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Agricultural productivity under *taungya* and non-*taungya* land-use options: a case study of Vandeikya Local Government area, Benue State, Nigeria

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ABSTRACT

Taungya farming is a special arrangement between the forestry department and farmers, which combines the production of both arable and forest tree crops simultaneously on a piece of land. The practice was adopted in Vandeikya Local Government area of Benue State Nigeria, in mid 1950s up to 2000. This study evaluated the method as an option for food and fiber production compared to the traditional farming and forest management practices. Using Stratified random sampling, two sets of questionnaire were used to appraise the productivity of some arable crops and forest regeneration under *taungya* and non-*taungya* cultural practices. The yields of arable crops were significantly higher under *taungya* farming that in non-*taungya* plots in the study area. There was however no significant difference in the total forest area regenerated under the two land-use systems. The apparent land hunger among farmers is a favourable factor for adoption of *taungya* as a land use option in the study area. There is need to adopt multi-species planting approach in future programmes. Also, the land tenure system which limits access to land by strangers needs to be reviewed and greater awareness on the programme needs to be generated among the farmers and forestry staff alike.
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Keywords: *Taungya*, agroforestry, arable crop, productivity, forest.

INTRODUCTION

The biggest challenge for sustainable development in many parts of Africa, appears to be how to provide enough suitable land to poor farmers while preserving a safe environment and conserving biodiversity (Sadio and Daga, 2004). Management options for optimizing productivity in plant communities under *taungya* practice are based on the manipulation of solar radiation profile. The principle of plant productivity has been viewed as a system of conversion of solar energy into chemical energy that can be transported and stored through the process of photosynthesis (World Agrofrestry Center,

2008). The selection of species, their arrangement and maintenance determine the photosynthetic efficiency of the whole plant community.

The traditional bush fallow system could be sustained with sufficient fallow length which allows the soil to replenish itself during the fallow period. Furthermore, biodiversity in shifting cultivation landscapes is of interest because it contributes to agricultural sustainability and human wellbeing, and may also contribute to the conservation of native forest biodiversity (Bryan and Robert, 2004).

However, increase in human population leads to decrease in length of fallow and increase in cropping intensity. Shortened fallows caused by population explosion and excessive demand for farmland in many parts of Nigeria and elsewhere in Africa has led to over-cropping of available land with various environmental consequences which include: degradation of rain-fed crop lands, fuel wood and fodder shortages, sheet and gully erosion (Okojie, 1997; Sadio and Daga, 2006). This in turn decreases soil fertility and productivity and keeps agricultural productivity at a marginal level.

Sanchez (1997) observed that high cost of fertilizer has compounded the problem of decreasing soil fertility and the accompanying declining crop productivity as most farmers cannot afford to buy fertilizers at high costs. Soil management practices should at this time be concerned with farming systems aimed at optimizing and sustaining productivity. *Taungya* farming as an aspect of agro-forestry has the potential of meeting these criteria. Bashir et al. (2006) affirmed that species mixtures instead of plantation monocultures should be used in order to improve regional biodiversity and maintain ecosystem resilience.

Higher crop yields have been observed when agricultural crops are planted near leguminous trees such as *Faidherbia* (*Acacia albida*) (Del.) Chev (Kumar, 2006). The choice of trees and crops for inclusion in proposed *taungya* plantations should however take cognizance of the various intra and inter-specific interactions. It is thus the objective of this study to compare the yield of agricultural crops in *taungya* farming practice with non-*taungya* farming practice and to compare the success of forest plantation establishment under the two systems in Vandeikya Local Government Area, Benue State, Nigeria.

MATERIALS AND METHODS
Study area

Vandeikya Local Government Area (VLGA) is located between longitude $8^0 45' – 9^0 .00$ E and longitude $6^0 .30' – 7^0 .00'$ N. VLGA is made up of twelve administrative wards (Figure 1). The projected population of the study area is about 532,881 (www.benuestate.gov.ng May 2, 2010).

There are two seasons namely dry and wet seasons which occur from November to March and April to October respectively. The climate is the tropical humid type with very high temperatures between March and April. The cool, dry harmattan weather is witnessed between December and February. The terrain is undulating, low-lying and drained mainly by Rivers *Aya, Sambe, Be* and *Uaghshu.*

The Local Government Area has 48 forest estates unequally dispersed in the 12 wards. Most of these forest estates were established with the assistance of the host or neighbouring communities through *taungya* system between 1945 and 1970 and were inherited from the defunct *Gboko* Division (formerly in *Tiv* Native Authority). For administrative convenience, the forest estates in each ward are grouped into a single management plan. This study is based on *taungya* operations within the forest estates owned by the local government council and does not include privately owned forest estates.

