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EFFECT OF CLIMATE CHANGE ON RABBIT PRODUCTION AND CHOICE OF ADAPTATION COPING STRATEGIES BY SMALLHOLDER FARMERS IN ANAMBRA STATE, NIGERIA

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Abstract

Effect of climate change on rabbit production and choice of adaptation coping strategies by smallholder farmers in Anambra State, Nigeria was studied. The specific objectives of the study are to describe the rabbit farmers' socio-economic characteristics, identify the adaptation coping strategies adopted by the farmers, determine the effect of the farmers' socio-economic characteristics on adopting of adaptation coping strategies to climate change, ascertain the effects of variability of climate elements on rabbit production and identify the factors limiting farmers' adaptation coping strategies to climate change in the study area. A total of one hundred and twenty respondents (120) were selected using multi-stage random sampling technique. Data for the study were collected using structured questionnaire and oral interview. Percentage responses, multiple regressions and Multi nominal regression models were used to analyze the objectives of the study. The results showed that males (58.3 %) predominated rabbit farming. In addition, 58.3 % of the respondents were within age range of 20 – 40 years old; 16.7 %; 41 – 61 years and 25 %; 61 years and above. Also, majority of the sampled farmers were married (50 %), educated (94.3 %) with 60 % of them having household size of 7-12 persons. As well, majority (66.7 %) of the respondents was members of organizations and 66.7 % had no contact with extension services. The result of adaptation coping strategies adopted by the rabbit farmers were use of shade (57 %), use of cool drinking water (85 %), use of fan (54.2 %), management practices (66.7 %), heat tolerant breed (65 %), heat resistant material (51.7 %) and hutch positioning (56.7 %). In addition, rainfall (4.403),*** temperature (4.44),***, relative humidity (3.31)***and wind (2.60)** were the weather elements that affected rabbit production in the study area. Furthermore, the farmers' socio-economic characteristics that affected the adaptation coping strategies to climate change in rabbit production were level of education, weather information, age of the farmers, rearing experience and extension services Finally, the factors limiting rabbit farmers' adaptation coping strategies were poor access to; credit, access to weather information, and extension services and high cost of labour. The need to ensure farmers' access to credit, education and extension services were recommended.

Key words: Climate change, Adaptation, Coping Strategies, Rabbit and Smallholder Farmers.

1. Introduction

Agriculture is the engine of the economy of most countries in Sub-Saharan Africa, with small scale farmers constituting the bulk of the farming population (Mengistu, 2011). The small scale farmers constitute a significant portion of the world farming population with an estimated 450 - 500 million representing 85 % of the world's farmers. This farming population has characteristic features of being resource poor, low institutional and technological adoption capability (FAO, 2008). Studies showed that among livestock produced by this farmers, rabbit production stands pre eminence (Marai, *et al*, 2002; Ajasin, *et al*; 2003; Ume, *et al* 2016).

Rabbit is an important micro and monogastric livestock raised for: meat production, fur production, wool production, as laboratory animals, pets and exhibition (Ajasin *et al.*, 2004). It has features of being highly prolific; limited competition with humans for alike food, feeds easily, outstanding adaptive abilities, suitable for breeding, and meat production with small capital investment (Hassan and Owolabi, 2009). Moreover, the dietetic and gustatory properties of rabbit meat are highly appreciated, as short gestation interval (30 - 32 days), as well as the ability to utilize diverse forage ((Nworgu and Hammed, 2009). Rabbit meat has characteristics of being tender, fine quality and a high nutritional value with high protein (56 %), low fat (9 %), low in cholesterol, sodium and calories (8 %) and contain 28 % phosphorus, 13 % iron, 16 % zinc, 14 % riboflavin, 6 % thiamin, 35 % B12 and 48% niacin - making it ideal meat for hypertensive patients (Ozor and Madukwe, 2005; Okorie, 2011).

The above potentials of this animal endeared it as among the category of under-utilized livestock species in developing countries that could be most suitable and sustainable means of producing high quality meat (protein) to combat animal protein shortage in the diet of people in developing economy(Nworgu and Hammed, 2009; Okorie, 2011). Nevertheless, in many regions of the world, Sub- Saharan Africa as a case in point, rabbit production is primarily carried out by small holder farmers with their production largely traditional, non-commercially oriented, family consumption targeted, and smallholder type operation comprising 2 - 7 does and 3 bucks (Hassan and Owolabi, 2009). One of the main characteristics of such production systems are of simple, outdated technologies, low returns and high seasonal labour fluctuations (Okorie, 2011). Nevertheless, the production of rabbit was constrained in most developing countries by among others climate change (Ozor and Madukwe, 2005; FAO, 2008).

