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Full Length Research Paper

Adoption rate of land clearing techniques and their effects on some soil fertility parameters of an Alfisol in southwestern Nigeria

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This study aims at investigating the determining factors of land clearing techniques and their effects on some soil fertility parameters of an alfisol in a derived savanna agroecology of southwestern Nigeria. The stratified simple random technique was used to obtain primary data using structured questionnaire and also to collect topsoil from 33% of the respondents' farms for the soil physicochemical properties in 2008 and 2009. Data collected were analyzed using appropriate statistical tools. Determining factors identified for the choice of land clearing techniques include: sex, family size, level of education, land size, level of awareness and farmers' source of income. The study identified manual stumping as the land clearing technique adopted by most farmers, but with least adverse effect on soil fertility parameters measured. Bulldozing was the least adopted method, but with negative impact on soil properties. Lack of fund, low level of education and poor government intervention were identified factors keeping agriculture at its subsistence level in the study area. Hence, sound enlightenment campaign program through radio jingle, posters and handbills in local languages on appropriate land clearing technique(s) most adequate for a typical humid tropics soil is desirable for sustainable and sound soil health.

Key words: Bulldozing, manual stumping, slash and burn, soil degradation, adoption rate, Ibarapa.

INTRODUCTION

Nigeria is an agrarian country with over 65% of her population in agricultural sector (Abdullahi, 2008) and land remains the basic factor of crop production. There is an increasing pressure on the use of land with an effort to meet the demand for food and services of an ever increasing population of the country, Nigeria. This has resulted into serious depletion of the quality of soil with all the attendant problems such as soil erosion, low soil fertility and low crop yield (Mbagwu, 2008). Among various attempts to boost agricultural productivity by the Nigerian government, according to (Idachaba, 1988) was the introduction of Agricultural Development Projects (ADPs) in 1975.

Current increase of quacks and part-time farmers in agric-business in order to solve the problem of food scarcity is contributing to the problem of soil degradation (Adewole et al., 2009). Many of these 'new comers' are ignorant of the fragility of African soils. The food scarcity notwithstanding, tropical soils are naturally sandy and fragile. Added to the fragility and sandiness is: the low activity clay minerals (Obatolu and Agboola, 1993) and low organic matter (Agboola, 1982) thus, resulting to low soil fertility status of the tropical soils (Kang, 1993). Native soil fertility status plays significant roles in subsequent soil management practices during crop production.

High crop productivity and sustainability depend on soil potentials, among others. Agboola and Omueti (1982) observed that soil fertility is an aspect of crop productivity. Hence, land clearing, which is the first major step in crop husbandry, must be handled with care. Mbagwu (2008) reported cases of serious water run-off leading to soil erosion and soil compaction after land has been cleared mechanically for cultivation.

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Table 1. Farmers' level of awareness of land clearing technologies.

Land clearing technology	Aware frequency (percentage)	Not aware frequency (percentage)
Manual stumping	210 (100.0)	0 (0.0)
Slash and burn	200 (95.2)	10 (4.8)
Bulldozing	163 (77.6)	47 (22.4)
Complete bush burning	105 (50.0)	105 (50.0)
Chemicals	24 (11.4)	186 (88.6)

Field survey, 2008.

Land clearing is the removal of native vegetation for agricultural purposes and other developmental projects. When clearing land, particularly for agricultural purposes, the density of native cover and soil type must be considered to help conserve the topsoil. Raintree (1983) and Oputa (1984) stated that acceptability and adoptability of any technology towards solving farmers' problems is greatly enhanced provided the identified problems will lead to enhanced physical productivity and economic profitability of his farming business. Support for technology towards agricultural land preservation was however, viewed differently by Feenstra (1997) as putting in place sustainable agricultural research programme and education as major indicators for technology adoption by farmers. The main objective of this study is to investigate the nutritional status of the soil as influenced by the land clearing methods adopted in selected farms in Ibarapa zone of Oyo State, Nigeria. The specific objectives are to:

1. Identify the land clearing technologies being practiced by the farmers in the study area.
2. Determine the farmers' level of adoption vis-à-vis their socio-economic status; and
3. Determine the soil nutrients' levels as affected by these technologies and make policy recommendations based on the findings of the study.

MATERIALS AND METHODS

The study area is the Ibarapa zone of Oyo State, Nigeria, comprising three Local Government Areas namely: Ibarapa North, Ibarapa Central and Ibarapa East with the administrative headquarters at Ayete, Igboora and Eruwa respectively. The area falls within the derived savanna agro-ecological zone of southwestern Nigeria. Majority of the inhabitants of the study area are predominantly farmers and the ease with which land is being acquired or leased to people willing to go into agriculture is high. Aromolaran (1998) earlier reported that land availability is not yet a serious problem for farming in most parts of Nigeria.

