
CROP FARMER INDIGENOUS KNOWLEDGE OF SOIL AND WATER CONSERVATION PRACTICES UNDER CLIMATE CHANGE IN SUDAN SAVANAH ZONE OF BORNO STATE, NIGERIA

BY

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ABSTRACT

The study examined crop farmer indigenous soil and water conservation practices under climate change in Sudan Savannah zone of Borno State, Nigeria. Structured interview schedules were administered to 128 respondents selected through random sampling technique. Data were analysed using descriptive (frequencies, percentages, mean scores and standard deviation) and inferential (logit regression analysis) statistics. The study revealed that majority of the farmers (57.8%) was male and economically active, had attained one form of formal education or other with reasonable years of crop farming experience. The soil and water conservation practices of the farmers had influence due to climate change were zero tillage and dry planting. The socio – economic factors which significantly affected the indigenous soil and water conservation measures under climate change were age and farming experience. The study uncovered the integration of indigenous and modern knowledge, through agricultural extension contact as important factors required for improved farm practices in soil and water conservation practices against climate change for better crop yields. The study recommended that there should be an improved integration of indigenous and modern soil and water conservation practices supported through adequate extension services in the study area.

Keywords: *Indigenous Knowledge, Conservation, Soil and Water, Climate change, Crop Farmers, Nigeria.*

INTRODUCTION

Background to the study

The term 'indigenous knowledge' is used to explain the traditional farmer practice developed by as opposed to the scientific knowledge that is generally referred to as 'modern' knowledge (Ajani, Mgbenka, and Okeke., 2013). It is cornerstone used for decision-making by rural farmers. Indigenous knowledge has value not only for the culture in which it evolves, but also for scientists and agricultural planners striving to improve conditions in farming communities (Sadiku and Sadiku, 2011). The knowledge set is influenced by the past generations' observations and experiments and provides an inherent connection to one's surroundings and environment. Therefore, indigenous knowledge is

transferable and provides relationships that connect people directly with the environments and the changes that occur due to climate change (James, Zibanani and Francis, 2008).

It is anticipated due to geographical location of Nigeria that climate variability and change in Nigeria will have overwhelming effects on agriculture, land use, ecosystem biodiversity, human settlements, diseases and health and water resources. Agriculture and land use, climate change could elicit a significant change in crop production both in terms of the quantum of products as well as the location or area of production. This is because when change is expected to lead, among other things it should follow a shift in rainfall belts. Since agriculture is largely rain-fed in

Nigeria, this will be accompanied by a shift in the traditional areas of production of certain crops with all the possible negative consequences that this may bring to the rural people (Achiando, Birech and Ochola, 2013).

Farmers have developed varied practices/measures that led to reduce vulnerability to the effect of climate variability and extremes. One important step in reducing this vulnerability of a climatic change was that development of an early warning system for the prediction of the event (James *et al.*, 2008). There is a lot of local knowledge based for predicting weather and climate. A study of weather knowledge in various parts of the sub-Saharan Africa reveals the wealth of knowledge that farmers possess. These farmers have developed intricate systems of gathering, prediction, interpretation and decision-making in relation to weather. These systems of climate forecasts have been very helpful to the farmers in managing their vulnerability to a very great extent (Ibrahim, Mohammed and Marte, 1999). Farmers are known to make decisions on cropping patterns based on local predictions of climate and decisions on planting dates based on complex cultural models of weather.

Some attempts have been made to study climate change adaptation by farmers in Nigeria (Apata, Samuel, Adeola, 2009). However, such studies failed to indicate the socio - economic factors which dictate adoption of soil and water conservation strategies against the impact of climate change by food crop farmers in Sudan savannah agro - ecological zone of Borno State, Nigeria. The study, therefore, focused on adoption of indigenous knowledge of soil and water conservation as a strategy for climate change adaptation among food crop farmers in the Sudan savannah agro - ecological zone of Borno State, Nigeria.

