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Off-Farm Job as Climate Change Adaptation Strategy for Small Scale Rice Producers in the Volta Region of Ghana

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Abstract
Changes in Climate pose a significant threat to agriculture which is by far the most climate-sensitive sector because of the sectors' over-reliance and dependence on rainfed production. This paper identifies off-farm job participation as one of the main climate change adaptation strategies used by small-scale rice producers in the Volta Region of Ghana. Stratified random sampling was used to select four hundred and forty (440) small-scale rice produces from the Volta Region of Ghana. Descriptive statistics were employed to analyse the socio-economic characteristics of respondents; determinants of off-farm job participation was analysed with Probit Regression while Propensity Score Matching was used to analyse the impact of the off-farm job on income. The study revealed that majority of small-scale rice producers in the Volta Region are into off-farm jobs as a means of survival against climate change. The factors that influence off-farm job participation positively were level of education and type of production system while age, average land size and average productivity of the land showed negative relationships. Majority of farmers who produced under rainfed production system were into off-farm jobs because of uncertainty in weather conditions compared to those under irrigation production system. It is therefore recommended that stakeholders such as NBSSI in the various districts and municipalities vis a vis other NGO's involved in entrepreneurship development programmes should train farmers on available off-farm job opportunities to reduce the adverse impacts of climate change on their livelihood.

Keywords
Off Farm Job, Volta Region, Propensity Score Matching, Climate Change, Probit, Regression Model

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1. Introduction

Climate change has gained much attention over the years due to its effect on agricultural production. In Africa, Sub-Saharan Africa is the most vulnerable to the adverse impacts of climate change and variability which has been attributed to low adaptive capacity and over-dependence on rain-fed cultivation [1]. In Ghana, almost all sectors in agriculture (crop, animal, soil, fishery, etc.) depend on the weather and climate. Agricultural production is largely rain-fed hence the effect of changes in the climate affects this sector the most. Further studies observed that the prediction of climatic changes has the potential to severely affect countries that are highly dependent upon agrarian livelihoods, resulting in food shortages, among other consequences [2]. Therefore, people who depend on farming activities require a variety of adaptation strategies to mitigate the negative effects of climate change and maintain the livelihoods of farming families. One of such strategies is farmers venturing into off-farm jobs.

Off-farm jobs in this study are jobs that are done outside the farm. Several studies have reported a substantial and increasing share of off-farm income in total household income [3]. Reasons for farmers to participate in off-farm jobs include declining farm income and the desire to insure against agricultural production and market risks [4]. That is, when farming becomes less profitable and riskier, as a result of unpredictable weather conditions leading to crop and market failures, households are pressed to participate in off-farm activities. On the other hand, households can also venture into the off-farm sector, especially when returns to off-farm employment are higher or less risky than in agriculture as a result of climate change.

However, despite the growing body of knowledge attached to climate change adaptation strategies [5; 6], there is no research on participation in off-farm work as an adaptation strategy against climate change by small-scale rice producers in the Volta Region of Ghana. The study, therefore, discussed factors affecting off-farm job participation as an adaptation strategy and the impact off-farm job participation has on the annual income of small-scale rice producers in the Volta Region of Ghana.

2. Methodology

2.1 Study area

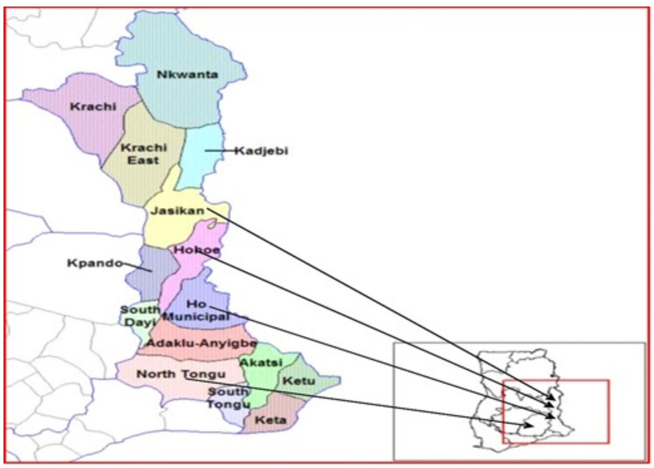

Figure 1. shows the districts in the Volta region where this region of Ghana where this research was done.

2.2 Sources of data

Primary data used for this research was obtained through the administration of a structured questionnaire to rice producers in the Volta Region of Ghana. Stratified random sampling was used for the data collection. Table 1 gives detail description of the sampling procedure and sampling size used in the research.