Climate change according to Mertez *et al.* (2009) and Onyekuru and Marchant (2017) is long term gradual change in weather variables such as temperature, rainfall, relative humidity, wind, sunshine and pressure. Climate change is caused by increase in greenhouse gases (in form of carbon-di-oxide, methane and nitrous oxide (N_2O) primarily due to industrialization, foil fuel use, land use change and change in agricultural activities (IPCC, 2001; Nhamachena and Hassan, 2007). Climate change is a global phenomenon and its negative impacts are more severely felt by poor people in developing countries who rely heavily on the natural resource base for their livelihoods (FAO, 2008; Ume *et al.*, 2018). It often manifest in varied forms in among localities but frequently reported according to Ozor and Cynthia (2010) in form of prolonged bad weather, change of weather conditions, situation of volatile

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weather, short rain fall duration and prolonged dry season and thunderstorm and heavy rains. The other forms are too much rain and too much sun, unpredictable start and end of rains, unstable weather and variation in rainfall pattern and sunshine intensity (Ozor *et al*., 2010; Ume and Kaine, 2017).

Rabbit is vulnerable to climate change as it resistance to diseases are weaken under wet and draft conditions but could tolerate low temperatures and excessive cold (Ajasin *et al*., 2003). Furthermore, Marari *et al*. (1994) reported that there is possible extinction of rabbit under extreme heat, hence opined that ideally temperature in the hutch should not be higher than 85 degrees while in enclosed buildings where temperature and humidity are controlled, the desirable combination is 60 - 78 degrees and 30 - 40 % humidity. The effects of climate change often reported among studies in rabbit production are lack of portable water for the livestock use, incidence of diseases and pests, extinction of the animal at extreme heat stress situation, changes in grazing behavior, feed intake, feed digestibility and efficiency of feed utilization (Marari *et al*., 1996; Ajasin *et al*., 2002). Other effects are lower rabbit carcass quality, increase in incidence of parasite and reduction in the storage and handling of animal products (Ozor and Madukwe, 2005).

In Africa, small holder rabbit farmers have devised varied adaptation coping strategies in cushioning the effects of climate change in their rabbit farms. Although, the coping strategies are location and farmers specifics, and included; provision of sunshade, use of fan, position of hutches, use of plastic bottle of frozen water, use of tolerant rabbit breeds, improved nutritional management and destocking (Marai *et al*., 1994; Okorie, 2011). However, it becomes necessary to identify the adaptation strategies used by the farmers and factors influencing their choice of adaptation strategies in the study area, since there is paucity of such knowledge.

The specific objectives are to describe the rabbit farmers' socio-economic characteristics, identify the adaptation strategies adopted by the farmers, determine the effect of the farmers' socio-economic characteristics on adoption of climate change adaptation coping strategies, ascertain the effects of variability of climate change elements on sheep and goat production and identify the factors limiting farmers' adaptation to climate change in the study area. This study will help to accelerate the adoption of appropriate cost effective mitigations and adaption practices which will drastically minimize their vulnerability and increase their output, income and overall wellbeing. Furthermore, the study will equally bring about the needed collaboration between the climate change information sources, trained extension agent and the farmers in order to bridge the information gap of rural farmers on climate change in most developing countries of the world and in particularly the study area.

Table – 1: The definition of variables used in the regression model

Variable	Definition of Value	Expected Sign
Age of household head	Number of years of Head of Household	+
Rearing experience	Rearing experience number of years	+
Flock size	Flock size in No	–
Educational Level	Number of years of schooling	+
Membership of cooperative	1=yes and 0=no	+
Rainfall	Amount of precipitation Mm	+
Temperature	The hotness and coldness of the body(^{oc})	+
Wind	Movement of air, Velocity	+

2. Materials and Methods

Anambra State of Nigeria was the study area. The state is located between latitude $5^0 38'N$ and $6^0 47'E$ of the Equator and longitude $6^0 36'N$ and $7^0 21'E$ of the Greenwich Meridian. The state is bounded in the east by Enugu State, in the West by Delta State, in the South by Imo State and in the North by Kogi State. Anambra State has Awka as capital with population figure of 4.184 million people (NPC, 2006). It has four agricultural zones (Anambra, Awka, Onitsha and Aguata), many blocks and circles. The state has mean temperature of 28 – 38^0C and rainfall of 1500 – 2500mm. Anambra state is agrarian and engage in crop production, processing, marketing, and animal husbandry production, precisely monogastic animals such as rabbit, pig and poultry. Other non-farm activities engaged by the people are hunting , petty trading, driving, vulcanizing and among others.

