Off-Farm Income Effect on Farmer Response to Climate Change in the Northern Region of Ghana

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Off-Farm Income Effect on Farmer Response to Climate Change in the Northern Region of Ghana

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ABSTRACT

This study assessed the effect of off-farm income on maize farmers' responses to climate change in the Tolon district of Northern Region of Ghana. Using multi-stage sampling technique and semi-structured questionnaires, 150 maize farmers from five communities were interviewed. Heckman's treatment effect model was used. The result showed that majority had off-farm income that they received from trading. Furthermore, off-farm income has a significant effect on adoption of adaptation strategies. The majority of the farmers had perceived changes in the climate over the past decades and adaptation strategies practiced included changing planting date, changing crop variety, diversifying crop type, mixed cropping, and keeping animals alongside crop cultivation. Based on the findings from this study, government should provide enabling environment that will create and increase opportunities for farmers to engage in other income-generating activities that will provide them with additional income to procure necessary inputs and tools for appropriate response to the ongoing climate change problem.

KEYWORDS

Adaptation Strategies, Climate Change, Off-Farm Income, Tolon District

1. INTRODUCTION

Climate change continues to pose a threat to the lives and livelihood systems of many communities, especially rural communities. For many families, agriculture remain their primary source of food and income. Although the contribution of off-farm income to the total household income in the rural areas is increasingly recognized, not much is known about how it affects farmers' response to the challenges posed by the ongoing climate change issue. Adaptation as a form of response to climate change is generally costly, largely revolving around adoption of new or improved technologies such as improved varieties and use of improved crop husbandry practices (Nabikolo, 2014; Kalungu *et al*., 2013). But it is a response that many poor farming households have embraced.

Families with higher incomes and adaptive capacities are better able to experiment with new technologies and management systems that might be expensive but offer higher productivity and

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resilience in the future (IFPRI, 2009). Adaptive capacity of farmers takes several key factors into consideration but more importantly income of the farmers. This is recognized in United Nations Framework Convention on Climate Change (UNFCCC) grouping of the World (into Annex I and Non-Annex I Parties) in an effort to mitigate and adapt to the changing climate.

Many people believe that we cannot solve the climate change problem if we fail to address the issue of income inequality in the society. The proposition is that income of farmers of which off-farm income forms part, exerts great influence on their adaptation decisions. Off-farm income opportunities have been widely understood to be an important strategy for overcoming credit constraints faced by the rural households in many developing countries (Barrett, Reardon, & Webb, 2001). As about 40–45% of average household income come from non-farm sources (Bryceson & Jamal, 1997; Reardon, 1997).

Some empirical studies have been conducted regarding off-farm income and adoption in different parts of the World. Such studies include; impact of off-farm income on agriculture technology adoption intensity and productivity of maize farmers in Uganda (Diiro, 2009), impact of off-farm income on hybrid maize adoption and productivity of maize farmers in three ecological zones of Ghana (Addai, 2015) and some climate change related studies, including; Farmers' perception on climate variability and its effects on adaptation strategies (Yildiz, FatihEhiakpor & Danso-abbeam, 2016), determinants of choice of climate change adaptation strategies (Mabe.et al) and the work on impact of climate change on agriculture and crop yield in northern Ghana (Amikuzuno, n.d.). This study seeks to assess the effect of off-farm income on maize farmers' response to climate change in five selected communities in the Tolon district.

1.1 Study Objective

The main objective of this study is to assess the effect of off-farm income on farmers' response to climate change.

Specific objectives are:

1. To identify the various sources of off-farm income available to maize farmers in the Tolon district.
2. To identify the various climate change adaptation strategies practiced by maize farmers in the Tolon district.
3. To determine the effect of off-farm income on farmers' choice of adaptation strategies in response to climate change.
4. To identify constraints associated with the adoption of climate change adaptation strategies by maize farmers in the district.

2. LITERATURE REVIEW

2.1 Adaptation Strategies and Maize Farmers

Adaptation strategies may be specific to geographical area or vary from time to time and as a result, climate change adaptation strategy could become inappropriate overtime (FAO, 2009). According to (IPCC, 2012), adaptation refers to the adjustments in natural or man-made systems in response to actual or expected climatic stimuli or their effects. By this definition, the acceptance and use of strategies and technologies by farmers in a sustainable way to reduce the impact of climate change can be termed as adoption. Most of the local communities have developed indigenous-based adaptation practices which could be harnessed to improve the resilience of such communities (IPCC, 2007).

