Deterioration of Soil Organic Components and Adoptability of Green fallows for Soil Fertility Replenishment

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Abstract: We studied the adoptability of green fallow technology in soil fertility regeneration in Owerri agricultural zone, southeastern Nigeria in 2005. A well- structured interview schedule was used in collecting socio-economic data. Using target soil survey sampling technique, soil samples were collected to evaluate fertility status in continuously cultivated soils. Soil samples were air–dried and passed through 2-mm sieve before they were subjected to routine laboratory analyses. Socio-economic and soil data were analyzed statistically using some descriptive and inferential statistical tools. Results indicated the influence of age, education and farm size on willingness to adopt green fallow periods while soil fertility indices of organic matter and total nitrogen showed that soils were highly deteriorated. While soil organic matter showed significant (p=0.05) relationship with available phosphorus and cation exchange capacity, total nitrogen exhibited strong relationship with available phosphorus, pH and caution exchange capacity at 5% level of significance. Studies on the restorative capacities of some tropical plant species should be conducted to ascertain their efficacy. [The Journal of American Science. 2008;4(2):78-84]. (ISSN 1545-1003).

Keywords: Adoption, degradation, organic matter, socio-economy, soil fertility regeneration

Introduction

The rapidity of soil organic matter decline in tropical soils is worrisome as it is a principal factor in soil quality of the biome. Low content of soil organic components has been attributed to shortened fallow cycles (Aikorie et al., 2003).Poor management practices (Pagliai et al., 1998), changes in microbial population (Whalley et al.,1995), decline in microbial chemistry (Piovanelli et al., 1998), bush burning (Reich et al., 2001), deforestation (Cattaneo, 2002) , longterm tillage (Hooker et al., 2004., Wright and 2005, Hons, 2005) , harvest of forest products (Hassled and Zak,) , mining (Onweremadu ,2007).and poverty (Place et al ., 2005: Smith et al., 2006). Of all these causes of low organic composition of soils, deforestation takes a great toll in sub-Saharan Africa, and indeed the tropical world .A comprehensive assessment of the state of the world's forest released by the Food and Agriculture Organization of the United Nations (FAO) indicates that total forested area continued to decline significantly in the 1990s (FA0,1999). Based on this analysis, deforestation is concentrated in the developing countries, which lost approximately 62 million hectares between 1990 and 1995, with in average annual loss of 12.5 million hectares.

In central southeastern Nigeria, there is increased deforestation and resultant erosion damages of soil resource (Oti, 2007). Erosive activities in the agro-ecology has led to a decline in organic matter (Mbagwu and Obi, 2003). Consequently, there is reduced biological activity, adverse changes in physical properties of soils, adverse changes in soil nutrient status and build-up of toxicities.

In the light of the above, several soil fertility enhancing practices have been suggested with little success due to increasing population and poverty which consequently resulted to pronounced degradation of soil resources. Common soil conservation practices in the area include mulching, mixed cropping, terracing and ridging (Ogbonna et al., 2006) but whose efficacy has declined (Matthews-Njoku and Onweremadu, 2007). Adverse climatic conditions coupled with fragile soils of the study area require a conservation technique that minimizes high erosivity of rainfall in the agroeclogy. It is based on this premise that we suggest the use of green fallows. Green fallow periods restore soil fertility quickly and reduces the competitiveness of weeds on farmlands (Van Scholl, 1998). However, adoption of this technology is inter alia a function of socio-economic factors (Ogbonna et al., 2006; WOCAT,2007). The major objective of this study was to investigate the status of organic components of soils of the study site while estimating the adoptability of green fallow periods as soil fertility-enhancing strategy.

Materials and Methods

Study Area: The study was conducted in Owerri agricultural zone in 2005. Owerri agricultural zone (Latitudes 5^o 15'-5^o45'N; Longitudes 6^o45'-7^o30'E) is located in Imo State, Southeastern Nigeria. It has a land area of about 3000 km^2 and consists of eleven local government areas. Soils of the area are derived from Benin Formation (Coastal Plain Sands). The area has a humid tropical climate with an average annual rainfall of about 2500 min and mean annual temperatures ranging from 26-30 ^{0}C. It has 3 distinct months of dry spell. Owerri agricultural zone is characterized by a highly depleted rainforest vegetation due to high demographic pressure. The Imo River and others such as Otamiri, Mbaa, Uramiriukwa, Ogochic, Okitankwo and Nworie contribute to hydrology of the agricultural zone. A variety of socioeconomic activities abound ranging from farming, cottage industrialization, fishing, hunting, sand mining and automobile servicing . Owerri agricultural zone houses the seat of government, and this influences socio-economic activities of the area. However, a majority of traditional farming practices including slash- and- burn clearing are retained in its agriculture. But, increase in population has altered the traditional long fallows to shortened ones and in severe cases, continuous cultivation is practiced irrespective of declining yield.