Table 1. Summary of sampling size of farmers

Strata	Zones	No of Villages	Sample size		Sampling Technique
Irrigated	Kpong Irrigation Scheme	5	20 farmers from each village	100	Stratified Random Sampling
	Afefe	5	20 farmers from each village	100	
Rainfed	Ho	5	20 farmers from each village	100	Stratified Random Sampling
	Hohoe	10	14 farmers from each village	140	
Total				440	

NB: Due to missing data only 435 of the 440 data collected were used for the analysis

2.3 Method of Data Analysis

In this study, off-farm participation simply describes the situation in which small farm households take up nonfarm activities or rely on nonfarm income to supplement income from agricultural production. Nonfarm occupations reduce risk by combining activities that have different risk profiles; they can also ameliorate the labour and consumption smoothing problems associated with seasonality. The researchers' hypothesise that small-scale rice producers especially those who produce under rainfed undertake an off-farm job as a result of changes in climate which affects agricultural production. Thus farmers who undertake off-farm jobs are those who see changes in rainfall patterns as a result of climate change which affects their production negatively. They then, undertake off-farm jobs as a risk-reducing strategy. The extent of diversification away from agriculture may be an indicator of one of the possible ways farmers are coping with climate change.

2.4 Model Specification

In this study, to address rural farm households' decision to enter into a livelihood diversification activity as a result of climate change and to analyse the factors influencing these decisions in the Volta Region of Ghana, Probit regression model was used. Probit model used in the study constraints estimated probabilities to be between 0 and 1 and relaxes the constraint that the effect of independent variables is constant across different predicted values of the dependent variable. The model assumes that one can only observe the values of 0 and 1 for a variable y, there is a latent, unobserved continuous variable y* that determines the value of y. We assume that y* can be specified as follows:

$\phi^{-1}(P_i) = \sum_{k=0}^{k=n} \beta_k X_{ik}$ 1

$y* = x_i^T \beta_k + U_i$ 2

$y_i* = \beta_o + \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 Xik + U_i$ 3

Where:- y_i*= a continues real-valued index variable for observation I that is unobservable, or latent

$x_i^T = X_{i1}, X_{i2}, X_{i3}$............$X_{ik}$,(1 x k) row vector represent vector of random variables i

$\beta_i = (\beta_o, \beta_1, \beta_2, \beta_3 +$ ....$\beta_k)^T$, a(K x 1) column vector represents a vector of unknown parameters

U_i=Random error term (disturbance term) for observations i

The observable outcomes of the binary choice problem are represented by a binary indicator variable y_i that is related to the unobserved dependent variable y_i*.

In the Probit Regression Model, we observe only

$y_i = 1$, if y_i*>0 (If the household participate in the off-farm job as climate change adaptation strategy)

$y_i = 0$, Otherwise

2.5 Impact Assessment of Off-farm Job on Annual Income

Propensity score matching was used to analyse the impact of the off-farm job on an annual income of small-scale rice producers. According to [7], Propensity Score Matching (PSM) uses information from a pool of units that do not participate in the off-farm job to identify what would have happened to off-farm Job participants in the absence of the intervention. By comparing how outcomes differ for participants relative to observationally similar nonparticipants, it is possible to estimate the effects of the off-farm job. Propensity-score matching requires two main assumptions to correctly estimate the impact of a program.

Assumption 1 (Conditional Independence Assumption or CIA): there is a set X of covariates, observable to the researchers, such that after controlling for these covariates, the potential outcomes are independent of the treatment status:

$(Y_i, Y_0) \perp D|, X$............................4

The CIA is crucial for correctly identifying the impact of an off-farm job since it ensures that, although participants and non-participants groups differ, these differences may be accounted for in order to reduce the selection bias. This allows the untreated units to be used to construct a counterfactual for the treatment group.

Assumption 2 (Common Support Condition): for each value of X, there is a positive probability of being both treated and untreated:

0<P(D=1|X)<1 5

This second equation implies that the probability of participating in the off-farm job for each value of X lies between 0 and 1. By the rules of probability, this means that the probability of not participating in off-farm job lies between the same values $P(D = 0|X) = 1 - P(D = 1|X)$. Then, a simple way of interpreting this formula is the following: the proportion of participants and nonparticipants individuals must be greater than zero (positive) for every possible value of X. The second assumption, known as the Common Support or overlap condition, requires the existence of a substantial overlap between the propensity scores of treated and untreated units. [8] as quoted by [9] indicated that, if this assumption does not hold, it is impossible to construct a counterfactual to estimate the impact of the program. When these two assumptions are satisfied, the treatment assignment is said to be strongly ignorable.