Multistage random sampling technique was used to select agricultural zones, blocks, circles and respondents for the study. In stage 1, three agricultural zones were selected out of four. In stage 2, four blocks were selected from each of the zones. Stage 3 involved selection of five circles from each of the sampled block. This brought to a total of sixty circles. In the final stage, sixty farmers were selected from each circle and this brought to a total of one hundred and twenty farmers for detailed study. Structured questionnaire was used to collect information on primary data in respect to farmers' socio-economic characteristic (age, educational level, household size, farming experience, membership of organization), farmers' adaptation strategies and limitation of farmer to adaption to climate change such as credit, labour and poor extension outreach. Secondary data was obtained from literatures, journals, proceedings, textbooks and other periodicals. Data collected were analyzed using descriptive statistics such as percentages and frequency distribution table, relevant inferential statistics and factor analysis in order to achieve the specific objectives.

Model Specification

Multinomial logistic model (MNLM)

Multinomial logistic model (MNLM) was be used to analyse the factors influencing households' choice of climate change adaptation strategies. According to Nhemachena and Haddai, (2007), MNLM for choice of adaptation strategies specifies the relationship between the probability of choosing an adaptation option and the set of explanatory variables. The adaptation strategies are grouped into six groups, since the households use more than one strategy and one group is "no adapting to climate change".

The MNL Model is stated as follows:

$$Y_i = \ In (P_i, P_I) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \ ei$$

Where

Y_i = adaptation strategy (Positioning of hutch, no adaption; heat tolerant breeds, heat resistant roofing materials, management practices, use of fan, use of shade and any other strategies).

X_i, where i = 1, 2, ….. 7 are explanatory variables,

X_1 = Marital status of the farmers (dummy)

X_2 = Age of the farmers (yrs)

X_3 = Educational attainment (years)

X_4 = Rearing experience (years)

X_5 = Access to extension services(no)

X_6 = Membership to social network (dummy)

X_7 = Climate change information (dummy)

ei = error term

Multiple regression model

The multiple regression models can be implicitly represented as:

$$Y = \ b_0 + b_1 x_1 + b_2 x_2 + b_3 x_3 + b_4 x_4 + b_5 x_5 + b_6 x_6 + b_7 x_7 + ei \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1).$$

The four functional forms (linear model, exponential model, double log and semi log of production function were and explicitly represented as:

Linear function

$Y = b_0 + b_1 x_1 b_2 x_2 + b_3 x_3 + b_4 x_4 + b_5 x_5 + ei$ …………………………. (2)

Double log function:-

$\ln(y) = \ln b_0 + b_1 \ln x_1 + b_2 \ln x_2 + b_3 \ln x_3 + b_4 \ln x_4 + b_5 \ln x_5 + ei$ …………… (3)

Semi log

$Y = \ln b_0 + b_1 \ln x_1 + b_2 \ln x_2 + b_3 \ln x_3 + b_4 \ln x_4 + b_5 \ln x_5 + ei$ ………………… (4)

Exponential function

$\ln Y = b_0 + b_1 x_1 + b_2 x_2 + b_3 x_3 + b_4 x_4 + b_5 x_5 + ei$……………….………… (5)

Where:
Ln = Natural Logarithm
Y = Output Variables (kg) ie (sheep and goat)
Bo = Constant term (y)
B_1 = Regression C0-efficient
X_1 = Temperature (0*c*),
X_2 = Rainfall (mm),
X_3 = Relative humidity (%)
X_4 = Wind (v)
N/B. The choice of the best functional form was based on the magnitude of the R^2 value, the high number of significance, size and signs of the regression coefficients as they conform to *apriori expectation*.

