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DETERMINANTS OF FARMERS' ADAPTATION TO CLIMATE CHANGE IMPACTS IN SOUTHWEST CAMEROON

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ABSTRACT

In recent times, increasing temperature, declining precipitation, increasing sunshine, drought and flood incidents have become a primary concern. A plethora of studies have shown how changes in climatic conditions negatively affect agricultural production in Cameroon. Adaptation is considered as a resilient measure to negative effects of climate change, reducing impacts and giving hope to livelihood. However while some farmers have taken measures to adapt, some have simply remained dormant. This research uses binary logit regression model to determine factors influencing farmers' decisions to adapt to climate change in Southwest Cameroon. Results revealed that female farmers are less likely to adapt to climate change than male farmers and the value is significant at p-value <.05. Also, the age group 40-49 years positively influences adaption even though the effect is not significant. Education positively influence adaptation and the effect is significant for farmers who have attained tertiary education (pv=0.01). House hold size also negatively influences farmers' adaptation to climate change and the negative sign indicates that as household size increases, the probability of farmers' adapting to climate change decreases. There is a negative relationship between land ownership, farm size and adaptation to climate change. The positive value of B is an indicator that farming experience influence farmers' adaptation even though the effect is not significant. There is a negative relationship between awareness of causes of climate change and adaptation thus farmers who are not aware of the causes will likely not take measures to adapt and the effect is significant at (pv=0.00).

Keywords: Climate change, Adaptation, Farmers, Determinants

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1. INTRODUCTION

Cameroon is one of the countries in Africa whose geographical position provides many opportunities for diverse agricultural production. The country produces a variety of agricultural commodities (cocoa, oil palm, coffee, rubber, cotton, bananas, plantain, cassava, maize, millet, cocoyam, yam, sorghum, groundnut, Irish and sweet potatoes) for export and domestic consumption. In recent times, increasing temperature, declining precipitation, increasing sunshine, drought and flood incidents have become a primary concern. A plethora of studies have shown how these changes in climatic conditions negatively affect agricultural production in Cameroon. Molua and Lambi (2007) noted that 2.5°C increase in temperature would cause net revenues from farming in Cameroon to fall by $0.5 billion and a 7% decrease in precipitation would cause net revenues from crops to fall by $1.96 billion. Tingem *et al*., (2008) established that increase temperature and low precipitation decreased yield of maize and sorghum in Cameroon since higher temperatures translate into faster crop development and earlier maturation. In Kimengsi and Tosam (2013) climate change was observed to negatively impact cocoa which is the principal income crop of farmers of Meme Division in Cameroon. The consequences of low yields resulting from changing climate are poverty, hunger, school dropout and social vices like stealing of farm outputs as noted by Defang *et al*., (2014).

Adaptation is considered as a resilient measure to negative effects of climate change as it reduces impacts and gives hope to livelihood. Epule and Bryant (2016) identified diversification of livelihood, use of organic fertilizer and expansion of farmlands as some adaptation measures opted by farmers in Meme and Fako Divisions of Cameroon. Molua (2008) identified treatment of seedlings with chemicals to reduce seed rot incidence as adaptation measures applied by some farmers in Cameroon. In Tingem and Rivington 2008, change in sowing dates and change in crop cultivar were coping measures used by farmers in Cameroon.

However while some farmers have taken measures to adapt, some have simply remained dormant. What intrinsic or extrinsic factors motivate or trigger farmers to take actions to adapt? Previous studies have shown that adaptation to climate change is determined by certain factors. In Fosu-Mensah *et al*., (2010), land ownership and access to extension services were important elements igniting adaptation. Dhaka *et al*., (2010) and Deressa *et al*., (2009) mentioned age, sex, education, wealth, access to climate information, and access to market as determinants of adaptation to climate change). This notwithstanding, adaptations are not region specific and determining factors therefore vary from place to place. This research seeks to determine factors influencing farmers' adaptation in Southwest Cameroon.

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2. METHODOLOGY

2.1 Study area

Southwest region has equatorial climate characterized by a short dry season and long rainy season. The mean monthly temperature for the region ranges between 20^{o}C and 28^{o}C with highest monthly record 32.1^{o}C in February and the minimum of 21.4^{o}C in January. The Southwest region is entirely composed of volcanic soils that result from volcanic eruptions. Agriculture is the major activity of majority of population living in rural areas of the region and is of pivotal importance not only providing food and income for the rural people but also meeting the food needs of urban populations. Farming activities range from food to cash crops and livestock production. The study was carried out in the divisions of Fako, Meme and Kupe Manenguba.

