Explaining farmers' willingness-to-insure farms and resilience to climate change in Ghana

William Adzawla[1*], Nicaise J. Aman[1], Moussa Diallo[1]
[1]University of Cheikh Anta Diop, WASCAL, Climate Change Economics, Dakar, Senegal.
*Correspondence: adzawlawilliam@gmail.com

Abstract

This study analysed farmer's willingness-to-insure their farms and their recovery from climate shocks. A primary data from 209 farmers were selected through multistage sampling procedure and analysed using double hurdle and ordered probit regressions. The findings showed majority of the farmers were willing-to-insure their farms and also pay insurance premiums. Farmers' decision to insure their farms was significantly influenced by their membership in a farmer group, producing beyond subsistence, flood, drought, windstorm, shock awareness and use of drought resistant variety. The level of premiums they are willing to pay was also influenced by education, extension, remitters, prior awareness of shocks and climate perception had significant effect on the premium farmers were willing-to-pay for farm insurance. The study concluded that farmers in Northern region were generally willing to insure their farms. Nearly all the farmers indicated an ability to recover from climate shocks with varying times and this was influenced by climate and socioeconomic factors such as age, sex, education, adults, extension, credit access, welfare, perception and willing-to-insure farm. Therefore, farm-insurance is an important strategy of making farming households recover faster from climate shocks. Hence, farm insurance policies must be provided to crop farmers in the region at an agreed price between farmers and insurance providers.

Keywords: Climate resilience; Double hurdle model; Farm insurance; Willingness-to-insure.

Résume

Cette étude a analysé la volonté des agriculteurs d'assurer leurs exploitations et leurs rétablissements après des chocs climatiques. Les données primaires de 209 agriculteurs ont été sélectionnées par une procédure d'échantillonnage à plusieurs étapes et analysées à l'aide de régressions à double obstacle et de régressions probit ordonnées. Les résultats ont montré que la majorité des agriculteurs étaient disposés à assurer leurs exploitations et à payer également des primes d'assurance. La décision des agriculteurs d'assurer leurs fermes a été fortement influencée par leur appartenance à un groupe d'agriculteurs, produisant au-delà de la subsistance, les inondations, la sécheresse, les tempêtes de vent, la sensibilisation aux chocs et l'utilisation de variétés résistantes à la sécheresse. Le niveau des primes qu'ils sont prêts à payer a également été influencé par l'éducation, la vulgarisation, les expéditeurs, la connaissance préalable des chocs et la perception du climat ont eu un effet important sur la prime que les agriculteurs étaient prêts à payer pour l'assurance agricole. L'étude a conclu que les agriculteurs de la région du Nord étaient généralement prêts à assurer leurs exploitations. Presque tous les agriculteurs ont indiqué leur capacité à se remettre des chocs climatiques à différentes périodes et cela a été influencé par des facteurs climatiques et socioéconomiques tels que l'âge, le sexe, l'éducation, les adultes, l'extension, l'accès au crédit, le bien-être, la perception et la volonté d'assurer la ferme. Par conséquent, l'assurance agricole est une stratégie importante pour permettre aux ménages agricoles de se remettre plus rapidement des chocs climatiques. De plus, les polices d'assurance agricole doivent être fournies aux agriculteurs de la région à un prix convenu entre les agriculteurs et les assureurs.

This paper was presented at the Conference on Climate Change and Food Security in West Africa co-organized by Université Cheikh Anta Diop de Dakar (UCAD) and Center for Development Research (ZEF), University of Bonn, on 17-18 November 2019 in Dakar, Senegal.

