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Farming Practices and Desertification in the Sudan-Sahel Region: A Case Study of Zamfara State, Nigeria

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Abstract
Desertification in the Sudan Sahel has, repeatedly, been reported to be a serious environmental condition afflicting the peoples of the region. Farming has also, repeatedly, been fingered among the causal agents. Incidentally, farming is the main stay of the people. The encroaching desertification has severely affected their livelihood with calls been made for a review of their farming practices. But empirical evidence is required to conclusively establish that the desertification expansion which has resulted in poor farm results, hunger, poverty and death was indeed brought about by farm practices in place. Therefore, to ameliorate the sufferings of the people, it is necessary to, empirically, determine to what extent farming practices contributed to desertification and what could be done about it. Zamfara state, which shares the same environmental, religious and, to a large extent cultural characteristics, was randomly picked from among Nigeria's eleven front line states for the study. Applying Taro Yamen's formula, 500 farmers on whom were administered structured questionnaire, were selected for the exercise. Using SPSS, regression analyses were applied to test the hypothesis: "there is no significant relationship between desertification and farming practices in the area." At $p = 0.046$, the regression analysis revealed that farming practices have significant effect on the desertification process. We, therefore, concluded that farming practices aggravated desertification. To reverse the situation, recommendations were made.
Keywords: Desertification, Climate Change, Farm Practices, Sudan Sahel, Nigeria, Zamfara State
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1. Introduction

Climate Change is a global phenomenon whose impacts are seen in the deleterious changes in drought, desertification, sea and ocean levels, flooding etc. Man, in his many activities, has aided and/or exacerbated these effects. For instance, as population increases and the need to achieve food security heightens, man tills and "grazes" the land resources beyond their carrying capacities to meet his sustenance (Briassoulis, 2019). Increased exploitation of marginal lands, informed by reduced available "productive" land, seem to have further increased the occurrence of land degradation, Kenga *et al* (2003), Fasona and Omojola (2005), Brahic, (2007), Liehr et al (2016) and Tella, (2016). It has also been suggested that the methods employed in farming such as bush clearing/ burning, weeding, herding and irrigation all add to land degradation that could yield to desertification (Jew et al, 2017, Olagunju, 2015, Afroz Alam, 2014 and Daniel Callo-Concha et al, 2013).

Soil degradation sets off a chain of events each of which has grievous impacts on man's livelihood. It starts with the dryness of the soil which is occasioned by a drastically reduced soil moisture which, in turn, results in a drastically reduced farm yield, enhanced food insecurity, hunger, death and a totally dislocated community (Nerendra et al 2017 and Leif and McDonnel, 2020). Oldeman *et al*, (1990) suggested that over 70% of land degradation in Africa was brought about by man and animal activities.

The interconnections of these activities are depicted in the desertification - farming cycle shown in figure 1, below.

