farmer to adopt Index-based Cattle insurance or not depends upon an unobservable utility index Y_i^*, that is determined by the independent variables. Therefore, a binary probit model may be used to model such an objective (Abugri et al., 2017). It is further assumed that the higher the utility index, the higher the probability of IBCI adoption by the farmer, thus limiting the probability of willingness to adopt IBCI (dependent variable) Y_i to range between the values 1 and 0.

$$Y_i = \begin{Bmatrix} Y_i^* \ if \ Y_i^* > 0 \\ 0 \ if \ Y_i^* \ \leq 0 \end{Bmatrix} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (1)$$

The probit model following the condition of normally distributed variables is expressed as:

$$Prob(Y^* > 0) = F(X'\beta) = \int_{-\infty}^{X'\beta} \emptyset(Z)dZ \ldots\ldots\ldots\ldots.. (2)$$

Where; 〖F(X〗^' β) represents the cumulative degree of freedom of the standard normal distribution.

The specific empirical model used for the study is expressed as follows;

$$Y_i^* = X'\beta + e_i \ldots\ldots\ldots\ldots\ldots\ldots. (3)$$

Where; Y_i^* with Y_i^*=1 if a farmer is willing to adopt Index based Cattle insurance as a climate change adaptive strategy and Y_i^*=0 otherwise. These indicate a dichotomous farmer adoption decision outcome which is dependent on age of the farmer (AGE), gender of the farmer (GENDER), marital status (MARI_S), education level (EDU_LV), farming experience (FRM_EXP), experience of Cattle loss (LS_LOSS), land ownership (L_OWN), farm income (FRM_INC), off-farm income (OFF_INC), access to extension services (A_EXT), credit access (CRED_A), household size (HH_SIZE), farm size (FRM_SIZE) and awareness to agricultural insurance (AA_INSUR)

$$X'\beta = \beta_0 + \beta_1 AGE + \beta_2 GENDER + \beta_3 MARI\_S + \beta_4 EDU\_LV + \beta_5 FRM\_EXP + \beta_6 LS\_LOSS + \beta_7 L\_OWN + \beta_8 FRM\_INC + \beta_9 OFF\_INC + \beta_{10} A\_EXT + \beta_{11} CRED\_A + \beta_{12} HH\_SIZE + \beta_{13} FRM\_SIZE + \beta_{14} AA\_INSUR + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (4)$$

Table 2 below indicates the independent or explanatory variables hypothesized to influence the decision of willingness to adopt index-based Cattle insurance among smallholder cattle farmers. The choice of such variables is fully guided by existing literature on the subject matter (index-based cattle insurance adoption and participation) and the description of the explanatory variables are explained in the below Table 2.

Table 2. indicates the independent or explanatory variables hypothesized

Dependent variable		**Description**	
Willingness to adopt IBCI (Y*)		Binary: 1= if the smallholder cattle farmer is willing to adopt IBCI on their farm, 0= not willing to adopt IBCI	
Explanatory Variable	**Variable type**	**Description and units of measurement**	**Expected sign**
Age (AGE)	Continuous	Age of the smallholder cattle farmer (years)	+/-
Gender (GENDER)	Dummy	1 if the smallholder cattle farmer is male and 0 for otherwise	+/-
Marital status (MARI_S)	Dummy	1 if the smallholder cattle farmer is married and 0 for otherwise	+
Educational level (EDU_LEV)	Continuous	Number of years the smallholder farmer attended school (Years)	+
Farm experience (FRM_EXP)	Continuous	Number of years the smallholder farmer has been farming (Years)	+
Cattle loss (LS_LOSS)	Dummy	1 if the smallholder farmer had any experienced Cattle loss due to climate change and 0 otherwise	+
Land ownership (LND_OWN)	Dummy	1, if the smallholder farmer has ownership of farmland and 0 otherwise	+
Sources of income (SO_INC)	Dummy	Farm income (FRM_INC) 1 if yes, 0 for otherwise Non- Labour Income (NONL_I): 1 if yes and 0 for otherwise Off-farm Income (OFF_INC) : 1 if yes and 0 for otherwise	+
Access to extension (A_EXT)	Dummy:	1 if the smallholder farmer receives extension services and 0 otherwise	+
Credit access (CRED_A)	Dummy:	1 if the smallholder farmer has access to credit and 0 otherwise	+
Household size (HH_SIZE)	Continuous:	The number of family members within the smallholder farming household (number)	+/-
Farm size (FRM_SIZE)	Continuous:	Total number of cattle owned	+
Awareness to agricultural insurance (AA_INSUR)	Dummy:	1 if farmers is aware of agricultural insurance, 0 for Otherwise	+/-