Introduction

A major threat to global development and a concern for both policy makers and researchers is climate change. Scientific predictions and analysis shows that climate change is non-contestable and if nothing is done, its future impacts are high than currently observed. This is likely to constraint the achievement of sustainable development across the world. For instance, Filho et al., (2018) established that there is a strong relationship between climate change and development. Africa is particularly projected to experience different and more severe impacts of climate change (Filho et al., 2018; Adenle et al., 2017). The major effects of climate change on Africa is on food security, depletion of natural food sources and efforts to restore depleted lost habitats (Abrams et al., 2018). Similarly, climate change and variability would decrease crop productivity and resource use efficiency in Africa (Amouzou et al., 2019). Arndt et al. (2015) revealed that climate change could lead to as high as 1.9% reduction of agriculture's share of Ghana's GDP by 2050. Unfortunately, although agriculture is a high climate risk economic activity, it still remains a significant sector of Ghana's economy; contributing 18.9 percent to Gross Domestic Product (GDP) in 2016, 36 percent of employment in 2015 and the primary source of employment for new workers entering the labour force of the country (World Bank, 2018). World Bank (2018) also noted that growth in the agricultural sector is at least twice more effective in benefiting the poor than growth in the non-agricultural sector of Ghana. Ghana's climate has become drier in recent times and this have major negative implications on all sectors of the country (Ankrah, 2018). Farmers have observed changes in both rainfall and temperatures (Apuri et al., 2018). This have raised concerns for climate adaptation in the country in order to build the resilience of the households. Thus, in order to minimize the agricultural losses and take advantage of existing emerging potentials provided by climate change, there is the need to enhance the resilience of households through climate adaptation (Holzkämper, 2017). Building climate resilience is therefore an essential objective for improving the adaptive capacities of farming households. A number of climate adaptation strategies are available to farmers. One of these strategies is farm insurance. However, in order to ensure that there is no loss of livelihoods under worse climate conditions, farmers must start to insure their farms.

Falco et al. (2014) noted that financial insurance against extreme climate events is an important strategy for prevarication of the impacts of climate change, and further argued that crop insurance is likely to increase under climate change. Although risks and shocks are common feature of crop production, farmers can rely on insurance and other financial mechanisms to protect their livelihoods against these shocks (Jensen and Barrett, 2017). Unfortunately for most rural parts of developing countries where agriculture is their mainstay, there are nearly nonexistence of insurance opportunities (Jensen and Barrett, 2017). Müller et al. (2017) described farm insurance as largely a 'developed country businesses. Jensen and Barrett (2017) observed that, the absence of agricultural insurance opportunities have forced rural farm households to adopt strategies that are detrimental to their wellbeing. For instance, engaging in low risk and low yielding production practices, skipping of meals, selling of capital assets and withdrawal of children from school. Müller et al. (2017) also explained that if adaptation is not carefully developed with local-specificity, it would lead to maladaptation which would have negative consequences on the households. Because climate shocks are covariate in nature (affects several people within an area), it can be concluded that exposure to uninsured climate risks is a major reason for low yields, persistent poverty and slow growth in most rural agrarian economies. The severity of climate shocks means that farming households are unable to offset the impacts from self-finance mechanisms such as using savings or credit facilities. Jensen and Barrett (2017) concluded that although index insurance does not remedy all the impacts of climate shocks or risks, it is a cost-effective approach of providing social support and improving the lives of rural agrarian households.

Although studies on the impacts of market systems such as insurance on poverty reduction have been given a considerable study, the impacts on climate resilience of farm households is less studied (Kuhl, 2018). Like most developing countries, farm insurance is less developed and promoted among farming households in Ghana. Therefore, there is the need to first examine the existence of or otherwise, a potential market for farm insurance in the Northern region of Ghana. Also, this study analysed the effects of climate shocks on the farmers' decision to insure their farms and the impact of farm insurance on climate resilience of the farm households.

1. Methodology

1.1 Study Area

The study was conducted in the Northern Region of Ghana. As at the time of the study design and data collection, this was a single region but now divided into three (Northern region, North East and Savannah region) by constitutional instrument in 2019. The then Northern region occupied 70,384 square kilometres of Ghana's landmass. Due to its geographical location, temperatures are higher than the southern parts of the country and also have only one cropping season due to a unimodal rainfall pattern; a mean annual rainfall of 740mm minimum and 1230mm maximum. Associated with these climatic conditions are shocks such as floods, droughts, bush fires and diseases. The region is widely seen as one of the most vulnerable regions to climate change in the country. Majority, 69.72%, of the residents are located in rural areas and engages primarily in agriculture (GSS, 2012).

