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Effect of Changing Landuse/Landcover Pattern on Traditional Farming System in the Upper Niger Delta Region of Rivers State Nigeria.

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Abstract
The landuse/landcover pattern of a region is an outcome of natural and socio -economic factors including agricultural practices. Landuse/landcover change has become a central component in current strategies in managing natural resources as well as monitoring environmental changes. Settlement expansion has increased the exploitation of farmlands (natural resources) and has changed the landuse/landeover pattern of the predominantly agricultural landscape of the upper Niger Delta region of Rivers State. Change in the landuse/landcover pattern of this region was investigated using landsat imageries(TM 1986, ETM 2003 and ETM 2008). The supervised classification methodology was employed using the maximum likelihood technique to categorise the images. The classified landuse/landcover categories were plantation, primary forest, secondary forest, farmland, settlement (Built-up land), bareground, waterbody and mangrove. It was observed that while farmlands constantly decreased in size, settlement continued to increase. Farmland which decreased from 136,820.701ha to 96,019.54ha (10.27%) between 1986 and 2003, further decreased from 96,019.54ha to 93,643.97ha (0.60%) between 2003 and 2008. Field studies were also carried out and the Pearson Product Moment Correlation method was applied to arrive at appropriate results. Volume of farm produce (cassava) correlated strongly with land size, implying that as farmland (size) decreased, volume of farm produce decreased as well. Results showed that there is a statistically significant correlation between the two variables in the three studied local government the areas thus: 0.0719 for Ikwerre, 0.6498 for Etche and 0.2 748 for Emohua Local Government Areas respectively.

Keywords: Landuse/landcover, traditional farming, Landsat imagery and natural resources.

Introduction

Landuse and landcover change has been variously linked to different aspects of its impact on the global environment. Accordingly, landuse and landcover changes have impacts on such environmental and landscape attributes as water quality, land and air resources, ecosystem processes and function and the climate system itself through green house gas fluxes. In the study of landuse and landcover change, it is essential that a knowledge of the nature of their configuration across spatial and temporal scales is consequently indispensable for sustainable environmental management and development. In a region characterized by subsistence agricultural practice as in the Upper Niger Delta area of Rivers State, such changes in landuse and landcover regime can

be suppressed without showing its environmental and social effects.

In a report by Njungbwen, Mbakwe and Leke (2010) Geomatics International Inc. in 1996 carried out analysis on the National landuse and vegetation change of Nigeria between 1976 - 1995. In that analysis, urban landuse covered an area of 2083km2 (0.2%) of Nigeria's total land area in 1976/78 and increased to 5444Km^2 (0.6%) of the total land of the country in 1995. This indicated a significant 0.4% increase of urban landuse of the National land. This increase in urban landuse and a decrease in forest or vegetation cover is still continuing till present date as population continues to increase. The result of this variation will manifest either positively or negatively on a lot of environmental scenes that benefit mankind. Thus one of the resources that is negatively being affected by the changing landuse/landcover variation in this region is the traditional farmlands. The importance of this resource in this region stems from the fact that the indigenous populations are mainly peasant farmers. It therefore becomes a major challenge in conserving this green infrastructure and the increasing fragile ecosystem against increasing population and food production (Innis, 1980).

For resource management, remote sensing presents a unique perspective for observing and measurement of landuse and landcover changes and other biophysical characteristics (Bosco et al, 2011). Other measurements can be done to compliment data obtained from remote sensing. This research aimed at establishing the extent to which changing landuse and landcover pattern has affected traditional farming using crop production as a significant variable.