Furthermore, the study considered marginal effects. According to Norton et al. (2019), marginal effects are important in binary probit regression because they allow one to estimate the impact of changes in the explanatory variables on the probability of the outcome variable and identify which variables are most important in predicting the outcome variable. Thus, in this study, marginal effects were accounted for to determine how much alterations in the explanatory variables influence the dependent variable.

The general model of marginal effects to supplement Binary logistic model is given as:

$$\frac{\partial P_J}{\partial x_K} = P_J\left(\beta_{JK} - \sum_{J=1}^{J} P_K \beta_{JK}\right) \quad \text{..... (5)}$$

4. Descriptive Results and Discussions

The results obtained in the below Table 3 shows that the average (mean) age and educational level (i.e. the number of years in school) of sampled smallholder cattle farmers are 62 and 8 years with a minimum of 23 and 0 years and a maximum of 102 and 17 years respectively.

Table 3. Descriptive statistics of Categorical variables used in the Probit regression model (n=110)

Variable	Mean	Std. Deviation	Min.	Max.	T-test (Sig. 2-tailed)
Age of farmer	62	14.448	23	102	45.019***
Educational level	8	4.544	0	17	18.612***
Farming Experience	18	17.594	1	85	10.844***
Household Size	5	2.540	1	13	19.183***

Number of cattle owned	12	11.999	1	94	10.140***

Notes: *** indicates statistical significance at a level of 1%

The two-tailed t-test also results revealed the highly statistically significant ($p<0.001$) mean difference between the farmers' ages and educational levels. Additionally, the results in Table 2 indicate the highly significant mean difference in the number of years in farming (farming experience) of the sampled smallholder cattle farmers. On average a farmer was found to have 18 years of farming experience with the minimum being a year and a maximum of 85 years. The average household size of the smallholder cattle farmers had 5 persons with the lowest having an individual person (1) and the largest household had 13 people living together. Finally, the smallest farm had 1 cow with the largest farm was found to have a total of 94 cattle and on average farmers owned a total of 12 cattle. The two-tailed t-tests for both household size and farm size indicated high statistical significance at 1%, which infers that there is a strongly significant difference in both the number of persons living in one household and the total number of cattle owned by the farming household in the study area.

Table 4. The willingness to adopt IBCI among the sampled smallholder cattle farmers (N=110)

Sampled smallholder cattle farmer's decision to adopt IBLI or Not	Frequency	Percentage (%)
Willingness to adopt IBCI	98	89
Willingness not to adopt IBCI	12	11
Total	**110**	**100**
Extent of sampled smallholder cattle farmers' willingness to adopt IBCI		
Less willing to adopt	2	2
moderately willing to adopt	16	16
More willing to adopt	80	82
Total	**98**	**100**

A larger proportion, at 89% (98 farmers) from the total sampled smallholder cattle farmers as depicted in Table 4, indicated willingness to adopt index-based Cattle insurance irrespective of the level of willingness to adopt the insurance product (IBCI). These findings imply that farmers value their cattle and are committed to protecting their smallholder farms from the adverse effects which climate change imposes on cattle production. Most of the interviewed farmers elucidated that they view the index-based cattle insurance as a good innovation which would highly benefit them given the cattle losses they experience mostly at the hands of drought since their cattle graze on communal land. On the other hand, fewer farmers totalling 12 (11%) from the sampled smallholder cattle farmers were not willing to adopt IBCI. These farmers' reasons for not willing to index-based Cattle insurance are summarised in Table 5 to clearly capture the different supporting information behind the lack of interest in the adoption of IBCI to cover cattle on their smallholder farms. The study survey unveiled that the farmers who were willing to adopt IBCI on their farms had varying views on the total number of cattle to cover if they were to obtain a policy for their cattle through the IBCI product. Hence, as indicated in the research methods, the contingent valuation technique allowed for the capturing of different levels of willingness to adopt IBCI among farmers who answered "yes" to the question of willingness to adopt the insurance product on their smallholder farms if it were to be introduced in the Polokwane Local Municipality. Therefore, the different levels of willingness to adopt among the sampled farmers who indicated willingness to adopt are categorised below in Table 4 showing the extent of willingness to adopt IBCI.