2.6 Estimating the Impact of off-farm Job Participation

The propensity score is the predicted probability from a probit or logit model regression and its goal is to achieve balance on covariates between participants of off-farm job and non- participants. After propensity scores have been estimated and a matching algorithm has been chosen, the impact of the off-farm job is calculated by just averaging the differences in outcomes between each treated unit and its neighbour.

The impact of an off-farm job for an individual i, noted δ_i, is defined as the difference between the potential outcome in case of the programme and the potential outcome in absence of programme:

$\delta = Y_{1i} - Y_{0i}$ 6

$ATE = E(\delta) = E(Y1 - Y0)$ 7

Where E(.) represents the average (or expected value).

Another quantity of interest is the Average Treatment Effect on the Treated, or ATT, which measures the impact of the program on those individuals who benefited

$ATT = E(Y1 - Y0|D = 1)$ 8

Finally, the Average Treatment Effect on the Untreated (ATU) measures the impact that the program would have had on those who did not participate:

$ATU = EY_1 - Y_0(|D = 0)$ 9

In the random assignment, all the characteristics of the individuals are equally distributed between participants and non-participants groups (i.e., the proportions are the same). On average, the groups will be identical, except for the fact that one of them received the treatment. This implies that:

$ATE = E(Y|D = 1) - E(Y|D = 0)$ 11

Table 2 shows the description of variables used in the Probit analysis. From Table 2, age, education, a farmer being a family head is hypothesized to have a positive effect on off-farm job participation. Also, type of production system is hypothesised to have a negative effect on off-farm job participation and it is incorporated in the model as a dummy variable with the value of 1 if a farmer produces rice under rainfed and 0 for irrigated or otherwise system of production. Gender which is also a dummy variable is also hypothesized to have a positive effect on off-farm job participation because it is likely that males will seek the extra income aside their rice production to support household incomes. However, the land size and an average of the quantity of rice harvested and average productivity from 2013-2015 are hypothesised to have a negative effect on off-farm job participation.

Table 2. Description of variables used in the Probit regression

Variable	Description	Type	Measurement	Expected sign
Dependent variable (Off Farm Job Participation)	Participation in Off Farm Job	Dummy	1 if yes, 0 otherwise	
Independent variables				
Age	Total number of years of farmer	Continuous	Number	+
Education	Number of years of Education	Continuous	School Years	+
Dependants	Number of Dependants	Continuous	Number	+
Land Size	Average land size planted from 2013-2015		Acres	-
Quantity Harvested	Average Number of bags of rice harvested from 2013-2015	Continuous	Number	-
Productivity	Bags of rice harvested per acre from 2013-2015	Continuous	Bags/Acre	-
Gender	Sex of the sampled producer	Dummy	1=Male 0=Female	+
Head of Family	Head of Family	Dummy	1=Yes, 0= otherwise	+
Type Production System	Produce under rainfed or irrigation(Proxy for climate change)	Dummy	1=Rainfed 0=Irrigation	-
Outgrower Scheme	Participation in outgrower schemes	Dummy	1=Yes 0= Otherwise	+

3. Results and Discussion

From Table 3, gender distribution showed an estimated 162 (37.2%) rice producers interviewed were females whereas an estimated value of 273 farmers (62.8%) of sampled rice producers were males. Among the female producers, 101 (41.3%) were participating in off-farm jobs while 61 (32.1%) were off-farm non-participants. Generally, the majority of the rice producers in the Volta region were males.

Again, the highest form of education among respondents was tertiary education. Considering tertiary education, ten (10) out of the total number of fifteen (15) were into off-farm jobs. It clearly indicates that rice producers are highly educated farmers. The high level of education among rice producers can contribute to their participation in off-farm jobs as they will be informed in reducing their risk in rice production while increasing their income through off-farm jobs.

The age distribution revealed ages of producers in the Volta Region of Ghana ranges from 20 to 85 years. The age group with the highest frequency is 41-60 years representing 56.3% of the sampled producers. This is followed by the age group of 20-40 years which represents 31% of respondents. The mean age group of the sampled farmers is 47 years. The least age group was those above 60 years representing 12.2%. The results indicate that majority of the farmers are above their mid age which implies the rice industry does not attract enough young ones although it has enormous potential and benefits.