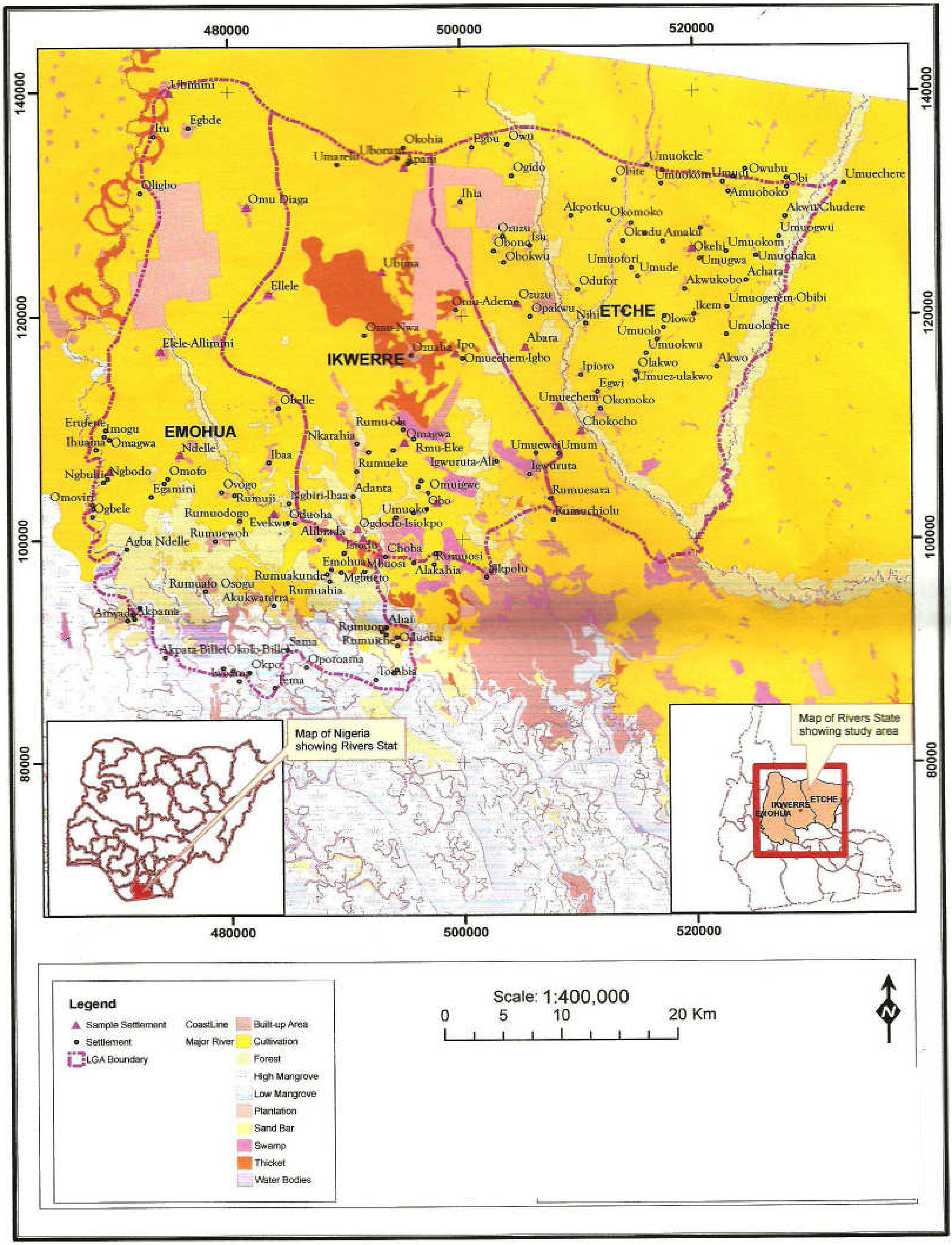

Fig 1: Location map of the study region

Study Area

The study area lies in the forest zone of southern Nigeria where it occupies the southernmost fringes of the tropical rainforest belt of the country. The area lies within the geographical co-ordinates of latitude 4°46" and 5° 17" N and longitude 6°40" to 7°05"E. It is situated at the eastern part of the Upper Niger Delta Basin. The landform is coastal plains, almost featureless. The whole area is generally flat except at some interfluve areas where river channels cause the dissection of the almost monotonous plain. The geology is relatively young and composed of sedimentary rocks made up of sandstones, shales and clays of cretaceous and tertiary ages (Ofomata, 1975).

The climate is the tropical wet climate (Koppen's 'AF' classification) due to its latitudinal location of just 4° above the equator. It is characterized by heavy rainfall and high temperatures accomplished by high humidity all the year round. The natural vegetation is the low latitude evergreen rainforest although what is presently available is mainly secondary forest occasioned by several activities of man. In areas where the original natural vegetation has not been destroyed, they retain the unique characteristics of the rainforest such as the three-layer canopy, floristic diversity, and open forest floor. In such undisturbed forests, it is common to find such fancied wood species as Iroko, chlorqphora exelsa; Obeche, Triplochintos scleroxylon; Afara, Teminalia superba; Mahogany, Kyaya ivoriensis and sik cotton tree Ceiba pentandra.

