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Machinery Use in Agricultural Mechanization and Biodiversity Change in Selected Communities in Cross River State, Nigeria

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Abstract— *The study accessed biodiversity loss in Cross River State, Nigeria as a result of machinery use in agricultural mechanization activities in the area. Increase in the development of sophisticated technology and increased agricultural production activities with use of agricultural machineries have led to increased degradation of flora and fauna over the years. It is viewed that depletion of bioresources is a colossal loss to the country in terms of economic returns and environmental quality as well as social systems. Cross River State was split into two zones, A & B comprising of the rain forest and derived savanna respectively. Data were derived from structured and open-ended questionnaires distributed to farmers in the study area. Data generated were analysed using descriptive statistics, t-test and multiple regression analysis. 83% and 44% of the respondents in zones A & B respectively agreed that there was loss of soil fertility in the zones. On the other hand, 91% and 80% of the respondents in zones A & B respectively asserted that wild animals are on the decline. T – tests conducted in zones A & B showed that at P<0.05 there are differences in vegetation forms in the last 15 years where the vegetation has considerably reduced. In conclusion, multiple regression results showed that the socio-economic parameters in zones A & B contributed immensely to biodiversity loss. It is further recommended that in order to save the derived savannah zone from gradually turning to a desert, annual bush burning should be discouraged.*

Keywords— *Machinery, Agricultural Mechanization, Biodiversity, Change, Forestry.*

I. INTRODUCTION

The forests of the tropical rain forest zone of the country have been a basic support system for the society, making available such goods and services as agricultural land, timber, fodder, medicinal plants, soil formation and protection, water shed protection and climatic amelioration. The pristine rainforest of Cross River State of Nigeria is ecologically a region of species endemism and one of the 25 biodiversity hotspots in the world. Globally, there has been a drive for sustainability of these valuable ecosystems (Enuah and Bisong, 2014). Munasinghe (1993) observed that as humans have developed more sophisticated technology throughout history, the impact they have had on forests has tended to increase the level at which forests are degraded to the long term detriment of the overexploiting society. Biodiversity loss may be described as any act leading to the removal or destruction of flora and fauna unaccompanied by deliberate efforts at replacement. The term therefore, includes not only felling of trees but also removal of shrubs, lianas, animals and other plants from the forests.

Odey, *et al.* (2008) revealed that efficient food supply in any country depends to a large extent on the level of agricultural mechanization of such nation. Agricultural Mechanization is not only important for accelerating agricultural development but also for improving farmers\' efficiency. Over the years, there has been an increasing demand for tractor use due to general awareness of agricultural mechanization in Nigeria. The use of farm machineries including tractors in farming has great potentials in alleviating rural poverty (Odey, et al., 2008). Depending on the type of agriculture practiced, the natural tree vegetation is considerately altered or replaced entirely with other plants in the case of arable farming activities. Also annual bush fires have been a part of Nigerian land use problems for years.

FAO (1989) notes that more important than food provision, forests provides a source of income and employment for many families. Millions of rural people depend on money earned from generating, processing and selling agricultural and forest products to buy food and other basic necessities (Nwungwu, 2003). However, adequate and continuous food production need to be ensured to meet up with population growth estimated at 3-5%, FAO (1989b) in several developing countries. This can only be achieved through intensive farming activities that cause little or no damage to the environment. Continuous and unguarded loss of vegetation as a result of agricultural production activities through shifting cultivation results in habitat destruction for wildlife which in effect disrupts the forest ecosystem. Akinola (1995) observed that occurrence of derived Savannah vegetation in the southern part of the country has been attributed to continuous cultivation coupled with annual bush burning where fire tender species have been progressively eliminated. Agricultural mechanization practices are largely land-intensive and require removal of vegetation before they could be carried out effectively.