Data collection

Primary data were obtained using structured questionnaires while the secondary data were obtained from the records of the Department of Agriculture of VLGA. The twelve wards in VLGA were listed in alphabetical order and all the six odd-numbered wards were selected through balloting. The six wards surveyed included: *Mbadede, Mbagbera, Mbaityough Mbakaage, Ningev* and *Tsambe* (Figure 1).

The two sets of questionnaire administered included: 200 for t*aungya* farmers on VLGA forest estates and 16 for government officials working in VLGA forestry service. The universal population of the farmers was 562, while the corresponding population of forestry staff was 16. This constitutes approximately 36% sampling intensity for *taungya* farmers and 100% for forestry officials.
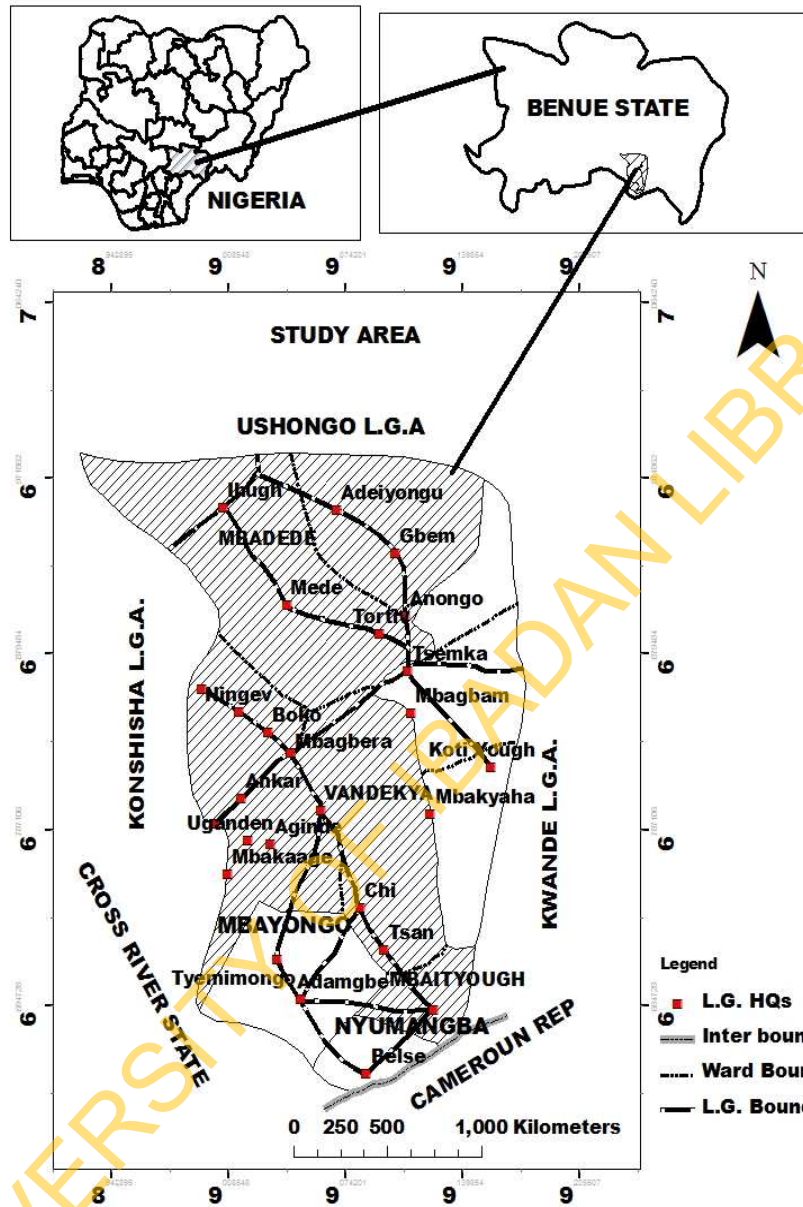
Figure 1: Map of *Vandeikya* Local Government area showing survey wards.
Source: Department of Agriculture, Vandeikya Local Government Secretariat, Benue State, Nigeria.

The questionnaires sought information on the productivity of agricultural crops grown under *taungya* and non-*taungya* plots as well as the forest areas regenerated through *taungya* farming and non-*taungya* plantation establishment techniques. Through personal interviews, all the 216 questionnaires administered were retrieved. Edaphic and climatic properties between the various pairs of *taungya* and non-*taungya* plots were assumed to be fairly uniform enough to allow uniformity in crop productivity. Thus, any differences noticed in crop yields were ascribed to the cultural practices adopted.

