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Agricultural Extensification and Biodiversity Loss in Ikom Cross River State, Nigeria

Ogah, Odey Moses., Tsue Peter Terfa and Ugorja, Comfort Livinus
Department of Agricultural Economics, University of Agriculture Makurdi, Nigeria
Corresponding Author: odey_ogah@yahoo.com

Abstract

The study used primary data with the aid of a well-structured questionnaire to collect data from one hundred and ten respondents (110) through simple random sampling technique. Data collected were analyzed using descriptive statistics as well as inferential statistics. The results revealed that animals like hare, wild cat, gorilla, hyena and elephant with mean scores of 2.53, 2.89, 3.40, 3.09 and 3.21 respectively were almost lost. Gorilla was at danger of extinction. Plants like ropes, otasi, hotleaf, bamboo and iroko with mean scores of 1.66, 1,62, 1.64, 1.61 and 2.00 respectively were not completely lost. Analysis of logic regression results revealed that age with coefficient 0.161, slash burn (2.734), awareness of biodiversity (3.392) years before fallow (0.842) were positive and significant at 10% level of probability. The results also revealed that the coefficient of mixed cropping (2.495), trees felling (3.006), herbicides (0.494) were positively significant at 5%. These variables, trees felling, herbicides, mixed cropping, slash burn, years before fallow and awareness of biodiversity increases the probability of high extent of biodiversity loss. Farming experience, extension visit and acreage increase have negative coefficients and are significant at 5%, also land conflict (-1.996) was negatively significant at 10% implying that these variables decreases the probability of biodiversity loss. The study recommended that government should enact or enforce a law to prevent human activities from engaging in excess deforestation and exploitation of organisms so as limit biodiversity loss, education of the farmers on the implication of biodiversity loss is advocated.

Keywords: Biodiversity loss, Extensification, Effects, Agriculture.

1. Introduction

Extensification of agricultural production is a relative extension of the area under cultivation without expanding the existing labour force or other inputs. Extensive agricultural systems have a high return per capita (as relatively few people are needed), as in sheep rearing or large-scale cereal growing (Van der Veen and O'Connor, 1998).

Kroll (1997) described an extensive cultivation regime on the loss plateaus and grass land, with large surfaces of land under cultivation, often with one single crop, which is undemanding. If a farming community decided to expand by increasing the area under cultivation without an associated increase in available traction, manure or labour, this would inevitably result in a gradual deterioration of the soil conditions in the fields (Grassini *et al*., 2013).

The increasing world population in combination with a more affluent diet is projected to demand an increase in crop production of 50% and in livestock production of 70% by 2050. According to Tilman *et al*. (2011), most likely the food industry even has to double their productivity to satisfy people's demand by 2050. The larger part of the increase of demand for cereals would be to feed livestock to meet the increase in diets rich in animal protein. Many projections indicate that such an increase can be met by yield gap closure (Foley *et al*., 2011 and Mueller *et al*., 2012). This will lead to expansion of agriculture land area (notably in developing countries). For the first time since 1980 harvested areas for wheat and corn have started to increase (Grassini *et al*., 2013). This increase in part was caused by increased demand for biofuels.

This land extension is a direct threat to biodiversity (Alkemade *et al*., 2009 and Van Vuuren, 2012). Without additional efforts, current agricultural practices also will increase global emissions of greenhouse gasses and lead to higher losses of nitrogen and phosphorus to the environment (Tilman *et al*., 2011, Garnett and Godfray, 2012). The main challenge is therefore to guarantee future food security, while reducing environmental pollution and biodiversity loss. A major environmental effect of current agricultural activity is the loss of biodiversity on cultivated land, which raises important concerns because demand for agricultural food and energy products is expected to continue to increase strongly (Alexandratos and Bruinsma, 2012; Fritz *et al*., 2013). The scientific and political debate surrounding this topic has partly centred on the following dilemma: should agriculture be concentrated on intensively farmed land in order to conserve more natural spaces which are rich in biodiversity? or is it better to favour a more diversified but less productive agriculture, i.e. more extensive wildlife-friendly farming that conserves fewer natural spaces (land sharing)?

