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APPLICATION OF FRACTIONAL REGRESSION IN MODELING MAIZE FARMERS' ADOPTION OF CLIMATE SMART AGRICULTURAL PRACTICES IN KATSINA STATE, NIGERIA

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ABSTRACT

Nigeria's Maize production had been endangered and bedeviled by periodic droughts, torrents, storms and other extreme weather events, owning to climatic fluctuations. This occasioned in food insecurity and national economic hardship. This study sought to model the adoption of climate smart agricultural practices by the maize farmer in katsina state, Nigeria. Multi-stage sampling procedure was used for the study. Primary data were used to elicit information from maize farmers through pre-tested structured questionnaires. Socio economic characteristic reveals the mean age of the maize farmers to be 48 years. This indicates that maize farmers in the study area were dominated by young people who are active and fall within the productive age group. The mean household size of the respondents was 7. This signals that majority of the maize farmers in the study area had larger household sizes. Further descriptive analysis shows that 30.0 % of the maize farmers had secondary education, 22.0 % had tertiary education, 16.0 % had Arabic education, and 12.0 % had primary education, while only 20.0 % of them had no formal education. About 68.33 % of maize farmers had farming experience of 1 – 10 years, while only 10.0 % of them had 41 – 50 years of farming experience. Fractional regression model Analysis shows that marital status was negatively significant ($P < 0.01$).This connotes that the single farmers are less likely to adopt CSAPs practice than married farmers. It then means that a unit increase in adoption by an unmarried farmer will lead to reduction in the rate of adoption by 20.30 %. Membership of cooperatives was negatively significant ($P < 0.05$). It means that involvement of the maize farmers in cooperative will less likely influence the adoption of CSAPs. Therefore, a unit increase in cooperative fund will lead to a reduction in the adoption of CSAP s. The study concludes that CSAPs maize farmers' adoption in the study area cannot be predisposed absolutely by identified predictors. Youth enlightment program that can reorientate the single farmers is needed in the area. Cooperative loan should be utilized in a good way.

KEYWORDS: *Fractional-Regression, Maize-Farmer, Adoption, Climate-Smart-Agricultural*

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INTRODUCTION

Agricultural sector is a driver of Nigeria's economy. Therefore, desertion of the sector is tantamount to endangering the economic fortunes and political will of the future generation. Agricultural lands occupy about 40 to 50 % of the Earth's land surface (Ayanwale et al., 2013). Nigeria is blessed with massive agricultural land area, out of which less than 30 % is

used for agriculture. Williams (2014), estimated that agriculture is responsible for about three-quarters of tropical deforestation and accounts for about 10 to 12 % of the total global anthropogenic emissions of Green house gases (GHGs) in 2005 (Ayanwale et al., 2013).

Globally, the challenges of food shortage and malnutrition increase unabated in spite of networking efforts of the developed nations and partners to eradicate hunger yet, the world needs more food than ever before to sustain the explosive teaming population especially in sub-Saharan Africa. The last three decade in Nigeria, had witnessed a tremendous development and promotion of several initiatives aimed at promoting sustainable agriculture. Many of these have emphasized the need for Nigeria farmers to engage in an agricultural system that ensures food security whilst at the same time addressing and adapting to climate change. The menace of climate change in sub-Sahara African countries had contributed adversely to shortage of raw materials to agro-allied industries and sapped the foreign currency. This constitutes greatly to economic loses and threaten food security and income generation opportunities for the farming households that rely primarily on crop production both as mean of livelihood and feeding of the local industry

Maize production in Nigeria over the years had been in inadequate, threatened and bedeviled by recurring droughts, floods, storms and other extreme weather events, due to change in the climate. This scenario posed a great challenge to maize production and food security and consequently draws a setback to Nigeria Economy (Shideed and Mourid, 2005). Inadequate efforts had been made in the past by Nigeria's government to meet up the growing demand in nation's maize demand. To cope with the increasing demand in maize grain, good production techniques is needed to be employed. To this end urgent measure is needed to address this unpleasant situation and save the country from importation of maize with hard earned foreign exchange.