3. Results and Discussion

The Table - 2 showed that 58.3 % of the respondents were males, while 41.7 % were females. This implies that females dominated rabbit rearing and this could be allied to females having good animal husbandry and management traits than males (Ume *et al.*, 2016). More so, most (58.3 %) of the sampled farmers fell within the age range of 20 - 40 years, 16.7 %; 41 - 61 and 25 %; above 61 years of age. The aged people was into rabbit in the study area because rabbit rearing is less labour intensive as well this age group are capable of dictating weather changes as such is a function of long time observation (Brayan *et al.*, 2009). In contrary, Apata, *et al.* (2007) reported that aged people are less able to source and synthesize weather information. Furthermore, most of the respondents were married (50 %). The implication is that households with large members and of labour age could be used as family labour in implementing technologies in rabbit production aimed at averting the effects of climate change (Ume *et al.*, 2018). Table - 2 showed that most (60 %) of the respondents had household size of 7-12 persons, followed by 33.3 % of the respondents having 1 - 6 persons, while 6.7 % had 13 -18 persons. Household members engage in off- farm income in order to among others to generate for procurement of material inputs to be used in abating risks and uncertainties associated with climate change in rabbit production (Adesiji *et al.*, 2012). Also, 94.3 % of the respondents had formal education, while only 6.7 % had no formal education. The educated features of the farmers are good for increasing level of knowledge on climate change and for the development of indigenous farm practices for adaptation (Bradshaw *et al.*, 2004).

More so, 50 % of the sampled farmers had rabbit rearing experience of 22 - 32 years, followed by 33.3 % that had 11 - 21 years and the least, 16.7 % were 1 - 10 years. The number of years of farmers' rearing experience facilitates to mitigate the effects of climate change as climate change is an annually recurring decimal (Braklacich *et al.*, 1994). Additionally, majority (66.7 %) of the respondents belonged to one or more social organization, while 33.3 % belonged to no organization. Organization helps to disseminate climate change information to the farmers and this perhaps has a multiplier effect (Bryant *et al.*, 2000). As well, 50 % of the respondents had flock sizes of above 32 rabbits, while the least (8.3 %) had 1 – 10 rabbits. This implies that the respondents are small holder farmers, thus vulnerable and less able to cope with the consequences of climate change as they are poor and cannot have access to climate change alleviation technologies (Ogunjiru *et al.*, 2007). Moreover, majority (66.7 %) of the respondents had no access to extension services, while 33.3 % had access. Extension services help to disseminate information on improved farming practices, climate change and emerging climate change adaptation measures (Ume and Kaine, 2017).

Adaptation strategies adopted by rabbit farmers against Climate Change is shown in Table - 2.

Table - 2: Adaptation Strategies Adopted by Rabbit Farmers against Climate Change

Position of Hutch	68	56.7
Heat resistant roofing material	62	51.7
Destocking	45	37.5
Enough drinking cool water	102	85
Use of fan	65	54.2
Heat tolerant rabbit breed	78	65
Good management practices	80	66.7
Use of Shade	70	58

*Multiple Responses.
Source; Field Survey; 2017

The Table - 3 revealed that, 54.2 % of the respondents used fan to cushion the effects of heat stress in their rabbit farms. Fan facilitates in to renew the oxygen and get rid of excess humidity (evaporation, exhalation) in the rabbit hutch (Ume *et al*., 2016). As well, 56.7 % of the respondents used hutch positioning in combating the ills of climate change in rabbit production. Ajasin *et al*. (2003) reported that rabbit hutches should be positioned in south direction to avoid draft. Furthermore, use of tolerant breed of rabbit was reported to be used by 65 % of the respondents to battle effects of climate change. The need to use strain of rabbits that has shown the greatest degree of heat tolerance to combat maximally heat stress in rabbit production is very effective (Marai *et al.*, 1994).

More so, good management practice was used by 66.7 of the sampled farmers to checkmate efficiently climate change in rabbit production. The climate change adaptation management practices could be in form of feeding rabbits during the coolest periods of the day (early morning, late in the evening or by night) as these periods have the features of lower temperature and lower humidity in summer months, isolation of heat stressed rabbit to a quiet and well ventilated place, avoid mating does during hot period in order to avoid much stress on the animal during pregnancy and Injection vitamins A, D or E to the young rabbits (Habeeb *et al.,* 1993; Marai *et al*., 2002). In addition to the management practices are addition of vitamin C in rabbit drinking water, spraying the roofs and outer wall with water and by putting vitamin E + Selenium in rabbit drinking water in order to enhance rabbits' fertility during hot weather (Marai, *et al*. 1996).