A model by Green *et al.* (2005) compares the level of biodiversity obtained from intensive high-yield farming and extensive low-yield farming when biodiversity is a decreasing function of yield. For a given production target, the two methods of agriculture lead to the same level of biodiversity when biodiversity is a linear function of yield. Accordingly, when shifting from intensive to extensive farming, the biodiversity gain on previously cultivated land is exactly compensated for by the biodiversity loss on newly cultivated land. If the relation between yield and biodiversity is convex, however, extensive farming leads to a biodiversity loss compared with intensive farming. In this case, shifting to extensive farming leads to a small increase in biodiversity on previously cultivated land, while strongly decreasing biodiversity on newly cultivated land. The opposite result obtains if the relation between biodiversity and yield is concave.

In view of concerns about nutrient losses to air and water, one could, however, hypothesize that sustainable extensification could also be a strategy for the farmers in order to meet both the global and regional demand for food and biodiversity. Against this backdrop, this study is carried out and aimed at creating room for improving the balance between food production (agriculture) and environmental pressure (Biodiversity) through agriculture extensification in Ikom, Cross River State, Nigeria.

2. Materials and methods

Modern day Ikom began as a constituent part of the Afikpo Division in the early 1950s when it was together with Afikpo now in Ebonyi State and in 1976, Ikom local government was created with headquarters at Ikom in the eastern area of Cross River State. Nigeria. It is located on Longitude 5°57′40″N and latitude 8°42′39″E.

It has a land area of about 1,861.926 square kilometres and a population of 162,383 at the 2006 census. It is bounded to the North by Ogoja on the North-East by Boki, in the East by Etung and South by Obubra Local Government Area. The local government is made up of eleven (11) council wards namely: Abanyum, Yala-Nkum, Olulumo, Ofutop I, Ofutop II, Nta/Nselle, Nde, Abijinkpor, Ikom Urban, Akparabong, Nnam. Other towns in the local government area include: Ikom four conner, Okuni and Nakrasi. The vegetation of the local government is that of a tropical rain forest, and experiences rain fall all year round with little or no dry season. The local government is surrounded by uphill stretching through the Northern part, while the lowland has fadamas fit for wet cultivation. This makes the local government (Ikom) endowed with soil that not only accommodates the growth of cocoa but generously produces fine succulent plantain and banana. The research adopt simple random sampling to select ten (10) farmers from each of the extension cells making a sample of one-hundred and ten respondents for analysis.

Structured questionnaire was used to elicit information from the respondents. Information collected cantered on socio-economic characteristics, agricultural practices and biodiversity. Parameters such as: age, sex, marital status, farm size, annual income household size, farm income, various farm practises, biodiversity losses, causes of biodiversity losses and conserved area were captured. Descriptive statistics such as frequency, distribution, mean and percentages as well as logit regression were used as tools of analysis.

The determinants of frequency result showing the influence of farm size increase and farming practices on the extent of biodiversity loss in the study area were estimated using binary logistic regression model for the various individual social-economic characteristics as factors influencing frequency of use of farm size increase and farming practices on the extent of biodiversity loss. If individual influence and farming practices lead to biodiversity loss, we assign the value 1 and 0 if otherwise.The model is expressed as:

$$P_i = \frac{1}{1+e^{-(\beta_o+\beta_1 x_{i1}+...+\beta_k x_{ik}}} \quad (1)$$

Where,

P_i=Probability of individual influence farm size increase and farming practices on the extent of biodiversity loss

β_0=Constant term

β_k=Coefficient to be estimated

X_k=for K=1……..21 which are independent variables

i=ith observation.