1.2 Sampling procedure and data collection

The research employed a multi-stage technique in the selection of the respondents. In the first stage, stratified sampling was used to put the various districts of Northern region into three strata. In the second stage, one district from each stratum was selected using simple random sampling procedure. In the third stage, simple random was used to select three communities from each selected district. Again, simple random sampling was used to select a total of 23 farmers from each community; given a total of 209 farmers.

The study used a primary data that was collected in 2017. The primary data was obtained through the administration of a pre-tested questionnaires. The data collected includes information on the socioeconomic characteristics of the farmers, climate shocks experienced by farmers within the past ten years, farmers perceptions on climate change, farm characteristics and farmers willing-to-insure their farms.

1.3 Analytical framework and empirical model

Theoretically, farmers make rational decisions based on expected benefits from farm insurance. Therefore, the theory of utility maximisation was used as the theoretical explanation of the study. Empirically, a double hurdle model as proposed by Craig (1971) was used to analyse both the decision and amount farmers are willing-to-pay as an insurance premium while an ordered probit was fitted to estimate the effect of insurance decision on climate resilience of farmers.

From the utility maximization theory, a farmer takes a decision on whether or not to insure farm, and the amount to pay based on the expected satisfaction or benefits from each decision. The farmer does not only consider how to maximize profit from a decision but considers how to attain the highest level of utility, otherwise referred to as utility maximization (McConnell and Leubold, 2009). This means that the utility levels for farmers differ from one another. Ultimately, a farmer takes a decision that would give the maximum expected benefit. In this study for instance, a farmer is faced with two discrete choices, either to insure farm or not to insure farm. These types of discrete choices are modelled using the random utility theory (Lubungu, 2012). Choices made between alternatives will be a function of the probability that the utility associated with a particular option is higher than those for the other alternative (Hensher et al., 2005). However, there is no market incentive for farm insurance in the study area. Therefore, economic analysis of these types of relationship follows the stated preference approach. In this study, the contingent valuation (CV) method was used to provide a further theoretical diagnosis of the empirical work.

CV is a widely used technique for estimating non-market benefits of environmental goods and services (Vossler and Kerkvliet, 2003). The efficiency can be improved by asking a follow-up question relative to a single dichotomous choice question when there is inconsistency in responses. Hanemann et al., (1991) and most subsequent studies have argued that the double bounded model and its variations provide efficient estimates beyond the single bounded models. Therefore, the double bound approach was used to ellicit information from the farmers.

The empirical models to estimate the decision and amount willing-to-pay for farm insurance is given as:

$$\begin{aligned} Y = b_0 + b_1 Farmer\,group + b_2 Extension + b_3 Commercial\,production + b_4 Education + b_5 Climate\ perception \\ + b_6 prioaware + b_7 emigremit + b_8 Off-farm + b_9 drought + b_{10} flood + b_{11} Windstorm \\ + b_{12} Drought\ resistant\ variety + £_i \end{aligned} \quad (1)$$

Where *Y* is defined the decision and premium. The definition of the independent variables and their mean statistics are provided in Table 1.

In addition to the farm insurance, an ordered probit was estimated to determine the effects of farm-insurance on the recovery period of the farmers from climate shocks. This is given as

$$\begin{aligned} r \quad p \\ = \gamma_0 + \gamma_1 A \quad + \gamma_2 S \quad + \gamma_3 E \quad + \gamma_4 A \quad + \gamma_5 Chil \\ + \gamma_6 E \quad + \gamma_7 C \quad f \quad + \gamma_8 F \quad g \\ + \gamma_9 C \quad a \quad + \gamma_1 F \quad s \quad + \gamma_1 Cli \quad p \\ + \gamma_1 F \quad i \quad + u_i \end{aligned} \quad (2)$$

