Adoptability of Planted Fallows and Efficacy of Natural Types in Fertility Regeneration of a Typic Paleudult

Edna Chioma Matthews-Njoku [1] , Emmanuel Uzoma Onweremadu [2]

1. Department of Agricultural Extension, Federal University of Technology, PMB 1526 Owerri Nigeria.
2. Department Of Soil Science And Technology, Federal University Of Technology, PMB 1526 Owerri Nigeria. uzomaonweremadu@yahoo.com

ABSTRACT: We investigated the willingness to adopt planted fallows as replacement to the natural fallows among farmers in Owerri Agricultural Zone of Central Southeastern Nigeria, in 2006. Structured interview schedule was used to generate socioeconomic data from respondent farmers. Data were analyzed using percentages and multiple regressions for socioeconomic analysis. Soil samples were also collected from soils under natural fallows but of 5 different fallow lengths. These surface soil samples were analyzed using laboratory techniques for status of soil fertility indices. Resulting data were subjected to Analysis of Variance (ANOVA) and means were separated using the least significant difference (LSD) at 5% level of probability. While analysis of socio-economic data showed that adoptability of fallows had good relationship with education, age and farm size; soil data indicated inability of natural fallow to cope with soil productivity demands at all fallow lengths studied when judged with existing standards. Establishment of planted fallows in demonstration farms of Agricultural Development Programmes (ADPs) of the agroecology, and studies on them may enhance certainty in the prediction of adoptability of these novel techniques of soil fertility regeneration. [Nature and Science. 2007;5(3):12-19]. (ISSN: 1545-0740).

Key word: Degradation, adoption, efficacy, fallows, soil fertility

INTRODUCTION

Over the last couple of decades, conservation agriculture has gained increasing interest in Africa and worldwide, in an attempt to eradicate extreme poverty and hunger; ensure environmental sustainability and develop a global partnership for development (IIRR and ACT, 2005). In response to these problems, some researchers look specifically at soil fertility replenishment systems (CTA, 2002; Place et al., 2005).

Soil fertility restoration strategies have been suggested. The *Gliricidia* and *Leucaena* cropping fallows were recommended since the fallows maintained maize yields at 3.5 tha^{-1}, over six planting seasons without fertilizer (Mafongoya et al., 2001). Yields markedly increased by *Gliricidia manuring* to an average of 1800-2500 kg ha^{-1} (Bohringer and Akinifesi, 2001). In Zimbabwe, farmers apply plant litter from woodlands on very sandy soils (Nyati and Cambell, 1994) while in Malawi, over 1000 farmers used improved fallows, relay cropping and mixed cropping with efficacy of intercropping and closely spaced *Leucaena* hedgerows on soil conservation and maize yield on sloping terrain of Malawi.

In the Central Southeastern Nigeria, there is widespread land degradation due to accelerated soil erosion (Igwe. 2003) resulting to a decline in soil productivity. Increased demographic pressure has led to conflictive land uses and shortened fallow lengths (Onweremadu, 1994) as farmers still hold tenaciously to traditional fallow practices. There is increased deforestation activity and resultant erosion damages of soil resource (Oti, 2007). It is also probable that sociopolitical and anthropogenic activities may have added a negative weight on biophysical factors (Boers, 1990), and this tends to question the capacity of traditional fallow systems to sustain soils for agriculture and non-agricultural uses. Oti (2007) called for an assessment of traditional fallows for the restoration of erosion degraded lands of Southeastern Nigeria and this becomes more expedient with the current campaign for food security. Based on the above, we investigated the efficacy of current traditional bush fallow on owner- managed farms of Central Southeastern Nigeria.

MATERIALS AND MEHTODS

Study area: The study was conducted in Owerri Agricultural Zone in the central Southeastern Nigeria, lying between latitudes $5^0 15^1 3.15$"and $5^0 45^1 10.21$"N, and longitudes $6^0 45^1 8.15$" and $7^0 30^1 15.11$"E. The land area of the agricultural zone is about 300 km^2 and comprises eleven local political units, namely Aboh Mbaise, Ahiazu Mbaise, Ezinihitte Mbaise, Ikeduru, Mbaitolu, Ngor Okpala, Oguta, Ohaji/Egbema, Owerri North, Owerri Municipal and Owerri West. The area is characterized by very high population density of about 1150 persons per square Kilometer, and this situation is increasing due to rapid urbanization of the area. Soils of the area are formed from coastal plain sands and are classified as *Typic Paleudults* (Onweremadu, 2006). It is a lowland area with humid tropical climate having a rainfall of over 2500 mm and mean annual temperature of 26-29 ^{0}C. Tree plants dominate the vegetation popularly referred to as the rainforest belt of Nigeria. Farming is a dominant socio-economic activity of the study area. Farmers still stick to traditional slash-and-burn system of clearing and soil fertility regeneration is by natural bush fallow where are soils allowed to regain their lost nutrients without intentional input from farmers.

