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Full Length Research Paper

Econometric analysis of the micro-level determinants of woodland conversion to arable cropping and implications to policy in Eastern Nigeria

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An empirical investigation was carried out to understand the impact of micro-level determinants of woodland conversion on arable cropping in the Sub-Sahara region of Africa because of the increasing rate of land conversion to agricultural use in the recent time. The study was based on a sample size of 291 farmers from Enugu State, Nigeria. Three sets of micro-level factors were examined and they are: farmer's background and preference (decision parameters) representing their inherent behavior and practices regarding woodland conversion to other use, farmers' characteristics and institutional factors. The study used simple statistics to analyze the effect of farmers' behaviors and their local practices on woodland conversion to other uses while ordinary least square regression model was used to capture the role of decision parameters on woodland conversion to arable cropping. The study noted that arable cropping, plantation agriculture, timber exploitation and house development were the major conversion options or alternative uses of woodlands in Enugu State. The results of the analysis indicated that arable agriculture was the most important (24%) form of human economic activity to the respondents in which they converted woodland. This was followed by cash crops/plantation agriculture (18.3%), fuel wood exploitation (15%) and timber and non-timber exploitation (14.3%) in that order. Regression analysis indicated that up to 78% of woodland conversion was attributed to farmers' characteristics and decision parameters. Econometric estimation indicated that land per capita, leadership status, poverty level, land tenure, dependency on woodland resources for fuel wood and income were negative but statistically significant at 5% probability. A test of significance of the parameter estimates of the variables indicated that 15 out of 17 woodland factors under study were statistically significant in their deterministic role to woodland conversion behavior of the rural farmers. Sign-wise, 8 determinants showed direct relationship with the conversion process. These were land per capital, leadership status, market access, age, land tenure regime, economic orientation/poverty level, dependency on woodland for income and dependency on fuel wood for domestic energy. The remaining determinants have indirect (that is, positive) relationship with the conversion phenomenon and therefore positively related to woodland retention.

Key words: Woodland conversion, farmer's characteristics, farmer's decision parameters, fuel wood, forestland, forest dependency, technology access, market Access, woodland conversion and policy Implication.

BACKGROUND INFORMATION

Vast areas in the tropics once harboured natural luxuriant deciduous woodland, which comprises forestland, scrubland, brush land, bush land and other woody vegetation lands. The rich flora and fauna found in these

areas met the subsistence needs of the numerous communities, primarily those living in the vicinity of the woodland (Kailsha, 1993; Stietenroth, 2005). Thus, woodland or forest in Nigeria, as elsewhere in the world has been a major source of livelihood to millions of humans throughout the evolutionary history of our species. Different parts of the plants (leaf, flower, fruit, seed, twig, pod, stem, root, tuber, bark and exudates and whole plant) in the region are used for various purposes such as food, fodder, fibre and fuel wood as well as sources of household articles, construction materials and ornamentals to mankind (Adegboye, 1992; Kailsha, 1993; Louis, 1993; Brown, 1994; Thomasin-Foster, 2009). Woodland also provides other utility values often not marketed such as maintenance of environmental equilibrium, through prevention of soil erosion, protection of watershed and headwater areas, regulation of atmospheric humidity, carbon sequestration (Adger and Brown, 1994; Brown and Adger, 1994; Stietenroth et al., 2005). These functions have been expanded by governments elsewhere to include income generation through mining, logging, game reserve, timber and non-timber products marketing (FAO, 1992; Grainger, 1993; Barber and Burgess, 1996; Arild and David, 1999). But, for man to continue deriving these benefits (both marketed and un-marketed) woodland must be well protected against conversion to other uses. Unfortunately, this is not so. Man continuously exploits woodland for many uses without making much effort to ensure its conservation (Ofomata, 1981). Expropriation of woodlands or forest from the traditional system has brought visible signs of environmental degradation such as loss of biodiversity, desertification, gully erosion, global warming, war and conflict, climate change and its increasing effects in the universe, etc, yet evidence of further degradation persists, mostly in the developing world with little effort to arrest the process (Stietenroth et al., 2005). For instance, eighty percent of the forest that originally covered the earth has been reported cleared, fragmented or otherwise degraded (World Resources Inventory WRI, 2003). A survey by Shepherd et al. (1993) showed that the world forests were estimated to have covered 5.2 billion hectares or about 40 percent of the total land space. Globally between 1990 and 1995, about 56 million hectares of forest and woodland were lost, a total of 65 million hectares in developing countries being partially offset by an increase of nearly 9 million hectares in the developed world (FAO, 1997; GEO, 2000). The scale of woodland conversion in the moist tropics has equally been quantified. For example, data compiled by FAO (1993) show that during the period 1980 - 1985, loss of tropical closed wooded land averaged 75,000 km^2 per year or an area of roughly equivalent to the country of Panama the report states. Myers (1986) and Sayer and Whitmore (1991), had estimated the original extent of tropical woody vegetation land at 16 million km^2. But a combination of ground surveys, aerial photos and remote sensing from satellite images shows that in 1992 only, 9.5 million km2 of the woody vegetation land remained unaltered, an area about in size to the continental United States. Richards (1995) had projected that at the current rate of woodland loss, there will be very little of tropical forest left after the year 2040 except in the relatively small areas under protections. In a similar vein, Robin and Gerald (1988) stated that forests in some countries such as Sudan will fall to zero by the year 2005. In Nigeria, data on land use change (including woodland conversion) during the last decade are relatively limited and based on estimate from satellite imagery, (Federal Department of Forestry, FDF, 2003). But, evidence of progressive conversion of woodland abounds in the increasing level civil works of in urban and semi-urban areas and people's propensity to fend a living from land resources due to poverty level in the rural areas.