Majority of smallholder farmers interviewed represented by 239 farmers (54.9%) depend on rain for their rice production. Among the farmers who undertook rainfed rice production, 136 (55.5%) were off-farm participants whereas 103 (54.2%) were off-farm non-participants. On the other hand, out of 196 (45.1%) farmers who produced under irrigation 45.5% were into off-farm jobs. The results suggest that off-farm job is dominant among rice producers in the Volta region. It implies that small-scale rice producers are using off-farm jobs as a coping strategy against climate change. Commenting on this, one of the farmers indicated that, the majority of the farmers depend on rainfall for production however due to changes in the climate, may have resorted to off-farm jobs as a risk-reducing strategy.

The results further indicate the number of dependants and years of experience in rice farming. Respondents had a maximum of 10 dependents and over 40 years of working experience.

From the Table 4, two hundred and forty-five (245) producers represented by 56.3% of the total number of farmers interviewed were into off-farm jobs whereas one hundred and ninety (190) represented by 43.7% of the

Table 3. Household characteristics of sampled farmers

Variable	Off-farm Participation		Off-Farm Non-Participation		Total	
	Frequency (N=245)	Percentage (%)	Frequency (N=190)	Percentage (%)	Frequency (N=435)	Percentage (%)
Gender						
Male	144	58.3	129	67.9	273	62.8
Female	101	41.3	61	32.1	162	37.2
Formal Educational level						
No Formal Education	30	12.5	40	21.1	70	16.1
BECE/MSLC	145	59.2	113	59.5	258	59.3
O Level	11	4.5	6	3.2	17	3.9
WASSCE/SSCE	23	9.4	16	8.4	39	9
A Level/Professional Course	26	10.6	10	5.3	36	8.3
Polytechnic	6	2.4	3	1.6	9	2.1
University	4	1.6	2	1.1	6	1.4
Number of Dependants						
0 – 5	150	61.2	118	62.1	268	61.6
6 – 10	95	38.8	72	37.9	167	38.4
Age (years)						
20-40	78	31.8	59	31.1	137	31.5
41-60	133	54.3	112	58.9	245	56.3
Above 60	34	13.9	19	10	53	12.2
Experience						
1-10	242	98.8	188	98.9	430	98.9
11-20	1	0.4	2	1.1	3	0.7
21-30	1	0.4	0	0	1	0.2
31-40	1	0.4	0	0	1	0.2
Type of Production System						
Rainfed	136	55.5	103	54.2	239	54.9
Irrigation	109	45.5	87	45.8	196	45.1
Outgrower Scheme Participation						
Participation	162	66.1	145	76.3	307	70.6
Non-Participation	83	33.9	45	23.7	128	29.4

Source: Authors computation based on 2016 field data. NB; MSLC= Middle School Leavers Certificate, BECE= Basic Education Certificate Examination, SSSCE=Senior Secondary School Certificate Examination, WASSCE= West African Senior School Certificate Examination

Table 4. Producers Off-Farm (Climate Change Coping strategy) Job Participation in Volta Region

S.No	Off-Farm Job (Climate Change Coping Activity)	Number total in %	A share of the
1	Off-Farm Job Participants	245	56.30%
2	Off-Farm Job Non-Participants	190	43.70%
	Total	435	100%

producers were not into off-farm jobs. The results indicate that off-farm job participation is one of the major adaptation strategies used by farmers in reducing their vulnerability as result of climate variability. The results are similar to studies by [10] and [2] who revealed that off-farm job participation is one of the major climate variability adaptation strategies.

Table 5. Sources of off-farm income in the Volta Region among small-scale rice producers

S/No	TYPE OF OFF FARM JOB	NUMBER	SHARE OF TOTAL (%)
1	Machine operator	7	2.86
2	Welder	2	0.82
3	Trading	91	37.14
4	Input dealer	10	4.08
5	Baker	5	2.04
6	Kente Weaving	15	6.12
7	Carpentry	20	8.16
8	Driving	15	6.12
9	Mason	4	1.63
10	Electrician	7	2.86
11	Head dresser	3	1.22
12	Painter	7	2.86
13	Caterer	3	1.22
14	Public Servant (Teaching, Surveyor Extension officer and COCOBOD	20	8.16
15	Steel Bender	3	1.22
16	Seamstress/ Tailor	7	2.86
17	Security Guard	3	1.22
18	Photography	2	0.82
19	Managing corn mill	5	2.04
20	Mechanic	10	4.08
21	Fridge Repairer	2	0.82
22	Herbalist	2	0.82
23	ICT personnel	1	0.41
24	Spare parts dealer	1	0.41
	TOTAL	245	100

From Table 5, the majority (91) of respondents which is represented by 37.14% of farmers who are into off-farm jobs were traders. Under trading as an off-farm job, the specific jobs participated by farmers interviewed were food vendors, kente and cloth sellers, fishmongers, mobile money operators, provision store operators and phone repairer. Small-scale rice producers were into these jobs because it did not depend on the weather but rather on the market hence they are able to earn some income to cater for their households. However, only one (1) producer was into ICT and spare parts business.