FIELD SAMPLING

Field studies were conducted in 2006, in which three local government areas were purposively chosen based on intensity of farming activities. The three local government areas were Ohaji-Egbema, Owerri West and Ngor Okpala. In each of the three local governments, two towns were randomly selected as follows: Umuagwo and Umuoknne (Ohaji-Egbema), Emeabiam and vu (Owerri West0 and Okpala and Nnorie (Ngor-Okpala). Twenty arable and owner managed farmers were randomly chosen from each town in the local government area. One hundred and twenty arable farmers constituted the sample size for the purpose of this investigation. These farmers are registered with the Agricultural Units of ADP with their respective local government areas.

Structured interview schedule was used to elicit information from the farmers. The structured interview schedule was validated using the content validity technique, which according to Chuta (1992) is used to determine the relevance and suitability of items included in the study. Items contained in the draft interview schedule for the study were validated and thoroughly examined criticized by three lecturers in the Department of Agricultural Extension, University of Nigeria, Nsukka, Nigeria. The final structured interview schedule for the study was certified by the expert opinions of these lecturers. Socioeconomic attributes studied include age, educational status, membership of social organizations and farm size.

Based on personal communication of respondent farmers, five fallow lengths, namely continuous cropping, 3-,5-,10 - and 15 - years fallows were identified and 10 surface soil samples (0-20 cm depth) were collected from each fallow length for laboratory analysis of fertility indicators.

LABORATORY ANALYSIS

Cation exchange Capacity (CEC) was determined by repeated saturation using I M NH_4OA_c followed by washing, distillation and titration (Soil Survey Staff, 1996). Exchangeable basic cations were estimated by inductively coupled plasma atomic emission spectrometer (ICP-AES) (Integra XMO, GBC, Arlington Heights, IL). Available phosphorus was measured by Olsen method as described by Emteryd (1989). Total nitrogen was determined by Kjeldahl digestion with a Kjeltec Auto 1030 System (Tecacor, Hoganas, Sweden). Soil organic carbon was estimated after combustion on a Leco Model 521-275 (Leco Corporation, Svenka AB Upplands, Vasby, Sweden). Soil pH was measured potentiometrically (I:I soil to solution) in water (Thomas, 1996). Base saturation was calculated as the sum of exchangeable basic cations divided by cation exchange capacity, multiplied by 100 percent.

DATA ANALYSIS

Descriptive statistical tools were used in analyzing collected data. Analysis of variance (ANOVA) was used to determine variation among soil data and means separated using least significant difference (LSD) while willingness to adopt planted fallow technology (Dependent variable) was regressed to selected socio-economic characteristics as independent variables.

The multiple regression model used is shown as follows: $Y= a+ b_1X_1+b_2X_2+b_3X_3+b_4X_4+e$... 1
where Y = Willingness to adopt planted fallow

a = intercept

B_1b_4 = regression coefficients

X_1 = age

X_2 = education

X_3 = membership of social organization

X_4 = farm size

e = error term.

Results

The socioeconomic characteristics of respondent farmers are shown in Table 1, indicating that most farmers in the study site are of youthful age bracket (70%). Again, secondary and primary education dominated the educational status of these respondent farmers while fewer farmers engaged in more than four social organizations. Farm sizes were generally low (40%) to every low (32%). These results contrasted with the findings of Nwuzor (2007) in Abakaliki, another part of the same agroecology where farmers were older and less educated. But, Agwu and Chukwu (2006) reported that age of most farmers in Aninri Enugu State Nigeria lies within 20-39 years, a result resembling the trend in this study.

Natural bush fallow, farmyard manure and mulching dominated the existing soil conservation practices in the area when compared with the use of diversion ditches and terracing (Table 2). This is consistent with the findings of Odii (2002) that bush fallowing dominated soil conservation against soil erosion in this agroecology. Although, there exists sources of modern soil conservation practices in the area (Table 3), bush fallowing is allowed to naturally check environmental influences on soil resource and maintain soil fertility. However, agricultural extension services occupy 38% of the sources of information on soil conservation, followed by education and mass media, yet their influences have not changed the tenacity to which farmers hold to traditional bush fallow practice. This is because about 56% of the respondent farmers were not aware of the use of planted fallow technology (Table 4). Among the population with the knowledge of planted fallow technology, 55% are willing to adopt planted fallow technology (Table 5), indicating that a good proportion (45%) of the respondents are currently unwilling to accept and adopt the fertility regeneration and soil conservation technology.