Though, different crop farmers may have different adaptation strategies in response to climate change, many of the strategies are common. Other studies such as (Mabe et al, 2014) identified the following strategies being practiced by farmers in northern Ghana in response to climate change; changing crop varieties, changing planting dates, planting of trees, destocking, increase farm size, application of fertilizer, farming on fallowed land, diversification and mulching.

Also, (Ehiakpor et al, 2016) found that cocoa farmers in Suaman district of western region practice the strategies of; changing planting date, keeping livestock, fertilizer use, off-farm income, use of improved seeds and seedlings, mixed cropping, pesticides application, planting of shade trees and, land and water management practices in response to climate change. According to (Nhemachena & Hassan, 2007) most commonly cited adaptation methods in literature include the use of new crop varieties and livestock species, irrigation, crop diversification, mixed crop livestock farming systems, changes of planting dates, diversification from farm to non-farm activities, increased use of water and soil conservation techniques, and trees planted for shade and shelter.

2.2 Effect of Off-Farm Income on Adoption of Climate Change Adaptation Strategies

Literature on effect of off-farm income on the agriculture production sector presents mixed views and conclusions. Some literature have indicated that off-farm income is a collateral substitute for borrowed capital in rural economies where credit markets are either not there or malfunctioning (Collier & Lal, 1984; Reardon, 1997; Ellis and Freeman, 2004). Off-farm earnings may serve as collateral to facilitate access to credit by smallholder farmers (Barrett et al., 2001).

In view of this, off-farm income is expected to strengthen the capacity of farmers by providing them with cash for the purchase of productivity enhancing inputs such as improved seeds and fertilizers and to adapt and practice better farming practices that could survive the effects of extreme events such as drought resulting from climate change. In contrast, other studies revealed that off-farm income has the potentials to diverse the focus of farmers from farming, especially when the off-farm enterprise is more rewarding, and this may undermine their adoption of modern technologies/strategies in farming (McNally, 2002; Goodwin and Mishra, 2004).

In addition to the differing views and conclusions, a work done by (Gedikoglu, 2007) in a related topic, found that off-farm income may have significant effect on adoption of new/improved practices depending on whether a particular practice to be adopted by the farmers is labour or capital intensive. The work of (Diiro, 2009) modeled the effect of off-farm income on technology adoption among maize farmers in Uganda using Tobit model and concluded that off-farm income has significant effect on technology adoption. In their studies conducted in Northern Ghana, (Mabe et al, 2014) also concluded that nonfarm income has significant and positive relationship with the practice of some climate change adaptation strategies. However, a work conducted by (Addai, 2015) in three ecological zones of Ghana showed no impact of off-farm income on the adoption of hybrid maize by farmers.

3. METHODOLOGY

3.1 Study Area – Tolon District

The Tolon District lies between latitudes 9°15^ and 10°0 02` North and Longitudes 0°53′and 1°25′ West. It shares boundaries to the North with Kumbungu, North Gonja to the West, Central Gonja to the South, and Sagnarigu Districts to the East with a population of 72,990. More than nine out of ten of the population (92.4%) of households in the District are engage in agriculture, Crop farming is the main agricultural activity with almost ten out of ten (97.5%) households engage in it. Those in livestock rearing account for 74.1 percent and tree planting 0.7 percent.

In the rural localities, more than nine out of every ten (96.6%) of the households are farm households and 65.4% are in the urban localities. Poultry (chicken –36.8%) is the dominant animal reared in the District. The district is characterized by a single rainy season, which starts in late April with little rainfall, rising to its peak in July-August and declining sharply and coming to a complete halt in October-November. The dry season starts from November to March with day temperatures ranging from 33°C to 39°C, while mean night temperature range from 20°C to 26°C. The Mean annual rainfall ranges between 950mm -1,200mm.

Figure 1. District map for Tolon district (GSS, 2010)

3.2 Sampling Procedure and Sample Size

The study employed multi-stage sampling technique where; five communities were purposely selected from the 20 largest communities in the district at the first stage. The communities were purposely selected based on their known cultivation of maize in the district. Simple random sampling approach was then used to select the farmers from the selected communities.