Methods and Materials

The main data sets used for this project were three cloud — free landsat TM (Thematic Mapper), Landsat ETM+ (Enhanced Thematic Mapper) and Landsat ETM+ Scenes. The three satellite image datasets consisted of Landsat TM, acquired on 19 December 1986; Landsat ETM+, acquired on 8 January 2003 and Landsat ETM+ acquired on 14 February 2008. All the images were dry season images to avoid seasonal effects on the analyses. The software packages used were the ERDAS Imagine 9.1. This was used in the display, and processing/image enhancement (landuse/landcover classification). The ArcGIS Software was also used in the preparation of maps. Idrisi 32 was used to run the Markov chain model to determine the future change of landuse/landcover in the study area. (Jensen, 2007). The assessment of landuse/landcover was done by adopting a classification scheme for the Landsat images for years 1986, 2003 and 2008 and carrying out a supervised classification (maximum likelihood) based on ancillary data from thematic maps, ground truthing and other information from literature sources. (Coppin & Baur, 1996).

Administrative and Local Government maps of Rivers State with a scale of 1.350,000 for the year 2000 were obtained from the Ministry of Lands and Survey. Also landuse/landcover map of the state for the year 2008 with a scale of 1:350,000 was also obtained from the same source. Data on farm sizes and volume of crops produced were obtained through on-farm measurements as well as questionnaire administration.

Finally, the Pearson's Product Moment Correlation analysis was used to test the correlation between volume of crop production and decreasing landuse under traditional farming system.

Results and Discussion

Landuse/Landcover pattern which varies from one region to the other is a factor of several variables ranging from climate, level of economic and industrial development, soil characteristics and these factors will also have effect on the area coverage of each identified landuse/landcover type in the region of location. Thus the following landuse/landcover types were derived from the interpretation of the satellite imageries of the study area (Fig 2, 3 -4). They are plantation, settlement, primary forest, waterbody, secondary forest, mangrove farmland, and Bareground.

