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Determinants and Policy Implications of Farmers' Climate Adaptation Choices in Rural Cameroon

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Abstract: The issue of climate change and its related impacts is now a social reality. The paradigm shift today in climate change issues is focused on mitigation and adaptation. Besides mitigation, adaptation is considered as an essential strategy for reducing the severity and cost of climate change impacts given the fact that additional future climate change is considered as being inevitable. In this paper, we analyze household socio-economic determinants of climate change adaptation and their policy implications. A survey of 130 farmers in four farm communities in Cameroon was conducted to capture the determinants of farmers' adaptation to climate change. We employed the binary Logistic regression model to assess the determinants of climate adaptation. Results reveal that in the midst of climate change, 78.33% of farmers have adopted rainfall-related adaptation while 63.33% have resorted to temperature-related adaptation. Based on the binary logistic regression, access to road, access to non-farm income source, and membership of farmers' groups were significant determinants for the adoption of temperature-related adaptation options. Furthermore, access to improved seeds was found to be the lone significant determinant for the adoption of rainfall-related adaptation options. All in all, much is required to strengthen farmers' adaptive capacity and increase the range of adaptation options undertaken. As such, policies geared towards building farmers' resilience should effectively capture the following tri-factors: provision of access roads linking farm communities to nearby urban centres, upscaling institutional interventions with regards to providing high quality and resistant seeds to farmers, and incentivizing farmers to create or join social groups in order to facilitate adaptation uptake.

Keywords: climate change; adaptation strategies; determinants; policy implications; rural Cameroon

1. Introduction

The issue of climate change and its related impacts is now a social reality as reflected in several studies. Many studies have confirmed that the Sub-Saharan African region wherein Cameroon is found is highly vulnerable to climate change particularly its rain-fed agricultural systems, to which a greater proportion of livelihoods depend on and constitute approximately 96% of overall crop production [1–6]. In addition, recent projections for Africa's climate change scenario through modeling, indicate continuous and stronger warming (1.5–6.5°C) with a wider range of precipitation uncertainty approximately between (−30 and 30%) characterized by substantial dry spell lengths [7]. Climate change has been noted to impact the economy of Cameroon both positively and negatively with much greater negative impacts from temperature changes. Earlier investigations [8] modelled that if temperatures increase by 2.5°C, the country will lose approximately $0.65 billion from agriculture. A further $4.56 billion loss in revenue related to agriculture is anticipated if precipitation reduces by 14%. A later study by Reference [9] confirmed though with different strengths that a 1 mm increase in rainfall leads to an increase in net farm income of 2322 FCFA per hectare, while a 1°C increase in temperature leads to a decrease in net farm income of 2200.20 FCFA per hectare. Recent studies have confirmed the issue of climate variability over the Muyuka sub-division with registered variability in annual mean rainfall and mean temperature, particularly with recorded decreasing trend in annual rainfall amounts and an attendant increase in mean temperatures [10,11] over the subdivision. This has been noted to impact negatively on the population who depends solely on farming as their main livelihood-sustaining activity.

The agricultural sector in Cameroon is largely rain-fed and climate-sensitive. As such, any variability and change in climatic elements of temperature and rainfall may therefore impound on this sector in different ways. Earlier scientific investigations have observed related impacts of temperature and rainfall variability on different crops within the country [8]. Within the Southwest region of Cameroon, climate change effects have been foretold and documented to impact negatively on cocoa production [12] which constitutes a major cash crop for the population particularly within the Kumba-Muyuka areas of the region. This zone constitutes a major break-basket zone for the country and whose influence goes across the national territory and beyond. Also, oscillations in rainfall and temperature have been found to impound negatively on maize production within the Fako Division [13] and also on food crop production in the Muyuka subdivision [10] of the Southwest region of Cameroon. Climate change has also had negative implications on the water resources of the area and has intensified flooding in many areas where agriculture is carried out in the Division. In Muyuka subdivision, climate change has been noted to influence the cash crop sector through its related impacts on cocoa (a major cash crop for low-income households within the sub-division and a major contributor of household income) and on food crops such as cocoyam, egusi, cassava and plantain [10].

The paradigm shift today in climate change issues is focused on adaptation to the adverse effects of climate change and variability. This is clearly spelled out in the 13th Sustainable Development Goal [SDG], which calls for climate change awareness and the urgency for countries to build resilience in the midst of climate change by the year 2030. However, there is the complexity in identifying clearly Cameroon's agriculture-related climate change adaptation policies. Besides, the country's 2009 development plan and the Cameroon Vision 2035, acknowledges the need for climate change considerations in national growth planning [14]. Adaptation to climate change and variability today is seen more as a problem of the South, with low mitigative capacity and with high adaptation needs [15,16]. Adaptation refers to adjustments in ecological, social or economic systems in response to actual or expected stimuli and their effects or impacts [17]. These include changes in processes, practices and structures to moderate potential damages or to benefit from opportunities associated with climate change. However, depending on its timing, goal and motive of its implementation, adaptation can either be reactive or anticipatory (takes place before the impacts are observed), private or public, planned (result of deliberate response based on awareness about the impacts) or autonomous and considered to be either short or long term, localized or widespread [17,18]. Adaptation involves both building adaptive capacity (thereby increasing the ability of individuals, groups, or organisations to adapt to changes) and implementing adaptation decisions (transforming that capacity into action). Both dimensions of adaptation can be implemented in preparation for, or in response to, impacts generated by a changing climate. Hence, adaptation is a continuous stream of activities, actions, decisions and attitudes that inform decisions about all aspects of life, and that reflect existing social norms and processes [19].