The sample size (n) was determined by this formula, $n = N/ (1+ Ne^2)$, (Calderon, 2003) Where n= sample size, N= number of households in maize production in the district and e = desired margin of error. In all, one hundred and fifty (150) farmers were interviewed and primary data collected.

3.3 Data Analysis

The nature of this study where farmers adopt more than one adaptation strategy in response to climate change and where the strategies are not independent of each other should have required the use of multivariate model to achieve the objective of determining the effect of off-farm income on farmers' choice of adaptation strategies in response to climate change. But due to the issue of selectivity bias resulting from the inherent differences or heterogeneity among individual farmers who have off-farm income and those who do not have, Heckman selection and treatment effect model was chosen for the analysis.

Response in this study is operationalized as adoption of climate change adaptation strategies to cope with the changing climatic system. Off-farm income as dummy, also covers all incomes/monies that come to the farmer aside the income from his/her main farm production.

3.4 Theoretical Model

The Heckman treatment effect model is a two- stage analytical model, where the first stage for this study, deal with whether a maize farmer has off-farm income or not. This involves selection and therefore, binary probit is employed at the first stage. The second stage is the linear response model or output model, which defines the strategies being practiced by the farmers.

The predicted value of the dependent variable (off-farm income) from the first estimate is used to form another variable called Inverse Mills Ratio (IMR). If the IMR is significant then the use of the model is justified. It is used as an additional variable in the substantive (output) equation to ensure that the independent variables are free from biasness (Heckman, 1979; 1980). This will make it possible for the true effect of off-farm income on adoption of adaptation strategies in response to climate change to be assessed.

Selection equation (Off-farm income equation):

$$P(I_i = 1 / Z_i, \beta) = \phi(h(Z_i, \beta) + \mu_{i1} \quad (1)$$

where I_i is the latent level of utility a farmer drives from his/her off-farm income (1 = off-farm income, 0 = no off-farm income), Z_i is a set of variables that influence off-farm income, β is a set of parameters to be estimated, φ is a standard normal cumulative distribution function and μ is the error term.

Substantive equation (adaptation strategies equation):

$$E(Y_i / I_i = 1) = f(X_i, \beta) + \gamma_I \frac{\varphi(Z_i, \delta)}{\phi(Z_i, \delta)} \quad (2)$$

where E is expectation from adopting adaptation strategies, φ is a normal probability density function, Y is the number of climate change adaptation strategies adopted by maize farmers, X is a set of exogenous variables, χ is a parameter estimate of IMR (λ), calculated from first the equation as shown in Equation 3.

IMR estimation:

$$\lambda = \frac{\varphi(Z_i, \delta)}{\phi(Z_i, \delta)} \quad (3)$$

Finally, the mother equation is stated as shown in Equation 4.

Corrected for selectivity:

$$Y_i = X_i\beta + I_i\varpi + \gamma_i\lambda^* + \mu_{i2} \quad (4)$$

3.5 Econometric Model

Selection equation:

$$I_i = \beta_0 + \sum_{i=1}^{7} \beta_i X_i + \mu_i \tag{5}$$

where $X_1 \ldots X_7$ represents explanatory variables influencing off-farm income and include; farmer's access to weather information, gender, membership of farmer based organization (FBO), type of off-farm activity that the farmer engaged in, experience in farming, household size and marital status of the farmer. I_i, denotes off-farm income and μ represents the error term.

Substantive equation:

$$Y_i = \beta_0 + \sum_{i=1}^{10} \beta_i X_i + I_i + \mu_i \tag{6}$$

where $X_1 \ldots X_{10}$ defines variables that affect adoption of adaptation strategies and include; years of education, access to weather information, high cost of technological tools, high cost of inputs, low technical support, age, gender, membership of FBOs, household size and weather a farmer has perceived any change in rainfall and temperature in the past two decades or not. I_i, denotes off-farm income, Y_i is the adaptation strategies and μ represents error term. Note: $\gamma_i \lambda^*$ did not appeared in (6) because it is automatically generated in the course of estimation.