Objectives of the study

The main objective of the study was to examine factors influencing the soil and water

conservation practices against the effect of climate change among the farmers in the study area. The specific objectives were to:

- (i) describe the socio - economic characteristics of the farmers;
- (ii) investigate the soil and water conservation practices through extension education that the farmers used as mitigation due to climate change;
- (iii) analyse the socio - economic factors influencing the adoption of indigenous soil and water conservation practice by farmers due to climate change; and
- (iv) assess the factors required for improved soil and water conservation practices as a remedy to effect of climate change by respondents.

METHODOLOGY

The Study Area

The study was carried in Sudan Savannah Zone of Borno State, Nigeria. Borno State is located in the extreme north-east corner of Nigeria. The state has a land area of about 73,273km² and roughly lies between latitudes 11° 09' and 11° 45' North of the equator and longitudes 09° 10' and 14° 20' East of the Greenwich Meridian (Daura, 2001; BOSADP, 2003). The state shares international borders with Niger Republic in the north; Chad Republic in the North - east, and Cameroon Republic in the east. Within the country, Borno state shares borders with Adamawa state to the south, Yobe state to the west and Gombe state to the south - west. Nigeria's National Population Census (NPC, 2006) gave the population of Borno state to be 4,151,193 with an annual growth rate of about 3.4 percent.

Joshua and Teli (2007) reported that the study area is made up of 14 Local Government Areas (LGAs). Borno state has a hot climate for most part of the year especially in the Northern part of the state, while the Southern part is slightly milder in climatic

temperature. The rainy period varies from the extreme North to the Southern part of the state with the former having about 250mm per annum, while the later records about 1000mm per annum (Daura, 2001).

The Sudan Savannah Agro – ecological Zone is found between the Sahel savannah and the Guinea savannah in Borno state. The zone consists of Sahel affinity mixed with broad leaved species of Guinea affinity. There is a more or less continuous grass cover, grasses being short and feathery, contrasting with the tall grasses of the Guinea savannah (Maryah, 2004).

Agriculture is the main stay of the economy of Sudan Savannah Zone of Borno state. The major crops cultivated include: millet, sorghum, groundnut, maize, cowpea and vegetables (onion, pepper, tomatoes). Gum Arabic production is also one of the major farming activities in the area. The major livestock reared in the area are cattle, sheep, goats and poultry.

Sampling Procedure and sample size

Primary data was mainly used for the study. These were generated from heads of farming households through the use of structured and pre-tested interview schedules. The interview schedules were administered as a result of the assumed low level of literacy of the respondents. These were administered by enumerators who were trained for this purpose under the supervision of the researcher. Secondary information from Area Extension Officers (AEOs) of BOSADP was used to complement the primary data. Other sources of secondary information include: research reports, the internet, government publications, textbooks, journal publications and other write-up that are relevant to this study.

Multi - stage sampling techniques was used to select the respondents for this study. Sudan savannah agro – ecological Zone of Borno state comprises of 14 LGAs. At the first stage, random selection of four LGAs was made. At the second stage, three villages were randomly selected from each of

the selected LGAs making a total of 12 villages sampled. At the third stage, 11 food crop farmers were purposively selected from each of the villages selected. Therefore, a total of 132 food crop farmers served as the total sample size for this study, however only 128 were used for analysis, as a result of the fact that the remaining four interview schedules were not properly completed. The list of the villages was obtained from the LGAs that served as the sampling frame for this study.

Analytical Techniques

Both descriptive and inferential statistics were used to analyze the data for this study. These were used to achieve the specific objectives of the study. Descriptive techniques such as frequency distribution and percentages scale were used to categorize and summarize the data with respect to achieve specific objectives (i), (ii) and (iv). The inferential statistical technique that was used in this study was logistic regression analysis. The SPSS software was used to estimate the logistic regression analysis.

