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Looking out for a better mitigation strategy: smallholder farmers' willingness to pay for drought-index crop insurance premium in the Northern Region of Ghana

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Abstract

Background: The impact of climate change and variability on livelihoods of smallholder farmers in Northern Ghana has become severer than ever before. As a result, crop insurance has been advocated as one of the recommended risk transfer mechanisms to support farmers in coping with production risks. We used a multistage sampling procedure to select a sample of 315 farmers from 15 farming communities in the Northern Region of Ghana and obtained from this sample the data needed for the analysis. We then applied the contingent valuation method to the data and evaluated the premium amount maize farmers in the study area are willing to pay for crop insurance under a hypothetical market-based drought-index insurance regime. In addition, we used the binary probit model to identify the drivers of farmers' willingness to pay (WTP).

Results: The results revealed that the premium a maize farmer is willing to pay for crop drought-index insurance is GHS175.25/ha (circa USD39/ha). And while variables such as sex, level of education and perception index unexpectedly reduce farmers' WTP for weather-index crop insurance, others such as women's contributions to agriculture, previous farm income and landownership are significant drivers that enhance farmers' WTP.

Conclusion: It is concluded that the premium that maize farmers in the northern region are willing to pay annually per ha of a maize farm is GHS175.25 (USD). The results of the binary probit model revealed that sex, age, education, insurance awareness, regular payment of insurance premium, land ownership, farming methods, farm risk level, the nature of damage caused by an event, women contribution, income and mean perception index of crop insurance are factors that significantly influence the WTP amount for crop drought-index insurance.

Keywords: Climate change, Willingness to pay, Drought-index insurance, Northern region

Background

Agricultural systems in the West African Guinea Savannah Zone (GSZ) are challenged with myriad problems that have increased the portfolio of risks already faced by smallholder farmers in this semi-arid and resource-poor agro-ecological zone. One of such risks is the erratic nature of rainfall leading to frequent adverse weather events such as droughts and floods. These events have further intensified the vulnerability of farmers in the GSZ of West Africa.

In the framework of the "Global Index Insurance Facility" (GIIF) programme introduced by the International Finance Corporation (IFC) to provide insurance solutions for low- and lower-middle-income countries, some initiatives were launched in Ghana towards Index-Based Micro-Insurance (IMI) schemes. One of these initiatives was the drought-index insurance (DII) programme under the Ghana Agricultural Insurance Programme (GAIP).

The GAIP's DII programme, introduced in 2011, relies on climate and harvest indicators to predict yield losses

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for crops such as maize, millet, sorghum, soybean and groundnuts. The programme seeks to protect smallholder farmers' income by helping them get access to insurance contracts and credit facilities. The programme is not only a risk transfer mechanism, but is also increasingly employed as an initiative for building climate change resilience among farmers, especially in the semi-arid savannah zone of Northern Ghana. Ultimately, the programme is expected to mitigate the effects of crop yield losses resulting from drought on farmers as well as boost the confidence of financial institutions in lending to smallholder farmers.

Research in collaboration with national institutes is the basis for the development of GAIP's insurance policies. The positive response and continuous interest by farmers, input dealers and banks motivate the GAIP team to extend agricultural insurance in Ghana. The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) supports the set-up of GAIP with its Innovative Insurance Products for the Adaptation to Climate Change (IIPACC) project funded by the German Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU).

GAIP uses the Ghana Meteorological Agency weather stations to measure rainfall. If rainfall recorded falls below a certain level, it indicates drought on your field. Insured farmers within the 20 km radius around the weather station will get a payout. What to do: Call your local agent before the beginning of the season, pay insurance premium, enjoy insurance for the whole season, and get payout in case of severe drought [1].

Though there is a growing body of evidence showing that the DII scheme is an important agriculture production risk transfer strategy, the uptake of designed insurance packages under the DII scheme in Ghana is still low [2]. This is attributed to financial constraints faced by farmers, covariate risks and a low level of farmer's awareness of existing insurance packages, their benefits and how they operate. In addition, farmers who are aware perceive that the premium is not sustainably affordable and therefore do not make purchases during the cropping season.