FACTORS THAT AFFECT WOODLAND CONVERSION

A set of factors influencing woodland conversion have been put forward by Adger and Brown (1994). The factors according to them are population increase, poverty, debt and macro-economic adjustments, policy and market failures, agricultural practices and natural/environmental occurrences. Adegboye (1984) attributed woodland conversion to market forces, that is, the interplay of demand and supply. Adger and Brown (1994) were of the opinion that changes in land-use result from socio-cultural and economic forces within the context of which physical environment acquires a function as a medium for production. However, arguments still exist among foresters, ecologists and land authors on the influence of these factors on woodland change. For example, Colchester and Lohmann (1993) argue that the problem starts with perverse and inequitable agricultural policies in which erosion of land rights in agricultural systems results in marginalization and impoverishment of small farmers and consequently leads to colonization of woodland areas. But, Richards (1990) and Boserup (1985) argue that population expansion of the subsistence farmers is the underlying cause of woodland conversion since according to them, it is the primary determinant of land availability to user's demand. Mather (1990) in his 'Forest Transition' postulates that the level of economic development and population increase determine the demand for forest products, forest cover and other land resources. Allen and Barnes (1988) opposed the role of population increase on land-use change. They posited that occupation, labor supply and labour migration are chief determinants of land-use change. In a densely populated environment, occupational categories, which cut across non - agricultural activities (such as trading, weaving, etc.), have little or no

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influence on land use. Although population could increase, the authors opined that such increase may not result in labor injection to land use.

Following from the above diverse school of thoughts, it could be seen that the debates among foresters, ecologists, agriculturists and land authors on the determinants of woodland conversion is still inconclusive. No one factor has been identified to cause the conversion alone and no much effort to seek the causes of these changes at the rural settings has been made in the recent time. The debates call for empirical investigation and reconciliation at the rural settings. In reality, woodland conversion is rarely a simple process.

More often than not, it results from a complex chain of events, involving a number of different agents and causes in each locality and point in time. On a general level, population growth, economic growth, market penetration, infrastructure and poverty are some of the principal factors theoretically held responsible for the conversion to arable cropping. But, except for macro information through satellite imaginaries, very little and vague empirical understanding of the role of these factors and their interactive influence exists for many developing countries including Nigeria. Yet it is at the household level that decision to clear or not to clear woodland are taken, thus necessitating household level research to improve understanding of why and to what extend woodlands are being converted to arable cropping in the rural areas of Nigeria. This is because the landscapes and people of the rural areas, especially, are extremely diverse. But, rarely does research recognize that farmers approach to woodland is location specific and determined by their behaviour, characteristics, institutional and infrastructural parameters (decision parameters) and the agro-ecological features of that forest. Successful remedies for rural woodland conversion must be firmly rooted in these broader contexts otherwise interventions will fail. The value of this approach is obvious: the description and empirical analysis of wood conversion to arable cropping in the rural setting will enable research find out where the pressure points are and how to intervene to prevent conversion where it is undesirable instead of condemning the sources or agents alone as one way to mitigate the impact of climate change.

This study was therefore concerned with describing and analyzing farmers' behaviour and practices regarding the use of woodlands and their conversion to other uses and investigating the manner and to what extend farmers characteristics and decision parameters affect their decision to clear woodlands for arable use. The study focuses on empirical analysis of farmers' characteristics and their decision parameters. Farmers' characteristics are the exogenous factors which are those attributes of the farmer which he acquires as he grows to influence his behaviour. They include his background, resources and preferences and explicitly broken down into age, farming experience, land per capita, educational status, economic orientation, dependency on woodland for income, dependency on fuel wood for energy, income level, leadership status, farm holdings, off-farm employment, fallow period and land tenure regime. Institutional and infrastructural factors are rules, procedures, moral and ethnical behavioral norms, which influence human decision and represent the choice or decision variables during the conversion process. These include land access, credit access, technology access, market access, membership of rural institutions (e.g. cooperative, farmers club and age grade. The research questions addressed by this study were cast in the following sets of research questions:

1. In what manner and to what extent are farmers converting woodland to other uses?
2. Through what forms of human economic activity is woodland being converted to other uses?
3. What is the relative importance of these various forms of human economic activities in the conversion process?
4. In what direction and to what extent is the decision to convert woodland to arable cropping uses affected by the characteristics of the farmer including background, preferences and resources?
5. In which ways do institutional and infrastructural factors impact upon woodland conversion to arable cropping among the rural households?