Adaptation can therefore be undertaken by smallholder farmers themselves or by government implementing policies aiming at promoting effective and sustainable measures. Although adaptation strategies for agricultural production exist, and indeed rural communities have been adapting to climatic variability for centuries, the institutional and policy support needed to successfully implement such adaptation on the scale that SSA requires in the context of climate change would probably be very substantial. This is true as vulnerability and adaptation strategies are seen to be linked to poverty measures [20]. These adaptation decisions whether it be those related to temperature, rainfall or otherwise, all have been considered to be influenced by a range of factors such as perception of climate change, farm level, household, socio-economic, geographical and institutional factors [6,12,16,20–22] as shown in Figure 1. Example of such factors include: age of farmer, farm size, gender, access to climate change information, membership of any organisation, distance of agricultural office, access to credit, access to extension service, access to media information, access to road, perception of climate change, family type, years of education, size of household, distance to market, and non-farm income [16,20–22]. An understanding of farmers' preferences for adaptation strategies and the factors deriving their choices is important to inform policy for future adaptation of the agricultural sector to climate change [23]. Likewise, understanding farmers' adaptation behavior is an important goal in itself to assist planning by policymakers and private individuals [24].

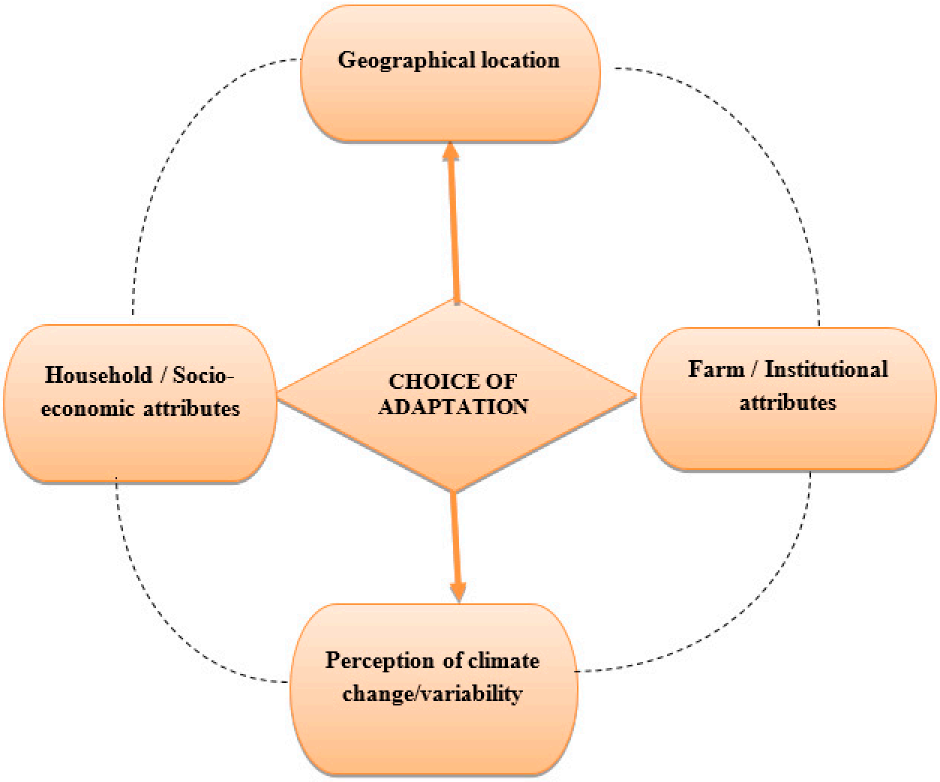

Figure 1. Factors hypothesized to influence choice of adaptation to climate change. Source: Adapted from References [6,12,16,20–22].

Numerous authors have attempted to assess the determinants of farmers' adaptation strategies to climate change in Africa [16,21,25]. Most of the factors affecting farmers' choice of adaptation however are already known, but the actual impact of these factors may vary across regions. Gender of farmer has been considered over much literature as a significant determinant of adaptation to climate change. This has been argued that male-headed households may likely get more information about new technologies related to agriculture but female-headed households may have limited access to information, land and other resources due to traditional barriers [12,26]. Also, the adoption of agricultural technologies requires sufficient financial wellbeing. As such, access to nonfarm income has been hypothesized to influence positively the adoption of climate change-related adaptation options. This is so as farmers with higher incomes may be less risk averse. Research on the adoption of agricultural technologies indicates that there is a positive relationship between the level of adoption and availability of credit. Access to climatic information and information on climate constitutes one of the important institutional determinants of adoption of adaptation options in the midst of climate change. In addition, effective adaptation responses will depend on policies and measures across multiple scales: international, regional, national, sub-national and local. Policies across all scales supporting technology development, diffusion as well as finance for responses to climate change, can complement and enhance the effectiveness of policies that directly promote adaptation [6].