Table 1: Definition of variables

Variable	Definition
Age	The number of years from birth
Sex	Dummy: 1 for males, 0 for females
Adults	Number of household members with 18 years and above
Children	Number of household members with ages less than 18 years
Education	Total number of years of formal education

Experience	Total number of years into farming
Extension	Dummy: 1 if a farmer had access to extension service and 0 if not.
Farmer group	Dummy: 1 if a farmer belonged to a farmer group and 0 if not.
Remitters	Total number of family members outside the community who sends money home.
Contract farming	Dummy: 1 for contract farmers, 0 otherwise
Farm size	Total acreage cultivated by a farmer
Credit	Dummy: 1 for farmers who accessed credit,0 if otherwise
Commercial production	Dummy: 1 if farmer produce for sale or partly for sale and 0 for sole subsistence
Flood	Total number of times in 5 years a farmer experienced floods on farm.
Drought	Total number of times in 5 years a farmer experienced droughts on farm.
Windstorm	Total number of times in 5 years where windstorm destroyed farmer's farm.
Shock awareness	1 if a farmer was aware of a climate shock prior to its occurrence, 0 otherwise.
Climate perception	Dummy: 1 if farmer perceived rainfall as decreasing and temperature increasing, 0 if otherwise.
Drought resistant varieties	Dummy: 1 if a farmer planted drought resistant maize variety and 0 otherwise.
WTP-decision	Dummy: 1 if a farmer is willing-to-insure farm, 0 if otherwise.
WTP-Amount	The premium (in Ghana cedis) a farmer is willing-to-pay to insure farm.

2. Results and discussion

2.1 Willingness-to-insure farm

From Table 1, the majority (58%) of the farmers were willing-to-insure their maize farms. The risk associated with agriculture is worsening due to the changing climate. Therefore, to be at least partially protected against agricultural risks and/or distribute climate risks, farm insurance and other forms of agricultural insurance are crucial. It is therefore consistent that most of the farmers were willing-to-insure their farms. However, about 1% of farmers who were willing-to-insure their farms were not willing-to-pay a positive premium. Empirically, Dewi et al. (2018) found that 44% of the respondents were willing-to-pay an insurance premium for their insurance while Velandia et al. (2009) found that 46% of their respondents engaged in crop-insurance. Averagely, a farmer was willing-to-pay 163.12 Ghana cedis as an insurance premium per annum, thus, per a production year. The positive willingness-to-pay revealed by the farmers is an indication that there is an economic market for farm insurance.

2.3 Factors explaining farmers' decision to insure farms and the premiums willing to pay

Table 2' willingness-to-insure decisions and amount willing-to-pay as an annual insurance premium. From the result, farmer groups, commercial production, flood, drought, windstorm, shock awareness and drought resistant variety had significant effect on the decision to insure farms. Also, education, extension, remitters, awareness of shocks and climate perception had significant effect on the premium farmers were willing-to-pay for farm insurance.

The effect of education on willingness-to-pay is positive in both the decision and the amount. Thus, farmers with higher formal education have higher probabilities of insuring their farms and were willing-to-pay higher insurance premiums. This is consistent with Ali (2013), Falola et at., (2013) and Ellis, (2016) who also found a positive relationship between education and willingness-to-pay. Farmer groups have a mixed effect on willingness-to-insure farms. While it had a negative effect on insurance decision, it had a positive effect on insurance premium. However, the effect is statistically significant only at the decision stage. This means that farmers who belonged to a farmer group were less likely to insure their farms. Nonetheless, Elum et al. (2018) also found a negative insignificant effect of farmer group on crop insurance decision. Extension access had a positive effect on both the decision and amount farmers were willing-to-pay for farm insurance. This is significant for the amount but insignificant for the decision. This means that farmers who had access to extension services have higher probabilities of engaging in farm insurance and were willing-to-pay higher amounts for insurance. This is contrary to the findings in Ellis, (2016).