JUSTIFICATION

Woodland and forest conversion has been a source of worldwide concern, especially with the emerging environmental problems of global warning. Historically people all over the world have cleared woodland to make productive use of the land beneath it. In some cases the act brought about extinction of biodiversity, global warming, war and conflict among neighbourhoods, erosion of cultural heritage, breakdown of watershed insurance, soil degradation, increased salinity, sedimentation of reservoir, etc. (Grainger, 1993) yet, woodlands are reported to disappear in some countries by the year 2005 (Robin and Gerald, 1988; GEO, 2000). If some conversions are indeed inevitable yet undesirable, it would seem futile to attempt to halt them completely. A more realistic target would be to exert tighter control of the changes or conversions by tackling the causes rather than the symptoms of the problem, so that future rates of conversion are kept at manageable levels. Any research such as this, which sets out to provide comprehensive information on the causes, scale and possible consequences of the problem and suggests how it might be tackled, is quite justifiable. Incidentally, a lot of existing research work on woodland conversion have centered on macro-economic factors such as population growth, poverty level, national income, economic growth and foreign debt, which remain ambiguous to

the ordinary man at the village level where the bulk of conversion takes place. The role of micro level decision parameters and farmers inherent characteristics and behaviour to such land though theoretical where they exist are still weak in empirical approach to enable both land users and government agents understand the process of this conversion. Few environmentalists and socio-economists that tried to do so have muddled together the agents, sources and causes of woodland conversion thereby creating confusion in the classification and description of the entire conversion process. Therefore, before useful predictive analysis of woodland conversion trend can be attempted in any location, greater attention has to be paid to the collection of accurate woodland-use data, comprising woodland conversion choices, causes and effects of woodland as well as establishing clear difference between the agents, sources and forms of conversion. New information from research such as this will help in this regard. This study, therefore, differentiates clearly between agents, sources, agents' decision/farmer characteristics/immediate causes and their decision parameters/underlying factors.

Finally, all the partners involved: governments, intergovernmental organisations, private sectors, NGOs and other major groups interested in eco-balance and environmental quality will by this research be equipped with up-to-date working material to understand and resolve the dynamics of woodland conversion. Enugu State, members of academia, students and land users in the Nigeria and sub-Sahara Africa will particularly benefit from the research.

OBJECTIVES OF THE STUDY

The general objective of the study is to investigate the micro-level factors affecting the conversion of woodland to arable cropping and the direction and magnitude of their effects. In order to achieve the general objective, the following specific objectives were considered:

1. To describe and analyze farmers' behaviour and practices regarding the use of woodlands and their conversions (both partial and complete) to other land uses and
2. To identify agents of woodland conversion as well as investigate the manner and to what extent farmers' characteristics (background, preference and resources) and institutional factors (forest/woodland tenure, market access, technology access, membership of rural groups and credit access) affect woodland conversion to arable cropping.

RESEARCH HYPOTHESES

Based on the specific objectives the following null hypotheses were tested:

$H0_1$: Woodland conversion to arable cropping is not caused by land per capita, poor literacy level, poverty/income level, greater dependence on forest/woodland resources for income generation and fuel wood energy.

$H0_2$: Woodland conversion to arable cropping is not enhanced by market access, communal ownership arrangement, access to off-farm employment, technological alternative, membership of rural groups and credit availability.

METHODOLOGY

Study area

The study was conducted in the rural areas of Enugu State, Nigeria. The state is located between latitudes 5°56 N and 7°06 N and longitudes 6°31E and 7°55E. The State had a land area of 8000 km2 or 800,240 hectares and a population of 2.1 million persons made up of 1.0 million and 1.1 million males and females respectively (NPC, 1991). This population grew to 3.3 million persons that are made up of 1.62 million males and 1.63 million females (NPC, 2007). These correspond to a population density of 263 persons/km^2 in 1991 and 407.2 persons/km^2 in 2006. The population density of 407.2 persons/km^2 overshot the projected densities of 350 persons/km^2 in 2001 and 360 persons/km^2 in the year 2005 (FOS, 2001). The trend indicates a continuous decrease in land area per capita and suggests incidence of land hunger in future. The State was purposively chosen because of the presence of large expanse of woodland, existing potentials for their conversion to arable cropping and the researcher's familiarity with the rural areas, which assisted in data generation. A multi-stage random sampling was employed to ensure good spread of the respondents in data collection. In stage I, three communities were randomly selected from each of the 12 purposively selected local government areas in the State. In stage II, for each of the randomly selected communities, nine farmers were randomly selected from the list of farmers groups obtained from the State Agricultural Development Programme. This gave a total of 324 farmers who responded to the structured questionnaires administered to them for primary data generation. Out of the 324 questionnaires administered to the respondents, 33 were unusable while 291 were analyzed. Secondary data were obtained from the State Ministry of Agriculture.