Moreover, 85 % of the respondents used clean and cool drinking water to control climate change on the animal. Studies show that giving to the animal cool drinking water during the hot period could help to control heat stress and in metabolism in the animal (Luketahr and Cheeke, 1991). During periods of extended heat and humidity, literatures showed that it is necessary to provide extra clean water and such water should be changed very often (Ume *et al.,* 2016). Table - 3 shows that 58.3 % of the sampled farmers curtailed the effects of heat stress on their animals through provision of shade. Trees when used as shade in rabbit production is capable of reducing ammonia emission by the animal as well clean air by capturing carbon dioxide and releasing oxygen back into the air for animal use. These are capable of improving the animal's weight gain, milk production and reproduction (Ajasin *et al.,* 2004; Okorie *et al*., 2011).

The result of the effects of climate change variables on rabbit production is shown in Table - 4 using regression model analysis. Double Log functional form was chosen as the lead equation based on having the highest coefficient of multiple determinations (R^2), number of significant variables, Durbin Watson value and F-values. The R^2 was 0.750, which indicates that 75 % of the variations of the dependent variables in the model are due to variation of independent variable included in the model, the remaining 25 % were due to error term. The overall effect of the independent variables on the dependent variables as shown by F-ratio (5.006) was significant at 1 % level significant. This implies that the forecasting power of the explanatory variables is very high since relevant variables were not omitted in the regression model. Thus, implies that the model is good fit.

Table – 3: Effects of Variability of Weather Elements on Rabbit Production

Variable	Linear	Exponential	Double log	Semi log
Constant	3.231 (-5.463)***	4.006 (5.217)***	3.600 (4.403)***	4.943 (6.017)***
Rainfall	-0.541 (3.347)***	2.371 (3.009)***	-0.787 (6.500)***	-1.851 (-5.045)***
Relative humidity	2.120 (4.354)***	-0.467 (-2.631)**	1.343 (3.317)***	0.008 (2.219)**
Wind	0.238 (0.805)	1.2003 (-2.006)**	0.090 (2.600)**	0.209 (0.409)
Pressure	0.108 (0.105)	0.100 (0.301)	0.809 (0.775)	0.008 (0.404)
Temperature	1.178 (2.905)**	0.178 (0.808)	2.908 (4.444)***	0.228 (1.605)*
R^2	0.398	0.560	0.750	6.080
F – ratio	3.867	4.573	5.006	4.091
Durban Watson	3.765	4.009	5.490	4.004

Source: Field Survey, 2017

*,** and *** Implies significant at 10%, 5% and 1% respectively.

The coefficient of temperature had direct relationship with the dependent variable at 95 % confidence level. Literatures how that high ambient temperatures can impair the reproductive performance of rabbits. For instance, when male is rabbits subjected to high temperature, there will be an increase in the pH of the semen, decrease in sperm motility, reduction in sperm concentration, an increase in the percentage of abnormal spermatozoa and a decline in libido (EL – Raffa, 2005; Okolie *et al*., 2011). In the female, Luketahr and Cheeke (1991) observed that at high temperature, smaller blastocysts and embryos will result, as well increase in embryo mortality rates. However, Marai *et al*. (1994) opined that for good health and good spermatozoa stability, rabbit should be reared at temperature of 43.3 °C and relative humidity of 30 to 40 %. The other effects of heat on rabbit are high mortality, decline in growth and feed traits, poor weight gain, impaired appetite, reduction in feed conversion and milk production and increase in disease incidence (Habeeb *et al*., 1993). The coefficient of Rainfall was positive and significant at 1% alpha level. Rainfalls ensure availability of water for animal use and in controlling the environmental temperature (Marai *et al*., 2002). Furthermore, in contrary, Ume *et al*. (2018) reported that global warming and changes in precipitation affect the quantity and spread of vector-borne pests such as flies, ticks, and mosquitoes in animal production.