The Logistic Regression Analysis

Logit model is one of the most commonly used models in agricultural technology transfer research. It has been employed in climate change studies because of the conceptual similarities with agricultural technology adoption studies (Hassan and Nhemachena, 2008). The logit model can be used to analyse crop (Kurukulasuriya and Mendelsohn, 2006) choices as measure to adapt to the effect of climate change. The logit model considers the relationship between a dependent variable and a set of independent variables whether binary or continuous. The choice of explanatory variables to be used in this study is guided by empirical literature and theoretically hypothesized relationship with dependent variables. The proposed explanatory variables considered as potential factors affecting food crop farmers' decisions to adopt soil

and water conservation strategies in this study is presented in equation (ii).

The data on the dependent variable (soil and water conservation) is bivariate, that is, used soil/water conservation or otherwise. Therefore, the Binary Logit (BNL) model was therefore, employed due to the nature of the decision variable. For such a dichotomous outcome, the BNL model was the most appropriate analytical tool (Benedicta, Paul and Ahmad, 2010; Jinxia *et al.*, 2009; Apata *et al.*, 2009). The implicit form of the model was expressed as:

$$Y_i = \alpha_0 + \sum_{i=1}^n \beta_i X_i + e \text{ -----}$$

(i)

Where;

Y_i = Dependent variable (i.e. the binary variable; $Y_i = 1$ for a household that used soil/water conservation practices and $Y_i = 0$ for otherwise.

- α_0 = Intercept
- β_i = Parameters to be estimated
- X_i = Explanatory variables
- $i = 1, 2, 3, \dots, n$ number of explanatory variables
- e = Error term

This model was used to achieve objective three (iii). The BNL model was explicitly expressed as:

$$Y_i = \alpha_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + e \text{ -----}$$

(ii)

Y_i = Dependent variable (i.e. the binary variable, $Y_i = 1$ for a household that practice soil/water conservation practices and $Y_i = 0$ for otherwise. In this study, five separate equations were run to model the effects of factors on soil/water conservation practice in the study area. The soil/water conservation practices considered were:

1. Drought-tolerant varieties
2. Zero tillage technique
3. Crop rotation
4. Mixed cropping
5. Dry planting

Y_i = Dependent variable (i.e. the binary variable; $Y_i = 1$ for a household that practices soil/water conservation and $Y_i = 0$ for otherwise.

- α_0 = Intercept
- $\beta_1 - \beta_n$ = Parameters to be estimated
- $X_1 - X_n$ = Explanatory variables
- e = Error term

The proposed independent variables specified as factors in this study were defined as follows:

- X_1 = Age of food crop farmer (years)
- X_2 = Sex of food crop farmer; Dummy (D) = 1 if male; 0 if female
- X_3 = Marital status of food crop farmer; Dummy (D) = 1 if married, 0 if single
- X_4 = Household size (number)
- X_5 = Formal education (years)
- X_6 = Farming experience (years)
- X_7 = Farm size (hectares)
- X_8 = Farmland ownership; Dummy (D) = 1 if owned; 0 if otherwise
- X_9 = Membership in farmer organization; Dummy (D) = 1 if yes, 0 if otherwise
- X_{10} = Access to agricultural credit; Dummy (D) = 1 if yes, 0 if otherwise
- X_{11} = Extension contact (Number of contacts per season)

RESULTS AND DISCUSSION

Socio-economic characteristics of the crop farmers

The socio-economic characteristics of the farmers were examined with respect to their gender, marital status, age, farm size, household size and level of education as presented in Table I. The results show that majority (62.20%) were male, while female constitutes only 37.80% of the respondents. This implies that gender was an important factor in agriculture, because of its vital role in determining farming activities in the study area. In addition, 68.90% of the respondents were married and were in their economically active and productive age (30-49 years) representing 71.10% in the study area.