Fig 2: TM 1986 landuse/landcover after classification of study are

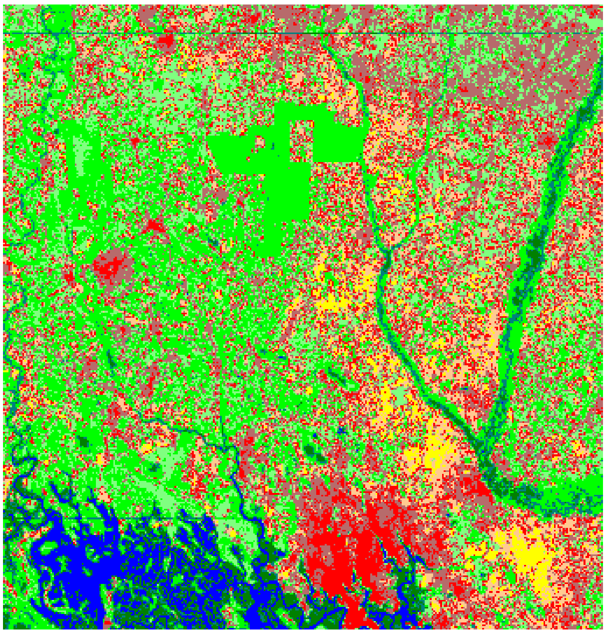

Fig 3: ETM 2003 LU/LC after classification of study area

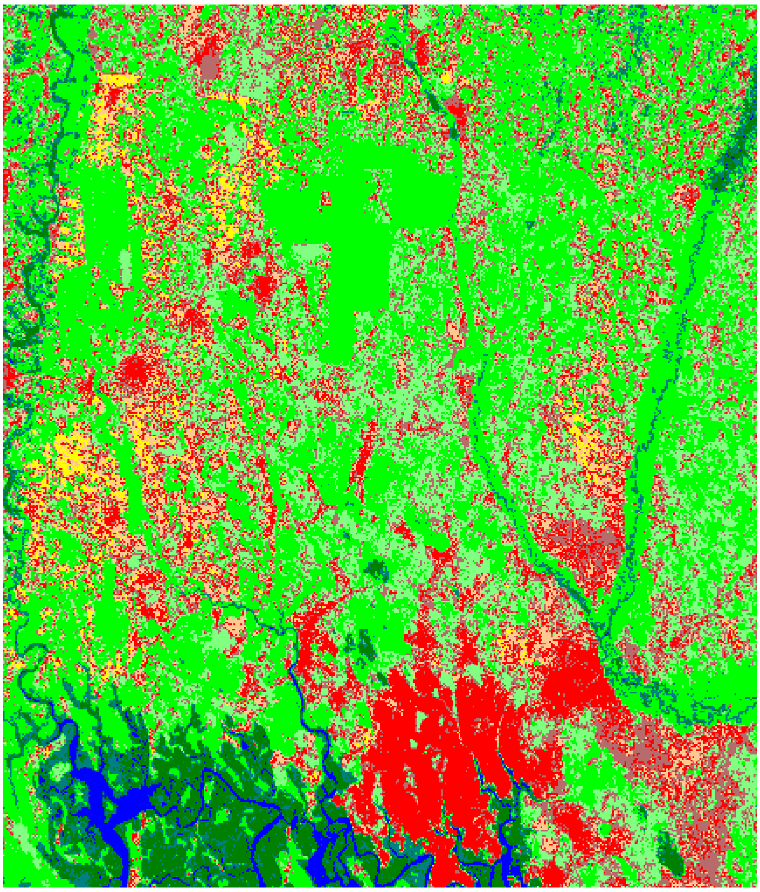

Fig 4: ETM 2008 LU/LC after classification of study area

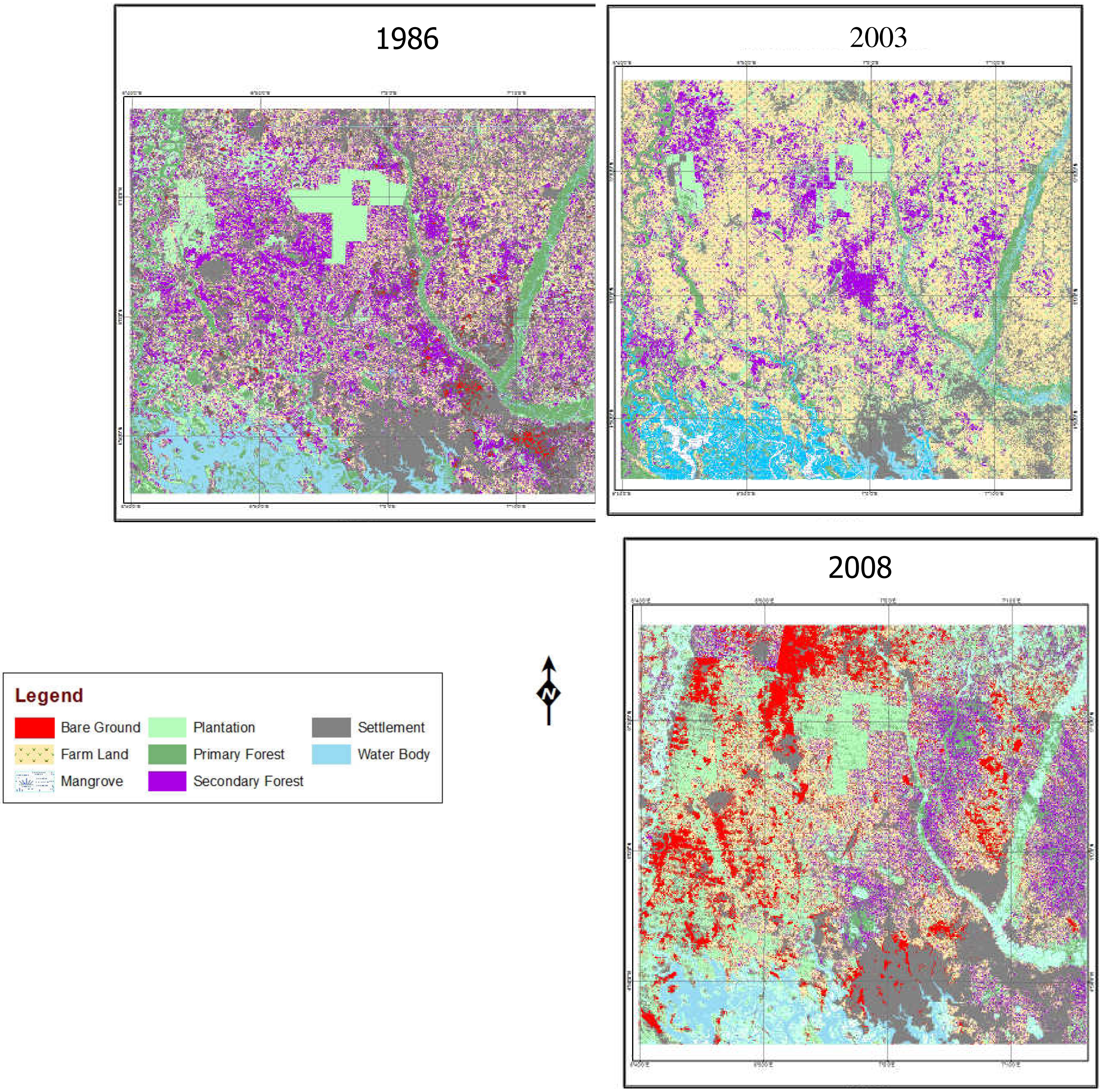

Fig 5: Landuse/Landcover Change Maps derived from TM Landsat Image 1986 ETM , 2003 and ETM 2008 showing changes in size of farmlands.