Olu (1986), stressed that indiscriminate and malicious bush burning has resulted in vegetation and colossal economic losses to the Nation. Most bush fires in Nigeria result from the age long traditional farming method of shifting cultivation which involves complete removal of vegetation (including trees) from the soil surface and burning of plant and other

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organic materials. This practice renders the soil very vulnerable to erosion by wind and water, making such soils less capable of supporting crops and other formed of vegetation. As a result of deterioration of the environment, rate of soil improvement and recuperation through fallow is very low and poor and he pressure on land due to population density and growth makes fallowing impracticably unsustainable. Okojie (1997), emphasized that developed countries saw tropical forests a treasure house of biodiversity and green house gas "sinks" that absorb carbon (iv) oxide and help keep global warming in check. Increased deforestation and great reduction of the vegetation will be accompanied by increased extinction of species (flora and fauna). Loss of habitat is expected to be the single most important factor threatening the fauna diversity in the tropics. FEPA (1992) estimated that 90% of the original forest cover has been cleared and only two percent (2%) of what remains is undisturbed. However, recent estimates indicate that forests account for 9.61% of the nations total land mass. An analysis of biodiversity loss as a result of crop production in thus essential especially at this age of multiple land use approach in Nigeria.

The objective of this study therefore is to access biodiversity loss as a result of machinery use agricultural mechanization activities in the study area. This study is further justified because depletion of bioresources (both flora and fauna) is a colossal loss to the nation as regards the economic returns and environmental quality as well as social systems. Biodiversity loss deprives the present and unborn generations the benefits from our resource endowment. There is the need to identify the economic causes and impacts of biodiversity loss not only for conservation purposes but also to guide the policy makers on how to design projects that could arrest the implications of indiscriminate and deliberate deforestation with a view to protecting the environment and ensure sustained food production simultaneously.

II. METHODOLOGY

Study Area – Cross River State is split into 2 ecological zones. The rainforest and derived savanna zones for the purpose of this study. Focus is on selected communities in the two zones viz

Zone A – The derived savannah zone comprising Okwango, Wula and ogoja and

Zone B - The rainforest zone comprising Idomi, Oban, Akpet and Akor. The communities selected and their specific positions were determined using the Global position systems (GPS) as shown in Table 1 below.

TABLE 1. Showing the locations of study sites

	STUDY AREA	LOCAL GOVT. AREA	LOCATION
Zone A	Ogoja	*1) Ogoja*	$4^0 49^1$N, 7^0 00 E
	Wula	Boki	$6^0{}_{30}{}^1$N, 9^0 00E
	Okwango	Boki	$6^0{}_{18}{}^0$N, 9^0 13E
Zone B	Idomi	*2) Yakurr*	5^0 45^1N, 9^0 05^1E
	Oban	Akampka	5^0 15^1N, 8^0 30^1E
	Akpet	Biase	$7^0 54^i$N, 9^0 30^i E
	Akor	Akamkpa	7^0 42^iN, 7^0 45^i E

III. SOURCES OF DATA

Data for the study were obtained from structured and open ended questionnaires for farmers in the study area as well as indebt interviews (I.D's) with Key informant as used by Nwangwu (2003).

TABLE 2. Questionnaires distribution in the study area.

ZONE A		ZONE B	
Selected Community	No of distributed questionnaires	Selected Community	No of distributed questionnaires
Ogaja	15	Idomi	16
Wula	15	Oban	16
Okwango	15	Akpet	23
		Akor	15
Total	35		70

A total of one hundred and five (105) questionnaires were administered and retrieved (35 in zone A and 70 in Zone B)

IV. DATA ANALYSIS

Data generated were analysed using descriptive statistics in form of tables, frequencies and percentages. The students t-test was used for comparison of vegetation forms within and between the two ecological zones over the years. Also multiple regression analysis and correlation coefficient were used to access the contribution of selected socio-economic variables on biodiversity change.

V. RESULTS AND DISCUSSION

Lard acquisition methods

TABLE 3. Showing farmers land acquisition methods

Land Tenure	ZONE A Frequency	ZONE A %	ZONE B Frequency	ZONE B %
1. Inheritance	22	62.86%	34	48.57
2. Gift	5	14.29	1	1.43
3. Rent	3	8.57	28	40.00
4. Lease	1	2.86	1	1.45
5. Purchase	1	2.86	3	4.29
6. 1 & 2	1	2.86	-	-
7. 1 & 3	1	2.86	1	1.43
8. 1 & 4	1	2.86	-	-
9. 1 & 5	-	-	1	1.43
10. 3 & 5	-	-	1	1.43
Total	35	100.00	70	100.00

Source:- Field Survey, 2015

The main method of land acquisition is inheritance representing 62.86% in zone A, followed by Gift 14.29% and rent 8.57%. There is contrasting observation in zone B, where inheritance represents only 48.7% followed closely by rent 40% and outright purchase at 4.29%. All other methods represent 7.15%. The main land tenure in zone A is inheritance while inheritance and rent are common land acquisition methods in zone B.