Table 1: Distribution of respondents by socio-economic characteristics (n = 128)

Socio-economic variable	Frequency (No.)	Percentage (%)
Sex		
Male	112	62.20
Female	32	37.80
Age (years)		
30 and below	22	12.20
30-39	52	28.80
40-49	76	42.30
50 and above	30	16.70
Marital Status		
Married	124	68.09
Single	46	25.06
Widow	10	5.50
Farm size (hectares)		
Below 1	104	57.80
1-2	68	37.80
Above 2	8	4.40
Educational status		
Primary education	44	34.00
WAEC/SSCE/TC	16	35.00
Tertiary education	34	10.00
Adult education	24	13.30
None	64	35.50
Household size (number)		
Less than 5	74	41.10
5-9	76	42.20
10-15	24	13.30
16-20	4	2.20
Above 20	2	1.00

Source: field survey, 2012

The results presented in Table 1 also shows 57.80% of the respondents cultivated less than one hectare of farmland, while 37.80% cultivated between 1 and 2 ha of farmland and only 4.40% cultivated above 2 ha of farmland. The result further shows that most (24.20%) of the respondents had household size of 5-9 members. The implication could be that provision of farm labour could not be a problem among the respondents. On the level of education, the result shows that most (35.00%) of the respondents had WAEC/SSCE/TC. This implies that the respondents could apprehend the improved technologies being

disseminated to them. The findings was not in agreement with that of Apata et al. (2010) who asserts that most of the Nigerian farmers have no formal education.

Soil/water conservation practices used by farmer

Soil and water conservation strategies adopted by the respondents was presented in Table 2. The results showed that mixed cropping (96.87%) and drought – tolerant varieties (68.75%) were the most importantly used soil/water conservation strategies against the impact of climate change in the study area. The mixed cropping as the most importantly used

could not come as a surprise. This could be as a result of the respondents experience coupled with the economic advantage associated with mixed cropping. The study also revealed that crop rotation was the least used soil/water conservation practices as remedy to climate change by respondents. This could be explained by the fact that most of the respondents either do not have personal access to farmland

ownership or could not have enough landmass that could accommodate the needs of crop rotation. It could be implied that despite the problem of access to farmland for crop rotation, the respondents tried to use all the remaining farm practices identified by the study in responding to the effect of climate change. This might augur well for improved agricultural productivity.

Table 2: Distribution of farmers based on Soil/water conservation practices used (n = 128)

Soil/water conservation practices	Frequency	percentage
Drought-tolerant varieties	88	68.75
Zero tillage technique	86	67.19
Crop rotation	38	29.69
Mixed- cropping	124	96.87
Dry planting	64	50.00

Source: Field survey, 2012

Socio – economic factors influencing adoption of soil/water conservation practices used by farmers

To identify factors which affect the likelihood of indigenous soil and water conservation practices against climate change among the farmers were estimated using the logit model. To achieve this objective, five separate equations were run to model the effect of factors on soil/water conservation practices against climate change among the farmers. The maximum likelihood estimates of the binary logit model are presented in Tables 3,4, 5,6 and 7 with respect to the following variables: drought-tolerant varieties, zero tillage techniques, crop rotation, mixed

cropping and dry planting respectively as significant coefficients.

Socio – economic factors influencing use of drought - tolerant varieties

Table 3 showed that all the identified variables were positive and significant at 1% level with the exception of farmland ownership which was significant at 5% level. This implies that an increase in one of the variables studied could have an increase in adoption of drought-tolerant varieties by the respondents, which consequently increases their adaptive capacity to climate change and hence their living standards.

Table 3: Logistic regression of socio-economic factors influencing drought-tolerant varieties among farmers

Factors		Std error	Significance	(Exp)
Years of schooling	0.114	0.032	0.001	1.118
Cooperative membership	2.382	0.477	0.000	0.072
Farmland ownership	0.124	0.076	0.004	0.645
Access to credit	0.119	0.044	0.000	1.000
Household size	0.138	0.035	0.000	0.076

Source: Field survey, 2012

Socio – economic factors influencing adoption of zero – tillage technique

Results in Table 4 indicated that all the variables considered were positive and significant at 1% in influencing adoption of zero – tillage technique.

The implication could be that as any of the variable studied increases in unit, there was the tendency for increase in the unit of zero – tillage techniques by respondents. This might enhance their productivity and hence their standard of living.