Table 1. Explanatory variables used in the Heckman's model

Variable	Description and measurement	Expected effect
Years of education	Number of years in school	+
Gender	Male = 1, female =0	+/-
Access to weather information	Access = 1, 0 if otherwise	+
Access to extension services	Access = 1, 0 if otherwise	+
Off-farm income	Have off-farm income = 1, 0 if otherwise	
Age	Age of farmer in years	+/-
Household size	Number people in a household	+/-
Experience	Number of years in farming	+
Membership of FBO	Member =1, 0 if otherwise	+
Marital status	Married =1, 0 if otherwise	+/-
Off-farm activity	Type of off-farm activity	+/-
Perception about climate	Perceived change = 1, 0 if otherwise	+
High cost of inputs	A constraint in adoption	-
High cost of technological tools	A constraint in adoption	-
Low technical support	A constraint in adoption	-

4. RESULT AND DISCUSSION

4.1 Proportion of Maize Farmers With Off-Farm Income

Majority (63.33%) of the farmers in the study area have off-farm income as revealed by the analysis and believed that off-farm income helps them in their farming activities. Many of the farmers indicated that they avoid distress sale of assets in the face of climatic shocks by using the incomes from their off-farm activities to purchase life supporting needs. Few of them directly used those incomes in the purchase of farm inputs but indicated that off-farm income is very important in their ability to cope with the changing climate.

However, a good proportion (36.67%) of the farmers do not have off-farm income but also indicated that off-farm income is very important, especially in the face of the increasing risks and uncertainties in the agriculture sector.

4.2 Sources of Off-Farm Income

The main sources of off-farm income indicated by farmers in the study area are summarized in Table 2. Majority of the farmers (64.2%) engaged in trade aside farming, to earn income to support their farming operations. They trade in agricultural commodities as well as petty trading of manufactured goods. A few (10%) of the farmers also earn income through salary from their work in either public or private organizations.

The major occupation in the study area is agriculture and therefore, it makes sense to see few people gainfully employed in the formal sector. About 19% of them also receive income from their artisanal skills including painting, craftsmanship and income from other vocational skills such as tailoring, mansion, and welding. Only 6.32% of the farmers receive income from remittances. This is in line with (Christopher, 2015) findings, regarding what constitute off-farm income.

4.3 Factors Influencing Off-Farm Income

Recognizing the contribution or share of off-farm income to the total household income of farmers and how that influence their response options to climate change requires that we appreciate the factors that could influence farmers' ability to have off-farm income. Table 3 provides the factors from the

Figure 2. Proportion of maize farmers with off-farm income

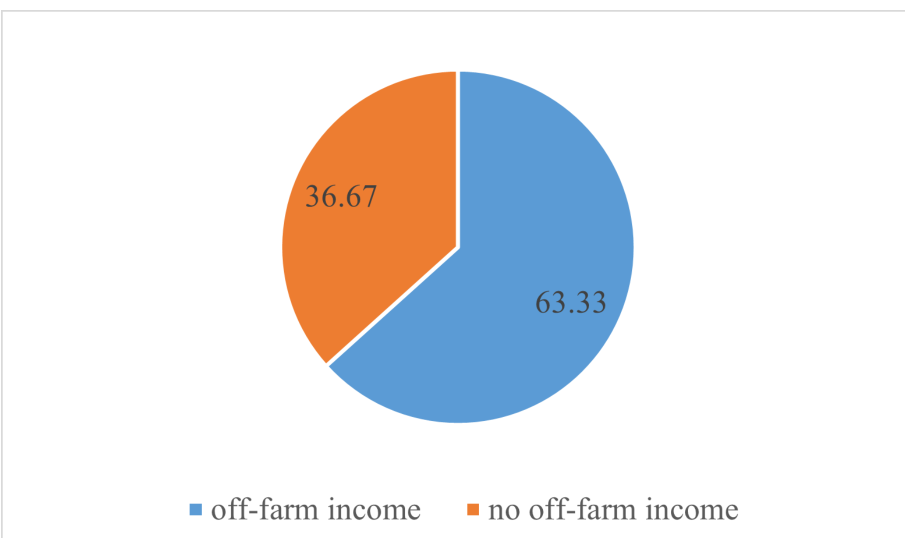

Table 2. Summary of sources of off-farm income of maize farmers

Source	Frequency	Percentage
Artisanship/vocational skills	18	18.95
Remittance	6	6.32
Salary work	10	10.53
Trading	61	64.20
Total	**95**	**100**