Data analysis

Descriptive statistics, student's T-test and analysis of variance (ANOVA) were used for data analysis. Post-mortem analysis involving the use of Least Significant Difference (LSD) was also employed to validate any observed variation.

RESULTS
Demographic attributes of respondents

The forestry members of staff were aged between 31 and 50 years; 87.50% of them were married. Majority of the staff had low levels of educational attainment with 68.75% having primary and secondary education without professional training. Over sixty two percent of the forestry staff had annual incomes of between ₦111, 000.00 and ₦150, 000.00 (₦ = Naira). Twenty seven percent of the farmer respondents were females. Sixty eight percent of them were aged between 31 and 50 years. Eighty six percent of the farmer respondents were married with family sizes of 7-12. Thirty eight percent of the farmers were literate and 55% of them earned between ₦21, 000.00 and ₦40, 000.00 per annum.

Comparison of crop productivity on *taungya and non-taungya* plots

The mean yield per hectare of each of the crops for the six sampled wards is presented in Table 1. The mean yields of yam, cassava, rice, sweet potatoes, maize, groundnuts, soybeans, guinea corn, cow pea, pepper and melon were significantly higher on *taungya* plots than non-*taungya* plots. Crop yield ranged from 306.67 kg/ha to 1,698.33 kg/ha. At P=0.05, t-values ranged from 1.80 to 9.82 at degree of freedom '10'. The result of t-test analysis presented in Table 1 indicates significant difference in crop yield on *taungya* non-*taungya* plots (P= 0.05). We therefore conclude that there were significantly higher yields on *taungya* plots than non-*taungya* plots in the study area provided that edaphic characteristics are sufficiently uniform to support fairly uniform crop productivities.

Forest area regenerated through *taungya* and non-*taungya* systems

The forest areas regenerated through *taungya* and non-*taungya* systems between 1955 and 2000 (for sampled years only) are as indicated in Table 2. A total of 63 hectares were regenerated through *taungya*, while a total of 74.7hectares were regenerated through other means (Non-*taungya*). The mean forest areas regenerated through *taungya* and non-*taungya* practices between 1950 and 2000 were 6.30 and 7.47 Ha per year respectively .These areas did not differ significantly (P = 0.05).

The reforestation efforts of VLG were centred on re-stocking with *Gmelina arborea* (Roxb), *Tectona* grandis (Linn. F) as well as *Faidherbia* species. The modal class of 41-60 and accounted for 46% of the farmers. The class 61-80 had the least respondents (7%).

ANOVA computation in Table 3 indicates that there were no significant differences in the number of trees planted among the six sampled wards (P> 0.05).

Reforestation outside forest estates of VLGA was low with only 6% of the farmers planting tree seedlings on both government forest estates and their own lands. 62.5% of the farmers were willing to practice *taungya* outside government forest estates but had no personal land while 31.5% of the farmers were not favourably disposed to practicing *taungya* on their own lands. Land tenure and availability were identified as the major obstacles to *taungya* practice.

Table 1: T-test of differences between mean crop yields per/ha for *taungya* and non-*taungya* plots.

Parameter	Mean yield per/ha (Kg)	t-cal	t-tab	Df	P
Yam (Dried chips)					
Taungya	1223.33	2.45*	0.26	10	0.0342
Non-*taungya*	1075.00				
Cassava (Dried Chips)					
Taungya	1698.33	9.83*	0.26	10	0.0000
Non-*taungya*	1372.67				
Rice (unmilled)					
Taungya	1155.00	7.05*	0.26	10	0.0000
Non-*taungya*	833.33				
Sweet Potatoes (Dried Chips)					
Taungya	1471.67	7.70*	0.26	10	0.0000
Non-*taungya*	923.33				
Maize					
Taungya	1133.33	13.40*	0.26	10	0.0000
Non-*taungya*	710.00				
Groundnuts (unshelled)					
Taungya	1083.33	6.14*	0.26	10	0.0001
Non-*taungya*	756.67				
Soybeans					
Taungya	620.00	5.18*	0.26	10	0.0004
Non-*taungya*	408.33				
Guinea corn					
Taungya	725.00	5.73*	0.26	10	0.0001
Non-*taungya*	516.67				
Beans					
Taungya	458.33	2.42*	0.26	10	0.0358
Non-*taungya*	408.33				
Pepper					
Taungya	366.67	1.80*	0.26	10	0.1018
Non-*taungya*	320.00				
Melon					
Taungya	306.67	2.07	0.26	10	0.0655
Non-*taungya*	250.00				

* Significant
** Each value represents the mean yields for 5 years

Table 2: Forest regeneration through *Taungya* and non-*taungya* methods.