According to [3], risk is the key concept of insurance and normally conceptualised as a standardised decision tool that multiples the probability (P) of the occurrence of an event e with the damage inflicted (D).

$$R(e) = P(e) \times \mathrm{D}(e)$$

The available literature has, however, confirmed that crop insurance is a means of protecting farmers against production losses due to risks and uncertainties [3, 4]. The advantage of weather-index crop insurance especially is that, in the event of yield failure resulting from natural occurrences beyond farmers' control, crop insurance will protect the farmer against total income losses [5]. Crop insurance is also an alternative source of farm revenue that helps reduce the impact of the incurred losses [6]. In this regard, properly designed and implemented crop insurance programmes safeguard the investments of the otherwise vulnerable, smallholder farmers, reduces their detrimentally risk-averse behaviour and enhances their efficient use of scarce, but productive resources [7, 8].

One other potential benefit of agricultural index insurance to financial institutions that lend to resource-poor farmers in weather-dependent agriculture regions such as semi-arid Northern Ghana is that insurance indemnifies a part of their loan portfolios against crop losses. This reduces lending risks, helps lenders continuously provide credit in high production risk-prone areas and enables farmers adopt remunerative, but high-risk production technologies [9, 10]. In the above cases, crop insurance may be described as a climate smart strategy useful to both the farmer, the insurer and consumers agricultural commodities alike.

To protect smallholder farmers against possible yield losses, the DII scheme over the years of its existence designed and offered different packages of the scheme to farmers at different parts of Ghana with financial subsidies from either government or private development organisations (NGOs). Unfortunately, the average uptake of these packages has been very slow. To help create the needed awareness and increase the uptake rate in Ghana, rigorous empirical research evidence on the willingness to pay (WTP) and the factors influencing this willingness is required. Such evidence will be useful to farmers, insurance companies, governmental and non-governmental development organisations, policy makers and other key stakeholders in the agriculture sector.

So far, there have been very limited attempts to investigate the WTP for the premiums offered by the various packages under the DII scheme. In addition, little is known of the factors influencing farmers' WTP. Even though it is known that information on the terms and conditions of claims following climate-related shocks and risks are issues of most concern influencing the decision of the smallholder farmer to subscribe to farm insurance or otherwise, empirical evidence on these factors is still lacking.

Motivated by the need to fill the above-mentioned empirical knowledge gap in this emerging dimension of climate change mitigation research, this paper seeks to evaluate the premium amount maize farmers in the study area are willing to pay for crop insurance premiums under the GAIP. The paper also evaluates the factors influencing farmers' decisions to participate or otherwise in existing insurance schemes. The goal is to help in the design of attractive crop insurance packages to increase the uptake by farmers and lending from financial institutions to smallholder farmers in Ghana.

Study area and data collection

The study was conducted in three districts within the semi-arid GSZ of Northern Ghana. These are the Tolon and Kumbungu districts, and the Savelugu municipal district, which formed part the pilot districts of the GAIP's crop insurance scheme. The three districts combined have an estimated population of about 250,000. Rainfall in the study area is mono-modal in distribution and ranges from 900 to 1100 mm, and lasts from 71 to 78 days between May and October annually.

Agriculture in the form of rain-fed, semi-subsistence farms comprising "homestead farms" dominated by maize and sorghum systems with mixtures of cowpea, and vegetables; outfields dominated by rice, groundnuts and other monocrops; and the rearing of livestock is the main source of livelihood for the majority of the population in the area. Maize is the most important crop among the systems in all these three districts.

The study used the multistage sampling procedure to obtain the farmers covered by the study [11]. The districts were purposively sampled based on their pilot status in the GAIP, while communities and individual farmers were sampled by means of the simple random sampling procedure. The literature has shown that a sample size that is appropriate for any research is determined by a number of variables in the models. As the number of variables increases, the sample size should be statistically large to avoid biased results [12]. An appropriate sample size for a research, however, depends on the type of problem under study, the precision required and the resources available [13].

Tabachnick and Fidell [14] established that a sample size of 300 is adequate for factor analysis, and for regression analysis, a sample size $N \geq 50 + 8^{*}M$ is adequate, where M is the number of independent variables. There are 15 independent variables in this study; a sample size of $50 + 8^{*}15 = 170$ is adequate for regression analysis. The final sample comprised 105 farmers from five communities in each of the three districts. Thus, t a total sample size of 315 farmers was covered by the study.

A survey field using questionnaire was conducted in the three districts for the purpose of collecting the relevant data needed for the analysis. The survey was conducted using face-to-face personal interviews with farm household heads. The data, which pertain to the 2015–2016 agricultural production year, include variables like sex, age, education, insurance awareness, regular payment of insurance premium, land ownership, farming methods, farm risk level, damage caused by an event, women contribution, income and mean perception index of crop insurance.