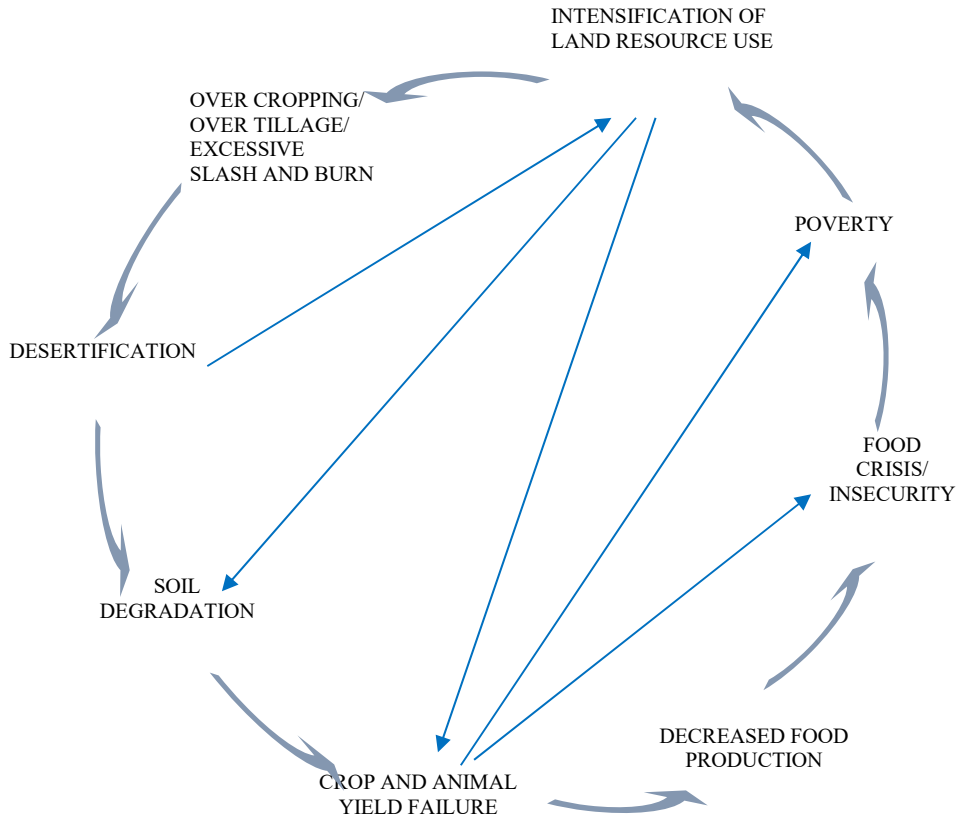

Fig 1: The Desertification-Farming Cycle

The figure demonstrates how intensification of land use could lead to soil degradation which in turn leads to crop and animal failure and then to decreased food supply. It is this decreased food supply that instigates food crisis/insecurity, hunger and then aggravated multidimensional poverty. Regrettably, it is this state of affair that forces the farmer to intensify the land resource use by overgrazing, over copping etc resulting in the exposure of the soil to adverse weather conditions that eventually result in desertification/soil degradation.

The above scenario tends to conclude that farm practices do aggravate land degradation that culminate in desertification. This study, therefore sought to, empirically, examine this hypothesis so that sustainable farm practices could be encouraged and entrenched in the Sudan Sahel Region as a way to minimize the incidence of land degradation.

The United Nation has defined desertification as a process of land degradation in arid, semi-arid and dry sub-humid areas caused by changes in climatic factors as well as human and animal activities (UNCCD, 2004). The Sahara Desert covers parts of the Middle East, North, East and West Africa while the Sudan Sahel Region is that column lying in the middle of Africa and extending from the fringes of the Sahara Desert and covering all that area from the Atlantic Ocean in the West to the Red Sea in the East and dipping, southwards, into the Guinea Savanah. It traverses twenty-two (22) countries in the southern part of some north African countries, central African countries and northern parts of some west and east African countries. The countries that are totally or partly immersed in the Sudan Sahel are: Mauritania, Guinea, Gambia, Senegal, Guinea Bissau, Sierra Leone, Cote D'Ivoire, Burkina Faso, Mali, Ghana, Togo, Benin, Niger, Nigeria, Cameroon, Central African Republic, South Sudan, Sudan, Eritrea, Ethiopia, Uganda and Democratic republic of Congo. The area is estimated to cover more than 100m ha and is home to over 100 million people who are, traditionally, agrarian.