TABLE 4. Showing farming systems adopted by farmers in the study area.

Farming System	ZONE A Frequency	ZONE A %	ZONE B Frequency	ZONE B %
1. Land rotation/ Bush fallow	8	22.86	34	48.53
2. Crop rotation	4	11.43	5	7.14
3. Mixed cropping	14	40.00	24	34.29
4. Relay cropping	1	2.86	1	1.43
5. 1 & 3	5	22.86	6	8.57
Total	35	100.00	70	100.00

Source: Field Survey, 2015

The result in zone A shows that 40% of the farmers practiced mixed cropping, 22.86% practiced bush fallow/land rotation, 22.80% combine bush fallow and mixed cropping while 11.43% and 2.86% practiced crop rotation and relay cropping respectively. Here, mixed cropping is the most dominant farming system followed by land rotation/ bush fallow system. However, in zone B, bush fallow/land rotation accounts for 48.57% mixed cropping 34.29%. combination of mixed cropping and land rotation 8.57%, crop rotation 7.14% and relay cropping 1.43%. Zone B has bush fallow/land rotation as the dominant farming system followed by mixed cropping.

TABLE 5. Changes in yield over the years

Response	Zone A Frequency	Zone A %	Zone B Frequency	Zone B %
Increasing	5	14.29	21	30.00
Decreasing	29	82.86	31	44.29
Can't say	1	2.86	18	25.71
Total	35	100.00	70	100.00

Source: Field Survey, 2015

About 83% of respondents in Zone A agreed that there was decrease in yield over the years compared to only 14.29% that indicated increasing yield. However in zone B, the difference is not as wide (44.29% indicated decreasing yield as against 30% with increasing yield) while 25.71% were with no response.

TABLE 6. Observation of negative changes on land e.g Erosion

Causes	Zone A Frequency	Zone A %	Zone B Frequency	Zone B %
Loss of soil fertility	12	34.29	30	48.86
Little/no fallow period	4	11.43	3	4.29
Non-use of fertilizer	10	28.57	5	7.14
Removal of all trees	-	-	3	4.29
Don't know	9	25.71	29	41.43
Total	35	100.00	70	100.00

In zone A, 34% of respondents agreed that loss of soil fertility is responsible for decrease in yield while 28.57% indicated non use of fertilizer and 11.43% indicated little or no fallow period as a cause. No respondent however agreed that removal of trees could result in lo w yield. The result follows the same trend in zone B except that 4.29% of respondents agreed that removal of tree species on the farm could result in low yield while 41.43% of the respondents were indifferent

TABLE 7. Reasons for change in farmers population

Reasons	Zone A Frequency	Zone A %	Zone B Frequency	Zone B %
Unemployment	16	61.54	25	55.56
General population increase	2	7.69	3	6.67
Increase in farm returns	3	11.54	4	8.89
Bad Economy	4	15.39	12	26.67
Can't say	1	3.85	1	2.22
Total	26	100.00	46	100.00

Source: Field survey, 2015

Table 7, shows that unemployment and depressed economy are the main reasons for the increase in farmers population in the two zones. (61.54% and 15.39% respectively in zone A and 55.56% and 26.67% in zone B).

TABLE 8. Wild animals' availability over the years

Availability	Zone A Frequency	Zone A %	Zone B Frequency	Zone B %
Increasing	**3**	**8.57**	**10**	**14.29**
Decreasing	**32**	**91.43**	**56**	**80.00**
Can't say	**-**	**-**	**4**	**5.71**
Total	**35**	**100.00**	**70**	**100.00**

In zone A: 91.43% of the respondents agreed that wild animals are not as frequent compared to the past i.e decreasing, while 80% agreed in zone B that wild animals population in also on the decline compared to the past. Only 8.5% and 14.29% in both zones A and B respectively are with the impression that the animals are still as abundant as in the past.