Let $$Z_i = \beta_o + \sum \beta_k X_{ik} \quad (2)$$

Then $$Pi = \frac{1}{1+e^{-Z}} \quad (3)$$

As Z_i ranges from –α to + α, P_i ranges from 0 to 1 and P_i is non-linearly related to Z_i. The Logit of the unknown binomial probabilities i.e. the Logarithms of the odds, are modelled as a linear function of the Xi. In estimable form, the model is expressed as,

$$\log it(P_i) = \ln\left(\frac{p_i}{1-p_i}\right) = \beta_o + \beta_1 X_{i1} + ... + \beta_k X_{ik} + U_i \quad (4)$$

The unknown parameters β_i are usually estimated by Maximum likelihood. Thus, the model is explicitly expressed as

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + u_i \quad (5)$$

Where,

Z_i=frequency of use of farm size increase and farming practices on the extent of biodiversity loss;

β_0=Constant term; β_i=(1-6) vector of the parameter to be estimated; X_1= age of farmer in year; X_2=sex (dummy, 1 if male and 0 if female); X_3 = household size (number of persons); X_4 = Education (number in years); X_5 = years of farming experience; X_6= annual income (Naira); X_7= non-farm income(Naira); X_8= extension visit (numbers in year);X_9 = Mix cropping (number); x10 = shifting cultivation crop rotation (number); X12 = crop rotation (number);x13= trees faelling (Yes=1 and No=0); X14=slash burn (Yes=1 and No=0); X15 = Herbicides (number time); X16 = land conflict (yes=1 and No=0); X17= years of fallow (number); X18 = years before fallow(number); X19 = acreage increase (number of hectare); X21= aware biodiversity loss (Yes=1 and No=0). A 4-point Likert type scale was used such that 1=not lost, 2=not completely lost, 3=almost lost and 4=lost.

3. Results and discussion

3.1 Farm and Farmer-Specific Characteristics

The farm and farmers'-specific characteristics were analyzed using descriptive statistics as presented in Table 1. The age distribution of the respondents was grouped according to age bracket of ≤20, 21–40, 41– 60, 61 and above and this reveals 3.64%, 42.72%, 44.65% and 9.12% respondents respectively. The respondents in the group of 41-60 years with percentage of 44.65% contributed the highest number of farmers than the other categories in the study area. This implies that the farmers are vibrant and energetic people, this would have provided vigour for the extensification in farming. This age range is seen as the prime age of productivity (Onwumere and Alamba, 2012).This result also conforms with the findings of Ukohol (2016) who noted that farm activities are carried out by farmers whose ages fell within the productive ages and have the strength to carried out the tedious operations involved in farming.

Results from the table also indicates that 4.56% of respondents were divorced, 4.6% widowed, with the majority of 60.05% married. This indicates that most of the respondents in the study area were responsible individuals contributing to labour and ideas as in the growth of farming activities. This is in line with the findings of Ojo (2012) who noted that most farmers in Nigeria are married engaging in various enterprises which could translate into increased availability of family labour. This also conforms to the findings of Gyandenetal (2017), they noted that married people would be more involved in activities which led to biodiversity losses including agriculture for food production and as a source of income generation to take care of their families.

Majority of the respondents (56.49%) were males with females constituting 43.61%. This implies that greater percentages of farmers in the study area were males. This indicates that male folks were more involved in farming in the study area than females. This agrees with the findings of Tiwari et al (2008), Eloyi (2016) and Adewunmi (2008) as their reports indicated the males dominance in food production in Nigeria than females since most of the farm activities are tedious and laborious as such can be handle by men. As noted by Gyanden et al (2017) Males are generally more involved in practices that led to biodiversity losses including hunting of wild animal and farming among others. This means that male were more involved in carrying out activities which causes biodiversity losses.

For educational level, 37.36% of the respondents had secondary education. This will enhance new skills and technical know-how with respect to decision making in their farming business. About 17.34%, 29.14%, 12.78% and 32.68% of the respondents had primary, NCE/OND, HND/BSc and MSc,/PhD respectively. Gilber (2007) opined that the level of formal education attained by an individual goes a long way in shaping his/her personality attitude to life and adoption of new improve practice.