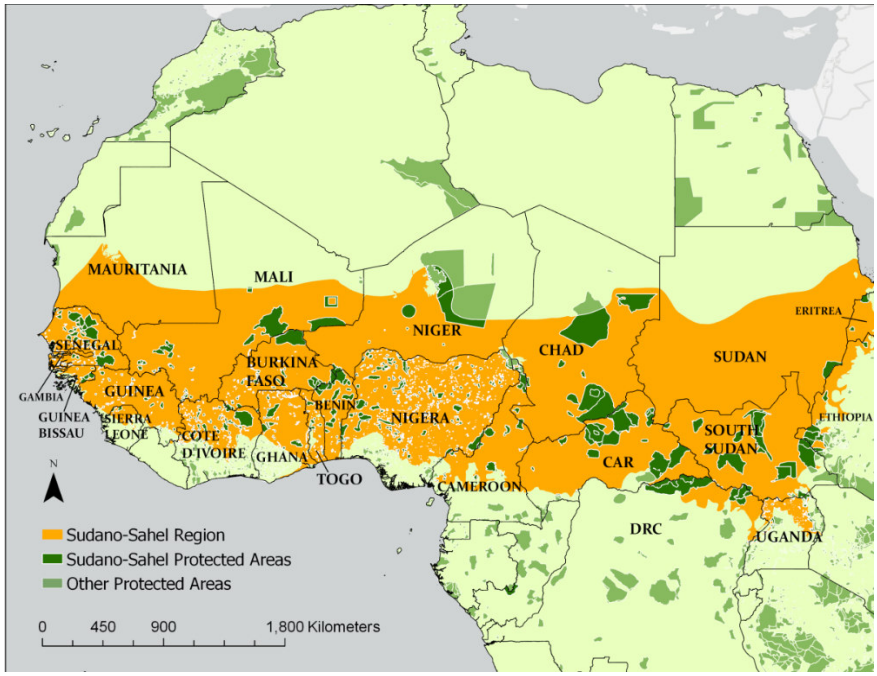

Fig 2: Map showing the Sudan Sahel

Source: Brottem, Leif and Andrew McDonnell (2020). Pastoralism and Conflict in the Sudan Sahel: A Review of the Literature, 1st ed Washington DC: Search for Common Ground

Farming in the Sudan Sahara area is largely traditional with local tools (Ezeh, 2016). Few commercial farms exist where modern equipment was deployed. Otherwise, land clearing is by slash and burn and tillage by hand hoes. Crops grown here are mainly grains such as millet, sorghum, maize and rice. Farming system in vogue is shifting cultivation. Animal herders are itinerant and move their animals from one place to another as dictated and attracted by the availability grazeable grasses. It is also suggested that the resulting soil degradation is the major factor underlying poor agricultural productivity (Zingore et al 2017). This will be on the increase as we witness the effects of climate change spiking.

Some northern parts of Nigeria are embedded in the Sudan Sahel. In fact, eleven of the nineteen northern states are within the perimeters of the Sudan Sahel. The eleven states are: Adamawa, Bauchi, Borno, Gombe, Jigawa, Kano, Katsina, Kebbi, Sokoto, Yobe and Zamfara. They share the same environmental, cultural and cultural experiences as other countries within the region.

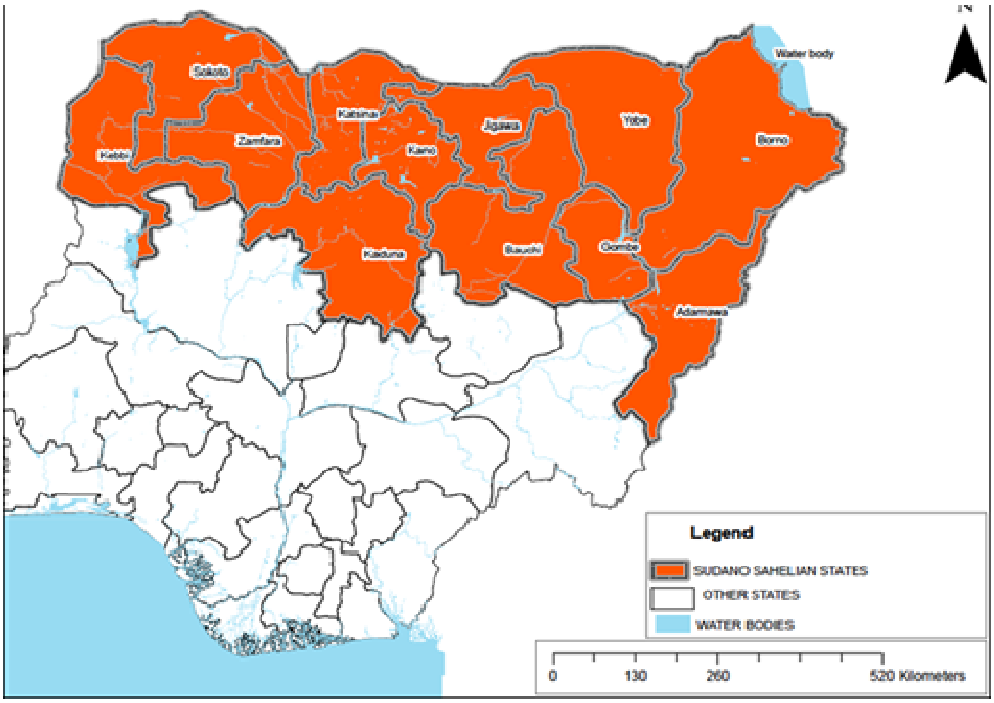

Fig 3: MAP OF NIGERIA SHOWING THE ELEVEN FRONT LINE STATES INCLUDING ZAMFARA STATE

With the exception of Kaduna state, the rest eleven are designated frontline states (by Nigeria's Federal Ministry of Environment) in recognition of the extent of Sahara Desert encroachment in those states. It is from among these eleven front line states that Zamfara State was randomly picked for the study.