Statistical data on the relationship between willingness to adopt planted fallow technology and socioeconomic attributes (Table 6) indicated that age, education and farm size were significantly (P=0.05) related to adoption. While education had a significant positive correlation with willingness to adopt, Korie et al (2006) reported a significant negative relationship between education and adoption of land tenure system, suggesting that modern farming agriculture may cease to adopt traditional land tenure system.

Status of soil fertility indicators in five natural fallows of the study area is shown in Table 7. Using existing standard (SPDC, 2003), values of cation exchange capacity, soil organic carbon, total nitrogen and available phosphorus were very low to moderate, and soils were strongly acidic irrespective of fallow length in natural fallows. These were significant differences among fallow lengths in measured soil attributes (Table 7).

Table 1: Distribution of respondents according to socio-economic characteristics (n=120)

Attribute	Percentage
Age (Years)	
21-30	25.0
31-40	45.0
41-50	20.0
51 and above	10.0
Education	
No formal education	6.3
Primary education	30.2
Secondary education	51.0
Tertiary education	12.5
Membership of social organizations	
1-2	51.0
3-4	36.1
5-6	12.9
Farm size (Hectares)	
1.0	32.0
1.1-2.0	40.0
2.1-3.0	18.0
7-3.0	10.0

(Source: Field Survey, 2006).

Table 2: Distribution of existing soil conservation practices

Practice	Percentage
Natural Fallowing	68
Mulching	10
Farmyard manure	12
Terrace	4
Diversion ditch	6

Table 3: Source of modern soil conservation knowledge (n=120)

Source	Percentage
Agricultural Extension Service	38
Education	24
Mass media	20
Farmers organization	18

Table 4: Knowledge of planted fallow technology (n=120)

Awareness level	Percentage
Unaware	56
Aware	44

Table 5: Willingness of respondent farmers to adopt planted fallow technology (n=120)

Attribute	Percentage
Highly unwilling	20
Slightly unwilling	25
Willing	30
Highly willing	25

Table 6: Multiple regression analysis on the relationship between willingness to adopt planted fallow and socioeconomic characteristics (n=120)

Independent Variable	Coefficient	SE	T-value	F- ratio	R^2 (adj)
Constant	62.15	0.92	16.60*	3.02	0.36
Age	-9.36	0.08	-7.32*		
Education	13.24	0.09	8.15**		
Membership of Social organization	6.21	0.11	1.63 ^{NS}		
Farm size	-11.23	0.05	-5.22*		

Table 7: Soil fertility indicators in natural fallows of the study cite

Length of pH Fallow (Water) (Years)	CEC (meq/100g Soil)	BS (%)	SOC (%)	TN (%)	Avail.P (ppm)	
Continuous Cropping	2.8	29.0	0.5	0.08	5.8	3.8
3	3.9	36.2	0.6	0.10	6.2	4.0
5	5.8	39.8	0.8	0.14	9.6	4.1
10	11.3	42.3	1.2	0.18	15.2	4.6
15	14.7	47.2	1.4	0.20	18.6	5.0
$LSD_{(0.05)}$	0.8	0.6	0.3	0.08	0.3	0.7

CEC = cation exchange capacity, BS = base saturation,
SOC = soil organic carbon TN = total nitrogen, Avail. P = available phosphorus, LSD = least significant difference.

DISCUSSION

The implication of the predominance of youthful age (45%) in Table 1 is that agricultural extension services should focus on such population moreso, where 51% of them have attained secondary education. Ozor and Madukwe (2005) suggested the use of Youth Farmers Clubs (YFCs) for such target population. However, we suggest that Agroforesty Clubs (AFCs) be mounted in secondary schools where experimental plots on planted fallows could be used for demonstration purpose by Agricultural Science Teachers (ASTs). In Southeastern Nigeria, educational level has been found to be one of the most closely related variables to adoption of improved farm practices (Mathews-Njoku and Asiabaka, 2003). The intervention of government and non-government bodies in encouraging the population of this educated youthful and emerging farmers is so desirable to forestall the migration of this category of human capital which were trained by urban settlement in South African agriculture (Ortmann and Machethe, 2003).

A good number of the respondent farmers (51%) had only 1-2 social organizations, which is an indicator of their rickety economic foundation as farmers may likely belong to more social organizations as income increases given the African cultural peculiarity. It is of note that social organization serves as forum through which farmers could exchange ideas and learn about new farm practices (Onu, 1991). However, social organization vary in the study area comprising agro-based groups, purely entertainment social groups, age-grade organizations, and spiritual groups but this classification was beyond the scope of the study.

About 72% of the respondent farmers population had less than 2.0 hectares of farmland, suggesting higher possibility of adoption of planted fallows in the area as a way of quickly rejuvenating soil fertility in a very short temporal specification. The more the land mass, the greater the propensity to hold to traditional bush fallow since farmers can afford to allow their farmlands rest for years without cultivation.