In the context of Cameroon, there is a dearth of information on the determinants of adaptation. Rather, most studies in Cameroon have focused on documenting the adaptation measures undertaken by farmers to climate change and the barriers linked to adaptation [11,13,27]. As if not enough, in the strive to solve climate change impacts on agricultural households in rural Cameroon, policy conceptions are rather macro than micro, and not concise but are rather interwoven in different text such as the country's Growth and Employment Strategic Paper [14]. These policy responses have been insufficient or unable to address issues of climate adaptation, implying that more research is needed to unravel the determinants of adaptation with a view to further inform policy responses. Even in recent studies on climate change within rural Cameroon (including Muyuka subdivision), the focus has been more on assessing the perceptions of climate change and a qualitative analysis of adaptation options undertaken by farmers [13,27], but little or no studies have focused on attempting a quantitative assessment of the determinants of farmers' climate change adaptation choices. We make a contribution in the context of rural Cameroon by analyzing household determinants of adaptation and their implications for policy towards achieving resilience in agricultural communities. Based on the aforementioned issues, this paper addresses the following questions: What major adaptation options have been undertaken by farmers in the midst of climate change and what factors influence their choice of adaptation? The next sections expose the study site, methodology (data collection, model specification used for analysis, data, variables and sample) and a presentation and discussion of the results of the study related to the objectives.

2. Materials and Methods

2.1. The Study Area

The Republic of Cameroon is located in the central African region between latitude 2° and 13° North of the equator and longitude 8°30′ and 16°10′ East of the Greenwich Meridian. It is bordered by Nigeria to the north and north-west, Chad to the north and north-east, Central African Republic to the east, the Republic of Congo to the south-east, and Gabon and Equatorial Guinea to the south (Figure 2). It is divided into 10 regions and often described as Africa in miniature. The study sites for this study are four farm communities within the Muyuka subdivision found within the Fako division of the Southwest region of Cameroon. The Muyuka subdivision is located between Latitude 4°11′ N to 4°28′ N of the Equator and Longitude 9°10′30″ E to Longitude 9°28′30″ East of the Greenwich Meridian, covering a total surface area of approximately 542.21 km^2. The Sub-Division shares boundaries with Mbonge Sub-Division in the west; Mbanga Sub-Division to the east; Buea and Limbe Sub-Divisions to the south, and Tiko Sub-Division to the south-east (Figure 2). The subdivision is situated north-east of the gigantic land mass (Mount Cameroon) which rises approximately to 4100 m above sea level. The sub-division has an equatorial climate characterized by two main seasons, that is, the wet season and dry season.