Commercial production had a positive significant effect on farmers' decision to insure their farms. This means that farmers who produced solely or partly for sale were more willing-to-insure their farms than those who produce solely for domestic consumption. This is because the commercial producers see their farms as a business venture that needs to be insured. The number of remitters in a household increases the decision of farmers to declare higher willingness-to-pay amount for farm insurance. This is because the extra incomes received from remitters can cushion the ability of the farmers to pay for farm insurance.

All climate variables had significant effect on the willingness-to-insure decisions of the farmers except climate perception. For the amount farmers were willing-to-pay, only climate perception and shock awareness were statistically significant. Thus, climate shocks have no significant effect on the amount farmers were willing-to-pay for farm insurance but only on the decision to insure. The positive significant effect of drought and floods means that farmers who experienced these climate shocks were more willing-to-insure their farms than those who did not experience these shocks. This is because the farmers become risk averse after experiencing climate shocks and would be willing to engage in strategies that would spread risks and reduce their exposure and vulnerability to climate shocks. Long et al., (2013) observed that experiencing shocks positively and significantly affects the amount farmers are willing-to-pay for insurance. Elum et al. (2018) found that there is a positive relationship between crop insurance and rainfall level. It is not clear the mechanisms through which the experience of windstorms would reduce the willingness-to-insure decision of the farmers. It was evident from the result that, farmers who were aware of climate shocks prior to their occurrences had less probabilities of declaring a positive willingness-to-insure their farms. This is because, as the farmers become aware of these shocks, they adopt coping strategies to minimse the impacts from the shocks. For instance, prior to floods, the farmers could have constructed bunds around their farms or harvest their crops that were almost matured. Contrarily, Ellis, (2016) estimated a positive relationship between awareness and ability to buy and pay for insurance.

Table 2: Determinants of farmers' willingness-to-insure and premium for insurance

	Decision	Amount

Variable	Coeff.	Std. error	P value	Coeff.	Std. error	P-value
Education	0.142	0.004	0.998	0.073***	0.024	0.003
Farmer groups	-0.135***	0.044	0.002	0.026	0.203	0.897
Extension	0.057	0.039	0.140	0.463**	0.195	0.018
Commercial production	0.049**	0.021	0.017	0.142	0.105	0.177
Remitters	-0.026	0.018	0.141	-0.117*	0.064	0.066
Flood	0.034*	0.019	0.072	0.131	0.105	0.213
Drought	0.028**	0.013	0.038	0.059	0.696	0.393
Windstorm	-0.040**	0.019	0.036	-0.098	0.100	0.33
Shock awareness	-0.077**	0.038	0.041	0.361*	0.192	0.061
Climate perception	-0.035	0.045	0.429	-0.549**	0.232	0.018
Drought resistant	0.095*	0.050	0.056	-0.191	0.242	0.431
Log likelihood (-178.86)		Pseudo R2 =0.1674				

Note: *, ** and * indicates significance at 1%, 5% and 10%, respectively.**

Source: Field Survey, 2017

2.3 Factors explaining households' recovery period from climate shocks

Table 3 shows the factors explaining the recovery period from climate shocks by the farmers. This self-reported recovery periods are a measure of the resilience of the farming households. Therefore, these results are interpreted as the determinants of households' resilience. Thus, the faster the household recover from climate shock, the higher the resilience to climate shocks. From the result, age, sex, education, adults, extension, credit access, welfare, perception and willing-to-insure farm had significant effect on the recovery period of farming households. The dependent variable in the model ranged from 1 (bounce back same season), 2(bounce back after one season), 3(bounce back after two seasons), 4(bounce back after three seasons) to 5 (never bounce back after climate shock). Therefore, the negative coefficients means that farmers recovered faster from climate shocks if the variable is positive or increased.