One would have expected a diminishing prominence of natural bush fallow in the area given high percentage of small-sized farms, but it was to the contrary (Table 2). It implies from the foregoing that respondents are left to regenerate their fertility or that they cultivated under shortened fallow lengths in line with the findings of Onweremadu (1994). Despite the leading position of agricultural extension service as source soil conservation knowledge (Table 3) it has not succeeded in attracting a good number of farmers to adopt planted fallow technology which has been a common practice in other African Countries (CTA, 2002). This is worst still with 56% of the respondents indicating ignorance of the technology (Table 4). It means that part of the Millennium Development Goals should focus great attention on such innovations as planted fallow technology since it takes the traditional soil fertility restorative technology longer time. Efforts in this direction must remember the inculcation of indigenous knowledge peculiar to the locality (Onweremadu et al., 2007).

Field studies also showed that many respondent farmers (55%) are willing to adopt planted fallow technology, implying that a lot of extension services to convert 25% of the “slightly unwilling” population to "willing" status (Table 5), willingness to adopt could be a direct response to low productivity of farmlands in the study area. Although the study did not evaluate soil productivity vis-à-vis crop performance, it was demonstrated by farmers during personal communication at different sampling points. The propensity to adopt planted fallow technology as a replacement to the traditional bush fallow system was regressed with studied socio-economic attributes and results indicated a very good positive relationship between adoption and education (T-Value = 8.15**), suggesting that adoption increase with enlightenment as an educated farmer can understand technologies which appear complex to the uneducated (Egbule and Mathews-Njoku 2002). Farm size had a significant negative relationship (T-Value = 5.22*) with adoption of planted fallows, implying that as farm size increases propensity to adopt decreases. The traditional fallow period is promoted by large farmlands amidst low farmer populations. But, the population density of the study area is so high amidst traditional land tenure system which promotes fragmentation and shortening of rest period. In the same manner, age had a significant negative relationship (T-value = - 7.32*) with willingness to adopt, showing that older farmer respondents were less willing to adopt this technology, possibly due to cultural attachment and disposition (Onweremadu and Mathews-Njoku, 2007) while younger population would want to increase their "pocket money" by any promising economic venture (Okoro, 1991).

Soil analytical data (Table 7) exhibits the relative productivity of soils at different fallow periods under natural bush fallow system, with data confirming the inability of popularly adopted system of soil fertility regeneration. In the context of increasing demographic pressure amidst rising and conflicting demands for farmland resources, soil resource is subjected to several forms of degradation. This is worst for continuously cultivated soils in a low-input farming system. Although Oti (2007) suggested the use of strategies which improve soil structure, soil organic matter levels, plant available water, essential nutrient reserves, and diversity of soil biodiversity to sustain traditional fallows, social understanding and applicability of the strategies may be difficult. The recalcitrance of farmers to adopting modern soil conservation strategies is worrisome since Zake (1993) reported failure of inorganic fertilizers in restoring yield levels in degraded Ultisols of Uganda, and soils of the site are mainly Ultsols whose landscape has been ravaged by soil erosion (Onweremadu, 2006). Efficacy of improved fallows for oil fertility replenishment using *Sesbania, Glicicidia* and *Tephrosia* has been reported in Kenya, Uganda, Zambia, Malawi and Zimbabwe (CTA, 2002), and could be used in soils of the study area. Evaluation of these fertility enhancing plants in combination with arable crops may be necessary for appropriate recommendations. This is because seed supply and viability may be unreliable hence a disincentive to farmers in such marginal environment of transitional economics. It may be necessary to resort to farmer decision-making models and econometric analyses (Benin et al., 2004; Gauchan, 2004), which consist of channels through which farmers acquire information and interact with the farmers who are practicing the technology in their farms.

CONCLUSION

The study revealed that majority of respondent farmers belong to youthful age bracket and with secondary education. Farmers belong to few numbers of social organizations and are mainly low income farmers based on the small farm holdings. Result also showed that natural fallows are still dominant, irrespective of their knowledge of modern soil conservation practices. However, majority of the farmers are unaware of the planted fallow technology although a good number of them are willing to adopt it. We also found that socio-economic characteristics such as education, age and farm size influenced willingness of respondent farmers to adopt, suggesting future use of these attributes in modeling adoption of improved and planted fallows in the study site, and this will certainly enhance precision farming in the study area.

Corresponding to:
Dr. Emmanuel Uzoma Onweremadu
Soil Survey and Environmental Management Unit
Department of Soil Science and Technology PMB 1526 Owerri, Nigeria
Phone: +234803495502.
uzomaonweremadu@yahoo.com

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