Source: Field survey, 2018

Table 3. Factors influencing off-farm income from the Heckman's model

Variable	Coefficient	St.err	P.value
Access to weather information	**0.4618797***	0.2429682	0.057
Membership of FBOs	**0.5083039***	0.2307966	0.028
Gender	**0.4177023***	0.24908	0.094
Household size	-0.0111005	0.0379146	0.770
Off-farm activity	**0.4962072*****	0.1075326	0.000
Marital status	-0.1940595	0.3947773	0.623
Experience	0.0065259	0.0144638	0.652

Note: *, ** and *** represent 10%, 5% and 1% confident levels respectively.
Wald chi2 (9) = 79.92, prob > chi2 = 0.0000

Heckman model estimate that have significant influence on off-farm income of maize farmers in the study area. These factors include access to weather information, FBO membership, gender and type of off-farm activity engaged in by farmers.

Membership of FBOs is found to have positive relationship with off-farm income confirming other empirical studies such as (Ehiakpor et al, 2016) and (Christopher, 2015) whose findings showed that farmers who belong to farmer based organizations have access to some relevant information and opportunities, and are also likely to practice what they have learnt from each other. Therefore, FBOs membership which Christopher described as social asset, will enable farmers to be better positioned in other income generating activities than those who do not belong to any farmer group.

The significant positive relationship between off-farm income and gender can be justified by the fact that male farmers have control and access to resources and opportunities than their female counterparts and therefore, able to engaged in other income generating activities aside farming.

There is also a positive relationship between off-farm income and the type of off-farm activity engaged in by farmers. This implies that farmers who have other income generating activities are more likely to have off-farm income than those farmers who do not have other activities aside their main farming operations and this has met the aprior expectation of the study. Remittances were part of the sources of off-farm income to maize farmers in the study area but what this finding implies is that even though, farmers can have off-farm income from remittances but those farmers participating in off-farm activities are more likely to have off-farm income than non-participants in off-farm activities. This is in line with the findings of (Christopher, 2015) who indicated that farmers with off-farm employment are more likely to have off-farm income than those without off-farm employment. Access to weather information is also found to have positive and significant relationship with off-farm income indicating that the more farmers have access to weather information, the more likely they are to have off-farm income and this is a reflection of how important information on weather is to farmers in regard to decision making. Access to weather information will affect farmers' decision to participate in off-farm activities and hence, affecting their off-farm income status.

4.4 Adaptation Strategies Practiced by Maize Farmers

Adapting to the ongoing climate change issue requires the adoption of micro or farmer level strategies that are suitable for practice in each ecological zone since the impact of climate change is area specific. Table 4 provides a summary of climate change adaptation strategies practiced by maize farmers in response to climate change and variability in the study area.

These micro level strategies identified in the study area include changing planting date, diversifying crop type, changing crop variety, mixed cropping and keeping livestock alongside crop cultivation. The strategies identified is consistent with existing literature (Ehiakpor et al, 2016; Nhemachena & Hassan, 2007; Mabe et al, 2014) on climate change adaptation strategies being practiced by farmers.

Majority of the farmers (81.33%) practice the strategy of changing planting date by adjusting their cropping calendar through delaying and early planting of crops in response to climate change and variability. Also, 80% of the farmers engaged in keeping animals including livestock (goats and sheep), poultry (chicken and guinea fowls) as means of coping with the changing climate. About 71% also practice the strategy of diversifying their crop type as means of spreading risk in the face of any climatic shock. A good number of them (70.67%) practiced mixed/inter cropping as a strategy to ensure optimum water and nutrient usage. Maize is mostly inter-cropped with leguminous plants that have high nitrogen releasing potential to minimize excessive use of inorganic fertilizers that exacerbate the impact of climate change on crops.

The strategy of changing crop variety, which involves substituting drought tolerance, high and early maturing crops and disease resistance varieties for varieties that lack these qualities as means of copping with the changing climate was practice by 64.67% of the farmers. It is important to note that these strategies are not independent of each other.

4.5 Effect of Off-Farm Income on Adoption of Adaptation Strategies

The effect of off-farm income on adoption of adaptation strategies was assessed from the second stage of the Heckman model and the result is shown in Table 5. Variables, including off-farm income that were found to have significant effect on adoption of climate change adaptation strategies are access to weather information, membership of FBOs, gender, and perception of farmers on climate change. The significance of Lambda in the results justifies the choice of the model for this study.