Modeling agricultural production showcases the scientific method of enhancing agricultural output through econometric model formulation and generates knowledge that allows researchers to solve complex problems or take informed agricultural decisions

This research work, therefore intend to model maize farmers' adoption of climate smart agricultural**,** identify farmers sources of information, determine the adoption level and determine the factor influencing the adoption of climate smart agricultural practices in the study area

MATERIAL AND METHODS

The Study Area

The study was carried out in Katsina state. The state covers an area of 23,938 square kilometer. Katsina state is located between latitudes 11°08′N and 13°22′N and longitudes 6°52′E and 9°20′E. The state is bounded by Niger Republic to the north, Jigawa and Kano states to the east, Kaduna state to the south and Zamfara state to the west. The state has 34 Local Government Areas. The state was divided into three agricultural zones namely: Funtua, Ajiwa and Dutsinma. Katsina State covers three agro-ecological zones: the Sahel, the Sudan and the Northern Guinea Savanna zones (Ogungbile et al., 1999). The rainfall pattern in the States is unimodal and ranges between 350 and 500 mm in the Sahel, 600 and 850 mm in the Sudan Savanna and between 900 and 1000 mm in the Northern Guinea Savanna (Ogungbile et al., 1999).

The onset of rains, which marks the beginning of the growing season, starts in May in the Northern Guinea and June in the Sudan agroecological zones (Elemo et al., 1990). Concurrently, the duration of the growing season spreads

from a range of 140 to 200 days in the Northern Guinea, 95 to 140 days in the Sudan to 68 to 102 days in the Sahel (Elemo et al., 1990).

The major crops grown in katsina are sorghum, millet, maize, rice, groundnut, cowpea, soybean and cotton. Pepper, onion and tomatoes are also grown. Though sole-cropped fields of crops occur, intercropping is the dominant practice. There is, however, always one crop dominant on any mixed-crop field (Ogungbile et al., 1999).. Livestock production is also an integral part of the farming system as both crops and animals are sources of food and cash income for farmers (Ogungbile et al., 1999). The livestock kept include cattle, goats, sheep, donkeys, horses, camels and poultry.

Sampling Procedures and Sampling Size

Multi-stage sampling technique was used to select the respondents for this study. The first stage, involved a purposive selection of Kafur local government. This was due to the high concentration of maize farmers in katsina state area. The second stage involved the random selection of five communities namely: Masari, Sabuwar kasa, Mahuta, Gozaki and kafur from thirty five communities. In the last stage, respondents from the listed communities were proportionately chosen using the technique of random sampling. Proportionate formula was used to determine number of respondents that was selected from each community;

$$n=(x/X)*N$$

Where;

n= number of respondents to be selected per village

x= number of maize farmers per village

X= total number of maize farmers in the selected villages

N= sample size for the study

Table 1: Sampling Frame and Sample Size

S. No	Name of Villages	Number of Maize Farmers	Number of Respondents Selected
1	Masari	37	25
2	Sabuwar kasa	30	20
3	Mahuta	28	19
4	Gozaki	27	18
5	kafur	27	18
Total		**149**	**100**

METHOD OF DATA ANALYSIS

Fractional Regression Models

Fractional Regression Models was used to model the adoption frequency of the climate Smart agricultural practices. Fractional response estimators fit models on continuous variables whose values ranges from zero to one. Using Probity, and Log it, as initiator. The model is specified implicitly as:

$$Y_i = \alpha + \beta_i X_i$$

Where Yi = Adoption response which takes continuous values from 0 to 1

α = Intercept

β_i = Parameter

X_i = Vector of explanatory variable

Explicitly, the model can be represented as:

$$Y_i = \alpha + \beta_i X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11}$$

X_1 = Age (years)

X_2= Gender (1 = male, 0 = female)

X_3 = House hold Size (number)

X_4 = Farming Experience (Years)

X_5 = Farm Size (Hectares)

X_6 = Monthly Income (Naira)

X_7 = Access to credit (1= Yes, No=0)

X_8 = Extension agent Contact (1= Yes, No=0)

X_9 = Membership of Cooperative (1= Yes, No=0)

X_{10} = Marital Status (Dummy = 1 if married; 0, if otherwise)

X_{11} = Educational Status (Dummy = 1 if educated; 0, if other

RESULTS AND DISCUSSION

Socio-Economic Characteristics

The results in Table 2 revealed that 24.0 % of the respondents were between 4150years of age, while the least age range71-80 years were just 7.0 % of the sampled population. The mean age of the respondents was 48years. This indicates that maize farmers in the study area were dominated by young people who are active and fall within the productive age group. The result agrees with the findings of Ojoko *et al.,* (2017), who reported that majority of the respondents (44.17 %) were between the ages of 46 to 60, which forms the active years of the farmers and therefore, they are strong enough to engage in agricultural practices.