Table 4: logistic regression of socio – economic factors affecting zero – tillage technique among farmers

Factors		Std error	Significance	(Exp)
Extension contact	0.373	0.060	0.000	1.220
Years of schooling	0.119	0.044	0.000	1.000
Cooperative membership	2.817	0.665	0.000	0.060

Source: Field survey, 2012

Socio – economic factors influencing farmers' use of crop rotation

The result of the influence of socio-economic factors on the crop rotation is presented in Table 5. The result showed that all the variables included in the model were positive and significant.

This implies that an increase in a unit of any of the variables could have a likelihood of increase the use of crop rotation by farmers which in turn lead to increase in their level of productivity, income and livelihoods.

Table 5: logistic regression of socio – economic factors influencing crop rotation practices

Factors		Std error	Significance	(Exp)
Extension contact	0.126	0.045	0.033	1.106
Family size	0.138	0.035	0.000	0.076
Access to credit	0.201	0.060	0.010	0.030

Source: Field survey, 2012

Socio – economic factors influencing use of mixed cropping among the farmers

Results in Table 6 showed the effects of socio-economic factors on mixed cropping in the study area. The results indicated significant and of farm size which was at 5% level. This implies that an increase in

any one of the variable could increase the likelihood of using of mixed cropping among the farmers. This might not be unexpected due to the fact that the first point of response to climate changes by crop farmers could be the mixed cropping, which possibly increases their productivity and income.

Table 6: logistic regression of socio – economic factors influencing the use of mixed cropping technique among farmers

Factors		Std. error	Significance	(Exp.)
Off farm income	0.000	0.000	0.006	1.000
Age	0.042	0.016	0.009	1.043
Farming experience	0.042	0.023	0.006	4.573
Farm size	0.172	0.080	0.032	0.958
Cooperative membership	1.520	0.488	0.002	1.188

Source: Field survey, 2012

Socio – economic factors influencing use of dry planting among farmers

Socio-economic factors that influenced the use of dry planting are presented in Table 7. The results revealed that farming experience and age were positive and significant at 1% level, while farm size was positively significant at 5% level. Thus, all the

variables considered were positive and significant, indicating that an increase in any one could have an increase on the likelihood of using dry planting method among the farmers. This could be to utilize the available water within the root zone of the soil, which might increase their productivity in the area.

Table 7: logistic regression of socio – economic factors influencing use of dry planting technique among farmers

Factors		Std error	Significance	(Exp)
Farming experience	0.054	0.023	0.019	1.000
Farm size	0.123	0.071	0.030	1.055
Age	0.066	0.015	0.000	1.131

Source: Field survey, 2012

Factors required for sustainable use of soil and water conservation measures

The results presented in Table factors that were required for sustainable use of soil and water conservation measures against the effect of climate change in the study area. The result indicated that the most important factor to be considered in the use of soil/water conservation measures was credit

facilities (76.56%). This was followed by improved extension services (69.53%) as identified by the farmers. The implication could be that the farmers were operating in small scale and need credit facilities and improved extension services to enhance their productivity and income in the changing climatic conditions.

Table 8: Distribution of respondents by factors required for sustainable use of soil and water conservation measures against climate change (n = 128)

Factors	Frequency	Percentage
Integration of indigenous and modern knowledge	52	40.63
Improved extension services	89	69.53
Credit facilities	98	76.56
Climate information	68	53.13

Source: Field survey, 2012

CONCLUSION AND RECOMMENDATIONS

The study revealed that indigenous knowledge practices have been employed under climate change to reduce its effect among crop farmers in the study area. However, the study noted that not all indigenous practices are sustainable; and not all indigenous knowledge can provide the right

solution for a given farm problem. Therefore, before using indigenous knowledge, integrating it into development programs or disseminating it, practices need to be scrutinized for their appropriateness just as any other technology. Incorporating indigenous knowledge into climate change policies can lead to the development of effective farm practices that can lead

to improve sustainable soil and water conservation. There is the need therefore to integrate this local knowledge into agricultural policies. Institutional support is also needed through agricultural extension in the form of information on cropping patterns; credit; crop insurance and government subsidized inputs.

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