TABLE 9. Factors for changes in wildlife population

Factors	Zone A Frequency	Zone A %	Zone B frequency	Zone B %
1. Loss of vegetation	18	56.25	20	35.71
2. Intensive hunting	5	15.63	11	19.64
3. Farming activities	2	6.25	2	3.57
4. 1 & 2	7	21.88	15	26.79
5. 1,2 &3	-	-	2	3.57
6. 1 & 3	-	-	4	7.14
7. 2 & 3	-	-	2	3.57
Total	32	100.00	56	100.00

In zone A. 56.25% of respondents agreed that loss of vegetation. is responsible for Wildlife depletion followed by the interaction of vegetation and hunting intensity 21.88%. contribution of hunting is only 15.63% while farming activities are responsible for 6.25%. In zone B, Wildlife population depletion is caused by loss of vegetation accounting for 35.71% and the interaction effect of vegetation loss and hunting intensity is 26.79%. Intensive hunting accounts for 19.64% in zone B. On the whole, loss of vegetation, intensive hunting and farming activities collectively serve as the main agents of Wildlife population changes in the study area.

VI. T-TEST RESULT

Vegetation Forms

Vegetation forms in the two ecological zones were considered in the test based on the respondents view. The test of comparison of vegetation forms were carried out within and between the two zones. The tested hypothesis here is H_0 = There are no differences in the vegetation forms, over 15 years ago, and presently, 10-15 years and presently, 5-10 years and presently

Ha = There are differences in the vegetation forms.

This in essence will enable the assessment of impact of agricultural productivity on biodiversity loss.

Zone A (within) –The test in the Table 10: below presents the comparison of vegetation forms within zone A over the years.

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TABLE 10. Vegetation forms within zone A over the years

1) Period	T-cal	t-tab	Df	P	Decision
Over 15 years & presently.	-3.87	1.753	15	0.002	P<0.05, Reject Ho
10-15 years & presently	3.11	1.746	16	0.007	P<0.05, Reject Ho
5-10 years & presently	-2.40	1.697	30	0.023	P<0.05, Reject Ho

Confidence interval is 95% or 0.05 significance level = α

1. Over 15 years and present:- At P< 0.05, the test is significant. Ho is rejected. Thus there are differences in the vegetation forms. Essentially, there are more woody Savannah vegetation over 15 years ago when compared to present day.
2. 10-15 years and present-At P< 0.05, there are significant differences in the vegetation form compared to the present time, Ho is rejected.
3. 5-10 years and present:- AT P< 0.05, the Ho is rejected because there are differences in the vegetation forms in the last five years compared to the present day.

Zone B (within) – Here the test is also carried out to measure differences in vegetation forms within the zone

TABLE 11. Vegetation forms within zone B over the years

2) Period	T-cal	t-tab	Df	P	Decision
Over 15 years & presently.	-2.72	1.676	48	0.009	P<0.05, Reject Ho
10-15 years & presently	1.88	1.672	55	0.066	P<0.05, Accept t Ho
5-10 years & presently	1.09	1.671	63	0.278	P<0.05, Accept Ho

1. Over 15 years ago and presently:- At P< 0.05, the Ho is rejected because the vegetation form was more tick or secondary forest compared to arable vegetation currently occupying the zone.
2. 10-15 years and presently:- At P< 0.05 the Ho is accepted as there have been no differences in the vegetation forms in the last 10 years and the present days.
3. 5-10 years ago and presently:- The P< 0.05, hence the Ho is accepted ie. there are no differences in the vegetation forms between the years compared, ie 5-years back and presently.

Zone A completely shows that there are differences in the vegetation forms compared to the present time. This implies that the vegetation continues to change to more and more grassy vegetation over the years, ie the woody materials are either removed through felling or destroyed by annual burning as a result of arable farming activities. Essentially, there has not been serious attempts to replace the woody species of the vegetation. Table 11, showed that in zone B, vegetation form is not significantly different between now and the last 10 years but significant changes had occurred in over fifteen years ago compared to the present situation. This is an indication that vegetation form in zone B is not adversely affected be arable farming activities.

VII. Multiple Regression Results

In accessing the impacts of some selected socio economic variables to biodiversity changes, the multiple regression test was used and three regression functions were considered including the Linear regression function, the semi-log function and the double log function. A total of 8(eight) independent socio economic factors were considered for the regression model

1) The linear regression function - $V_L = B_0 + B_1 Y_1 + B_2 Y_2 \ldots + B_n Yn + Error$

where VL = Biodiversity loss
B_0 = Regression constant
B_1 - B_n Regression coefficients
Y_1 -Y_n = Socio-economic factors
Error = Error of regression.