Also, the coefficient of relative humidity was positive and significant at 5 % level of significance. High humidity helps to minimize the sun intensity on the rabbit especially when they are reared under extensive system (Ajasin *et al*., 2004). Conversely, high relative humidity reduces the animal feed intake and building up of pests and diseases (Marai *et al*., 1994). A combination of high temperature and high relative humidity to most animals is very stressful and as reported by El- Raffa (2005) could be detrimental to rabbit productivity. Moreover, the coefficient of wind was positive and significant at 1 % probability level. Wind helps in abating odour from ammonia (NH_3) which is capable of deteriorating the rabbits' upper respiratory tract and predisposes rabbit to bacteria disease like *Pasteurella* and *Bordetella* (Habeeb *et al*., 1993). Also, wind facilities reduction in disease and pests building up in rabbit houses and in reduction of carbon-di-oxide (CO_2) and excess heat given out by rabbits in its pen (Ajasin *et al*., 2004). Also, the coefficient of sunshine was positive and significant at 10 % level of probability. Literature show that buck's spermatogenesis and sexual activity could be enhance through its', exposure to for 8 out of 24 hours of sunlight, while doe experience improved sexual activity and fertilization for 14 to 16 hours (EL - Raffa, 2005). The Multi nominal Logistic Model of result of choice of adopting adaptation strategies to climate change is shown in Table – 5.

Table – 4: Multi nominal Logistic Model of Result of Choice of Adopting Adaptation Coping Strategies to Climate Change

Variable	Fan	Resistant Roofing Material	Drinking Water	Resistant Breed	hutch position	Use of shade	Mgt. Practices	No Adaptation
Age	31.4753*** (3.6321)	11.3437*** (4.0005)	0.0197 (0.8875)	0.0007 (4.0089)	12.7733*** (6.0990)	12.0007*** (4.9915)	2.3488** (2.8885)	0.2138 (2.0765
Education	1.0397 (0.8815)	14.03437*** (4.9915)	15.0657*** (6.0987)	0.0010 (3.6915)	12.0607*** (5.0015)	0.09876 (0.9225)	0.4507 (0.7715)	
Marital Status	0.00421 (3.0984)	0.0137 (4.9321)	0.0777 (4.04225)	0.3307 (9.9915)	0.00634 (5.0010)	0.0434 (2.9665)	0.00035 (1.0065)	
Extn. Services	0.13007 (4.9321)	1.0133 (1.9623)	3.0135*** (3.9001)	3.0097 *** (2.9300)	2.0138** (4.0021)	0.0107 (1.0320)	4.0231*** (6.9001)	
Climate Inform.	0.01707 (6.9921)	0.0957 (4.98867)	1.0137 (1.9390)	0.01470 (0.3229)	0.9167 (2.5409)	0.7039 (3.6511)	0.00782 (2.4421)	
Rearing Experien.	2.0123** (3.5431)	0.07790 (3.8970)	0.8901 (6.9921)	7.9086*** (0.0933)	2.0908** (2.6067)	6.01808*** (3.0021)	0.0445 (1.0001)	
Constant	4.0901*** (6.6621)	14.0128*** (1.3321)	3.7009*** (7.0026)	4.8807*** (12.0908)	6.2107*** (3.3421)	5.0990*** (4.9021)	7.0543*** (6.7321)	

Diagnosis based category	
No. of observations	120
LR chisquare(50)	186.45***
Log Likelihood	-167.87655
R2	0.6860

Source; Field Survey, 2017

The Table - 4 showed that the choice of adaptation strategies insert into Multi Nominal Logit (MNL) model were resistant roof material, adequate provision of drinking water, good management practices, heat resistant rabbit breed, use of shade, use of fan, hutch position and no adoption were ran. The likelihood ratio statistics are indicated by statistics π2 (182:31) and was highly significant, suggesting that the model has a strong explanatory power. The coefficient of age of the household had a positive and significant effect on the use of adaptation strategies such as use of fan, positioning of hutch, resistant roofing materials and use of management practices in overcoming climate change effect in his/her rabbit farms. Coefficient of the educational level of the sampled farmers had a positive and significant impact on the choice of adaptation strategies to climate change. This implies that as the farmer gets educated, the higher the likelihood of adopting use of resistant roofing material, hutch positioning and cool drinking water as adaptation strategies to climate change in rabbit production. The finding of Ume *et al*. (2018) was in line with the above assertion. They were of the view that educated people are better equipped with information as relates to climate change and the best adaptation cooping options (Apata *et al.*, 2009).