Data analysis

Descriptive and inferential data analyses tools were employed in analyzing the obtained data. Basically simple tables and measures of central tendencies like means were the descriptive tools while ordinary least square regression model were the inferential tools used in the study. The first objective was achieved using descriptive statistics while the second objective was achieved using regression model.

Analytical framework

Ordinary least square regression, a statistical tool for evaluating or establishing the relationship between one dependent variable traditionally know as Y-variable (regress) and the independent variable traditionally known as X-variable/s (regressor(s) to draw certain statistical inferences about their association (manner and strength) was employed in the study. The model is given below:

$$Y_i = \alpha = \beta X_i + \mu_i \text{ for all observations } (i = 1, 2, \ldots..n) \quad (1)$$

The dependent variable Yi is the variable whose values change in response to changes in the values of the independent variables. Therefore, the values are determined within the model. The Xi represents explanatory (independent) variables and μi represent the random variables (or error term, with constant variance, zero means). The μi captures error arising from poor measurement, human behavior, and variable omission, aggregation of variable and wrong specification of the mathematical version of the model. The Linear regression model is based on 4 basic set of assumptions which have been summarized mathematically as follows:

$$Y_i = \alpha = \beta X_i + \mu_i \ (i = 1,2,.....n) \quad (2)$$

$$E[\mu_i] = 0 \text{ for all } i$$

$$E[\mu_i \ \mu_j] = \begin{cases} 0 \text{ for } i \neq j, \ i, j = 1,2,...n \\ \sigma^2 \text{ for } i = j, \ i, j, = 1, 2, \ ... \ n \end{cases}$$

Following from the information above the regression model used to analyse the causal relations of micro-level factors (farmer characteristics and institutional factors) and wood land conversion to arable cropping in rural areas of Enugu State was expressed as follows:

$$Wc = b_0 + b_1Lpc + b_2Ed + b_3Ec + b_4Fdi + b_5Fwd + b_6Ofe + b_7Ag + b_8Fex + b_9Fp + b_{10}Lds + b_{11}Ltr + Cra_{12} + Tech_{13} + Mka_{14} + Mrg_{15} + Fta_{16} + Atc_{17} + \mu \quad (3)$$

Where:

Wc = Percentage woodland cover belonging to the farmer (%)
Lpc = Land resource per capita i.e., total land area (ha) total household size (nos) – (ha/person)
Ed = Educational status of the household head (1, if household head attained secondary – level education, O, otherwise)
Ec = Economic orientation of the household head (% of total household output that is marketed)
Fdi = Household dependency on woodland resources for income (% share of income obtained from woodland)
Fwd = Household dependency on fuel wood for domestic energy (1, if wholly dependent on firewood; 0, if otherwise)
Ofe = Access to off-farm employment (% share of total income from off-farm employment)
Ag = Age of the household head (years)
Fex = Farming experience (Number of years in farming operations)
Fp = Agricultural Land use intensity/fallow period (Number of years for which the land is left uncultivated)
Lds = Leadership status (1, if a leader; 0, if otherwise)
Ltr = Land Tenure regime (1, if inheritance; 0, if otherwise)
Cra = Credit access (amount of farm credit obtained last year in Naira)

Fta = Forest or woodland tenure arrangement (1, for inheritance; 0, otherwise)
Mrg = Membership of rural group (1, for being a member; o, otherwise)
Atc = Access to conservation programme (index of conservation programme
Tech =Technology use level (index of technology adopted)
Mka = Market access (% share of farm output sold)
μ = Error term

From the model specification, conversion is achieved when the parameter estimates is negative. Woodland conversion is specified as the opposite of available woodland.

RESULTS AND DISCUSSION

Farmer's behaviour and practices regarding woodland conversion (both partial and complete) to other land uses

Farmers' behaviour and practices regarding woodland conversion to other land uses is by this research referred to as the various options and alternative uses of woodland including all the actions involved in such uses. Therefore, following from this definition, this study identified arable agriculture (subsistence and commercial cultivation), cash crop/plantation agriculture, pasture/livestock development, timber and non-timber exploitation (logging, lumbering, collection of stakes, fruits, honey and vegetables), fuel wood exploitation and civil works development as the various conversion forms, choices of options or alternative uses of woodland in Enugu State. The index of wood land conversion to other uses is shown in Table 1.