The effect of age on recovery period is negative. This means that age decreases the probability of recovering back faster and increase the probability of bouncing back faster from climate shocks. Hence, the elderly farmers recovered faster than the younger farmers. Consistently, Jiri et al. (2017) argued that younger farmers are more likely to adapt to climate change because of their flexibility in adopting new or modern technologies as well as their access and use of modern information. The result shows that the male farmers have higher chance of recovering lately from climate shocks than female farmers. Although this is contrary to expectations, this justified that there is a quick positive response in investment programs that seeks to reduce the climate vulnerability of female farmers. Although not significant, Tesso et al. (2012) estimated a positive effect of sex on the recovery period of farming households. Similarly, existing biases against women increases their challenge in adapting their farming practices against climate risks, thereby, reducing women's resilience (Perez et al., 2015). Consistent with the expectations of the research, education had a negative significant effect on recovery period. Thus, an increase in the educational level of the farmer decrease the probability of recovering back lately from climate shocks. Consistently, Tesso et al. (2012) found that education is an essential factor in building households' resilience to climate change.

Similarly, Kassem et al. (2019) also estimated that education improves climate adaptation abilities of farmers.

Access to extension services had a negative significant effect on recovery period. Thus, farmers who had access to extension services had lesser probabilities of recovering lately. In order words, access to extension service reduces the recovery period of the farmers. Consistent with this finding, Jiri et al. (2017) found that access to climate information through extension services improve the adaptive capacities of households. Kassem et al. (2019) recommended for extension to improve awareness on anticipated effects of climate change. Access to credit had a positive significant effect on recovery period from climate shocks. Thus, farmers who had access to credit had a higher probability of recovering lately from climate shocks. The implication is that in the midst of climate shocks, the provision of credit to farmers may not be an ideal situation unless well regulated. This does not invalidate the positive role of credit in improving adaptive capacities of households. For instance, in Jiri et al. (2017), it was evident that farmers with access to credit are more likely to adapt to climate change. The effect of farmers' perceptions on climate change is positive. This implied that farmers who correctly predicted changes in temperature and rainfall have higher probabilities of recovering lately from climate shocks. This is contrary to the expectations of the research since it was expected that farmers who have an understanding of climate change would be able to take necessary steps to improve their resilience.

Consistently, farm insurance (proxy by the farmers willingness-to-insure) had a negative effect on the recovery period of farmers. Thus, farmers who insured their farms have higher probability of recovering faster from climate shocks. This is due to the fact that the farm insurance provides the opportunity for the farmers to gain the losses they incurred on their farms. Hence, the impacts of climate shocks are negated by farm insurance, hence, shortening the recovery period of the farmers. This justified the need for providing farm insurance opportunities to farmers to avert the impact of climate shocks. It was clear in article 8 of the Paris agreement that there is the need for risk insurance facilities, climate risk pooling and other insurance solutions in the midst of climate change (United Nations, 2015). Falco et al. (2014) also noted that financial insurance is an important tool for hedging the impacts of climate change, especially on welfare losses. For Elum et al. (2018), agricultural insurance is being promoted to improve adaptation to climate change and improve farm production and farmers' livelihoods, as a result, estimated a positive impact of crop insurance on net farm income.

Table 3: Determinants of recovery period from climate shocks by farmers

				Marginal effects of recovery periods (Seasons)				
Variable	Coef.	Std. Err.	P>z	Same season	After one season	After two season	After three season	Never recovered
Age	-0.012*	0.006	0.053	0.002	0.002	-0.002	-0.002	0.0003
Sex	0.306*	0.180	0.089	-0.060	-0.061	0.050	0.062	0.009
Education	-0.016	0.019	0.387	0.003	0.003	-0.003	-0.003	0.0005
Adults	0.047**	0.022	0.038	-0.009	-0.009	0.008	0.009	0.001
Children	-0.009	0.024	0.709	0.002	0.002	-0.001	-0.002	0.0003
Extension	-0.278*	0.163	0.089	0.054	0.055	-0.045	-0.056	-0.008
Contract farming	-0.349	0.217	0.108	0.068	0.070	-0.057	-0.070	-0.010
Farmer groups	-0.211	0.158	0.180	0.041	0.042	-0.035	-0.043	-0.006