The results in figure 4.2 revealed that from the sampled smallholder cattle farmers in the PLM, 82% of the farmers where more willing to adopt IBCI as a coping mechanism against climate change for their smallholder farms. This implies that most of these farmers are willing to accept IBCI even if premiums were to increase by 10% (see chapter 3 for the contingent valuation technique used in determination of level of willingness to adopt IBCI). The remaining 18% comprised of 16% and 2% which were the farmers moderately willing and less willing to adopt IBCI respectively.

Table 5. Sampled smallholder cattle farmers' reasons for not willing to adopt IBCI (N=12)

Reasons	Frequency	Percentage
Unemployment	1	8
Old age and small farm size	1	8
I don't trust insurance	2	17
I would rather insure against stock theft	3	25
I don't think I'll have money for premiums	2	17
I don't want to complicate my farming activities	1	8
Just not interested	2	17

Respondents who indicated that they would not be willing to adopt IBCI if it were to be introduced in the Polokwane Local Municipality were asked to provide reasons for their decision. Based on that question in the data collection tool (questionnaire), Table 4 indicates the reasons of such respondents. The majority (25%) of the farmers who are not willing to adopt IBCI indicated they would rather insure against cattle/stock theft than obtain adopt IBCI. On the other hand, 24% divided into three equal proportions (8% each) indicated they are not willing to adopt IBCI as they; are unemployed, old and having small farms and finally the last 8% said they don't want to complicate their current farming activities. In three groups, each accounting for 17% of the respondents not willing to adopt IBCI, farmers outlined that they had lack of trust for insurance, others didn't think they will have money for premiums while the remainder where just not interested in IBCI. Table 6 below shows descriptive statistics of categorical variables used in the probit regression model.

Table 6. below shows descriptive statistics of categorical variables used in the probit regression model.

Variable	[A] Total from sample (n=110)	[B] Z = 0 (n= 12)	[C] Z = 1 (n =98)	Pearson Chi-Square
% of male	79	83	79	0.702
% of female	21	17	21	
Marital status (% of married)	66.4	75	66.3	0.502
Land ownership (% of yes)	1.8	8.3	1	0.074*
Farm income (% of yes)	3.6	16.7	2	0.011**
Off farm income (% of yes)	21.8	16.7	22.5	0.647
Experience of Cattle loss (% of yes)	34.6	25	35.7	0.461
Credit Access	5	0	6	0.378
Access to Extension (% of yes)	92.7	91.7	92.9	0.881
Agricultural Insurance awareness (% of yes)	2	0	2	0.617

Notes: **, and * indicates the significance levels of 5% and 10%, respectively

The analysis of categorical variables indicated a significant difference between willingness to adopt IBCI in land ownership, and farm income. The variable land ownership had a significant difference among farmers who were willing to adopt and those who were unwilling. The results show that out of the total sampled farmers who were not willing to adopt IBCI only 8.3% had ownership of land, whereas only 1% who had ownership to land was willing to adopt IBCI. Farm income also had a significant difference at $p<0.05$ among the two decisions of adoption of IBCI (i.e., the willingness and unwillingness to adopt IBCI). The results indicate that from the total sampled farmers who were willing to adopt IBCI, only 2% had income from their Cattle production activities (i.e. farm income), while 16,7% of the farmers who were not willing to adopt IBCI also had farm income as a major source of their monthly household income. The remaining variables: gender of the farmer, marital status, off-farm income, experience of Cattle loss, credit access, access to extension and agricultural insurance awareness all had chi-square

values which indicated an insignificant difference among the two decisions of willingness to adopt IBCI.