The index of woodland conversion to other uses as seen from Table 1 was generated from the farmers choice and ranking of all the human economic activities which led to the conversion of woodlands. The ranking was based on the degree of importance of the conversion options as perceived by the farmers and captured according to highly important, slightly important and least important for 1st, 2nd and 3rd ranking scores respectively. The result of the percentage of the total was performed and the rank outcomes were transformed or standardized to base **e** to reduce the large data to appropriate numerical value or to derive index used in interpreting the behavior of the farmers with respect to the conversion options. The analysis, as explicitly explained in Figure 1, indicated that arable agriculture was the most important form of human economic activity to the respondents in which they converted woodland. About 24% of the conversion was attributed to arable crops alone. This was followed by cash crops/plantation agriculture (18.3%), fuel wood exploitation (15%) and timber and non-timber exploitation (14.3%) in that order. Housing and ranch development ranked least in the order of importance and to the farmers' behaviours and practices regarding woodland conversion to other uses.

Impact of farmers' characteristics and institutional factors on woodland conversion to arable cropping

This study identified agents of woodland conversion as small farmers, ranchers, loggers, fuel wood collectors, plantation/cash crop growers, etc. These agents' action (behavior, attitude or practices) such as farming, ranch/pasture development, fuel wood exploitation, surface mining and cash crop/plantation agriculture are referred to, by this study, as sources of woodland conversion or alternative uses of woodland and have been analyzed using descriptive statistics as seen in

Table 1. Index of woodland conversion to other uses.

Forms of conversion	Ranked 1st score = 5	Ranked 2nd score 4	Ranked 3rd score 3	Total score	Index of forest conversion to base 10	(%)
Arable crop	218	48	18	365	2.41	24.0
Cash crop/Plantation agric.	131	110	35	276	1.83	18.30
Timber /Non-timber exploitation	27	41	149	217	1.43	14.30
Ranch/Livestock development	79	56	81	213	1.40	14.0
Fuel wood exploitation	83	56	86	225	1.50	15.0
Housing development	32	90	94	216	1.42	14.20
Total				1512	10.00	100

Source: Field Survey, 2004.

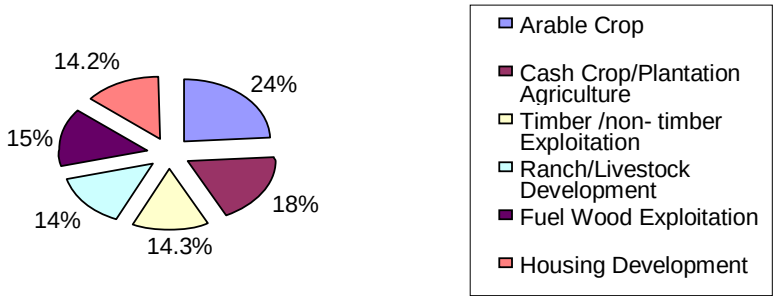

Figure 1. Woodland conversion choices/alternatives, Sources: Field Data, 2004.

Figure 1. The present section dwells on specific category of agents' decision factors, which are farmers' own characteristics such as background, preference and resources and the institutional factors, which here represent some of the set of rules, compliance, procedures, moral and ethnical behavioral norms as defined by Feency (1988) and Arkadie (1989). These are access to credit, market access, technology level, membership of group, tenure regime, etc. The empirical estimation of the regression model facilitated the understanding of the manner and to what extent the factors influenced the rural farmers in their attitude to convert woodland to arable cropping in the Enugu State. To achieve this, the individual and joint causal weights of the hypothesized variables were estimated and analyzed. As expected different values of coefficient of multiple determinations (R^2) and parameter estimates were obtained from the regression models. The double log model was chosen as the lead equation because of its suitability in causal relationship in producing the best value for R^2. The result of the analysis has been fitted in the model as shown as follows.

Fitted model

The analysis derived farmers' characteristics and institutional factors of woodland conversion to arable cropping model are as follows:

Double - log functional form

Log Wc = -2.116 - 0.021 log Lpc* - 0.112 log Lds* + 0.018 log Mrg** (1.02) (2.91) (2.63)(3.41)

- 0.084 log Ltr* - 0.264 log Mka* + 0.061 log Tech* + 0.031log Fta* (2.22) (2.11) (3.52) (2.96)

+ 0.127 log Cra* + 0.467 log Atc* + 0.037logFp* - 0.093 log A (3.0) (2.17) (1.98) (1.84)

+ 0.068 log Ed - 0.179 log Fdi** - 0.181log Fwd** - + 0.018 log Ofe (1.78) (3.41) (3.56) (1.64)

+ 0.018logFex - 0.211logEc* (4)
(0.15) (2.01)