Zamfara state is in the North Western zone of Nigeria. It is located between latitude $12^0$10'N longitude and $6^0$15'E. It is bounded by Katsina state to the east, Niger Republic to the North, Sokoto and Kebbi states to the west and Niger and Kaduna States to the south.

It has two major seasons. There is the rainy season that spans from June to October and the dry season, with whirlwind, which lasts from November to May. Its vegetation is a hybrid of Sudan Savannah and Northern Guinea Savannah. It has a temperature that could be as high as 38^0C (100.4^0F) between March and May (cometonigeria.com).

The economy of Zamfara state is largely agrarian with over 80% of its population involved in agriculture. The major crops produced include millet, guinea corn, maize, rice, groundnuts, cotton, tobacco and beans. Other agricultural products produced are cattle, goats, sheep, poultry, fish (aquaculture) etc. There are other economic activities found in the area. These include commerce, textile, industrial outfits and mineral mining.

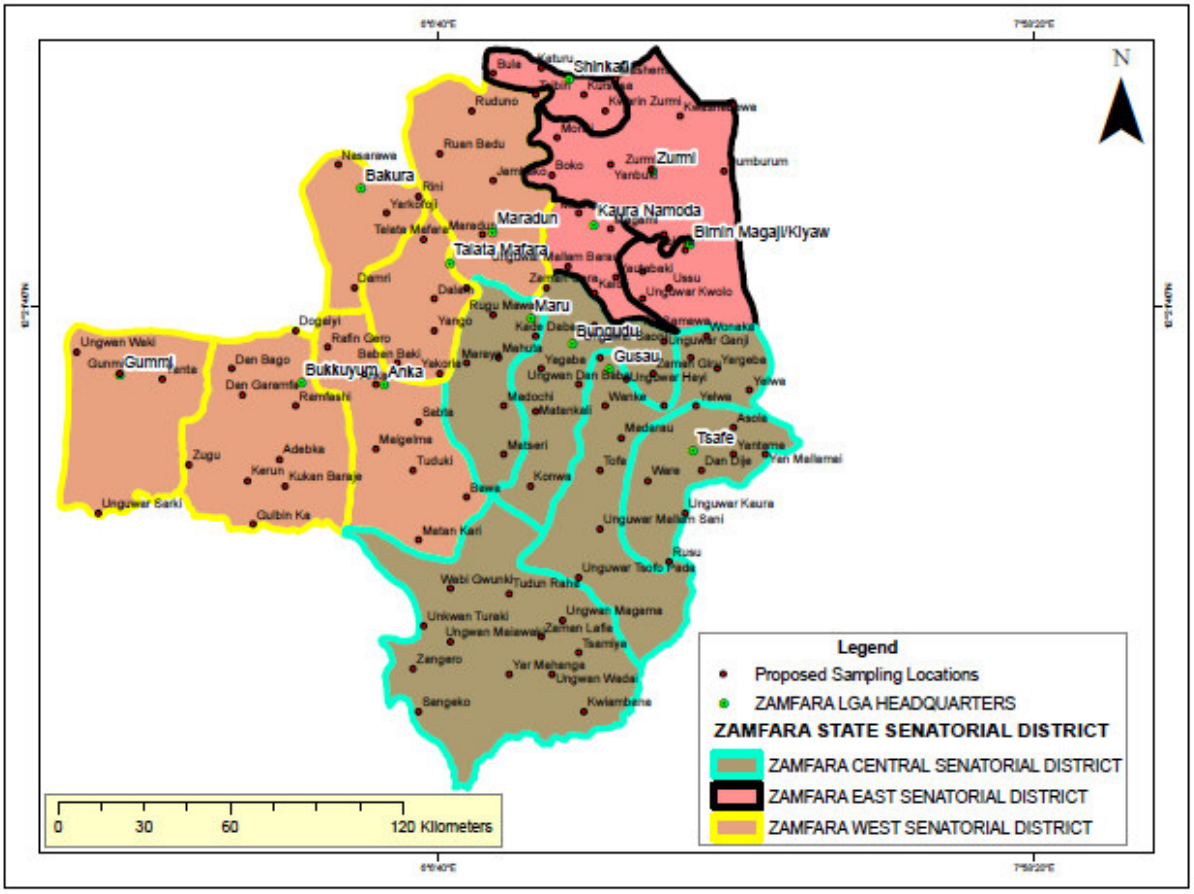

FIG 4: POLITICAL MAP OF ZAMFARA STATE

There are 14 local government areas (grouped into three senatorial districts) in the state and all were involved in the study.

2. Materials and Methods

The hypothesis under examination was: "there is no significant relationship between desertification and farming practices in the area". ` Zamfara State of Nigeria served as the study area. The population for the study comprises all registered farmers in the State. Since almost every farmer is registered with the state ministry of agriculture, for the purposes of farm input distribution, the number of each category of farmers in each local government area was easily retrieved from the ministry of agriculture. There are forty thousand, six hundred and forty-eight (40,648) registered farmers in Zamfara state, as at 2016. Out of this number, 4006 or 10% represented the large-scale farmers.

Taro Yamen's formula was applied to determine the sample size for the study thus:

$$n = N/1+e^2$$

Where n = sample size

N = population size

e = maximum acceptable margin of error (usually 0.05)

1 = a theoretical constant.

With Taro Yamen's formula, three hundred and ninety-six (396) was obtained as sample size. This was increased to five hundred (500) to reduce the standard error. This was distributed to Local Government Areas in proportion to the number of registered farmers each had using the stratified sampling technique.