Methods of data analysis

The WTP amount by farmers was estimated using the contingent valuation method (CVM), while the determinants of maize farmers' household annual WTP were estimated using the binary probit model (BPM). Operationally, WTP is defined as the amount that must be taken away from a person's income while keeping his/her utility constant. For [10], it is the maximum price a consumer (or a farmer in this case) is willing to pay to buy a good (insurance package). On the other hand, willingness to accept a good is defined as the amount of money that must be given to an individual experiencing deterioration in environmental or resource quality to keep his/her utility constant.

The WTP is usually specified as:

$$V(y - \text{WTP}, p, q_1; Z) = V(y, p, q_0; Z) \quad (1)$$

The WTA on the other hand is defined as:

$$V(y + \text{WTA}, p, q_0; Z) = V(y, p, q_1; Z) \quad (2)$$

where WTP and *WTA* are the willingness to pay and accept, respectively, and Z denotes farmers socio-demographic characteristics. V denotes the indirect utility function, y is income, p is a vector of prices faced by the individual, and q_0 and q_1 are the alternative levels of the good or quality indexes (with $q_1 > q_0$, indicating that q_1 refers to improved grades or quality of the good).

In Eqs. (1) and (2), utility is allowed to depend on a vector of individual characteristics influencing trade-offs that the farmer is prepared to make between income and the good in question (crop index insurance). An important implication of Eqs. (1) and (2) is that WTP or WTA depends on: (1) the initial and final level of the good in question (q_0 and q_1); (2) respondent income (y); (3) all prices faced by the respondent, including those of substitute goods or activities (p); and (4) farmers socio-demographic characteristics (Z).

Calculating the mean amount of WTP will depend on how it is operationalised and measured. If it is measured as a continuous variable by soliciting open-ended response values as in this research, the WTP amounts reported by the respondents can be used to statistically estimate the mean WTP as:

$$\text{MWTP} = \frac{1}{n}\sum_{i=1}^{n} yi \quad (3)$$

where MWTP is mean willingness to pay, n is the sample size and each yi is a reported amount [15].

Having estimated WTP by farmers, it is necessary to know the farmer or farm-level characteristics likely to influence farmers' decisions to participate (pay a minimum premium) in a weather-index crop insurance scheme. According to [16], such farmer/farm-level characteristics may be modelled using the binary probit model (BPM) as follows:

$$D_i = f(R_i, L_i, A_i(Y_i, C_i)), S \tag{4}$$

where D_i with $D_i = 1$ if a farmer participates in crop drought-index insurance and $D_i = 0$ otherwise represents a dichotomous farmer participation decision outcome which is dependent on the level of risk exposure (R_i), potential level of damage caused by an event (L_i) and the ability to pay for the insurance premium (A_i). The A_i is in turn partially a function of income flow (Y_i) and partially due to access to credit (C_i) and S is farmers socio-demographic characteristics.

The binary choice logit model is the appropriate estimating model if logistic (cumulative) distribution is assumed; otherwise, normal distribution is applied in estimating BPM [16]. This study assumes normal distribution and thus applied the probit model in assessing the effect of farmers' socio-economic attributes on the probability of subscribing to crop insurance packages available in their districts.

The empirical model used in the study is expressed as:

$$Y = \beta_0 + \beta_i X_i + u_i \tag{5}$$

$$\begin{aligned} Y_i = \beta_0 &+ \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 \\ &+ \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} \\ &+ \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + \beta_{14} X_{14} + \beta_{15} X_{15} + \mu_i \end{aligned} \tag{6}$$

where $Y =$ Willingness to participate and the dependent variable. The independent variables include: $X_1 =$ Level of risk exposure, $X_2 =$ Level of damage caused by an event, $X_3 =$ Ability to pay the insurance premium, $X_4 =$ Income of farmer (previous year's income), $X_5 =$ Access to credit, $X_6 =$ Perception index, $X_7 =$ Sex, $X_8 =$ Age, $X_9 =$ Educational level, $X_{10} =$ Farming experience, $X_{11} =$ Awareness $X_{12} =$ Land ownership, $X_{13} =$ Farm size, $X_{14} =$ Women contribution, $X_{15} =$ Farming methods, $\beta_0 =$ Constant, β_1 to $\beta_{15} =$ Coefficients, $\mu_i =$ Error term. The STATA software package Stata SE 14 version was used for the analysis.