R^2 = 0.78 F-ratio = 18.35

Figures in parenthesis are t-values

DISCUSSION AND INTERPRETATION OF RESULTS

Since F*cal = 18.35 > F-tab = 1.67 at 5 percent probability level, the null hypothesis: Ho: $b_1=b_2=b_3=b_4=b_5=b_n=0$ that is, farmers characteristics do not significantly influence woodland conversion to arable cropping. This result shows that the model is statistically

significant since the b_s are not all zeros. This result indicates that woodland conversion to arable cropping has a relationship with land per capita, poor literacy level, poverty level, market access, communal ownership arrangement, access to off-farm employment, technological alternative, membership of rural groups, credit availability, greater dependence on woodland resources for income generation and fuel wood energy. Analysis as indicated in the double-log equation produced a coefficient of determination R^2 of 0.78 and an F – ratio of 18.35. The significance of F-ratio in the analysis shows that the model is well fitted for the data on farmers' characteristics and institutional factors generated in the rural areas of Enugu State. It further indicates that 78% of the variation in woodland conversion is well explained by the lead model. This could mean that the contribution or influence of farmers' characteristics and institutional factors on woodland conversion to arable cropping is about 78%. The remaining 22% is attributed to other determinants not captured here such as the underlying forces of market failures, government policies, natural degradation and environmental problems (erosion, landslide, unguided burnings and agro ecological features of the vegetation land). A test of significance of the parameter estimates of the variable indicated that 15 out of 17 woodland factors understudy were significant in their deterministic role to woodland conversion behaviour of the rural farmers. The signs and magnitude of both coefficients and their respective standard errors were in line with *a priori* expectation. Sign-wise, 8 determinants showed direct relationship with the conversion process. These were land per capital, leadership status, market access, age, land tenure regime, economic orientation/poverty level, dependency on woodland for income and dependency on fuel wood for domestic energy. The remaining determinants have indirect (that is, positive) relationship with the conversion phenomenon and positively related with woodland retention.

Arable land per capita

The result of the analysis indicates that the coefficient of the parameter estimate is negative. Also analysis obtained a t-calculated value of 2.91 against 1.75 for t-tabulated at 5% probability level. This implies that land per capita was statistically significant in its deterministic role to woodland conversion. Since the study defines woodland conversion (Wc) as the percentage woodland cover available, it could be logically stated that conversion of woodland to arable cropping is directly proportional to increase in family size. Less land per capita will mean more conversion. The study captured an average of 10 plots per farm family representing about 2.5 hectares per farm family in Enugu State. A plot measures 0.25 ha in the study area. Also, field observation recorded an average family size of 7 persons per family and in the ratio of 3 males: 4 females. This translates to a land per capita value of 0.83 ha. An available 0.83 ha per family in a rural setting which primary occupation is mainly agriculture means an incidence of land hunger. This could result to clearing accessible community vegetation land to sustain their agriculture dependent livelihoods. The implication of finding for policy is that as long as dependency ratio within the household increases in rural settings without corresponding off-farm enterprises to support their living, land hunger will create undue pressure for households to interfere with their woodland. Policy framework that targets business oriented enterprises or control in family can form a panacea in this regard. Part of the policy could be to introduce a commodity value chain programme which substantially emphasizes on using best agronomic practices to optimize productivity, linking production, processing and marketing activities to market demand. The advantage of this model is that it leads to creation and progressive expansion of service markets which leads to job creation and significant return on investment for key stakeholders including farmers and their children along the segments. This value chain will accommodate the high dependency ration of the farm families through various service linkages and off-farm (factory and distribution) jobs. At the beginning, the tendency is to stimulate further land use, but on a short run it leads to a conscious effort by the public sector to invest in irrigation infrastructure, marginal land reclamation and reduction in land pressure. In the same vein, the private sector begins to invest in value addition through processing to expand range of products for consumers. The effort naturally leads to more factory jobs for youths thereby limiting the number of on-farm participants in the supply chain. The policy that limits the number of children per farm family through encouragement of rural education can complement this effort. Explaining the relationship between education and dependency ratio, Okpukpara and Odurukwe (2003), reported that educated farmers tend to have low dependency ratio than the non-educated one.

Leadership status

A leader is one who has the ability to command others. Social standing of rural farmers, which has been captured in this study by different leadership roles and responsibilities, conferred advantage on them to clear communal or own woodlands. The result of the analysis indicates that the coefficient is -0.112 and the t-value was 2.6 against t-tab of 1.75 at 5 percentage probability level. This means that leadership status contributed positively to conversion of woodland in the study area. A test of significance of the parameter estimate also showed that the coefficient was significant at 5% probability level. This finding, therefore, suggests that some leaders take advantage of their position to clear woodland for arable cropping. Part of the programme for National Orientation

Agency of developing countries will be to encourage the orientation of village heads on their role as custodian of natural resources to protect woodland from undue interference. In this regard, advocacy and the instrumentality of participatory involvement to environmental issues become obvious.

Membership of rural institutions

The result of the analysis shows that the coefficient (0.018) of the parameter estimate was significant and positively related to percentage of woodland cover of the respondents. The t-value of 3.41 against t-tab of 1.75 at 5 percent level of significance was recorded. This means that membership of rural institutions did not significantly encourage woodland conversion rather it was a useful instrument for woodland retention in the rural area of Enugu State. This could be due to available different options for increased yield provided to the members by cooperation as well as involvement in non-farm enterprises for their income. Most government programs on agriculture emphasize on group approach to facilitate access to high yielding technologies which has increased intensification process, according to field analysis. Up to 45% of the farmers confirmed their use of fertilizers and high yielding seed varieties for their farm operation. This according to them resulted in intensification of land use, long fallow period and increase in yield, a tendency that limited their urge to clear woodland. Therefore, one could infer policy measures that enhance group formation at the rural level. The activities of such groups should be free from government interference for sustainability and injection of market oriented enterprises as earlier reported could subsist.