Credit access	0.540***	0.170	0.002	-0.105	-0.108	0.088	0.109	0.016
Farm size	-0.018	0.013	0.160	0.004	0.004	-0.003	-0.004	-0.001
Perception	0.333**	0.159	0.037	-0.065	-0.066	0.054	0.067	0.010
Willingness-to-insured	-0.521***	0.159	0.001	0.102	0.104	-0.085	-0.105	-0.015
Pseudo R square		0.859						

Note: *, ** and * indicates significance at 1%, 5% and 10%, respectively.**

Source: Field Survey, 2017

3. Conclusions and policy implications

In this study, we examined the farmers' perceptions on climate change, their willingness-to-insure their farms and their resilience to climate shocks. Generally, it is concluded that most of the farmers were willing-to-insure their farms as well as willing-to-pay a positive premium for farm insurance. From the result, farmer groups, commercial production, flood, drought, windstorm, shock awareness and drought resistant variety had significant effect on the decision to insure farms. On the other hand, education, extension, remitters, prior awareness of shocks and climate perception had significant effect on the premium farmers were willing-to-pay for farm insurance. Evident from the study, climate shocks positively influenced farmers' willingness-to-insure their farms.

It is concluded from the findings that the farmers are generally able to recover from climate shocks after one season but not more than two seasons. Nearly all the farmers indicated the ability to recover from climate shocks with varying time periods. Generally, the factors that had significant effect on the recovery period of the farmers were age, sex, education, adults, extension, credit access, welfare, perception and willing-to-insure farm. It is concluded therefore that farm-insurance is an important strategy of making farming households more resilient to climate shocks. As such, there is the need to introduce farm insurance policies to crop farmers in the region. In order to ensure that the farmers remain loyal to the insurance policies, an appropriate premium should be determined based on the farmers declared premiums and not solely determined by the insurance providers. Also, in order to ensure that farmers recover faster from climate shocks, there is the need to improve extension service delivery and education of farmers on climate change.

References

Abrams R. W, Abrams J. F and Abrams A. L. (2018). Climate change challenges for Africa. *Encyclopedia of the Anthropocene*, 2, 177-194.

Adenle A. A., Ford J D., Morton J, Twomlow S. Alverson K., Cattaneo A. Cervigni R., Kurukulasuriya P. Huq S., Helfgott A. and Ebinger J. O (2017). Managing climate change risks in Africa - A Global Perspective. *Ecological Economics*, 141, 190–201.

Ali A (2013). Farmers' willingness to pay for index based crop insurance in Pakistan: A case study on food and cash crops of rain-fed areas. *Agricultural Economics Research Review*, 26(2), 241-248.

Ankrah J. (2018). Climate change impacts and coastal livelihoods; an analysis of fishers of coastal Winneba, Ghana. *Ocean and Coastal Management*, 161, 141–146.

Apuri I., Peprah K. and Achana G.T.W (2018). Climate change adaptation through agroforestry: The case of Kassena Nankana West District, Ghana. *Environmental Development*, 28, 32–41.

Arndt, C., Asante, F., and Thurlow, J. (2015). Implications of climate change for Ghana's economy. *Sustainability, 7,* 7214–7231.

Cragg J. G (1971). Some statistical models for limited dependent variables with application to the demand for durable goods. *Econometrica,* 39, 829–844.

Ellis E. (2016). Farmers Willingness to pay for crop insurance: Evidence from Eastern Ghana. MPHIL thesis. McGill University, Montréal; Quebec: Canada.

Elum Z. A., Nhamo G. and Antwi M. A. Effects of climate variability and insurance adoption on crop production in select provinces of South Africa. *Journal of Water and Climate Change,* 9 (3), 500-511.

Falco S. D., Adinolfi F., Bozzola M. and Capitanio F. (2014). Crop Insurance as a Strategy for Adapting to Climate Change. *Journal of Agricultural Economics,* 65(2), 485–504.

Falco S. D., Adinolfi F., Bozzola M. and Capitanio F. (2014). Crop insurance as a strategy for adapting to climate change. *Journal of Agricultural Economics*, 65(2), 485–504.