Moreover, results in Table 2 showed that majority (91.0 %) of the respondents were males, while (8.0 %) were females. This implies that there were more male maize farmers in the study area. Majority (79.0 %) of the respondents were married, 12.0 % were single, while only 4.0 % of them were divorced. This results implied that majority of respondents were married. This finding is similar to that of Olaniyi and Ismaila (2016) who reported that majority (84 %) of the sampled maize farmers were males and married respectively.

With reference to household size, most (43.0 %) of the maize farmer's had household size between 610, while only (3.0 %) of them had household size between 2125. The mean household size of the respondents was 7. This indicate that majority of the maize farmers in the study area had larger household sizes. This finding is similar to that of Olaniyi and Ismaila (2016) who reported that majority of the maize farmers in Ondo State had a large household size.

More also, the results showed that 30.0 % of the maize farmers had secondary education, 22.0 % had tertiary education, 16.0 % had Arabic education, 12.0 % had primary education, while only 20.0 % of them had no formal education. About 68.33 % of maize farmers had farming experience of 110 years, while only 10.0 % of them had 4150 years of farming experience. The mean farming experience of the maize farmers was 21years implying that almost all the maize farmers in the study area had longer years of working experience and this gave them advantage of adopting climate smart agricultural practices. This finding agrees with that of Ojoko *et al.*, (2017), who reported that majority of the rural farmers in Sokoto State, had farming experience of 16 to 30 years.

As indicated on the table, most (38.0 %) of the maize farmers had farm size of 2 hectares, while only 5.0 % of them had farm size of 5 hectares. The mean farm size of the respondent was 2 hectares. This indicates that majority of the maize farmers in the study area were small scale farmers. The result from Table 1 showed that about 44 % of the maize farmers earned < 20,000, 33.0 % of them earned between 20,00040,000, 10.0 % of them earned between 40,00160,000, 4.0 % of them earned between 60,00180,000, 4.0 % of them earned between 80,001100,000 while only 5 % of them earned > 100,000. This indicate that the maize farmers in the study area were average income earners, hence they may possess the financial muscle required to purchase and practice smart agricultural practices. As showed in the Table 1, majority (87.0 %) of the respondents had no access to credit, while only 13.0 % of them had access to credit. This implies that majority of the maize farmers in the study area do not have access to credit. Majority (74.0 %) of the maize farmers do not have access to extension officer, while 26.0 % had access to extension officers. Also most 75.0 % of the maize farmers were not members of a cooperative societies, while only few (25.0 %) of them are members of the cooperatives societies.

Table 2: Distribution of Respondents According to Socio-economic Characteristics (n=100)

Characteristics	Frequency	Percentage	Mean
Age (Years)			
21 – 30	12	12.0	
31 – 40	22	22.0	48.79
41 – 50	24	24.0	
51 – 60	16	16.0	
61 – 70	26	26.0	
Sex			
Male	91	91.0	
Female	9	9.0	
Marital status			
Single	16	16.0	
Married	84	84.0	
Household Size (Persons)			
1 – 5	33	33.0	
6 – 10	43	43.0	7.88
11 – 15	17	17.0	
> 16	7	7.0	
Educational Level			
No formal education	20	20.0	
Arabic education	16	16.0	
Primary education	12	12.0	
Secondary education	30	30.0	
Tertiary education	22	22.0	
Farming Experience (Years)			
1 – 10	30	68.3	
11 – 20	25	12.5	
21 – 30	19	8.3	

31 – 40	26	10	20.89
Farm Size (ha)			
< 1	30	30.0	
1 – 3	56	56.0	
> 3	14	14.0	
Monthly Income (₦)			
< 20,000	44	44.0	
20,000 – 40,000	33	33.0	
40,001 – 60,000	10	10.0	32310.00
60,001 – 80,000	4	4.0	
80,001 – 100,000	4	4.0	
> 100,000	5	5.0	

Source: Field Survey, (2018)

Adoption of Climate Smart Agricultural Practices among Maize Farmers

Table 3 shows the result of percentage distributions of the respondents on their adoption of CSAPs. The result revealed that majority (98.0 %) of the respondents adopted the use of organic manure, (90.0 %) adopted crop rotation, (85.0 %) adopted mixed cropping, (82.0 %) adopted use of cover cropping, (63.0 %) adopted minimum tillage and (56.0 %) adopted use of drought and heat tolerant crop varieties. About (42.0 %) of them adopted irrigation, (37.0 %) adopted afforestation, (36.0 %) adopted use of wet land (Fadama), while only few (21.0 %) of them adopted mixed farming/strip cropping, (15.0 %) adopted mulching, (10.0 %) adopted water harvesting and (3.0 %) adopted agro-forestry. This implies that CSAPs adoption in the study area is widespread among the farmers.