Therefore, since 500 represent 1.2% of 40648, 1.2% of total registered farmers in each local government area was selected for the exercise. Given that the number of large-scale farmers is 10% of the registered farmers, applying the stratified sampling technique, the constitution of respondents per Local Government Area is hence 10% large-scale farmers and 90% small-scale farmers. This ensures proper balancing thus avoiding biased sampling towards either the large or small-scale farmers. Simply, this ensured proper representation of the different categories of farmers.

It is on the selected respondents that the structured questionnaire was administered.

The instrument was designed to measure the respondents' compliance level with acceptable/standard farming practices. Part of the instrument was also designed to determine the impact of desertification as perceived by the respondent.

Before the questionnaire was administered to the selected respondents, it was subjected to validation and reliability tests and it passed. A total of fourteen assistants were drawn from among the extension agents in the state, aided in the administration of the questionnaire. These are grounded in the local language and, in some cases, well known to the respondents.

Data collected from the survey were analyzed using Statistical Package for Social Scientists (SPSS). Regression Analyses were used to test the stated hypothesis of the study. The regression equation used was of the nature:

$Y = a + b_1x_1 + b_2x_2 + \ldots + b_nx_n$

Where Y = Dependent variable (Desertification impact)
a = regression constant (the intercept).
b = regression coefficient.
x = Independent variables.

3. Results and Discussion

Out of the five hundred respondents selected for this exercise, four hundred and ninety-seven responded**.** This is shown in the table below:

TABLE 1: DISTRIBUTION OF RESPONDENTS BY LOCAL GOVERNMENT AREAS (LGAs)

LOCAL GOVERNMT AREA (LGA)	LARGE-SCALE FARMERS SAMPLE		SMALL-SCALE FARMERS SAMPLE		TOTAL SAMPLE		TOTAL FARMER POPULATION
	GIVEN	RETURNED	GIVEN	RETURNED	GIVEN	RETURNED	
ANKA	1	1	13	13	14	14	997
BAKURA	3	3	26	26	29	29	2338
B/MAGAJI	4	4	33	32	37	36	3156
BUKKUYUM	4	4	38	38	42	42	3472
BUNGUDUN	6	6	59	58	65	64	5387
GUMMI	4	4	32	32	36	36	2939
GUSAU	6	5	50	50	56	55	4656
K/NAMODA	4	4	35	35	39	39	3195
MARADUN	2	2	18	18	20	20	1495
MARU	4	4	40	40	44	44	3644
SHINKAFI	1	1	12	12	13	13	900
T/MAFARA	3	3	27	27	30	30	2390
TSAFE	6	6	50	50	56	56	4658
ZURMI	2	2	17	17	19	19	1441
TOTAL	50	49	450	448	500	497	40648