From Table 6, the likelihood ratio chi-square of 33.80 with a p-value of 0.0001 tells us that our model as a whole is statistically significant, that is, it fits significantly better than a model with no predictors. Also, if the average age of a farmer goes up by an infinitesimal amount of one year, the probability of the farmers' participation in

Table 6. Probit Regression Estimates of Determinants of Off-Farm Participation

Variable	Marginal effect (dy/dx)	Std. Error	Z	P>(Z)
Age	-0.0062	0.0023	-2.73	*0.0060
Level of Education	0.0219	0.0071	3.09	*0.0020
Number of Dependents	0.0004	0.0099	0.04	0.969
Average Land Size (2013-2015)	-0.0031	0.0015	-2.08	**0.0380
Average Bags harvested (2013-2015)	0.0003	0.0006	0.49	0.626
Average Productivity (2013-2015)	-0.0046	0.0026	-1.75	***0.0800
Gender	-0.081	0.0614	-1.32	0.187
Head of Family	-0.0222	0.0642	-0.34	0.73
Type of Rice Production	0.1222	0.071	1.72	***0.0850
Participation in Out grower Scheme	-0.0875	0.5713	-1.53	0.127
Number of observations = 435		Prob > chi2 = 0.0002		
Log likelihood = -253.04495		Pseudo R2 = 0.062		
LR Chi 2(10) = 33.80				

Source: Authors computation based on field data, NB: Significance; 1%=*, 5%=**, 10%=*

off-farm job decreases by 6.2%. This could be due to the fact the strength of people reduces by age increase hence might not be able to do two jobs at the same time.

Again, an increase in the level of education of a farmer increases the probability of participating in off-farm jobs by 2.19%. Furthermore, if the average land size and average productivity increases by an infinitesimal amount of acre and bags per acre respectively, the probability of farmers' participation in off-farm job decreases by 3.1% and 4.6% respectively.

Furthermore, a farmer who produces under rainfed is more likely participate in the off-farm job by 12.2% compared to a farmer who produces under irrigation production system. This shows that most farmers who produce under rain-fed agriculture have realised there are changes in climatic conditions hence they are involved in other off-farm jobs as a risk-reducing strategy. Commenting on this one farmer retorted that currently, he cannot rely on the rains for rice production because the rains are erratic or unpredictable hence have bought a motorcycle to do 'okada' business.

Table 7. Impact of off-farm Job Participation on Annual Income

Estimation Method	Annual Income	Std. Error	T-test
ATT Nearest Neighbour Matching	464.368	163.51	2.84
ATT Stratification Matching	95.923	27.251	3.52
ATT Kernel Matching	113.873	19.908	5.72

Source: Computation based on field data, 2016, NB: Average Treatment Effect on the Treated (ATT), 1$= GH¢ 4.2

The Average Treatment Effect on the treated (ATT) is useful to explicitly evaluate the effects on small-scale rice producers' who participated in off-farm Job. From Table 7, after matching treated (off-farm job participants) and control (off-farm Job non-participants), the effects of the off-farm job has resulted in higher annual incomes or earnings by about GHC 95.92 to GH¢ 464.37.

4. Conclusion and Recommendations

The study revealed that majority of small-scale rice producers in the Volta Region are into off-farm jobs as a means of survival against climate change. The factors that influence off-farm job positively are level of education and type of rice production. Majority of farmers who are under rain fed production were into off-farm jobs because of uncertainty in weather conditions. Furthermore, the factors that affected off-farm job negatively include age, average land size and average productivity. The study further showed that off-farm jobs result in higher income or earnings among small-scale rice producers. In the context of policy implications, Government together with NGO's and other investors should help establish appropriate irrigation facilities for farmers as a risk reduction strategy in the face of climate change. Also, stakeholders such as NBSSI and other NGO's involved in entrepreneurship development programmes should train farmers on other off-farm job activities to reduce farmers' vulnerability due to climate change.

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