Access to extension services had a significant effect in adopting adaptation coping strategies to climate change through use of heat resistant breed, hutch positioning, use of cool drinking water and management practices. Farmers with access to extension services is expected to be better informed with superior information and knowledge on climate change in order to make informed choices on the adaptation coping strategies (Onyekuru and Marchant, 2017). The coefficient of rearing experience was positive and had significant effect on adaptation strategies to climate change. This implies that the more farmers are experienced on climate change, the more likelihood of using adaption measures such as use of fan, use of shade, use of heat - tolerant rabbit breeds and resistant roofing material in abating climate change. Farmers with many years of farming experience have interacted much more with the climate in relation to their activities and therefore, have good knowledge of environmental factors as they relate to their daily operations (Bradshaw *et al.*, 2004; Apata *et al.*, 2009).

The limitations to adopting adaptation strategies to climate change by rabbit farmers are shown in Table - 6

Table – 5: Limitations to Adoption of Adaptation Strategies to Climate Change by Rabbit Farmers

Variable	Frequency	Percentage
Poor Access to credit	100	83.3
High cost of labour	75	62.2
Poor access to improved rabbit breed	60	50
Poor access to extension services	90	75
Poor access to information	80	66.7
Poor government involvement	45	20
Poor access to extension services	78	65

*Multiple Responses
Source; Field Survey; 2017.

The poor access to credit was reported by 83.3 % of the respondents. This could be linked to lack of information or awareness of the presence of loan facilities, high collateral and location of banks in urban which is far from the rural areas where farmers live (Ezeano *et al.*, 2017; Ume *et al.*, 2018). Also, 66.7 % of the sampled rabbit farmers had poor access to information on climate change. Ume and Kaine (2017) reported that farmers' with timely access to weather information helps for rational decision making on the best adaptation coping strategies to climate change to adopt. As well, 50 % of the sampled farmers reported that poor access to tolerant improved breeds of rabbit was a limitation to adaptation to climate change. It is important to state that most of improved and high prolific rabbit breeds in most developing countries have poor adaptability to extreme high temperature that is often associated with the tropics. Studies inferred that local rabbit breeds that are heat resistant breeds are typified by poor growth, low weight gain and low mothering ability by the doe (Opata *et al*., 2009; Ume *et al.*, 2017).

Furthermore, the problem of poor access to extension services was reported by 75 % of the respondents. Extension agents who are suppose to help in enhancing farmers' awareness of changing climate are short in supply in many developing countries and more so most often not adequately motivated to discharge their duties by governments of these countries (Ozor and Cynthia, 2010). Again, 62.2 % of the respondents reported high cost of labour as a limiting factor to adopting climate change adaptation strategies. The high cost of hired labour is occasioned by urban drift of able- bodied youths for 'white collar job', while the few ones that are left behind, charges high to keep afloat with the urban counter pacts (Ezeano *et al.*, 2017).

4. Conclusion and Recommendation

The result of the socioeconomic characteristics of rabbit farmers showed that most farmers were males, aged, had poor access to extension services, member of organization and well educated. Also, the adaptation coping strategies adopted by the farmers were use of shade, fan, cool drinking water, positioning of hitch, resistant breed of rabbit, heat resistant roofing material and good management practices. Furthermore, the level of education, rearing experience, aged, membership of organization and contact with extension services affected their adaptation of coping strategies for climate change in rabbit production. As well, rainfall, temperature, relative humidity and wind were the weather elements that effected rabbit production in the study area. Finally, the factors limiting farmers' adaptation coping strategies were poor access to credit, poor access to information, poor access to extension services and high cost of labour. Based on the findings, the following recommendations were proffered:

- Ensure farmers' access to credit access through micro finance, commercial banks and other lending institution, in order to take care of material inputs and labour costs in applying technologies related - adaptation scooping strategies to climate change.
- Information on climate change should be made available to the farmers at right time for rational decision making by the extension agents and metrological experts.
- Extension agents should be adequately motivated in order to be alive in their duty stations by adequately paying their salaries and allowances as when due.
- There is need to encourage the farmers to form cooperatives for easy mobilization and massive enlightenment campaign on agriculture related climate change issues by related government agencies.
- There is need to teach climate change adaptation and mitigation measures to farmers using the language the farmers can understand by appropriate government agencies and non- government organizations(NGO).
- Farmers should be exposed to climate change information and the best adaptation coping strategies options through adult education, seminars and workshops by experts in the subject area.
- The rabbits should be provided with shade, good drinking water, the hutch should be placed east ward to avoid draft, heat tolerant rabbit breed should be used by the farmers, good management practices should be inculcated into the farmers by extension agents in order to control heat stress in rabbit farms

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