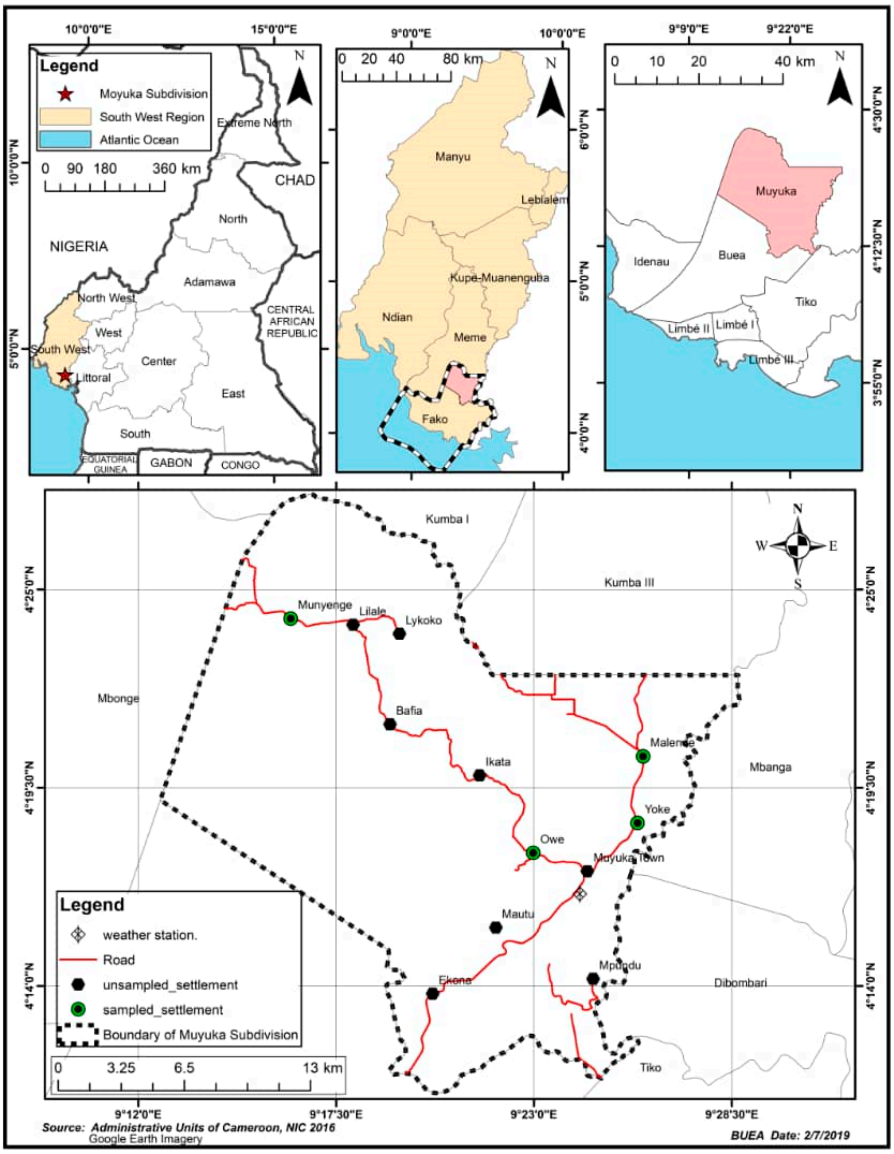

Figure 2. Location of study sites in Muyuka Sub-Division, Cameroon. Source: Extract from Database of National Institute of Cartography, NIC by Cho Cosmos.

The Sub-division is made up of 18 villages and an estimated population size of 118,470 inhabitants [28] of a diverse ethnic representation drawn from within and without Cameroon comprising the Bangwas, Bamileke, Bikom, Mankon, Bafut, Ibo's, Ibiobos, Banyangs and Ejaghams [28] whose major activity is farming. Major crops cultivated include both cash crops (cocoa and palm oil) and food crops (plantain, cocoyam, bananas, yams and maize). The heart of rural agricultural is focused in two of the three axes within the subdivision of Muyuka, that is, the Muyuka-Malende axis and the Muyuka-Muyenge Axis. Meanwhile, the Muyuka-Ekona axis is a zone characterised by plantation agriculture with rubber, oil palm and banana as major crops owned by the Cameroon Development Cooperation, (CDC). Based on this, the zone was purposively left out for the study. Within the two zones, the axis of Muyuka-malende is dominated by two major agricultural zones, that are Yoke and Malende. Unlike the Muyuka-malende axis, the Muyuka-munyenge axis is characterised by six major farming communities with intense cultivation in three communities (Munyenge, Ikata and Owe) with the major crop being cocoa and cassava cultivation. The subdivision is a home to only two weather stations owned by the CDC, an indication of low climate infrastructures in the subdivision—an area of high agricultural activities.

2.2. Data, Sample and Variables

This study employed a social science methodology which involves both data collection and analysis. Primary data was collected from a self-administered questionnaire with some 130 farmers (both Male and female headed) within four communities (Munyenge, Owe, Yoke and Malende) with a total population of approximately 29,000 adults (both men and women above 16 years of age) [24] within the Muyuka sub-division. This was done via a stratified random sampling technique. This was because there is no concrete data on the total number of farmers within the subdivision. As such, the random sampling technique was adopted to select farmers for the study. The communities were purposively selected as they constituted zones of high concentration on different crop types. These are villages within the rural areas along the Muyuka-Malende (Yoke and Malende) and Muyuka-Munyenge (Owe and Munyenge) axes of the sub-division which form the heart of rural agriculture. A designed questionnaire was drafted to capture the various adaptive measures put in place to cope with the variations in temperature and rainfall in the sub-division and to capture respondents' characteristics and responses on some socio-economic indicators that influence climate adaptation. A designed questionnaire was made and the questions were categorized under three main themes: household characteristics, adaptation strategies to climate change, and socio-economic indicators of adaptation. The socio-economic variables are dummy variables with response categories as Yes and No. Based on a review of past works [12,16,21,24,26,29–32], we consider the following explanatory variables for this study: perception/knowledge of climate change, access to agricultural extension service, access to climate information, gender of farmer, access to credit, access to road, member of farmers group/cooperative, land ownership, access to information media, nonfarm income source and access to improved seeds while dependent variables captured questions related to whether farmers have adopted an adaptation strategy to temperature variability and rainfall variability. These were all also considered as dummy variables in nature, which corresponds to the requirement of the binary logistic regression model.

2.3. Model Specification and Data Analysis

To examine the determinants of adoption of adaptation strategies to climate variability, we employed a binary logistic regression model. The logistic regression model is an appropriate statistical tool to determine the influence of independent variables on dependent variables when the dependent and explanatory variables has only two groups or categories (dichotomous) and are categorical and dummy in nature. We consider rather the binary logistic regression due to the dichotomous nature of the variables used unlike the multinomial logistic regression whose variables categories are more than two. The logit model sought to identify the magnitude and direction of the factors influencing the choice of adopting adaptation strategies to rainfall and temperature variability by farmers in the Muyuka subdivision. The likelihood of a certain farmer to adopt adaptation to climate change can be described by a logit model. This study considers two sets of adaptation strategies; those related to temperature variability and those related to rainfall variability. As such, this study analyses each of the adaptation sets independently and separately, that is, data analytical process on the logistic regression were done in two steps: firstly, we ran those between adoption of temperature-related adaptation with all the explanatory variables; secondly, processed those for rainfall-related adaptation and with all the explanatory variables.