Market access, credit access and technology access

A test of the significance of the parameter estimates of market access, technology access and credit access indicated that the coefficient of the decision parameters (market access, credit access and technology access) were all significant at 5% probability level. However, result indicated that market access has negative coefficient (-0.264), credit access (0.127) and technology access (0.076) each recorded positive coefficient. This is consistent with *a priori* expectation, the values of t-calculated for the three determinants were 2.11, 3.0 and 3.5 respectively against t-tabulated of 1.75. Finding indicates that the negative sign of market access suggests that market access significantly influenced woodland conversion to arable cropping. It indicates that increased income from sales of woodland products such as oil bean seeds, stakes, bamboos, trunks, planks, fruits, vegetables, timber products, honey, etc was a motivation for continued interference with woodland. Also, available market for farm produce could contribute to more market-oriented agriculture which can lead to further expansion of farmland (in the short run) or increase the farmers' resource base to access modern inputs. This finding is consistent with Arild and David (1999) who stated that when farmers are fully market integrated, high prices for agricultural products stimulate forest clearing. According to the Authors, as agricultural frontiers become more profitable, both the existing population and migrants from other areas begin to shift resource to forest clearing. Higher prices according to them provide capital to put additional land into agricultural use. But this research observed that the scenario is correct in a situation that lacks safety nets in industries or defined product range where the forest or woodland is under partial interference gatherers than for absolute clearing by farm holdings. This is probably why findings indicate that market access, brought about by greater proportion of the woodland products disposed for sale, decreased percentage of woodland conversion of the respondents.

This scenario above is also a typical traditional oriented agriculture where livelihoods is sustained by forest products and output level is based on land expansion with no inherent attribute for off-farm jobs as observed by research. This is different for credit and technology access. Credit access showed positive sign and was significant at 5% probability levels meaning that credit access did not significantly influence woodland conversion to arable cropping. This is justified by the fact that some of the respondents who benefited from rural saving scheme used the credit for the purchase of yield enhancing technologies (such as improved, seeds, fertilizers and crop protection chemicals). The study observed that the use of the yield enhancing technologies increased crop productivity by over 100% especially for rice, maize and seed yam, and confers an incentive for farmers to limit conversion of fresh woodland. It was observed that this model is a quick money generation strategy for youth to raise capital for other high turnover and non-seasonal businesses. The study recommends for a policy framework aimed at encouraging sustainable credit lending for agri-inputs and payment through a buyback arrangement. The use of out-growers scheme and the active participation of the private sector are re-emphasized as panacea in this regard. This behaviour with credit access is also similar with technology access. A test of significance of parameter estimate b indicated that technology access was significant at 5% probability level. This means that access to technology did not significantly influence woodland conversion in Enugu State. Findings indicate that available technologies such as improved seedlings; fertilizers and chemicals restore the hope of the rural farmer over depleted lands. Thus, in line with Holden (1993) respondents prefer intensive use of the land with high productivity input indicators instead of extensification involving expansion of agricultural land. Holden had observed that in a general context, technologies that make intensive production systems

more profitable reduce the need for additional woodland for agriculture. In line with Holden and the findings from this study, it implies that agricultural research and extension policies designed to limit woodland conversion should focus on promoting access to yield enhancing and commercial-led agricultural technologies with minimum on-farm labour supply initiative.

Age and educational background

A test of the significance of the parameter estimate of age and educational background indicated that the coefficient was negative for age (-0.93) and positive for educational background (0.68). It also indicated a t-cal of 1.84 and 1.78 against a t-tab of 1.75. This means that while age has significant influence in woodland conversion, educational background did not significantly influence the conversion process. The analysis implies that age has a significant effect on woodland conversion to arable cropping. The age of household head and the entire family composition determine the level and direction of their participation in agricultural practices and other economic activities from labour supply theory (Odoemena, 1997). The study recognizes that efficiency requires physical vigor and muscular strength especially for un-mechanized agriculture in the rural areas. Physical and muscular exertion is a function of productivity for effective manual work. In the rural settings, young farmers usually farm for their parents, but by early maturity (usually 30 to 45 years), the entrepreneur's instinct takes over and the desire to own a home and become economically independent predominates his thinking. The zeal to achieve higher output to gain social recognition pushes him along side his peers through shared labour arrangement to clear woodlands that have been either abandoned or partially touched, especially where there is limited alternative option for livelihood. This reinforces the need for the public and private sector to support policy framework on value addition through processing, branding packaging and marketing which provides sustainable incentive in service expansion along the entire segments of the commodity chain by creating off-farm employment opportunities that discourage youth from woodland conversion. Similarly, this research findings show that respondents' involvement in woodland conversion declined with level of education. This could mean that attainment of more education broadens the horizon of the farmers. The educated farmer is more likely to take agriculture as a serious and income generating venture by shifting from subsistence to commercial agriculture, which will ordinarily approximate to clearing additional farmland. But, he has better access to credit (Desai and Mellor, 1993) and other enhancing productivity opportunities (such as membership of rural groups/cooperative, efficient use of cultural methods, better adoption of integrated agronomic practices, etc) to increase his/her output level. He also appreciate the value of forest more than the uneducated ones. Though, the scale of farming and better access to machines could lead to expansion to virgin lands including woodland, this was not obtainable in the study area where agriculture was yet to be mechanized. The study indicates that up to 80 percent of the respondents have formal education. A tendency to protect woodland instead of seeking conversion is therefore possible with better literacy level hence the positive coefficient of the parameter estimate in the study. One can infer policy measures that enhance the educational level of the farmers. Emphases should be placed on gender education and other means of empowering the vulnerable groups since woman farmers who constitute majority of the faming population do the bulk of the conversion with child's labour.