The results from the table also revealed that 60.91%, 34.59%, 4.63% of the respondents had household size of <5, 6-10 and 11 -15 persons respectively with average household size of 5 persons. The large family size is an indication that there are enough hands to carry out the farming activities

Years of experience in farming by respondents, shows that 37.36% of the respondents had between 6-10 years of experience in farming. About 24.58%, 187.24% and 20.02% had between <5, 11-15 and 16 and above years of experience respectively. The average years of farming experience for the respondents is 12 years, this indicate that the farmers in the study area were well experienced. Eloyi (2016) reported that farming experience could enhance production and less resistant to adoption of innovation.

The results from the table also showed that 35.58% of respondents cultivated between 3 and above hectares (Ha) of farm land before extensification while 19.18%, 26.36%, 19.13% respectively cultivated ≤1, 1.1 -2, 2.1-3 . The average farm size before extensification is 2.96 hectares. This implies that most of the farmers are small scale farmers This agrees with the findings of Iyortom (2016) that most farmers in Nigeria are small scale farmers. From the results on farm size, majority (556.50%) of the respondents cultivate 3 hectares and above after extensification with average farm size of 3.8 hectares As the table reveals54.46%, 19.13% and 20.02% cultivated between 0 and 1, 2 and 3 hectares respectively. This indicates that the current farm sizes of the respondents after extensification are larger an indication that farmers in the study area are practicing agricultural extensification.

3.2 Extent of Biodiversity loss

The Likert-typescale was used to measure the extent of biodiversity loss. A 4-point Likert type scale was used such that 1=not lost, 2=not completely lost, 3=almost lost and 4=lost. Table 2 shows that birds with the mean score of 1.27, snakes (1.28) insects (1.46), guinea fowl (1.90), grass cutter (1.88) and antelope (1.93) were not lost while red ruler hog, rock fowl, crocodile, hare, and wild cats with mean score of 2.21, 2.16, 2.24 ,2.53 and 2.89 respectively were not completely lost. Gorilla, chimpanzee, hyena, elephant having mean score of 3.40, 3.31, 3.09 and 3.21 respectively were almost lost. This implies that gorilla with highest mean score of 3.40 was at danger of extinction.

3.3 Extent of Lost Plant Species

Table 3, present results of extent of lost of plant species. The table showed that kolanut and bush mango with mean score of 1.33 and 1.39 respectively were not lost , raffia palm, Afang, mushroom, Ropes, Otasi, Hotleaf, Bamboo, Iroko, Mahogany and medicinal herbs have mean scores of 1.60, 1.50, 1.50, 1.66, 1.62, 1.64, 1.61, 2.00, 2.17, and 2.10 respectively were not completely lost. This indicates that plant species are not at danger of extinction.

3.4 Binary Logic Regression Results of the Influence of Farm Size Increase and Farming Practices on the Extent of Biodiversity Loss

The results of binary logistic regression showing the influence of farm size increase and farming practices on the extent of biodiversity loss is presented in table 4. The non-significance of Hosmer and Levelshow Chi-Square (X2=3.228, P>0.05) implied that the model is not significantly different from the standard model. The results also showed that Chi-Square test of model coefficient was significant at 1% level (X2=57.643, P=0.01). This implied that the independent variables included in the model are significantly related to the extent of biodiversity loss in the study area. Furthermore, the results of the coefficient of age(0.161), slash burn (2.734), awareness of biodiversity loss (3.392) were positive and significant at 10% this implies that increase in age of the farmers, slash burn and awareness of biodiversity loss, increases the probability of high extent of biodiversity loss. Coefficient of Farming experience (-259), extension visit (-1.022) and acreage increase (-1.290) were negatively significant at 5%. This indicated that decrease in farming experience, extension visit, acreage increase of the farmers decreases the probability extent of biodiversity loss. More so, the results revealed that the coefficient of non-farm income (0.000), mix cropping (2.495), trees faelling (3.006), herbicide (0.494) were positively significant at 5%. This implies that increase in these variables increases the probability of high extent of biodiversity loss in the study area. The result also shows that the coefficient of land conflict (-1.996) was negative and significant at 10% which indicated that decrease in land conflict in the study area would most likely increase the probability of extent of biodiversity build up.