Suppose Y is the available adaptation set to the farmer, which is a random variable, and X is the explanatory variables used (gender, land ownership, access to agro-extension service, access to media information, access to credit, access to road, access to climate information, non-farm income source, access to improved seeds and farm technology, membership in farmers, group/cooperative, and knowledge/perception on climate change) (Table 1). For such a dichotomous outcome, the inferential statistical analysis used for the study is the binary logistic regression model [33]. The effect of X on the response probabilities, $P\,(y = j/x)$, can be estimated by using a binary logit model which is expressed as:

$$P\left(\frac{Y_i}{X}\right) = F(Z_j) = \frac{e^{z_i}}{1+e^{z_i}} = \frac{1}{1+e^{-z_i}} \quad (1)$$

$$Z_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} +, \ldots, +\beta_n X_{ni} + \mu_i \quad (2)$$

The specific binary logit model is expressed as follows (Equation (3)). The model is commonly used since they guarantee that the estimated probability increases lie within the range of 0 to 1. In this model, the dependent variable becomes the natural logarithm of the odds when a positive choice is made:

$$\ln\left[\frac{P_i}{1-P_i}\right] = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} +, \ldots, +\beta_n X_{ni} + \mu_i \quad (3)$$

where P_i in (3) is the probability of adaption; $(1 - P_i)$ in (3) equals probability of non-adaption; the subscript i in (3) is the observation in the sample; $\beta_1, \beta_2, \ldots, \beta_n$ (Equations (2) and (3)) equals to the regression coefficients of the explanatory variables; $X_1, X_2, \ldots, X_n$ (Equations (2) and (3)) equals the explanatory variables (Table 1); β_0 refers to the constant term and u_i (Equations (2) and (3)) equals the error term of the model [33].

Table 1. Explanatory variables hypothesized to affect farmers' climate adaptation choices.

Variable	Description	Measurement	Slope Coefficient
X_1	Gender	1 if male, 0 if otherwise	β_1
X_2	Land Ownership	1 if has access, 0 if otherwise	β_2
X_3	Access to agro-extension service	1 if has access, 0 if otherwise	β_3
X_4	Access to media information	1 if has access, 0 if otherwise	β_4
X_5	Access to credit	1 if has access, 0 if otherwise	β_5
X_6	Access to road to nearby urban centre	1 if has access, 0 if otherwise	β_6
X_7	Access to climate information	1 if has access, 0 if otherwise	β_7
X_8	Non-farm income source	1 if has, 0 if otherwise	β_8
X_9	Access to improved seeds	1 if has access, 0 if otherwise	β_9
X_{10}	Membership of farmers, group	1 if member, 0 if otherwise	β_{10}
X_{11}	perception on climate change	1 if aware, 0 if otherwise	β_{11}

Collected data from field survey were entered and analysed using Microsoft Excel 2016 and Statistical Package for Social Sciences (SPSS) version 25. The analysed data were presented as tables and figures.

3. Results and Discussion

This study sought to investigate the adaptation options undertaken by farmers within four farm rural communities of the Muyuka subdivision and to identify through modelling the determinants of farmers' choices of adaptation to climate change. With insights from a sample of 130 farmers in four farm communities within the Muyuka subdivision, the results and related discussions are presented in the sections following.

3.1. Adaptation Strategies to Climate Variability

An analysis of farmers' responses on the range of adaptations undertaken (Table 2) shows a great variability in the number of adaptation options undertaken by farmers in the midst of the observed changes in rainfall and temperature in the subdivision. It was revealed that 16.92% of farmers have not undertaken any adaptation strategy. Besides this category, 83.08% of farmers are indicated to have undertaken at least one adaptation strategy in the midst of the recorded annual and long term changes in temperature and rainfall within the Muyuka subdivision. The variation in the number of farmers and the range of adaption(s) taken are presented in Table 2.

Table 2. Range of climate adaptation strategies available to farmers.

Range of Adaptation	Number of Farmers	% of Farmers	% Cumulative Frequency
9	1	0.77	0.77
7	1	0.77	1.54
6	2	1.54	3.08
5	4	3.08	6.15
4	17	13.08	19.23
3	20	15.38	34.62
2	36	27.69	62.31
1	27	20.77	83.08
No adaptation	22	16.92	100
Total	130	100	100

Amongst the categories that undertook adaptation, 20.77% undertook just a single adaptation strategy, while 27.69% undertook two adaptation strategies. However, 15.38% of farmers indicated to have adopted three adaptation strategies while 13.08% of the farmers employed up to four adaptation options. Besides, a small proportion of farmers (6.15%) indicated to have undertaken up to between five to nine adaptation options. Cumulatively, 76.93% of farmers undertook one to four adaptations out of the 12 adaptation strategies, while 16.92% of farmers did not undertake any adaptation strategy. In a study in the Southwest region of Cameroon, up to 39% of the farmers studied were unable to adopt any adaptation option amidst climate change [27]. Also, a clear example of low adaptation uptake was recorded in a study in Buea where up to 48% of sampled farmers did not take any adaptation strategy amidst increasing temperatures observed in the area [13].