5. Empirical Results and Discussions

The results shown in Table 7 depict that fourteen (14) hypothesized socio-economic factors of sampled small-scale farmers have potential to influence their willingness to adopt Index-based cattle insurance. Moreover, these variables were empirically tested. The goodness-of-fit of the model is relatively well with an estimated Cox and Snell and Nagelkerke R squares of the model with 73% and 72%, respectively. This is satisfactory since this shows that the model was of good fit because 71% and 69% explain the change in the dependent variable whereas the remaining 27% and 28% are not explained in the model.

Table 7. Binary Probit Regression Model results of sampled smallholder cattle farmers under the Polokwane Local Municipality, South Africa (n=110)

Variables	**Coefficient**	**Std. Error**	**Z**	**dy/dx**	**VIF**
Constant	-4.827***	1.224	-3.943		
Age of farmer	0.008	0.007	1.149	0.251	3.544
Gender of the Farmer	-0.190	0.161	-1.180	0.238	1.470
Marital Status	0.357**	0.153	2.337	0.319	1.828
Educational level	-0.053***	0.018	-2.916	0.137	3.012
Farming Experience	0.016***	0.003	4.702	0.103	1.725
Household Size	-0.043*	0.025	-1.764	0.120	1.304
Credit access	0.134	0.224	0.598	0.273	1.306
Access to Extension services	0.490**	0.225	2.175	0.212	1.290
Agricultural Insurance Awareness	-0.320	0.379	-0.844	0.410	1.203
Major sources of income					
Farm income	0.228	0.465	0.490	0.624	1.259
Off-farm income	1.124***	0.183	6.132	0.125	1.060
Farm characteristics					
Farm Size (number of cattle owned)	-0.008**	0.006	-1.503	0.340	1.690
Land Ownership	1.729*	1.023	1.691	0.388	1.231
Cattle loss	-0.285**	0.113	-2.524	0.542	1.230
Number of observations = 110					
Pearson Goodness-of-Fit Test	**Chi-Square**		**df[a]**	**Sig.**	
	1271.782***		95	0.000	
Cox and Snell R square	0.732				
Nagelkerke R square	0.719				
-2 Log-likelihood	87.831.				

Note: *, ** and *** implies statistical significance at levels; 10%, 5% and 1% respectively

Marital status of smallholder cattle farmers

The empirical results shown in Table 7 depict that marital status of sampled smallholder farmers was found to be positively and statistically significant at 5% level of significance. This positive association implies that sampled smallholder cattle farmers who are married are 32% more likely to adopt Index-based cattle insurance to protect their farms in the face of climate change as opposed to non-married sampled farmers. The results conform to the findings of Aina et al. (2018) who also found a positive correlation. Therefore, this infers that smallholder cattle farmers who are married are more likely to adopt IBCI (at a 0.02 percentage point increase) as a climate risk mitigation strategy.

The educational level of smallholder cattle farmers (EDUL_LV) Contrary to prior expectations the empirical results in Table 7 showed that the estimated coefficient of educational level (EDU_LV) was negative and statistically significant at a level of 1% significance. This implies an inverse relationship with the willingness to adopt IBCI which stands to infer that the willingness to adopt IBCI declines with an increase of years of education by 14%. Although these findings are consistent with arguments by Isaboke et al. (2016) who postulated that better

education may have a negative effect on participation in weather index insurance, there is sufficient information to conclude that these results are inconsistent with much of the previous literature. These include, Kalapo et al. (2020) and Bishu et al. (2018) who both found education to have a positive and significant influence on the decision of participation in an agricultural insurance scheme. The marginal effects results suggest that a unit increase in the years of education reduces the willingness to adopt IBCI by the 0.0004 percentage point.