Falola, A., Ayinde, A.E. and Agboola, B.O. (2013). Willingness to take agricultural insurance by cocoa farmers in Nigeria. *International Journal of Food and Agricultural Economics* 1(1): 97-107.

Filho W.L., Balogun A., Ayal D. Y., Bethurem E. M., Murambadoro M., Mambo J., Taddese H., Tefera G. W., Nagy G.J., Fudjumdjum H., Mugabe P. (2018). Strengthening climate change adaptation capacity in Africa- case studies from six major African cities and policy implications. *Environmental Science and Policy,* 86, 29–37.

GSS. (2015). *Ghana poverty mapping report*. Accra, Ghana.

GSS. (2012). *Ghana Statistical Service. 2010 population and housing census summary report of final results May, 2012.*

Hanemann W. M., Loomis J. and Kanninen B. J. (1991). Statistical efficiency of doublebounded dichotomous choice contingent valuation. *American Journal of Agricultural Economics*, 73(4), 1255-1263.

Hensher D. A., Rose J. M and Greene W. H. (2005). Applied choice analysis: A primer. Cambridge: Cambridge University Press.

Holling C.S. (1973). Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics*, 4, 1–23.

Holzkämper A. (2017). Adapting agricultural production systems to climate change: What's the use of models? *Agriculture*, *7*(10), 86;

Jensen N. and Barrett C. (2017). Agricultural Index Insurance for Development. Applied Economic Perspectives and Policy, 39(2), 199–219.

Jiri O., Mafongoya P. L. and Chivenge P. (2017). Building climate change resilience through adaptation in smallholder farming systems in semi-arid Zimbabwe. *International Journal of Climate Change Strategies and Management*, Vol. 9 Issue: 2, pp.151-165,

Jones L. and Tannner T. (2017). 'Subjective resilience': using perceptions to quantify household resilience to climate extremes and disasters. Regional Environmental Change, 17(1), 229–243.

Kassem H. S., Bello A. R. S., Alotaibi B. M., Aldosri F. O. and Straquadine G. S. (2019). Climate Change Adaptation in the Delta Nile Region of Egypt: Implications for Agricultural Extension. *Sustainability* 2019, *11*, 685.

Kuhl L. (2018). Potential contributions of market-systems development initiatives for building climate resilience. *World Development*, 108, 131–144.

McConnell A. R. and Leibold J. M. (2009). Weak criticisms and selective evidence: Reply to Blanton et al. (2009). *Journal of Applied Psychology, 94*(3), 583-589.

Müller B., Johnson L. and Kreuer D. (2017). Maladaptive outcomes of climate insurance in agriculture. Global Environmental Change 46 23–33.

Perez C., Jones E. M., Kristjanson P., Cramer L., Thornton P.K., Förch W. and Barahona C. (2015). How resilient are farming households and communities to a changing climate in Africa? A gender-based perspective. *Global Environmental Change*, 35, 95-107.
Tesso G., Emana B. and Ketema M. (2012). Analysis of vulnerability and resilience to climate change induced shocks in North Shewa. *Ethiopia. Agricultural Sciences*, 3(6), 871-888.
United Nations (2015). Paris agreement. https://unfccc.int/sites/default/files/english_paris_agreement.pdf
Velandia M., Rejesus R. M., Knight T. O. and Sherrick B. J. (2009). Factors affecting farmers' utilization of agricultural risk management tools: The case of crop insurance, forward contracting, and spreading sales. *Journal of Agricultural and Applied Economics*, 41(1), 107–123.
Venkatachalam, L (2004). The contingent valuation method: a review. *Environmental impact Assessment Review*, 24, 89-124.
Vossler C.A. and Kerkvliet J. (2003). A criterion validity test of the contingent valuation method: comparing hypothetical and actual voting behaviour for a public referendum. *Journal of Environmental Economics and Management*, 45:631-649.
World Bank (2018). 3rd Ghana economic update- agriculture as an engine of growth and jobs creation. World Bank Group.