From the range of adaptation choices, farmers in the study area focus on the following adaptation measures as a result of changes in rainfall and temperature within the sub-division as shown in Figure 3. As shown in Figure 3, planting of shade trees is the most (22%) adopted measure to climate change by farmers. This was noted to be a major temperature-related adaptation option whereas shifting planting dates (due to late onset of rainfall) is the least adopted (5%) among the major adaptation measures identified in the Muyuka sub-division. Besides planting shade trees and the adoption of shifting planting dates, 16% of farmers resorted to planting different crops.

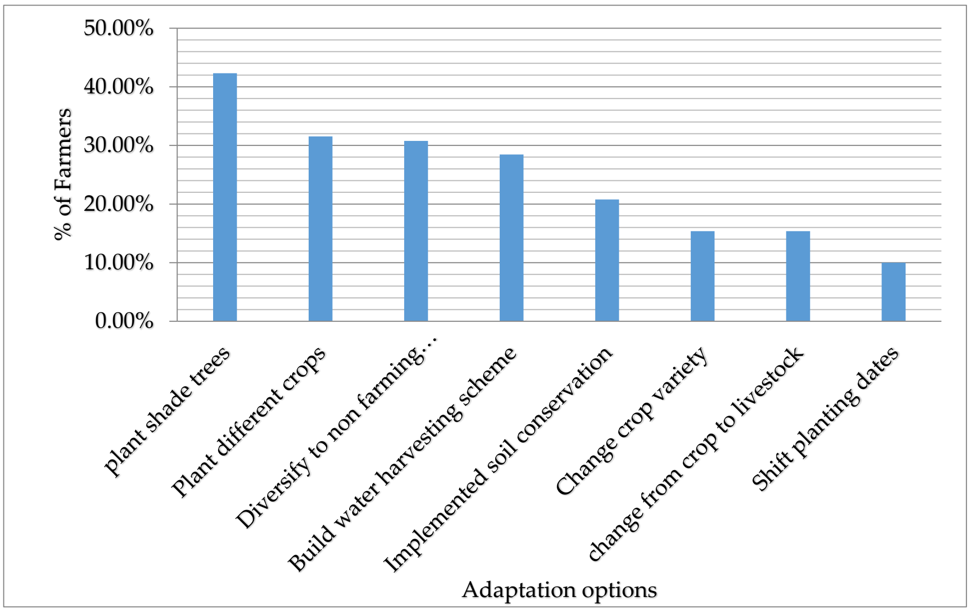

Figure 3. Current adopted adaptation strategies to climate change.

They have resorted to maize cultivation and practicing mixed cropping. These adaptation measures correspond to those undertaken by most farmers within Sub-Saharan Africa and the Fako division in particular [34]. Farmers within the Sekyedumase district in Ghana resorted to changing crop types, planting short season varieties, changing planting dates and crop diversification as major adaptation options to climate change [20]. In a study in Buea, it was revealed that farmers have resorted to diversification of crops, changing planting dates, planting of short season varieties, and engaging in off-farm jobs [13]. As such, their adaptation options where either related to temperature changes or rainfall changes.

As shown in Figure 4, farmers adaptation options to climate change were classified into two major categories: temperature-related and rainfall-related adaptation options. Based on this, results revealed that the majority of farmers (78.33%) have undertaken rainfall-related adaptation options against a small proportion of 21.67% who did not undertake it. On the other hand, 63.33% of farmers undertook temperature-related adaptations against 36.67% who did not undertake it (Figure 4). Also, a study by Reference [20] documented farmers' adaptations into similar categories; they noted that 40% of sampled farmers undertook rainfall variability-related adaptation and 44% adopted temperature-related adaptations. Their results and those in this study confirm that farmers showed more preference towards temperature-related adaptation options than rainfall-related adaptation. However, a 2017 study in Buea considered adaptation options to erratic rainfall and increasing temperatures and rather observed that farmers undertook more rainfall-related adaptation than temperature [13].

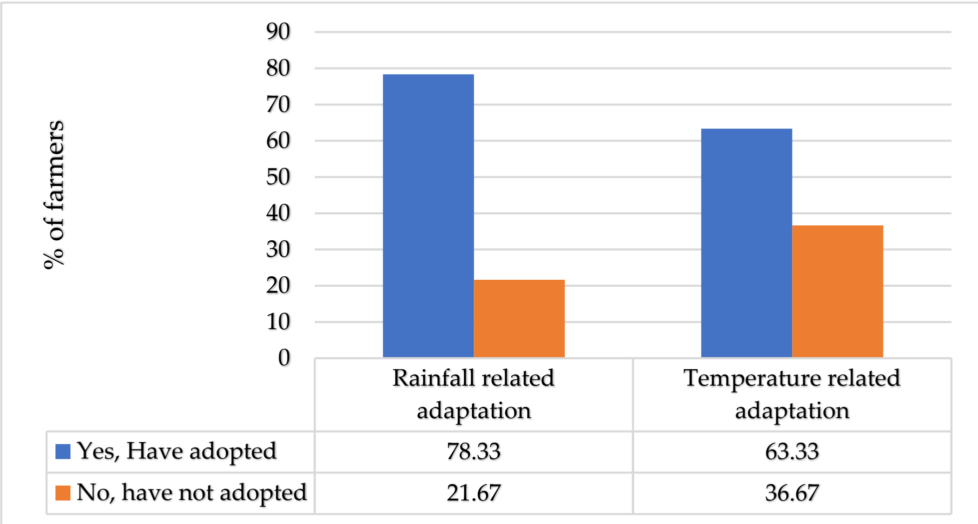

Figure 4. Classification of Farmers' Adaptation options to climate changes.