Table 3: Distribution of the Respondents Base on their Adoption of CSAPS

Climate Smart Agricultural Practices	Frequency	Percentage (%)
Use of cover cropping	82	82.0
Minimum tillage	63	63.0
Mulching	15	15.0
Mixed farming	21	21.0
Mixed cropping	85	85.0
Crop rotation	90	90.0
Afforestation	37	37.0
Strip cropping	21	21.0
Use of drought and heat tolerant crop varieties	56	56.0
Use of organic manure	98	98.0
Water harvesting	10	10.0
Use of wet land (Fadama)	36	36.0
Irrigation	42	42.0
Agro-forestry	3	3.0

Source: Field Survey, (2018)

Factors that influence the Adoption of Climate Smart Agricultural Practices among the Maize Farmers

The result of the fractional regression analysis in Table 4 shows the factors that influence adoption of CSAPs by the maize farmers in Kafur Local Government Area Katsina State. From the table, two variables were significant; these are marital status and membership of cooperative.

Marital status was negatively significant ($P < 0.01$).This connotes that the single farmers are less likely to adopt CSAPs practice than married farmers. It then means that a unit increase in adoption by an unmarried farmer will lead to reduction in the rate of adoption by 20.30 %. The results corroborate the work of Ekpa *et al.*, (2017), who found out that married farmers were significantly higher in terms of the use of climate smart agriculture for maize enterprise than their counterparts.

The result also shows that membership of cooperatives was negatively significant (P<0.05). It means that involvement of the maize farmers in cooperative will less likely influence the adoption of CSAPs. Therefore, a unit increase in cooperative fund will lead to a reduction in the adoption of CSAPs. The result is contrary to the findings of Ojoko *et al.*, (2017), who reported that member of a social group influenced the use of CSAPs in Sokoto State, Nigeria.

Table 4: Factors that Influence the Maize Farmer's Adoption Using Fractional Response Model

Variables	Marginal Effect	Standard Error	Z-value	Probability
Age	-0.0569	0.0533	-1.07	0.285
Sex	0.0639	0.1099	0.58	0.561
House hold Size	0.0 934	0.0589	1.59	0.113
Farming Experience	-0.0387	0.1026	-0.38	0.706
Farm Size	-0.0084	0.3669	-0.23	0.819
Monthly Income	-0.0318	0.0368	-0.86	0.387
Access to credit	0.0236	0.0208	1.14	0.255
Extension agent Contact	-0.0261	0.1186	-0.22	0.826
Membership of Cooperative	-0.1362	-0.6784**	-2.01	0.045
Marital Status	-0.2030	0.0716***	-2.84	0.005
Educational Status	0.0063	0.0347	0.18	0.855
Constant	-0.0042	0.0559	-0.08	0.940
Log likelihood ratio=- 67.17479				
Degrees of freedom = 13				

Source: Field survey, 2018

= Significant at 10 %

= Significant at 5 %

= Significant at 1 %

CONCLUSIONS

The findings from this study show that majority of the respondents have adopted the use of organic manure, crop rotation, mixed cropping, use of cover cropping, minimum tillage and use of drought and heat tolerant crop varieties. Inferential statistics affirmed that membership of cooperative and marital status was factors that are statistically significant thus influencing the rate of adoption of CSAPs in the study area. Finally, CSAPs maize farmers' adoption in the study cannot be predisposed absolutely by identified predictors.

RECOMMENDATIONS

Based on the findings, discussions and conclusions Drawn from this study. It can therefore be recommended that the single farmers should be encouraged in use of climate smart agricultural practices so that they can be more dynamic in adoption process. Youth enlightment program that can reorientate the single farmers is needed in the study area. Cooperative loan should be utilized in a good way in the study area. Efficient and trained extension workers are also recommended in order to provide training and teaching in climate smart agricultural practices education for agricultural production.

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