2.2 Sampling procedure

The population of the study was constituted of farmers belonging to CIGs and cooperatives. The sampling technique used was simple random sampling and 680 farmers were selected and administered questionnaires.

2.3 Analytical framework

The study used binary logit regression model to determine the factors influencing farmers' decisions to adapt to climate change or not to adapt. This model considers the relationship between a binary dependent variable and a set of independent variables. Similarly, Fosu-Mensah *et al*., (2010) used this model to determine factors influencing farmers' choice to adapt to climate change.

In this study, the dependent variable (adaptation) takes the value 1 if the farmer adapted to climate change and 0 if otherwise. A farmer is considered to have adapted to climate change if he/she employed at least one of the adaptation strategies such as change in crop variety, use of fertilizer and treatment of suckers before planting. The intention is to test whether these variables explained farmers' adaptation to climate change in the Southwest region.

The binary logit regression is presented as follow:

$$P(y=1) = \frac{\exp(x^{1}\beta)}{\exp(x^{1}\beta)} \quad \text{.....(1)}$$

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$$P(y=0) = 1 - P = \frac{\exp(x^1\beta)}{1 - \exp(x^1\beta)} \quad \text{.....(2)}$$

Where

P(y=1) represents the probability of a farmer adapting to climate change

P(y=0) represents the probability of a farmer not adapting to climate change

$\mathbf{x^1}$ represents the set of all the independent variables that determine the farmers' probability to adapt to climate change. These include educational level of the farmer, size of the farm and size of household for example.

β coefficient represents the explanatory power of the independent variable

The binary logit equation in its explicit form is expressed thus:

$$\text{Adapt} = \beta_0+\beta_1X_1 +\beta_2X_2 +\ldots\ldots\ldots\ldots\ldots \beta_8X_8 \quad (3)$$

$$\text{Adapt} = \beta_0+\beta_1 \text{ sex} +\beta_2 \text{ age} +\beta_3\text{exp}+\beta_4\text{educ} +\beta_5 \text{ hhs}+\beta_6\text{size} +\beta_7\text{landown} \quad (4)$$

Where

Adapt= different adaptation measures employed by farmers

sex= sex of the farmer: This is a nominal categorical variable also referred to as a dummy variable. Male=0 and female =1.

age= age of the farmer. This is a continuous independent variable considered to influence farmers' adaptation to climate change. Deressa *et al*.,(2009) noted that age of the respondent represents experience in farming and the older the farmer, the more experienced he/she has in farming. According to Gbetibouo (2009), age influences adaptation to climate change and young farmers are more likely to adapt to climate change as older farmers may be less willing to adapt given the heavy labour requirements involved.

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exp = farming experience which corresponds to the total number of years the farmer has been into farming. It is a continuous variable. It is expected that the more experienced the farmer is, the more he/she is better informed about temperature and precipitation changes and the more he/she is likely to employ adaptation measures that reduce the impact of climate change on his/her agricultural activities. Hassan and Nhemachena (2008) contents that it is farming experience that matters more than merely the age of the farmer when it comes to adaptation to climate change. Studies by Maddison (2006) indicate that more farming experience increases the probability of a farmer adapting to climate change.

educ= level of education of the farmer is measured by the number of years of formal schooling and it is a categorical variable.

hhs= household size is measured by the number of members in a household and it is a continuous variable. It is assumed to represent the labour input to the farm.

fsize= farm size which refers to the total landholding of a farmer. This is a continuous variable measured in hectares in this study. It is considered that this variable influences adaptation and the bigger the farm size, the more likely the farmer is to adopt suitable strategies.

landown= land ownership refers to the relationship that the farmer has with the land and it is a categorical variable.

aware= Awareness of cause of climate change is a dummy variable where 0= yes and 1= no.. Exposure to information on cause of climate change can influence adaptation.

The null hypothesis that socioeconomic and farm characteristics do not influence farmers' decisions to adapt to climate change is tested.

The Statistical Package for Social Sciences (SPSS) and Microsoft Excel were the soft-wares used to perform the analysis.