Table 1: Area coverage and percentage distribution of landuse/landcover types for the years 1986, 2003 and 2008.

	1986		2003		2008	
Landcover type	**Area(Hectares)**	**Percentage**	**Area(Hectares)**	**Percentage**	**Area(Hectares)**	**Percentage**
Plantation	58,301.82	14.68	46,412.71	11.69	64,123.70	16.14
Settlement	57,969.36	14.60	77,727.49	19.57	8 9,803.76	22.61
Primary Forest	38,580.57	9.71	40,609.78	10.22	29,212.25	7.35
Water Body	17,610.39	4.43	25,206.28	6.35	17,707.37	4.46
Secondary Forest	55,563.30	13.99	41,085.97	10.34	39,000.74	9.82
Mangrove	13,164.03	3.31	41,719.75	10.50	30,020.18	7.56
Farm Land	136,820.70	34.45	96,019.54	24.17	93,643.97	23.58
Bare Ground	18,974.43	4.78	28,203.10	7.10	33,472.67	8.43
Total	396,984.60	99.95	396,984.60	99.95	396,984.60	99.95

Farmland

Farmland accounted for the largest portion of landuse/landcover category with a total area of 136,820.70 hectares (34.45%) in size by 1986 (Fig. 1). It decreased by 40,801.16 hectares (10.27%) in 2003. In 2008, it further decreased by 2,375.57 hectares (0.60%). This trend of reduction could be related to the conversion of farm lands to built-up areas (settlement expansion) and other infrastructural facilities. Thus this trend could also be related to the conversion of farm lands to the built-up areas where residential houses, schools, hospitals, army barracks, Police stations, airports as well as other government facilities are sited. Similarly, between 2003 and 2008, some traditional mixed crop farmlands could have been converted to monocrop plantation farms as well.

It should be noted that traditional mixed cropping agriculture is the economic mainstay of the people. With the continued trend in reduction of the size of traditional farmlands as seen in Table 1, it means that land for staple crop farming will continually be scarce. This is because, the traditional mixed crop subsistence farming is an extensive cultivation system where large expanse of land is required for increased production since artificial inputs are not added to improve yield. It is to be noted that in this farming system soil fertility is dependent on twigs and litter decomposition to enrich the soil with the required humus and this again is a product of the length of years the soil is allowed to recuperate. Thus the longer the fallow years, the richer the soil when it is cultivated, which means that the traditional farmer needs enough farmland so that as one portion is being cultivated the rest portions are allowed to “rest” and regain enough fertility. However, unless there is a change or adoption of a new farm management technique by the people, this gradual trend in reduction of the size of farm lands is detrimental to the practice of bush fallow traditional farming system in the region. Consequently, the concept of environmental sustainability will be in question if the decrease in size of farm lands continues since it is an important environmental resources.

Effect of Land use changes on the Traditional Farming System.

The traditional bush fallow farming system is an extensive method of crop cultivation different from the intensive cultivation method. In this system, which is a modified version of the old shifting cultivation, farm lands are rotated for the purpose of increasing production. In the region of study, cropping is done in one plot for only one year, then the farmer moves on to another rejuvenated plot the following year to continue cultivation. Thus in a region that has an average fallow period of four and half to five years, the farmer must own a minimum of five different plots. Each of these plots must be sizable enough for increasing output since artificial fertilizers are not used. Thus to ascertain this relationship between size of farm land and crop (volume) output the result of the survey conducted in the three local government areas that make up the study areas are presented. In the survey, one main staple crop, cassava, was considered. The return rates of the questionnaire was 95 percent successful. The reason for this survey was to ascertain how size of farm land that is cultivated is related to the volume of cassava produce that is harvested from that farmland using only this crop as representative sample since it is the most cultivated. The survey was carried out separately for the three Local Government Areas that make up the study region. The results are as presented below.