The analysis showed that off-farm income has a significant effect (at 10% confident level) on adoption of adaptation strategies in response to climate change which is consistent with the findings of (Diiro, 2009; Gedikoglu, 2007 & Mabe et al, 2014). This has also met the aprior expectation of the study. Off-farm income is expected to increase farmers' ability to procure necessary inputs and tools

Table 4. Adaptation strategies practice by maize farmers in the study area

Strategy	Yes		No	
	Frequency	%	Frequency	%
Changing planting date	122	81.33	28	18.67
Diversifying crop type	107	71.33	43	28.67
Mixed/inter cropping	106	70.67	44	29.33
Changing crop variety	97	64.67	53	35.33
Keeping livestock	120	80.00	30	20.00

Source: Field survey, 2018

Table 5. Effect off-farm income on adoption of adaptation strategies from Heckman's model

Variable	Coefficient	St. Err	P. Value
Years of education	-0.0033	0.0102	0.746
Access to weather information	**0.3957***	0.1528	0.010
Gender	**0.3027***	0.1501	0.044
High cost of technological tools	0.0912	0.0903	0.312
Household size	0.0261	0.0227	0.250
Membership of FBOs	**0.5531*****	0.1457	0.000
High Cost of inputs	0.1055	0.1169	0.367
Perception about climate change	**0.4720***	0.1965	0.016
Low technical support	0.1575	0 .1170	0.178
Age	0.0096	0.0068	0.159
Off-farm income	**0.6090***	0.3612	0.092
Lambda	**0.3893***	0.2262	0.085

Note: *, ** and *** represent 10%, 5% and 1% confident levels
Source: field survey, 2018

to assist them adopt some of the micro level strategies in order to be able to appropriately respond to the changing climate. Therefore, the more off-farm income a farmer has, the more likely he/she is, to adopt a number of adaptation strategies to minimize the impacts or effects of climate change. However, the findings contradict (Abunga, Emelia, Samuel, & Dadzie, 2012), and (Addai, 2015) who found Off-farm income to have no effect on the adoption of hybrid maize in three ecological zones of Ghana.

Access to weather information also has positive and significant relationship with adoption of adaptation strategies in response to climate change. This has met the aprior expectation of the study and it is in line with (Mabe et al, 2014) findings on the relationship between adoption of strategies and access to weather information. It is expected that the more a farmer has access to weather information, the more likely he/she is to adopt a number of strategies in response to climate change.

Also, perception of farmers about climate change is found to have significant and positive effect on adoption of adaptation strategies. This is consistent with the findings of (Mabe et al, 2014; Jiri et al, 2015; Oluwatusin, 2014; Nhemachena & Hassan, 2007 and Ehiakpor et al, 2016). This means that farmers who have observed changes in key climatic factors, including temperature and rainfall are likely to adopt strategies to counteract the effects of climate change than farmers who do not observed any change in the climate.

Gender of a farmer was also significant and has positive relationship with adoption of adaptation strategies. Which means that male farmers are more likely to adopt a number of strategies in response to the changing climate than their female counterpart. This is also in line with (Mabe et al, 2014). Generally, Male farmers by convention, have access and control over resources and therefore, it makes sense if they are more likely to adopt strategies in response to climate change than the female farmers. However, it contradicts the findings of (Addai, 2015), which showed no significant relationship between gender and adoption.

Membership of farmer based organization is positively related to adoption of adaptation strategies in response to climate change and significant at 1% confident level. This has met the aprior expectation of this study and in conformity with the findings of(Yildiz, FatihEhiakpor & Danso-abbeam, 2016). It is expected that farmers who belong to farmer based groups would be exposed to relevant information and opportunities that will enable them adopt some strategies to reduce the impacts of climate change on their livelihoods.

4.6 Constraints Associated With Adoption of Adaptation Strategies

The farmers indicated a number of constraints that they face in their attempt to cope with the ongoing climate change problem and these challenges were categorized into four major groups in Table 6. These constraints include; high cost of input, low technical support, high cost of technological tools and ineffectiveness of some of the strategies.

This is consistent with (Sangotegbe, 2012) findings on constraints faced by crop farmers in Nigeria. Majority (68.67%) of the farmers indicated that high cost of inputs is their major challenge in an effort to cope with the changing climate. Farmers who want to purchase inputs such as improved seeds, fertilizers, pesticides and herbicides to augment production most at times find it difficult, due to higher cost of those inputs.