Table 1. Farm and Farmer-Specific Characteristics

Variables	Frequency	Percentages	Mean
Age			
≤ 20	4	3.64	43.81
21 – 40	47	42.72	
41 – 60	49	44.65	
>60	10	9.12	
Sex			
Female	48	43.61	
Male	62	56.49	
Marital status			
Divorced	5	4.56	
Married	66	60.05	
Single	30	27.35	
Separated	4	3.64	
Widowed	5	4.6	
Education			2.46
F.S.L.C.	19	17.34	
S.S.C.E.	41	37.36	
NCE/OND	32	29.14	
HND/B.Sc	14	12.78	
M Sc/PhD	4	3.63	
Household size			5.23
≤5	67	60.91	
6 – 10	38	34.59	
11 – 15	5	4.637	
Farming experience			11.88
≤5	27	24.58	
6 – 10	41	37.36	
11 – 15	20	18.27	
>15	22	20.02	
Farm size before extensification			2.96
≤1	21	19.18	
1.1 – 2.0	29	26.36	
2..1-3.0	21	19.13	
>3	39	35.58	
Farm size after extensification			3.79
≤1	6	5.454	
1.1 – 2.0	21	19.13	
2.1 – 3.0	22	20.02	
>3	61	55.56	
Annual farm income *			225529.81
< = 100000	31	28.24	
100001 – 200000	23	20.91	
200001 – 300000	18	16.36	
>30000	38	34.59	
Non-farm income *			144545.23
< = 50000	35	31.81	
50001 – 150000	30	27.35	
150001 – 250000	16	14.53.8	
>250000	29	26.46	
Extension visit			1.144
< 1	61	55.45	
1 –2	21	19.09	
>2	26	23.63	
Remittance *			191002.720
< = 50000	70	63.64	
50001 – 100000	9	8.23	
100001 – 150000	5	4.63	
>150000	26	23.69	
Credit			
No	74	67.30	
Yes	36	32.73	

Table. 2 Extent of Lost of Animal Species in the Study Area

Animal Specie	Minimum	Maximum	Mean	Std. Deviation
Antelope	1	4	1.93 **	0.910
Grass cutter	1	4	1.88 **	0.920
Hare	1	4	2.53 **	1.059
Wildcats	1	4	2.89 **	1.021
Gorilla	1	4	3.40 **	0.973
Chimpanzee	1	4	3.31 **	0.997
Hyena	1	4	3.09 **	1.102
Elephant	1	4	3.21 **	1.081
Crocodile	1	4	2.24 ***	0.691
Snakes	1	4	1.28 ****	0.695
Birds	1	4	1.27 ****	0.662
Insects	1	4	1.46 ****	0.823
Red river hog	1	4	2.12 ***	0.879
Rock fowl	1	4	2.16 ***	0.818
Guinea fowl	1	4	1.90 ***	0.881

* = completely lost, ** = almost lost, *** = not completely lost, **** = not lost

Table 3. Extent of Loss of Plant Species in the Study Area

Species/resources(plants)	Minimum	Maximum	Mean	Std. Deviation
Rafia palm	1	4	1.60 ***	0.818
Kolanuts	1	4	1.33 ****	0.734
Afang	1	4	1.50 ***	0.857
Mushroom	1	4	1.50 ***	0,824
Ropes	1	4	1.66 ***	0.895
Bush mango	1	4	1.39 ****	0.792
Otasi	1	4	1.62 ***	1.351
Hotleaf	1	4	1.64 ***	1.351
Bamboo	1	4	1.61 ***	0.881
Iroko	1	4	2.00 ***	0.805
Mahogany	1	4	2.17 ***	0.855
Medicinal herbs	1	4	2.10 ***	0.793

Table 4: Binary Logic Regression Result Showing the Influence of Farm Size Increase and Farming Practices of the Extent of Biodiversity Loss.