Farming experience of smallholder cattle farmers (FRM_EXP)

The empirical results highlight the positive correlation of farming experience (FRM_EXP) with the willingness to adopt IBCI which conforms with prior expectations of the study. The variable FRM_EXP was found to be statistically significant at a level of 1%. The inference here is that farmers who have more experience in cattle farming are 10% more likely to be willing to adopt index-based Cattle insurance. This could be justified by the assumption that with more years in cattle farming, a farmer would be willing to do anything to protect an investment which they have spent a lot of their time and financial resources establishing. Runganga & Mumbengegwi, (2020) also indicated that more years of experience in farming positively and statistically influence the willingness to adopt crop insurance. Furthermore, the probability of willingness to adopt IBCI among more experienced farmers increases by 0.000029 percentage point in comparison to the less experienced.

Household size (HH_SIZE)

Household size is one of the important factors which influence the capacity of smallholder farmers to respond to climate risks by participating in agricultural insurance. This is supported by the study of Oduniyi et al. (2020) who highlighted a household head having the responsibility of caring for a family is 12% less likely to be willing to adopt index-based Cattle insurance as the family is prioritized with resource allocation (income). In line with these findings, the results of this study also revealed a negative correlation between household size (HH_Size) and willingness to adopt IBCI. The coefficient parameter for the variable HH_SIZE was found to be statistically significant at 10% level of significance. This evidence suggests that the variable HH_SIZE does affect the willingness to adopt IBCI. Furthermore, this infers that farmers who are heading a larger household are less likely to adopt IBCI to cover their cattle against risks posed by climate change. However, these findings contradict the empirical results of Bishu et al. (2018) who discovered that the household dependency ratio had a positive and significant influence on farmers' interest in cattle insurance. Hence, the positive correlation would seek to imply that farmers with larger households are more likely to adopt cattle insurance. The results further highlighted that the probability of smallholder cattle farmers with larger household sizes not to be willing to adopt IBCI decreases by 0.002 percentage point when compared to those with lower household sizes.

Access to extension services (A_EXT)

Access to extension services is one of the important factors hypothesized to have a positive influence on the willingness to adopt IBCI among smallholder cattle farmers. The parameter estimates of the coefficient for the variable A_EXT as indicated in Table 7 revealed a positive association with the willingness to adopt IBCI. Furthermore, the variable A_EXT is very statistically significant at 5% level of significance. This implies that there is sufficient evidence to suggest that access to extension services among smallholder cattle farmers positively influences the willingness to adopt IBCI. With this being the case, this further infers that the farmers who have access to extension services/ extension agent contact are 21% more likely to be willing to adopt IBCI as compared to their counterparts who do not have access to extension services. These results are in line with findings obtained by Kalapo et al. (2020) who discovered a positive correlation between access to extension services and agricultural insurance participation. However, the empirical results of this study contradict findings obtained by Ellis (2017), which revealed that farmers with extension contact were less likely to purchase agricultural insurance owing to being exposed to more information on a variety of risk management strategies. Furthermore, the marginal effects indicate that in comparison to farmers who had no access to extension services, the probability of willingness to adopt among farmers with extension access increases by 0.07 percentage point.

Off-farm income of the sampled smallholder cattle farmers

The estimated coefficient of off-farm income (OFF_INC) showed a highly significant (i.e., at 1% level of significance) and positive effect on willingness to adopt IBCI, indicating that farmers who have an off-farm source of income are more likely to be willing to adopt IBCI by 13%. For instance, an increase in household income due to an off-farm source of income may increase the capacity of a farmer to be willing to explore IBCI as a climate risk mitigation strategy on their farm as they would have the money to pay regular premiums. These findings are in line with prior expectations and findings of Tlholoe (2016). On the other hand, the results are inconsistent with Tang et al. (2021) who found a negative correlation between off-farm income and the demand for agricultural insurance. Additionally, the marginal effects for the estimated parameter of off-farm income (OFF_INC) indicate that as opposed to farmers with no off-farm income, the probability of willingness to adopt IBCI increase by 0.039 percentage point among the smallholder cattle farmers having off-farm income.