3.2. *Descriptive Statistics of Explanatory Variables Affecting Climate Adaptation Uptake*

In this study, we considered 11 explanatory variables (Table 3) which may influence farmer's adoption of either rainfall-related or temperature-related adaptation options. These explanatory variables include: knowledge or perception of climate change, gender of farmer, access to land, access to agro-extension service, access to information media, access to credit, access to a road to a nearby town, access to climate information, access to a non-farm income source, access to improved seeds and farm technology, and member of a farmers group. These variables are binary response variables with categories as "Yes (0)" and "No (1)".

Table 3. Results on explanatory variables affecting climate adaptation uptake.

Variables	Standard Deviation	% of Yes	% of No
Dependent variables			
Have you adopted any rainfall-related adaptation strategy?	0.447	78.33	21.67
Have you adopted any temperature-related adaptation strategy?	0.493	63.33	36.67
Explanatory variables			
Gender	0.499	55	45
Land Ownership	0.498	59.17	40.83
Access to agro-extension service	0.487	41.67	58.33
Access to media information	0.496	56.15	43.85
Access to credit	0.381	17.69	82.37
Access to road	0.210	96.92	3.08
Access to climate information	0.192	3.85	96.15
Non-farm income source	0.478	35.38	64.62
Access to improved seeds and farm technology	0.483	36.92	63.08
Membership in farmers' group/Cooperative	0.458	30	70
Knowledge/perception on climate change	0.435	80.83	19.17
N = 130			

Results revealed that the majority of farmers (78.33%) have rather adopted a rainfall-related adaptation strategy than temperature-related adaptation (63.33%). Farmers were found to show more knowledge on climate change (80.83); a greater proportion have access to road (96.92%). Still, a greater proportion of farmers are male (55%); 59.17% have access to land; and 56.15% have access to media information in the form of either radio or television. On the other hand, a greater proportion of farmers of approximately 96.15% do not have access to climatic information; 82.37% do not have access to credit; 58.33% do not have access to agro-extension service; 64.62% do not have nonfarm income sources; and 63.08% do not have access to improved seeds and farm technology. This is clearly seen in their Standard deviation values (Table 3). These correspond to the barriers to adopting adaptation strategies to climate change in the area. There is therefore a need to assess the numerous factors to identify those that influence positively farmers' adaptation decisions for better policy formulation.

3.3. Determinants of Adoption of Adaptation to Climate Variability

In this section, we present results on the determinants of farmers' adoption of both temperature-related and rainfall-related adaptation to climate change based on the binary logistic regression model. We present the odds ratios of the different variables that influence farmers' up-take of temperature-related and rainfall-related adaptation strategies (Table 4). Accordingly, if the odds ratio is >1, then the odds in favour of the variable being a determinant of farmers adopting an adaptation strategy to temperature/rainfall variability increases; that is, Y = 1 increases while it decreases if the odds ratio <1.

Table 4. Logistic regression results on the determinants of farmers' climate adaptation choices.

Variables	Adoption of Rainfall-Related Adaptation			Adoption of Temperature-Related Adaptation		
	Odds Ratios	95% CI	P-Value	Odds Ratios	95% CI	P-Value
Gender	1.850	0.722–4.740	0.200	0.846	0.361–1.981	0.699
Own Land	0.722	0.275–1.897	0.509	0.721	0.299–1.736	0.465
Access to Agro-extension service	0.751	0.257–2.199	0.602	0.467	0.175–1.248	0.129
Access to Media information	1.287	0.535–3.093	0.573	0.509	0.222–1.171	0.112
Access to credit	0.379	0.109–1.317	0.127	2.616	0.791–8.649	0.115
Access to road	1.091	0.166–7.179	0.928	10.744	0.998–115.657	0.050 **
Access to climate information	1.025	0.085–12.389	0.985	6.110	0.248–150.675	0.268
Nonfarm income source	1.197	0.498–2.879	0.688	2.600	1.099–6.149	0.030 **
Access to Improved seeds/farm technology	2.908	1.024–8.260	0.045 **	0.900	0.376–2.155	0.813
Member of Farmers group/cooperative	2.199	0.663–7.288	0.198	2.591	0.909–7.388	0.075 *
Perception of climate change	1.322	0.495–3.535	0.578	1.248	0.486–3.202	0.645
N = 130	Nagelkerke = 0.128 X^2 = 12.112 (Significance = 0.355) 2 Log likelihood: 141.295 68% of all cases were assigned correctly			Nagelkerke = 0.201 X^2 = 20.998 (Significance = 0.033) 2 Log likelihood: 155.479		

Note: **, * indicates significance at 0.05 and 0.10 level of significance respectively.