Independent variables	Coefficient	S.E.	Wald	Sig.	Exp(B)
X_1Age	0.161	0.097	2.768 ***	0.096	1.174
X_2Sex	0.858	1.030	0.693	0.405	2.358
X_3Household size	0.424	0.336	1.593	0.207	1.528
X_4Edu.	0.511	0.528	0.938	0.333	1.667
X_5 f-exp	-259	0.109	5.679 **	0.017	0.772
X_6Farm size current	-407	0.419	0.948	0.330	0.665
X_7Land acquisition	1.324	1.365	0.941	0.332	3.759
X_8Annual farm income	0.000	0.000	0.091	0.762	1.000
X_9Nonfarm income	0.000	0.000	5.039 **	0.025	1.000
X_{10}Ext visit	-1.022	0.941	4.327 **	0.038	0.360
X_{11}Mix cropping	2.495	1.108	5.068 **	0.024	12.123
X_{12}Shifting cultivation crop rotation	-0.061	0.919	0.004	0.947	0.940
X_{13}Crop rotation	0.789	0.876	0.810	0.368	2.210
X_{14}Tree faelling	3.006	1.522	3.903 **	0.048	20.214
X_{15}Slash burn	2.734	1.457	3.519 ***	0.061	15.394
X_{16}Herbicide	0.494	0.243	4.112 **	0.043	1.638
X_{17}Land conflict	-1.996	1.234	2.617 ***	0.100	0.136
X_{18}Years fallow	-0.547	0.432	1.603	0.205	0.578
X_{19}Years before fallow	0.842	0.476	3.130 ***	0.077	2.322
X_{20}Acreage increase	-1.290	0.600	4.622 **	0.032	0.275
X_{21}Aware biodiversity loss	3.392	1.932	3.083 ***	0.079	29.732
Constant	-18.53	7.093	6.825 *	0.009	0.000
Chi-square	57.643			0.000	
Hosmer and Lemeshow chi-square	3.228			0.916	
Nagelkeke R^2	0.683				

*, **, *** = wald test significant at 1%, 5%, and 10% levels respectively

4. Conclusion and recommendations

The study examined the extent of biodiversity loss as a result of extensification. From the findings the respondents were in their active age thus triggering extensification. The respondents were mostly married, educated, small scale farmers and they have high farming experience. The study established that gorilla was at the danger of extinction while animals like hare, hyena, wild cat, and elephant were almost loss. Also plants species like ropes, otasi, hot leaf, bamboo, iroko were not completely lost. Activities mostly responsible for loss of plants and animals were bush burning and hunting. A tremendous disappearance of natural species in recent times caused by agricultural practices by people in the study area was noticed. At the moment the rate at which biodiversity losses is occurring if not checked immediately will result to extinction of different species and causing decline in agricultural procedure, reduction in soil organic matter and limited crop diversity. Based on the findings, the study recommends that the government should enact/enforce a law to prevent human activities from engaging in excess deforestation and exploitation of organisms so as to avoid/limit biodiversity loss. The farmers should be educated properly on the implication of biodiversity loss; adequate information will help to slow down biodiversity loss. Agricultural extension agentsshould be encouraged and be motivated by the government in order for them to up their gameand make it a duty to pay constant visit to farmers in order to avoid biodiversity losses. Climate change is the major cause of several extinctions. Individual organizations or governments should make effort to slow down the current human-caused global warming so as to reduce the speed of biodiversity loss particularly in the study area.

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