Year	*Taungya*	Other Methods (Non-*taungya*)	Total
Forest Land Area Regenerated (Ha)			
1955	3.0	1.0	4.00
1960	2.3	4.5	6.80
1965	6.0	7.5	13.50
1970	9.0	11.0	20.00
1975	9.0	7.9	16.90
1980	9.9	6.2	16.10
1985	3.2	9.1	12.30
1990	10.0	8.7	18.70
1995	5.6	7.1	12.70
2000	5.0	11.7	16.70
Total	63.0	74.7	137.70
Means	6.3	7.47	13.77

Source: Department of Agriculture Vandeikya LGA.

Table 3: Analysis of variance table for tree seedlings planted among the six wards.

Source	DF	SS	MS	F	F-Tab	Remarks
Ward	5	641	128	0.27	3.02	ns
Error	194	93398	481			
Total	199	94039				

$P > 0.05$, ns: not significant

DISCUSSION

The higher crop yields observed on *taungya* plots could be attributed to better soil conditions in the forest reserves where the crops were raised. Undoubtedly, organic matter accumulation from decomposed litters and reduced leaching and erosion in the forest environment could contribute to greater soil productivity under the forest ecosystem. Fallows, incorporation of green manure, fodder and planting of grain legumes are known to have an overall effect on increasing the soil organic matter, nutrient cycling, soil fertility, soil fauna, weed and pest control, as well as fuel wood production (Ogungbile and Manyong, 1998; Bashir et al., 2006). Intercropping of agricultural crops among the tree seedlings can increase crop productivity through positive interactions among the intercropped species .The findings of the current study agrees with the observation of Anderson and Swift (1993) that plant litters high in nutrients (especially nitrogen) and which decompose rapidly increased crop productivity. In a similar study in Kenya, Bohringer and Akinifesi (2001) reported a maize yield of about 4.1 t/ha in agroforestry system compared to 1.7 t/ha in non-fertilized soils continuously planted to maize.

The low literacy rate among the farmers and low educational attainment of forestry service staff could slow down the adoption rate of *taungya* as a food production technology in the study area. Over 60% of the farmers had no personal land on which to practice *taungya* and had to rely on government estates to secure land for *taungya* practice. Joyce (1992) observed that the level of adoption of *taungya* practice may be low initially, but as population pressure on land increases, it would improve considerably over

time. This is a favourable factor for the adoption of *taungya* in this area.

Socio-cultural considerations if not taken seriously prior to the inception of *taungya* programmes could hinder the success of the programme.

Ecologists place a lot of premium on multi-species forest plantations compared to monoculture stands. The fact that forest regeneration programmes in this area are largely through mono-specific plantations establishment is a major ecological drawback for the programme (Taylor, 1999). Seventy six percent of the farmer respondents recalled existence of exotic monoculture stands on their allocated plots before such plots were cleared for *taungya*. This has serious ecological implications particularly as regards to biodiversity conservation and ecological and economic vulnerability of the dependent communities. (Mohan et al., 2006; Lindara et al., 2006.) The local communities and the forestry department need to be sensitised on the benefits of multi-species plantations as well as the benefits and demerits of sustainable *taungya* practice. There is need to develop appropriate management techniques for compatibility of the woody perennials and the arable crops; as there may also be negative interactions in certain herbaceous crop mixtures (Kumar, 2006).

The manual nature of *taungya* requires large households that can share labour for agricultural production for expanded operation. Households capable of supplying farm labour are most likely to participate more meaningfully in *taungya* since there would be division of labour. The low participation of women in *taungya* farming could be attributed to the inability of women to pay for the initial high labour cost for land clearing.

Conclusion

An assessment of the productivities of some agricultural crops on *taungya* and non-*taungya* plots indicates that generally, farming on *taungya* plots is more productive than farming on non *taungya* plots. In VLGA, there are no significant differences in forest areas in respect of reforestation through *taungya* and non-*taungya* methods. An overwhelming majority (68.5%) of the farmers had no personal land on which to practice *taungya* farming. Reforestation efforts were tilted in favour of mono-species plantations without regard for ecological sustainability and species diversity expected of sustainable *taungya* practice.

Taungya farming is desirable in the study area as a means of forest regeneration and food production. It should be intensified and refined for better adoption by farmers. Land tenure laws have to be reviewed to give *taungya* farmers easy access to land. There is also need to recruit qualified forestry extension workers to provide necessary technical assistance to farmers for increased adoption of *taungya* practice.

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