Results and discussion

Socio-demographic characteristics of farmers

The survey revealed (Table 1) that farming in the study area is dominated by men (62%) as compared to women (38%). This is due to the sociocultural setting of the people in the study area where resources, particularly productive agricultural lands, are controlled and owned by men, and maize production in particular is male-dominated. In all the districts, female farmers are less likely than male farmers to have access to productive land that is of economic value. A majority of the farmers are semi-subsistence in maize production.

Table 1 Summary statistics of farmers socio-demographic characteristics. *Source*: Authors' Analysis, 2016

Variables	Percentages
Sex of respondents	
Male	62
Female	38
Education level	
No education	59
Any form of education	41
Source of household income	
Personal savings	62
Wages	3
Family	21
Friends	0.5
Loans	0.5
Farming	13
Access to climate information	
FBO/CBO	3.7
NGO	3.7
Extension officers	1.6
Friends	20
TV	10
Radio	60
Insurance company	1

A relatively low level of formal education was observed among farmers with as high as 186 farmers out of the total 315 farmers representing 59% of them lacking any level of formal education. Since some level of literacy and numeracy contributes to farmers understanding and ultimately participating in non-traditional farm investments such as insurance, a higher proportion of the farmer population in the study area may not participate in the schemes without some level of informal education or information transfer from the extension services.

The availability, size and stability of cash income have been variously shown in the literature to spur a shift by farmers from their wholly or semi-subsistence systems to commercially sustainable agricultural systems. Income also influences technology adoption decisions of farmers. The survey results show in Table 1 that about 62% of farmers' income is personal savings, with just 13% of income being directly obtained from farming. Since crop farmers are among the poorest in Ghana, it means farmers in the study area may face liquidity constraints in adopting the DII schemes. In this case, the provision of subsidies or credit to farmers may likely ameliorate these constraints and improve farmers' participation.

Awareness is also very important in technology adoption, and therefore, for more farmers to subscribe to crop drought-index insurance there is the need for the sharing of information through reliable means to enable farmers subscribe to crop insurance. The results showed that about 60% became aware of index insurance through radio stations and a high proportion; around 96% perceive DII as means of mitigating the effects of yield failure resulting from drought. The low level of their education does not therefore appear to reduce farmer's perception of farm insurance as a mitigating measure for climate risk. Nevertheless, radio advertisements or discussions alone are inadequate to explain the relatively complicated procure of DII to largely illiterate farmers.

Climatic characteristics of farmers

Human activities are believed to be increasing the concentration of greenhouse gases naturally present in the atmosphere. With the verdict of the fourth assessment report by [17], there is now very little contention that man contributes to the heating up of the earth. Human daily activities are harmful to the environment, both at homes and on farms, and are threatening the security of the environment as well as the balance of the ecosystem.

Farmers often burn bushes to farm, practice agriculture without considering the environmental effects and cut trees down without knowing how these alter the ecosystem and nature. Bush burning contributes significantly to emission of greenhouse gases like carbon dioxide and methane into the atmosphere. Deforestation has adverse impacts on bio-sequestration of atmospheric carbon dioxide.

From Table 2, about 30% of farmers attributed the cause of climate change to the cutting down of tress (deforestation), 28% said climate change occur as a result of bush burning, 27% blamed it on nature, while the remaining 15% could not simply say why there is climate change. Although 15% of the farmers do not have any formal knowledge about the causes of climate change, maize farmers in the region have noticed the changes in climate over time in their communities from the field survey.

With the negative effects of climate change such as erratic rainfall, increase temperature, shorter rainfall, reduce rain quantity, floods and increase in the occurrences of diseases in animals as indicated in Table 2, farmers in their own way try to cope with it, and during data collection, the following were mentioned: early planting, venturing into other business enterprises, tree planting, mixed cropping and mixed farming. The survey results presented in Table 2 indicate that 70 respondents representing about 22% have adopted early planting measures, 21 each representing 7% seek tree planting and doing other businesses apart from farming, while mixed farming and mixed cropping were 11 and 16 respondents representing 3 and 5%, respectively.