3. RESULTS AND DISCUSSIONS

3.1 Socio-economic characteristics of respondents

The socio-economic characteristics of the respondents are reported in Table 1. The table shows that majority (71%) of respondents were males while 29% were females. This implies that males are more affiliated to groups and cooperatives than females. The results also indicated that most (85%) of the respondents were of age group 40 years and above. This implies they were matured enough to know the benefits of agriculture and are therefore more likely to take farming seriously. The educational status of sampled farmers show that majority of them have received

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formal education. Primary education was attained by 54% of respondents, secondary by 27%, high school by 8% and tertiary by 1% of respondents even though 15% had no formal education. Enujeka *et al*., (2012) noted that education is expected to influence the perception of farmers on climate change and enhance adaptation of innovation among farmers. Low level of education of farmers implies that education of farmers on how to adapt to climate change should be done in very simple language so that they will be able to assimilate the information and put into practice without having language barrier. Results further showed that 37% of farmers had household size of 1-5 persons, 10% had 11-15 persons and 2% had more than 15 persons. Majority of the farmers (51%) had household size of 6-10 persons. This is an indication that there might be enough labour from the household to manage farming practices. However the higher the family size, the more the expenses acquired especially if the children are going to school or a family member is sick and this could also be the reason for the low level of education in the study zone. Majority of respondents (80%) were landlords of the land they were cultivating while 16% were tenants and 4% were landowners and tenants. Just like capital and labour, land is an important factor of production and ownership influences the type of crops cultivated and adaptation measures opted. Tenants are less likely to plant perennial crops and adapt by planting trees and constructing water reservoirs as they might consider these as wastage of resources or investments. They however may over exploit a piece of land so as to maximize their profit during the period of tenancy. Regarding farming experience, 30% of farmers had been into farming for <10 years, 32% have been farming for 10-19 years and majority of the farmers (38%) have been into farming for 20 years and above. This means that most of the farmers have been farming long enough to have experienced climate change and therefore convinced of their perceptions regarding the climate variables considered in the study. With respect to farm size majority of farmers (47%) had farm size of 1-5 hectares. The size of land at the disposal of the farmer can influence productivity as it is expected that the greater the surface exploited the more the yields and income considering all factors favourable. Also, 16% had farm size 6-10 hectares, 11% <1 hectare, 6% >10 hectares and 20% did not have any idea about the size of their farms.

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Table 4.1: Socio-economic characteristics of respondents

Variable	Variable modalities	Frequency	Percentage
Sex	Male	481	71
	Female	199	29
	Total	680	100
Age	30-39	102	15
	40-49	259	38
	50-59	170	25
	60 and above	149	22
	Total	680	100
Level of education	Never attended school	71	10
	Primary	364	54
	Secondary	185	27
	High school	51	8
	Tertiary	9	1
	Total	680	100
Household size	1-5	254	37
	6-10	345	51
	11-15	65	10
	15 and above	16	2
	Total	680	100
Land ownership	landlord	544	80
	Tenant	111	16
	Both	25	4
	Total	680	100
Farming experience	<10 years	207	30
	10-19 years	218	32
	20 and above years	255	38
	Total	680	100
Farming purpose	Subsistence	35	5
	Commercial	17	3
	Both	628	92
	Total	680	100

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3.2 Determinants of farmers' adaptation to climate change impacts

3.2.1 Sex

Results showed that the estimated parameter for sex (female) is negative implying that female farmers are less likely to adapt to climate change than male farmers and the value is significant at p-value <.05. The H_0 that sex does not influence farmers' adaptation to climate change is rejected.

3.2.2 Age

According to analysis, the age groups 30-39 and 50-59 are negatively related to farmers' adaptive strategies to climate change effects. Farmers aged 30-39 can be said to have less interest in taking climate change adaptation measures because they are still excited getting white collar jobs and may not consider farming as a dignified and permanent profession.

Older farmers (50-59) are more conservatives and rather remain with their familiar traditional methods rather than adopting modern farming techniques and as such do not see the necessity to adapt to climate change effects. The age group which positively influenced adaption even though the influence is not significant is 40-49. This further confirms Ugwoke *et al*., (2012) point of view that farmers of age range 41-50 are willing to adopt measures or technologies geared at combating the challenges of climate change. This results are similar to Fosu-Mensah *et al.*, (2010) where age did not significantly influence adaptation but differs with that of Deressa *et al*.,(2009) where there is a positive relationship between age and adaptation to climate change, with more matured farmers adapting to climate.

3.2.3 Level of education

The regression model results explain that education positively influence adaptation and the effect is significant for farmers who have attained tertiary education (pv=0.01), primary education (pv=0.03) and secondary education (pv=0.05). This implies that the probability of adaptation to climate change is greater for farmers who are educated than those who are illiterate. It is obvious that educated farmers have more knowledge, greater ability to understand and respond to changes and have greater access to information which might encourage adaptation to climate change. Maddison (2006) argued that education increases the probability that the farmers who perceived climate change take measures to adapt. The H_0 is rejected and H_a that socio-economic and farm characteristics influence adaptation accepted.