Field Studies: Field sampling was conducted in 2006, involving three local government areas namely Ikeduru, Ezinihitte Mbaise and Owerri North. These local government areas were purposively selected based on the intensity of deforestation, and consequent land degradation. Three towns; Amakohia, Akabo and Eziama (Ikeduru), Onicha, Amumara and Udo (Ezinihitte Mbaise), and Emii, Nekede and Ulakwo (Owerri North) were randomly selected. A total of 180 project farmers constituted the sample size for the study. The target population was about 21, 000 project- farmers in Owerri agricultural zone.

A well- structured interview schedule was developed and used in the study,. The structured interview schedule was validated using the content validity technique (Chuta, 1992). All items contained in the draft interview schedule for the study were subjected to thorough examination and criticism by three lecturers of Department of Agricultural Extension, Federal University of Technology, Owerri, Nigeria. The final structured interview was certified by the expert opinions of these lecturers. Socioeconomic variables studied include gender, age, education, membership of social organization and farm sizes

In addition to the above 10 surface soil samples were collected from continuously cultivated owner-managed farm in each town, giving a total of 60 soil samples for the study. These soil samples were air-dried, gently crushed and passed through 2-mm sieve in readiness for laboratory analysis.

Laboratory Analysis: Exchangeable basic cations (Ca, Mg, K and Na) were estimated by inductively coupled plasma atomic emission spectromcter (ICP- AES- Integra XMO, GBC, Arlington Heights, Il). Cation exchange capacity was determined by repeated saturation using I M NH_40Ac followed by washing, distillation and titration (Soil Survey Staff, 1996). Available phosphorus was measured by Olsen method (Emteryd, 1989). Total nitrogen was determined by Kjeldahl digestion with a Kjeltec Auto 1030 System (Tecator Hogan as, Sweden. Total carbon was determined by combustion on a Leco Model 521- 275 (Leco Corporation, Svenka AB Upplands, Vasby, Sweden) and soil organic matter was estimated by multiplying carbon content by a factor of 1.724. Soil pH was measured (1:1 soil/ water) in water (Thomas, 1996). Particle size distribution was determined by hydrometer method (Gee and Or, 2002).

Statistics: Descriptive statistical tools were used in analyzing socioeconomic and soil data. Willingness to adopt green fallow period technique was regressed to some socio-economic characteristics. Multiple regression model was used as shown below.

$Y= a +b_1x_1 +b_2x_2+b_3x_3+b_4x_4+e$----1

Where Y= willingness to adopt green fallows

a = intercept
b1-b4 = regression coefficients
x_1= age
x_2 = education
x_3 = membership of social organization
x_4 = farm size
e = error term

Results

Respondent-farmers were mainly females (70 %) of youthful age (21-40) (70 %) with a majority of them attaining secondary education (Table 1). In addition to the above, these farmers belonged to 1-4 social organizations (85.9 %) but possessing about 2 hectares of farm size (80.1%) .Farm size, education and age significantly (P = 0.05) influenced willingness of respondent–farmers to adopt green fallow technique. Soil fertility indicators, namely organic matter, cation exchange capacity, pH, total nitrogen, available phosphorus and base saturation are shown in Table 3, indicating poor fertility status of soils using existing standards (FMANR, 1990; SPDC, 2003). Soils exhibited high degree of sandiness when compared with other particle sizes. Significant relationships (P= 0.05) were established among soil properties (Table 4). Soil organic matter was related with total nitrogen, cation exchange capacity, available phosphorus, clay and silt content. Soil pH had good relationships with available phosphorus, cation exchange capacity, total nitrogen, sand, silt and base saturation

Table 1. Distribution of respondents according to socio-economic characteristics (180).

Socioeconomic characteristics	Percentage
Gender	
Male	30
Female	70
Age (years)	
21-30	20
31-40	50
41-50	25
51-and above	5
Education	
No formal education	2.2
Primary education	36.3
Secondary education	52.6
Post- Secondary education	8.9
Membership of social organizations	
1-2	46.1
3-4	39.8
5-6	14.1
Farm size (Ha)	
1.0	42.0
1.1-2.0	38.1
2.1-3.0	19.9
Less than 3.1	14.6

Source: Field Survey Data, 2006.

Table 2. Multiple regression analysis on the relationship between willingness to adopt green fallow and socioeconomic variables (n=180).