Table 2 Summary of farmers' climate experience. *Source*: Authors' Analysis, 2016

Access to climate information	Percentage
FBO/CBO	3.7
NGO	3.7
Extension officers	1.6
Friends	20
TV	10
Radio	60
Insurance company	1
Perception about climate variability	
Bush burning	28
Don't know why	15
Natural	27
Deforestation	30
Copping strategies	
Did nothing	56
Early planting	22
Mixed farming	3
Mixed cropping	5
Trading	7
Tree planting	7
Climate change effects	
Erratic rainfall	18.10
Increase temperature	39.05
Shorter rainfall	24.76
Reduce rain quantity	13.97
Floods	2.86
Increase diseases occurrence	0.95
Others	0.32

From the above, it indicates that farmers affected by climate change have done one thing or the other to save the situation. Some other farmers have turn attention to doing other small businesses to help reduce the pressure on farm dependence.

Nevertheless, some farmers also believe that planting more than one crop on the same piece of land is an alternative in the sense that when one crop fails as least, the other will do well, while some are planting crops and rearing of animals at the same time to help remedy the effects of climate change in their lives.

A maximum of 176 maize farmers in northern region representing 56% have done nothing about the effects of climate change on their farms. This implies that since more than half of the respondents have done nothing, it means that if crop index insurance is packaged very well, it will be a source of mitigation for farmers since they have express interest in it. Their doing nothing can be as a result of lack of options or ideas, and therefore, crop index insurance can help fill that gap.

Farmers' willingness to pay for crop drought-index insurance

Table 3 shows the summary statistics, viz. means, standard deviations, minimum and maximum values of some variables used in the WTP model.

The results revealed that the Ghana Cedi (GHS) value of farmers' WTP premium per ha per annum within the study area ranges between GHS60.00 and GHS500.00 (circa USD13–USD111) with an average value of GHS179.68 (USD40). Despite the wide variation in the amount, the mean WTP amount implies farmers averagely are willing to pay about GHS180.00/ha/annum as means of transferring drought related risk on their crop yields to insurers (Table 3).

Table 3 Descriptive statistics of continuous variables. ***Source*****: Authors' Analysis, 2016**

Variables	Observation	Mean	SD	Minimum	Maximum
WTP/Ha (GHS)	303	180	38.38	60	500
Farmer_Exp (years)	315	19.20	8.89	3	50
Household_Size	315	13.38	5.21	3	25
Age (years)	315	36.43	10.14	18	70
Income (GHS)	315	1130.32	1064.86	50	7000

Fundamentally, it appears that large-scale, commercial farmers with higher incomes and investment portfolios are willing to pay more, whereas smallholder, semi-subsistence farmers who are most likely risk-averse, are willing to pay lower premiums [18]. According to [19], between 40 and 50% of Ghanaian farmers paid for insurance at reasonable premiums, but participation rates fell to 10–20% when insurance premiums doubled, and probably became unaffordable to low-income farmers.

From Fig. 1, about 4% of farmers are unwilling to insure, while more than half of the farmers 73.33% (118 + 113 farmers) are willing to pay a premium that is at least GHS20 more than the mean WTP amount with just about 23% farmers' willing to pay a premium which is higher above the majority (62 + 10 farmers).

The result from Fig. 1 implies only few farmers are likely to participate if premium for drought-index crop insurance is set at about GHS21 above the estimated mean willingness to pay.

Determinants of farmers' willingness to pay for crop drought-index insurance

Table 4 presents the estimated function of socio-economic determinants of farmers' WTP. The R^2 (0.74) indicates that 74% of the variation in the dependent variable (WTP amount) can be explained by the socio-economic characteristics of the farmers, included in the model. The LR $\chi 2$ (75.72), significant at 1%, means that the regressors