2) The Semi-log function
$VL = \log B_0 + B_1 \log Y + B \text{ Log } Y \ldots + B_n \log Y_n +$ Error

3) The Double log function
$\text{Log } VL = \log B_0 + B_1 + B_1 \log + B \log Y \ldots B_n \log Y_n$ + Error

The considered socio economic variables for the regression model ($Y_1 – Y_8$) are
V_L = Size of farmland
Y_1 = size of family household
Y_2 = Educational level of the respondents
Y_3 = faming experience of the respondents in years
Y_4 = Land tenure systems
Y_5 = No of members of family available for farm work
Y_6 = Willingness to plant multipurpose trees
Y_7 = Yield of crops over the years
Y_8 = population of farmers.

Regression analysis was carried out for the separate (2) zones under study to allow comparisons.

TABLE 12. Summary of regression results

	ZONE A					ZONE B				
Function	R^2	R^2adj	Fcal	Ftab	Con.st	R^2	R^2adj	F.cal	Ftab	con. St
Linear	0.13 61	– 0.12	0.51 22	3.08	5.32 78	0.26 27	0.16 60	2.71 71	2.9 3	2.94 10
Decision – Test insignificant, H_0 accepted						Decision–Test insignificant, H_0 accepted				
Double log	0.20 71	-- 0.03	0.84 90	3.08	0.71 34	0.10 49	-- 0.12	0.89 31	2.93	0.24 00
Decision – Test insignificant, H_0 accepted						Decision – Test insignificant, H_0 accepted				
Semi log	**0.25** 88	**0.03** 07	**1.13** 47	**3.08**	**5.89** 66	0.15 96	0.04 94	1.44 94	2.93	4.07 73
Decision- Test insignificant, H_0 accepted						Decision- Test insignificant, H_0 accepted				

VIII. Conclusion and Recommendations

Result of the tests carried out in the study show that farmers population has changed positively (increasing) over the years. This situation is attributable to the high unemployment rate in the society as well as the depressed economy in Nigeria currently as shown in table 7 with unemployment accounting for 61.54% and 55.56% in zones A and B respectively.

Also, the t-test carried out on the farmers knowledge of the physical outlook of the vegetation cover in their lands show that over 15 years ago (1990), there was a remarkable

difference in the vegetation form compared to what obtains presently.

In table 11, P=0.009< 0.05 ie the alternative hypothesis Ha is upheld from the test. However in the last 10 years, (1995) the vegetation form remains the same zone B (farmland/fallow occupied by arable crops). The test shows that P>0.05 (10 year) ago; P = 0.066, and five years ago P =0.0278, hence the null hypothesis (Ho) accepted, meaning that there are no differences in the vegetation form when the periods under t-test are compared.

The slash and burn supported by ridges/heaps construction during land preparation in order to maintain high yield always resulted in loss of vegetation because the fire tender tree species are exterminated and destroyed gradually over the years as farming intensity on the site increases. Heaps/ridges construction plus annual burning destroys the soil seed bank of the tree species thereby presenting a very difficult situation for trees re-establishing themselves Destruction of the vegetation leads to the ultimate destruction of wildlife habitats since absence of a guaranteed habitat for the animals will force them to leave the environment leading to a reduction in their population: This has far reaching consequences like reduction in animal protein availability both in the rural and urban areas as well as contributing to low income levels for rural dwellers who rely on hunting of wild animals as a means of survival.

Finally, the socioeconomic parameters investigated in the tests only explain about 25% and 26% in zones A and B respectively from the R^2 results of the regression analysis.

This shows that some other factors also contribute to biodiversity changes.

On the basis of the foregoing, the followings are recommended for adoption by the concerned stake holders in the agricultural sector.

- A participation and multidimensional approach is necessary for the effective implementation of extension services on agroforestry by the state ministry of agriculture and natural resources. There is urgent need for agroforestry extension campaign especially in the derived savannah area of the state.
- In order to save the derived savannah zone from gradually turning into a desert, annual bush burning showed be discouraged

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