Economic orientation and off-farm employment

A test of significance of the parameter estimate for economic orientation captured by poverty level of the respondents showed that the coefficient was significant and had negative sign (-0.211). This is in conformity with *a priori* expectation. The t-value was 2.01 against a t-tabulated value of 1.75. Findings imply that poverty is a driving force, which propels rural people to convert woodland to arable cropping. This was also reflected in the positive coefficient of the parameter estimate for off-farm employment. Findings indicate that high involvement of farmers in various off-farm employments did not translate to woodland conversion. This is also in line with Allens and Barnes (1988) who stated that occupational categories that cut across non-agricultural activities (such as trading, weaving etc) have little or no influence on land-use change. One has, therefore, strong reasons to believe that policies that encourages off-farm employment opportunities for rural farmers will reduce conversion of woodland. Such policies should emphasize development and commercialization of down stream agricultural production to alleviate rural poor and conserve woodland.

Dependency on woodland resources for fuel wood and income

These were very important determinants in the conversion of woodland to arable cropping model. Analysis indicated that the coefficients were -0.352 and -0.178, respectively for dependency on woodland resources for fuel wood and income. A test of significance of the parameter estimates produced t-values of 3.5 and 3.0 respectively at 5 percent probability level against 1.75 for t-tabulated. This means that dependency of woodland resources for either fuel wood or income has significantly

affected woodland conversion to arable cropping in Enugu State. Findings have indicated that 92% and 89% of the respondents depended on fuel wood for domestic cooking and pressing of cloths respectively. The farmers had reported that they generated extra income from sourcing and felling of yam stakes, collection of fuel wood, vegetables, trunks (for mortar construction), bamboos, tapping of wine from raffia palm trees, lumbering, harvesting of honey, picking of snails and mushrooms, gathering of breadfruits, etc. to sustain life. This implies that the act of sourcing livelihood from woodland facilitates conversion (partial degradation) of the natural resource. One could suggest for policy aimed at home agro-forestry and rapid reforestation through replacement of each tree felled by more than two species of it. An agency for monitoring and controlling the utilization of woodland resources is also advocated. The operation of such agency should be participatory in nature to accommodate the interest of all stakeholders and avoid conflicts.

Land tenure regime and woodland tenure arrangement

The regression results also indicate that land tenure regime and woodland tenure arrangement were among major determinants of woodland conversion to arable cropping. The result of the analysis produced coefficient values of -0.084 and 0.031 for land and forest tenure arrangement respectively. The statistical test (t-test) of significance indicated a t-ratio of 2.22 for land tenure regime and 2.96 for forest tenure arrangement against 1.75 for t-tabulated. Analysis shows that conversion of woodland to arable cropping was significantly discouraged by communal ownership of forest resources. Similarly, the negative and significant coefficient of land tenure regime indicated that individual inheritance other than communal property right facilitated conversion of woodland to arable cropping, because of inheritance attachment and generational division of land to household members. The scenario is different under community ownership where stringent conditions exist for the community members to interfere with the wooded vegetation for agricultural use.

Conclusion

This study has established that in the rural setting of Enugu State, Nigeria, woodland conversion to arable cropping is caused by land per capita, poor literacy level, poor economic orientation and greater dependence on woodland resources for fuel wood and income. The analysis also concluded that woodland retention is enhanced by communal ownership arrangement, access to off - farm employment, technological alternatives, membership of rural groups and credit availability. It advocates for policy that will encourage the use of high yielding technologies and investment in down stream segment of agriculture to provide employment alternative to youths. The policy framework is summarised in the support for a value chain agricultural development approach with integrates the participation of all the stakeholders – producers, processors, market actors, and government in the business and development of agriculture. For the rate at which woodland has been converted in the study areas, this research also advocates the creation of one green belt per state in Nigeria, to act as carbon sink, as well as recovery poll of lots of fauna and flora that are getting extinct in the country.

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