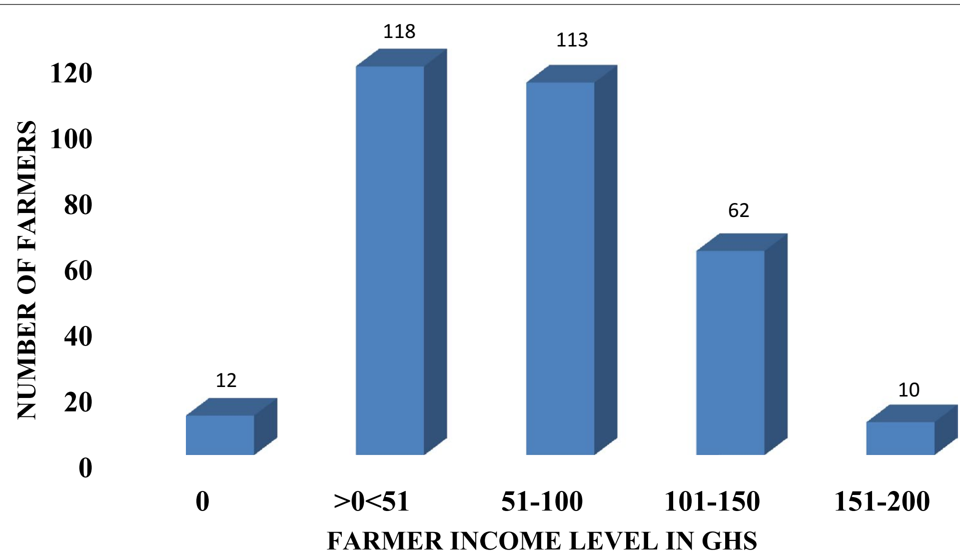

Fig. 1 Distribution of maize farmers according to WTP level. *Source*: Authors' Analysis, 2016

Table 4 Results of the binary probit model on the determinants of WTP. *Source*: Authors' Analysis, 2016

Variables	Coef.	SE	*P* > |*z*|	Delta's marginal analysis	
				Marginal effects	*P* > |*z*|
Sex	− 1.810	0.850	0.033**	− 0.041	0.009***
Age (years)	− 0.159	0.080	0.047**	− 0.004	0.026**
Edu._Level	− 0.915	0.420	0.029**	− 0.021	0.010***
Awareness	3.385	1.234	0.006***	0.077	0.000***
Regular_Payment	4.533	1.579	0.004***	0.103	0.000***
Creditaccess	1.524	0.963	0.114	0.035	0.091*
Land_Owership	0.889	0.439	0.043**	0.020	0.016**
Farming_Methods	− 1.994	0.869	0.022**	− 0.045	0.007***
Farmsize (Acre)	0.061	0.133	0.645	0.001	0.642
Farm_Risk level	2.564	1.333	0.054*	0.058	0.033**
Ccdamage_Caused	− 1.035	0.553	0.061*	− 0.024	0.039**
Women_Cont.	− 2.387	0.934	0.011**	− 0.054	0.002***
Income (GHS)	0.002	0.001	0.072*	0.000	0.047**
Perception_Index	− 2.605	1.362	0.056*	− 0.059	0.034**
Farmer_Experience (years)	0.530	0.652	0.416	0.012	0.407
_Constant	17.276	7.379	0.019		
Dependent variable: WTP	Number of observations = 315			LRchi2(15) = 75.72	
Log likelihood = −13.08147					

*, ** and *** denote statistical significance at the 10, 5 and 1%, respectively

jointly and significantly affect the WTP amount for crop index insurance by farmers in the Northern Region of Ghana.

Farmers awareness of the insurance as well as their ability to make regular payment for the packages under the scheme is highly significant (i.e. at 1%), implying that these variables positively influence farmers decision to participate in insurance by enhancing the probability of farmers to participate in the DII scheme. This means a farmer who is aware of the programme and has some basic information about the programme's benefits is better off in terms of his tendency to accept and pay for a DII package than one who is unaware and lacks the basic information. The financial ability of a farmer to pay seasonal crop index insurance premium regularly also spurs farmers to be willing to subscribe since demand is backed by purchasing power.

The coefficients for age (− 0.159), sex (− 1.810), farming methods (− 1.994), land ownership (0.889), women contributions (− 2.389) and educational level (0.915) of farmers are significant at 5% significance level. Among these, land ownership positively influences the decision of farmers to participate in the DII scheme. The other factors, however, negatively affect the probability of farmers' participation in the scheme. Sex, women's contribution and educational level of farmers did not meet the *apriori* expectations of positively influencing crop insurance participation. Age and farming methods, however, meet the *apriori* expectations of negatively affecting crop insurance participation. From Table 2, a female maize farmer on the average was willing to pay GHS0.0411 less for crop drought-index insurance than a male counterpart *ceteris paribus*. This could partly be because women are poorer than men

The effect of age on a farmer's WTP can be explained by a combination of factors such as farming experience and planning horizon. Although longer experience may have a positive effect on WTP, younger farmers may have longer planning horizons and, hence, may be more likely to invest in agricultural technologies [20–22] due to their expectations of the long-term benefits. If a maize farmer in northern region advances in years by one, his or her WTP for index crop insurance will decrease by GHS0.0036. This means that if a farmer who is 20 years is willing to pay GHS5.00 for crop insurance, then another farmer who is 21 years will pay GHS0.0036 less meaning older farmers pay less for crop drought-index insurance.