3.2.4 Household size

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House hold size also negatively influences farmers' adaptation to climate change. This negative sign indicates that with increasing size of the family, the probability of farmers' adapting to climate change impacts decreases instead. It is expected that large family size would provide more labor and encourage/facilitate adaptation. This finding is similar to that of Deressa *et al*.,(2009), where large family size was seen to negatively influence adaptation. They are however contrary to Gbetibouo (2009) where household size was found to enhance the farmer's adaptive capacity to respond to climate change.

3.2.5 Land ownership

From results it is seen that there is a negative relationship between land ownership and adaptation to climate change. It was however expected that being a landlord would influence adaptation since landlords have the power of disposition over the land while the tenants only have the right to work on the land. Analysis of this variable showed that being a landlord or tenant does not influence farmers' decision to adapt.

3.2.6 Farm size

There is a negative relationship between farm size and adaptation to climate change impacts. Specifically, results showed that increasing size of a farm decreases the probability of farmers' adaptation. This can be because farmers continued with traditional methods of farming despite modern technologies and the size of their farms has not altered their practices. Moreover large farms would require more investment in terms of inputs such as seeds, fertilizer and farmers considering the cost of the adaptation might not be willing to engage in such expenditures.

3.2.7 Farming experience

The positive value of B is an indicator that farming experience influence farmers' adaptation even though the effect in this study was not significant. This finding differs from that of Dhaka *et al*., 2010 where farming experience had a significant effect on adaptation as more experienced farmers were more likely take up adaptation measures.

3.2.8 Awareness of cause of climate change

In the definition of variables used for the binary logistic regression, 0 designated awareness and 1 unawareness of cause of climate change. Results of the regression show that there is a negative relationship between awareness of cause of climate change and adaptation. This implies that farmers who are not aware of the cause of climate change will likely not take measures to adapt and the effect is significant at (pv=0.00) This is in line with Kisauzi *et al.*, (2012) who noted that those who know the causes of climate change are more likely to adapt than those who do not.

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Table 2: Determinants of adaptation to climate change

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
	Sex(1)	-.525	.216	5.883	1	.015	.592	.387	.904
	Age_resp			3.241	3	.356			
	Age_resp(1)	-.397	.331	1.443	1	.230	.672	.351	1.285
	Age_resp(2)	.093	.258	.132	1	.717	1.098	.663	1.819
	Age_resp(3)	-.089	.266	.112	1	.738	.915	.543	1.541
	Level_educ			11.870	4	.018			
Step 1[a]	Level_educ(1)	1.950	1.152	2.868	1	.090	7.031	.736	67.180
	Level_educ(2)	2.392	1.119	4.569	1	.033	10.930	1.220	97.948
	Level_educ(3)	2.162	1.122	3.710	1	.054	8.689	.963	78.416
	Level_educ(4)	1.493	1.153	1.675	1	.196	4.449	.464	42.648
	Household_s			6.649	3	.084			
	Household_s(1)	.289	.558	.268	1	.605	1.335	.447	3.987
	Household_s(2)	-.230	.548	.177	1	.674	.794	.271	2.325

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Household_s(3)	-.125	.601	.044	1	.835	.882	.272	2.862
Land_ownership			1.268	2	.531			
Land_ownership(1)	-.398	.486	.673	1	.412	.671	.259	1.739
Land_ownership(2)	-.181	.538	.113	1	.737	.835	.291	2.397
Farm_s			3.692	4	.449			
Farm_s(1)	.155	.390	.158	1	.691	1.168	.544	2.508
Farm_s(2)	-.205	.279	.543	1	.461	.814	.472	1.406
Farm_s(3)	-.447	.334	1.793	1	.181	.639	.332	1.230
Farm_s(4)	-.088	.422	.043	1	.835	.916	.400	2.095
Farming_exp			.429	2	.807			
Farming_exp(1)	.086	.238	.129	1	.720	1.089	.683	1.739
Farming_exp(2)	.149	.228	.424	1	.515	1.160	.742	1.815
Awareness_causes_cc(1)	-1.179	.199	35.148	1	.000	.308	.208	.454
Constant	-.445	1.313	.115	1	.735	.641		

a. Variable(s) entered on step 1: Sex, Age_resp, Level_educ, Household_s, Land_ownership, Farm_s, Farming_exp, Awareness_causes_cc.

Source: Field survey 2016

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4. CONCLUSION

Farming is often the only means of livelihood in rural communities. Adaptation necessitates deliberate efforts by farmers who are the most affected. Farmers need to be motivated in their initiatives and decisions uplifting negative impacts. Sex, age, education, household size, farm size, farming experience, land ownership and awareness of causes of climate change are explanatory variables influencing farmers' adaptation to climate change negative impacts.

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