Source: Ezeh F. I. C. (2016) Anthropogenic Factors, Desertification and Environmentally Area Sensitive Indices for Sudan Sahel: A Case Study of Zamfara State, Nigeria. Unpublished PhD Thesis. Centre for Environment and Science Education. Lagos State University, Ojo, Lagos

Test of Hypothesis

The study sets out to examine the hypothesis that there is no significant relationship between desertification and farm practices in the Sudan Sahel Area. To do this, we deployed the Regression Analyses.

But we first confirmed the adequacy of the variation in the model using the analysis of variance (ANOVA) (table 2)

Table 2: ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	356.300	1	356.300	3.992	.046[a]
	Residual	44183.213	495	89.259		
	Total	44539.513	496			

a. Predictors: (Constant), FARMPRACT

b. Dependent Variable: DESERTIFICATION

At F (1,495) = 3.992; p = 0.046, the ANOVA shows that the model is adequate since p is less than 0.05. The

effect of the independent variable (Farming practices) on the dependent variable (Desertification) is shown by the regression analysis in table 3.

Table 3: Regression Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1 (Constant)	62.020	3.671		16.893	.000	54.806	69.233					
FARMPRACT	.133	.067	.089	1.998	.046	.002	.264	.089	.089	.089	1.000	1.000

a. Dependent Variable: DESERTIFICATION

At p = 0.046, the regression analysis revealed that farming practices have significant effect on desertification process and we therefore do not accept the hypothesis that states that there no significant relationship between desertification and farming practices. The resulting regression model therefore is given as:

Desertification = 62.02 + 0.133 Farm Practices.

Put in another way, the model implies that a unit increase in the current farm practice would increase desertification by 13.3%

4. Conclusion/Recommendations

The world population is increasing and so is the population of the Sudan Sahel region. The Climate Change has a deleterious effect in the region. Desertification has greatly dislocated livelihood in the area by destabilizing agriculture which is their mainstay. Their traditional method of doing this business has helped in aggravating the situation. The study, primarily, sets out to establish, empirically, how farming practices contribute to the desertification process. The result showed, empirically, that given the extant land use method, farming practices are drivers of the desertification process.

The implication of the findings is that the methods adopted by farmers have led to outcomes such as overgrazing, over cultivation and uncontrolled irrigation which either contributed to or instigated other soil degrading factors that laid the grounds for desert encroachment. Unfortunately, these results from the additional compelling need to meet the food requirement of the increasing population of the area. To address the issues arising from farming practices in the desertification process, the following are recommended:

a) It is very unlikely that all of the farm practices engender land degradation in the area. There are some that may, indeed, enhance conservation. It may therefore not be proper to make a general conclusion that all farm practices degrade the soil and eventually lead to desertification. Consequently, it will be necessary to disaggregate farm practices with a view to identify which practices are injurious to the soil. A separate study, therefore, will be required to identify the practices that drive desertification in the area.
b) Once the specific practices/activities that aggravate land degradation are identified, demonstration farms where land conservation practices are demonstrated for local farmers to learn and adopt modern practices of soil improvement across the area. This will amount to a disruption of what they are used to and resetting their thinking to new ways. Sufficient benefits must be inherent in the new ways to hasten the adoption of these new ways.
c) Given the number of the farmers and the economic role they play, they must be seen for who and what they are…partners in economic development. They must not be allowed to "be on their own". They must be assisted to acquire the techniques of improved land use methods. The extension officers need to be retooled through intensive and urgent training to be better able to impart this to these farmers. A timeline for this must be drawn and made as short as possible.

Author Contributions:

O.A. and E.F. designed the study. E.F. conducted the experiment and wrote the paper. O.A. supervised the entire study. Both authors read and approved the final manuscript

Conflict of interest:

The authors declare no conflict of interest

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