The influence of land ownership on WTP is positive. This finding agrees with the findings by Holden and Shiferaw [23] who concluded that land ownership is likely to increase farmers' willingness to pay for agricultural insurance since it guarantees security of tenure for them. Since land ownership and access by women in the study area are low, attempts to increase the participation of women in the DII scheme should be carried out alongside interventions that promote gender equity in land access.

The type of farming method a farmer practices affects willingness to participate negatively. This is explained by the fact that diversifying out of agriculture would enable farmers to earn more income, thereby easing the liquidity constraint which often hinders investments in new technology [22]. The results are in line with the previous studies such as [24, 25] regarding willingness to pay for crop insurance in developing countries.

The coefficients for farm risk level (2.564), experience of damage caused by an event of climate change on crops (− 1.035), income of the farmer (0.002) as well as the average farmer's perception index (− 2.605) about crop index insurance are significant at 10%.

Experience of damage caused by extreme climate event was expected to affect participation positively, but in this case it did not. This could be due to the fact that though farms are at risk, the damage caused did trigger a remedy/assistance from elsewhere. Farm risk level and income of farmer are positive; the significant effects suggest that farmers with higher income as well as farmers facing higher risk of drought due to climate change are more willing to pay and participate in crop index insurance.

On the other hand, the income level of farmers reduces their willingness and ability to invest in agricultural insurance [22]. Empirical studies have reported positive relationships between income and adoption of agricultural technologies of which crop index insurance is one [21, 22]. Farmers' perception of crop index insurance is significant and positively affects their participation negatively. This means that the more the farmers see crop insurance as a risk transfer measure and an important means for mitigating climate change-related yield losses, the more they will be willing to participate and pay for DII. Thus, increased education of farmers on the potential benefits of crop insurance would increase their uptake of the scheme.

Conclusions

The risks faced, especially by farmers, in rain-fed agricultural systems are more precarious now than ever before due to increasing incidence of erratic rainfall regimes under a changed climate. At the moment, there is no evidence to suggest a reduction in these risks and their associated impacts. According to [26], it is likely that these major risks will increase in the future due to a rise in the incidence of anthropogenic causes of climate change.

Under this context, farmers are exploring various strategies for transferring the potential risks they face due to drought and thereby mitigating the associated yield losses as a result. This paper uses the CVM for the estimation of the premium of crop drought-index insurance maize farmers are willing to pay annually per hectare of the crop. The paper also identifies the drivers of maize farm household annual WTP using the BPM.

Averagely, the premium that maize farmers in the northern region are willing to pay annually per ha of a maize farm b is S GHS179.68 (USD40).

The results of the binary probit model reveal that sex, age, education, insurance awareness, regular payment of insurance premium, land ownership, farming methods, farm risk level, the nature of damage caused by an event, women contribution, income and mean perception index of crop insurance are factors that significantly influence the WTP amount for crop drought-index insurance. This confirms [16] conclusion that farmers' willingness to participate in crop insurance schemes is influenced by a number of factors, especially those related to social capital.

The participation of farmers in crop insurance was low because of lack of awareness. Even though radio stations transmit information on available DII schemes, radio discussions alone are inadequate in explaining the real underlying terms and condition of crop insurance among farmers. As a result, farmers lack detailed information on crop weather-index insurance due to low education on crop insurance and an inadequate number of extension officers in the region to ensure that farmers are fully educated on this non-traditional investment scheme.

To this end, we recommend that crop insurance programmes first build on the capacity of agricultural extension services and agents to sensitise farmers on the need to insure their crops before presenting the insurance packages to them. In addition, government subsidies and/or credit may be required to alleviate the liquidity constraints that farmers face in subscribing to DII schemes. Lastly, ensuring gender equity in the participation of farmers in available DII schemes in the Northern Region of Ghana requires empowering women by increasing their access to land.

Authors' contributions

SAA designed data collection instruments, gathered data, analysed data and wrote the first draft of the manuscript. JA and EBD provided guide, corrections, inputs and supervision to the study. All authors read and approved the final manuscript.

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Competing interests

All authors declare that they have no competing interests.

Availability of data and materials
The datasets generated and analysed during the current study are available from the corresponding author on request.

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