Farm size and Cassava yield in lkwerre Local Government Area of Study Region

To empirically look at the changes occasioned by landuse changes as it affects the traditional farming system, the Pearson product moment correlation Analysis technique was adopted. This is because only two variables are involved, that is volume of crops produced and size of farm land. It is thus to compare the relationship between farm land size and the quantity of cassava produced from it. It is equally to find out if the relationship is positive or negative as well as how strong is the relationship. Thus the analysis of the data obtained from the field and collated showed the result of the Pearson Product Moment correlation coefficient as 0.0719 for Ikwerre Local Government Area. This shows a positive relationship between the two variables. However, to test the strength and level of the significance the student t-test was used. In applying the student's t-test, the result of the calculated t was 7.9950. The critical (tabulated) t-value at 5% level of significance is 1.96 implying t = 7.9950 > t (α) at 5% = 1.96. Thus, since the calculated t value is greater than the tabulated t value, we reject the Null hypothesis and conclude that there is a significant relationship between volume of crops produced and size of farmland. It therefore, infers a statistically significant relationship between size of farmland (land) and volume of crops produced (cassava). The inference to be drawn here is that as the size of the farmland increases (in the traditional farming system) the volume of cassava produced also increases. The conclusion to be drawn from the above is that farmland size is a critical factor in staple food crop production and this correlates positively with volume of crops harvested. In the study area reduction in farm land implies reduction in food crop production.

Farm size and cassava yield in Etche Local Government Area of study region

Similarly, the result of the Pearson Product Moment correlation coefficient for the data from Etche Local government area is 0.6498. This shows a strong positive relationship. In testing empirically the strength and level of significance using the student's t test, the result showed that the calculated t value of 2.974 is greater than the critical (tabulated) t value of 2.04 at 5% level of significance (t 2.974> t (31) at 5% = 2.04.) .The inference drawn here is that there is a statistically significant correlation between size of farmland and volume of crops produced in the traditional farming system in Etche Local Government Area. The analysis is that as the farmer increases the size of his farmland, the volume (harvest) of crops he will reap will also increase. Conversely, if the size of farmland is small or reduced, then volume of crops will also shrink, implying that the farmer involved in traditional bush fallow agricultural system needs more land for increased production.

Farm size and cassava yield in Emohua Local Government Areas of the study region

Using the data generated from the field survey in Emohua Local Government Area, the result of analysis for the computation of Pearson Product Moment correlation statistics is 0.2748. Though the result showed a positive relationship, in testing for the level of significance using the student's t test, the result indicated that the calculated t value = 3.7489 is greater than the critical(tabulated) t value of 1.96 at 5% level of significance (t = 3.4789 > t (100) at 5% = 1.96. The inference to be drawn here is that there is a statistically significant relationship between size of farmland and volume of crops harvested in the Local Government Area. This is because the calculated t-value is greater than the table t value, hence we reject the Null hypothesis which states that there is no correlation between size of farmland and volume of crops produced and thus accepts the alternate hypothesis. This implies that as the size of farmland increases, volume of crops produced also increase and as size of farmland shrinks the same thing happens to the volume of produce generated from that farm.

Conclusion

Thus it means that if a farmer in this study region wants to remain in farming business, he must change his farming system and techniques. This is because results from the interpretation of the satellite imageries (1986, 2003 and 2008) had indicated shrinking size of farmlands, secondary forest and primary forest (Table 3). The implication of this is that as farmlands use up the secondary and primary forest lands no new forests are created, while settlements use up farmlands, and this phenomenon is not healthy for extensive cultivation as practiced in the region.

Therefore if the peasant farmers must cultivate and produce their staple crops, they must adopt new innovations such as adapting to intensive cultivation system by cultivating one plot of land for more than one year or for a minimum of two years before moving to another plot in this fragmented system. Also such could be in form of application of artificial fertilizers, cultivation of new improved species of crops that mature early and disease resistant. Such intensive cultivation will increase yield but with minimum land size, although it has its environmental consequences such as elimination or total extinction of many forest resources that otherwise are valuable to the rural peasant populace.

Although it is believed that the traditional agricultural production is sustainable as it exerts minimum stress on the ecosystem, evident by such characteristics as maintaining rich crop diversity, attaining maximum crop cover and thus reducing erosion and run - off. It also produces for subsistence with few surpluses rather than for the market as well as maintaining ecological equilibrium and other such factors. It thus appears clearly evident from the foregoing results that this system will be forced to undergo an inevitable change. This is in respect with its production methods as it responds to factors in its production environment such as population pressure, social and institutional changes.

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