Independent Variable	Coefficient	SE	T-Value	F-ratio	R^2
Constant	112	0.77	14.26*	3.26	0.38
Age	-7.48	0.09	-6.24*		
Education	11.88	0.03	7.22*		
Membership of Social Organization	7.16	0.08	0.96*		
Farm Size	-15.43	0.04	-8.36		

Table 3 Soil properties of studied sites (mean value of sites)

Location	Sand (%)	Silt (%)	Clay (%)	pH (water)	OM (%)	BS (%)	TN (%)	Av.P (p.p.m)	CEC (meq/100g)
Ikeduru Amakohia	86	2	12	4.7	2.6	38	0.12	6.2	5.6
Akabo	84	6	10	4.6	2.4	35	0.109	5.7	5.2
Eziama Ezinihitte Mbaise	89	2	9	4.2	1.9	28	0.016	4.0	4.8
Amumara	83	4	13	4.8	2.8	36	0.128	6.8	6.0
Onicha	90	1	9	4.4	2.0	29	0.019	4.4	6.6
Udo Owerri North	89	4	7	4.4	2.1	29	0.100	4.6	5.0
Emii	82	3	15	4.9	2.9	36	0.17	7.2	6.1
Nekede	88	8	4	4.0	1.7	21	0.011	3.7	4.4
Ulakwo	85	3	12	4.6	2.3	33	0.102	5.3	5.0

OM= organic matter, BS= base saturation; TN= total nitrogen, Av.P= available phosphorus, CEC = cation exchange capacity.

Table 4. Correlation matrix for linear relationships between soil parameters (n = 90)

	OM	TN	Av.P	CEC	pH	Clay	Silt	Sand	BS
OM									
TN	0.72*								
Av.P	0.68*	0.46*							
CEC	0.73*	0.38*	0.61*						
pH	0.28^{NS}	0.41*	0.79*	0.43*					
Clay	0.51*	0.35^{NS}	0.48*	0.74*	0.46*				
Silt	0.43*	0.22^{NS}	0.23^{NS}	0.51*	0.19*	0.19^{NS}			
Sand	0.15^{NS}	0.19^{NS}	0.09^{NS}	0.16*	0.56*	0.44*	0.09^{NS}		
BS	0.20^{NS}	0.17^{NS}	0.33^{NS}	0.42*	0.39*	0.46*	0.25^{NS}	0.24^{NS}	

OM= organic matter, TN=total nitrogen Av.P =available phosphorus, CEC = cation exchange capacity, BS=base saturation, significant at P=0.5, NS= not significant

Discussion

Dominance of the female population is indicative of the need for their consideration in agricultural policies. The implication of this result is the extension services needed to spread the adoption campaign for green fallows must focus on women associations, especially those that are farmer-oriented. Women had been identified as having capabilities and resources for generating food security for their families in the sub-Saharan African countries (Brown et al., 2001). But, these potentials of women are hindered by socio-cultural factors in the southeastern Nigeria (Mgbada, 2007). Interestingly, majority of the farmer-respondents dominated by the feminine gender attained secondary education, suggesting greater possibility of adoption of green fallows since educated person understands innovations faster than the illiterate one. Further agricultural extension services can be directed to the social organizations since many of them belong to minimum of one social. grouping. In addition, the ownership of 2 hectares of farmland by 80.1% of the surveyed population portends greater propensity to adopt since such farm sizes under intensive management could be fairly profitable in small to medium scale arable agriculture, notwithstanding the crop type. These statements are confirmed by the significant (P =0.05) influence of farm size, education and age (Table 2) on the adoptability of green fallow periods. Unavailability of land or reduced farm size was identified as a principal reason for the discontinuance of a technology in southeastern Nigeria (Nnadi and Akwiwu, 2007).

Values of soil fertility indices (Table 3) call for soil fertility regeneration measures including green fallow period technology. Earlier studies in the same agroecology identified Ca: Mg imbalances (Oti, 2002), low values of basic cations (Onweremadu, 2007), preponderance of acidic cations (Esu, 2005), soil structural degradation (Onweremadu et al., 2007) and low organic matter content (Mbah et al, 2007). Sandiness, strong acidity, low organic matter composition, low values of available, low base saturation as well as extremely low values of cation exchange capacity in soils of the study site are a result of interaction between harsh tropical climate, increasing demographic pressure and fragile nature of soils. However. these changes in soil properties varied in space (Onweremadu and Akamigbo, 2007) but are aggravated by soil erosion by the agency of water (Igwe, 2003). In the studied soils, organic matter had significant. (P =0. 05) correlation with some soil fertility indices (total nitrogen, available phosphorus and cation exchange capacity), implying that adoption of green fallow period technology will certainly promote organic matter accumulation in these soils thereby improving soil fertility.

Conclusion

The study showed that socio-economic factors of age, education and farm size influenced willingness to adopt green fallow technology. Again, generated soil data indicated soil infertility in the study area while identifying organic matter as principal factor, having significant (P = 0.05) effect on the status of total nitrogen, available phosphorus and cation exchange capacity. Further studies should consider efficacious and adaptable plant species useful in green fallow technology in the study area.

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