The results of determinants of adaptation presented in Table 4 suggest that access to improved seeds is the lone most significant factor affecting farmers' adoption of rainfall-related adaptation in the subdivision. On the other hand, access to road, access to nonfarm income source and member of a farmer's group constitute the most significant factors affecting the adoption of temperature-related adaptation. These factors are found to be positively correlated with adoption of either rainfall and/or temperature-related adaptation options respectively (Table 4).

Access roads facilitate the transportation of farm tools, chemicals, and produce from farms to markets. It also facilitates the dissemination of climate change information from one farm community to the other. Access roads are essential to ensure the rapid and efficient transit of farm produce to nearby or far off markets in fresh and good conditions. Also, with an available and access road, information about new technologies and climate change manifestations can be disseminated. Road accessibility which may come from rehabilitation or maintenance can also enhance non-agricultural income opportunities for farmers [35].

Nonfarm income makes up the wealth of the farmer and may aid greatly in the purchase of farm equipment and other related agricultural technologies [12]. The positive correlation between adoption of temperature-related adaptation and nonfarm income observed in this study are in line with the findings of Reference [12,24]. Therefore, policies geared towards building farmers' resilience to climate change within the Muyuka subdivision should consider empowering farmers to gain different varieties of nonfarm income-generating activities in order to better reduce their vulnerabilities to climate change and to increase their adaptive capacity. However, increased access to nonfarm income was reported to reduce the likelihood of adopting soil and water-related measures in Ekiki State, Nigeria; meanwhile, it increased the probability of adopting mixed farming in the same area [36].

Access to improved seeds and farm technology was found to positively influence farmers' adoption of temperature-related adaptation in the subdivision. Limited availability of good quality seeds is a key constraint repeatedly identified by farmers in rural areas in many countries. These may allow farmers to withstand the shocks from erratic rainfall conditions and its associated effects on the general farm system [37]. A study by Reference [31] observed a similar positive effect of access to farm technology on adoption of adaptation. They express that farmers with better technologies are able to vary planting dates. As such, the availability of cheap technology for farmers can therefore increase their use of other designed adaptations [31].

Belonging to farmers' groups/cooperatives serves as a source of good quality inputs, labour, credit, information and organized marketing of products. Through this, local institution members participate regularly to share experiences about farming, synthesize new information and innovations, discuss problems and explore new opportunities on farming. Cooperatives can also facilitate increased access to government funding as well as information and consultation. They also provide market information and offer technical assistance in matters such as pest control and soil conservation methods. The positive correlation between adoption of adaptation and membership of farmers groups/cooperatives observed in this study are in line with the findings of Reference [38] in Nepal Himalayas and Reference [32] in a study in Nigeria. Therefore, policy decisions should therefore consider the sensitization of local farmers to join local farm groups or associations as institutions play a central role in reversing the vulnerabilities of farmers to climate variability and change as expressed in the sustainable livelihood framework in climate change adaptations.

4. Conclusions and Recommendations

This study sought to investigate the factors that determine the adoption of rainfall-related and temperature-related adaptations to climate change. These explanatory variables which cut across individual, institutional and socio-economic factors are considered as the heart in any climate change adaptation management framework. This study found that access to improved seeds/farm technology positively and significantly influences positively the farmers' choice of rainfall-related adaptation. Access to a road leading to a nearby urban centre, access to nonfarm income-generating activity and membership of a farmer group or cooperative constitute the most significant factors that influence positively farmers' adoption of temperature-related adaptation in the subdivision. Policies geared towards building farmers' resilience should effectively capture the following tri-factors: provision of access roads linking farm communities to nearby urban centres, upscaling institutional interventions with regards to providing high quality and resistant seeds to farmers and by incentivizing farmers to create or join social groups in order to facilitate adaptation uptake. It becomes imperative therefore for climate change adaptation policy frameworks to consider the provision of access roads linking farm communities to nearby urban centres such Kumba, Buea and Muyuka. Also, we recommend that policies geared towards building resilient communities to climate change and aimed at uplifting farmers' adaptive capacity should consider the sensitization of farmers to join farmer groups/cooperatives. In addition, policy decisions should also empower rural farmers with non-farm income activities so as to help them become financially independent and capable amidst climate change. Lastly, upscaling institutional interventions with regards to providing high quality and resistant seeds to farmers constitute another major policy implication in order to facilitate farmers' adaptation uptake in the subdivision. As such, these factors remain instrumental to developing effective and sustainable climate variability/change adaptation policies within the subdivision. Besides the relevance of this study's results, however, an in-depth study on assessing the determinants of farmers' choices of specific adaptation strategies besides those looked at in this study needs to be carried out so as to better identify specific factors that determine the uptake of specific adaptation measures by farmers. This will therefore contribute greatly to devising specific policies that will contribute to raise farmers' adaptive capacity to climate change and help build resilient agricultural communities in the midst of climate change within the subdivision.

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