Farm size of smallholder cattle farmers (FRM_SIZE)

Contrary to prior expectations, the empirical evidence with reference to Table 7 indicates a negative sign of the estimated coefficient of farm size (FRM_SIZE). This implies that there is an inverse relationship between the farm size (total Cattle owned by the smallholder cattle farmers) and the willingness to adopt IBCI implying that a unit increase in one hectare reduces the probability of smallholder cattle farmer's willingness to adopt IBCI by 34%. The variable farm size is statistically significant at a level of 5%. These findings are in conformity to the empirical evidence by Runganga & Mumbengegwi (2020) who found a negative correlation between farm size and willingness to adopt crop insurance among smallholder commercial farmers in Zimbabwe. However, they contradict the results of Stojanović et al. (2019) who found a positive relationship between farm size and willingness to purchase yield insurance. Furthermore, the marginal effects for the estimated coefficient of farm size (FRM_SIZE) revealed that a unit increase in the number of cattle owned reduces probability of these cattle farmers to be willing to adopt IBCI by a percentage point of 0.003.

Land ownership by smallholder cattle farmers (L_OWN)

In conformity with prior expectations, land ownership by smallholder cattle farmers was found to have a positively significant (10% level of significance) effect on willingness to adopt IBCI. The estimated coefficient for the variable L_OWN was found to be positive and significant at 10% level significance, indicating that farmers who have land ownership are 39% more likely to be willing to adopt index-based cattle insurance as compared to their counterparts who have no ownership rights to the land which they practice cattle farming on. These findings are consistent with those of Abugri et al. (2017) who found land ownership to be positive and significantly (at 5% level of significance) influencing farmers' participation decision in the drought index insurance scheme. The results are also supported by Holden & Ghebru (2016) who argued that secure land rights enhance investment and can provide collateral for landholders to access credit for investment towards improving the productivity of land. Likewise, the marginal effects for the estimated parameter for land ownership (L_OWN) suggest that the probability of willingness to adopt IBCI among cattle farmers who own land increases by 0.057 percentage point as compared to their landless counterparts.

Experience of Cattle loss due to climate change (L_LOSS)

The results also provided evidence of the significance ($p<0.05$) of experience of Cattle due to climate change towards the willingness to adopt IBCI. The estimated coefficient cattle loss (L_LOSS) was found to be negative and significant in influence to the willingness to adopt IBCI, which implies that sampled smallholder cattle farmers who experienced cattle loss are 54% less likely to adopt IBCI. This inference can be supported by Abugri et al. (2017) who postulated that the negative correlation of experience of damaged caused by extreme climate towards participation in drought index insurance could be linked to the fact that even though farms are at risk, the damaged caused could have triggered a different remedy/assistance instead of drought index insurance. Contrary to the findings of this study, Tlholoe (2016), discovered that experience of loss had a positive and significant influence on farmers' willingness to buy IBCI which implied that farmers who had experienced Cattle loss were more likely to take out an insurance policy (IBCI) than those who had not experienced any loss. However, the marginal effects for the estimated coefficient of Cattle loss (L_LOSS) suggest that there is less (0.026) probability for smallholder cattle farmers who experienced Cattle loss due to climate change to be willing to adopt IBCI.

6. Conclusion and Policy Recommendations

Results of the probit regression model indicated that farmer's willingness to adopt index-based Cattle insurance was positively and significantly influenced by marital status, farming experience, access to extension services, off-farm income and land ownership. On the other hand, educational level, household size, experience of Cattle loss and farm size all had a significantly negative affect on farmers' willingness to adopt the insurance product. The study recommends the implementation of workshops which focus of creating awareness IBCI to smallholder cattle farmers as the study survey indicated that most of the sampled farmers had no knowledge of IBCI let alone any agricultural insurance scheme. Such initiatives by insurance companies and or the government will assist in design and implementation of IBCI. This will further assist farmers understand the insurance product well and have their recommendations considered in the design of the insurance product. Thus, index-based Cattle insurance workshops and enhanced extension programmes should be implemented for better information access and awareness to climate risks and coping strategies among smallholder cattle farmers. Additionally, subsidization of IBCI by government may improve affordability of payment premiums.

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