High yielding, early maturing, drought and disease tolerance seeds varieties usually come at a cost and therefore, farmers who wished to change their crop varieties could not do so because of the cost involved. It is evident that climate change has brought on farmers an increased incidence and prevalence of pest and diseases and as a result, farmers must find ways to deal with it.

Maize farmers all over the country have suffered fall army worm infestation for the 2017/2018 cropping season which resulted in the farmers spending huge sums of monies in procuring chemicals, most of which were not effective and the few effective ones were expensive for ordinary farmers. As result of this, farmers recorded high yield losses. It is believed that the pests migrated from U.S.A into the country, which could be attributed to climate change because we believe that migration is stimulated when the environment become unsuitable and suitability of the environment depends on the climate.

A good number (23.33%) of the farmers also indicated that high cost of technological tools is a challenge in their ability to respond appropriately to the ongoing climate change issue. Technological tools such as spray machines, planters, ploughing machines etc. according to the farmers, are very expensive but important in their ability to cope with the changing climate. They have observed changes in the quantity and distribution of rainfall and believed that adjusting their planting dates (e.g. early planting) is one of the ways forward. But lack of or inadequate number of these tools due to the cost involved in procuring such tools is making practice of the strategy (changing planting date) difficult. Farmers complained that during the beginning of the farming season, those few farmers who own such tools/machines always want to finish on their own farms before working on other people's farms, which means that if those who are having such tools or machines are not many and a farmer does not have his/her own machines, then his/her dream of planting early becomes a mirage.

Only 6% and 2% of the farmers respectively, think that low technical support and ineffectiveness of some of the strategies were challenges in their ability to respond to the ongoing climate problem. Technical support involves services rendered to farmers by extension agents and other experts in agriculture. Some farmers also believed that some of the strategies are not working.

Table 6. A summary of constraints associated with adoption of adaptation strategies

Constraint	Frequency	Percentage
High cost of inputs	103	68.67
Low technical support	9	6
High cost of technological tools	35	23.33
Ineffectiveness of strategies	3	2
Total	**150**	**100**

Source: field survey, 2018

Most the farmers complained about the hybrid seeds not being effective because of the fact that if a farmer wants to change his seed variety for the improved ones, then he/she has to buy fertilizers in enough quantities to be able to get the desired results. The improved seeds are hybrids and their productivity goes down as farmers continue to plant them from season to season. This is very common in improved maize varieties and this discourages farmers from using those seeds because they would have to continuously buy the seeds every season which is not feasible on their part and therefore, farmers prefer using their own seeds which they can store for the next seasons instead of procuring the improved ones.

5. CONCLUSION AND RECOMMENDATIONS

It can be concluded from the analysis that off-farm income and other socio-economic factors such as membership of farmer based organization, gender, farmers' perception about climate change and access to weather information have significant effect on adoption of climate change adaptation strategies by farmers in response to the impacts of climate change in the Tolon district.

It can also be concluded that gender, type of off-farm activity engaged in by farmers, access to weather information and membership of farmer based organizations are the key factors influencing maize farmers' off-farm income in the study area. Farmers' major sources of off-farm income were trading, salary work and income from vocational/artisanal skills.

The major and common strategies practice by maize farmers in the district in response to climate change, according to this study were; changing planting date, keeping animals alongside crop cultivation, diversifying crop type, mixed cropping and changing crop variety. High cost of inputs and technological tools, low technical support and ineffective strategies are the constraints maize farmers faced in their attempt to adopt strategies in response to climate change in the district.

Based on these findings, government should create an enabling environment and increase opportunities for farmers to diversify and engage in other income generating activities. This will enable them to secure additional incomes to invest in their farming activities through the purchase of inputs and tools. This would support them to respond appropriately to the ongoing climate change issue.

Government and non-governmental organizations that aimed at improving the livelihoods of farmers in the face of climatic shocks should focus on providing subsidized inputs and technological tools that will enhance the capacity of farmers to respond appropriately to the ongoing climate change problem. It is clear from the analysis that effective tractor services are needed to be provided and rendered to the farmers especially at the onset of the farming season, to enable them do their cultivation on time against fluctuating climatic factors such as rainfall.

Development organizations should also incorporate climate change issues into their objectives and encourage formation of farmer based organizations through which relevant information concerning climate change could be disseminated and education on the right adaptation strategies would be made known to the farmers through these platforms.

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