The study area was divided into seven strata and simple random technique was used on each stratum to administer the structured questionnaire for data collection. The list of all the villages in each local government of the study area was collected from its administrative headquarters. A simple random selection method was used to pick three villages each from the seven strata to give a total of 21 sampling units. Ten copies of structured questionnaire were administered in each of the sampling unit to give a total of 210 observations in April 2008. A total of 33.3% of sampling unit was used for the soil physico-chemical analyses of the cleared land. It was a researcher designed- farmer managed collaboratory experiment. The farms were ploughed two times before the crop was planted. Two composite soil samples taken to the depth, 0 - 20 cm from each land clearing method adopted (excluding the use of chemicals) per stratum were sampled in April 2008 and 2009. This gave a total of 70 composite soil samples per year for soil nutrients' characteristics from the farms cropped with cassava in 2008 and 2009 since the land was opened up in 2007.

Laboratory analyses of the soil samples were carried out using standard methods. The particle size analysis was determined using hydrometer method in 5% calgon as the dispersing agent (Bouyoucos, 1951). Soil pH was determined potentiometrically in 0.01 M $CaCl_2$ solution at a ratio of 1: 2 (soil to $Cacl_2$) (Mclean, 1982). Soil organic carbon was determined using Walkey-Black method (Nelson and Sommers, 1982). Total nitrogen of the soil was determined by the macro-Kjeldahl method (Bremner and Mulvaney, 1982). Available phosphorus in the soil was determined using Bray P1 method (Olsen and Sommers, 1982). Exchangeable cations (Ca^{2+}, Mg^{2+}, K^+ and Na^+) were determined using 1 M NH_4OAc (Ammonium acetate) buffered at pH 7.0 as extractant (Thomas, 1982). The K^+ and Na^+ concentrations in soil extracts were read on Gallenkamp Flame photometer while Ca^{2+} and Mg^{2+} concentrations in soil extracts were read using Perkin-Elmer Model 403 atomic absorption spectrophotometer.

The exchangeable acidity (H^+ and Al^{3+}) in the soil was extracted with 1 M KCl (Thomas, 1982). Solution of the extract was titrated with 0.05 M NaOH to a permanent pink endpoint using phenolphthalein as indicator. The amount of NaOH used was equivalent to the total amount of exchangeable acidity in the aliquot taken (Odu et al., 1986). The total sum of exchangeable bases (Ca^{2+}, Mg^{2+}, K^+ and Na^+) and total exchangeable acidity (H^+ and Al^{3+}) gave the Effective Cation Exchangeable Capacity (ECEC) (Juo, 1982).

Descriptive statistics was used to describe the socio-economic characteristics of the respondents while Duncan's Multiple Range Test at $P < 0.05$ was used to separate the means of physico-chemical properties of the soils.

RESULTS AND DISCUSSION

Table 1 shows the level of farmers' awareness of land clearing technologies and this range between 11.4 and 100.0%. It is interesting to note from this study that three-quarter of the farmers know that the bulldozer can be used to open-up land for agricultural purposes while one-quarter claimed not to know that the bulldozer is useful in land clearing. This attests to the high level of ignorance of

Table 2. Farmers' level of adoption of land clearing technologies.

Land clearing technology	Adopter frequency (percentage)	Non-adopter frequency (percentage)
Manual stumping	169 (80.5)	41 (19.5)
Slash and burn	150 (71.4)	60 (28.6)
Complete bush burning	89 (42.4)	121 (57.6)
Bulldozing	21 (10.0)	189 (90.0)
Chemicals	0 (0.0)	210 (0.0)

Field survey, 2008.

these 'new comers' into agricultural business. All the farmers are aware that manual stumping, and slash and burn method can be used to open-up land for agricultural purposes. This level of awareness is reflected in the traditional subsistence farming that is predominant in the study area.

Table 2 shows that manual stumping, and slash and burn methods are commonly adopted by this sample of farmers as land clearing techniques. The reason given by the farmers was that the methods require less capital. Only 10.0% of the respondents adopt bulldozing despite the fact that 77.6% of them are aware of its advantages over other methods. The respondents complained of lack of fund and poor government intervention to boost agricultural production. The use of chemical looks alien as no one adopts this method to clear land, although, few farmers claimed to be aware of the method. It is interesting to see that about half of the respondents are adopting complete bush burning as a method to clear land. The study shows the high level of ignorance these farmers have about the adverse effects of bush burning on soil and air ecosystems.

Table 3 shows the summary of socio-economic characteristics of farmers in Ibarapa area, southwestern Nigeria. A little above 20% of farmers in the study area are female and this attests to the dominance of male in agric-business. This agreed with the findings of Omonona and Ologbon (2007), while working on the impact of mechanization on agricultural production among food crop farmers in Ikorodu Local Government Area of Lagos State, Nigeria found that more male were involved in agri-business than female. The age distribution of the farmers shows a range between 30 and above 51 years, with 67.6% of them found between the age brackets of 41 to over 51 years. The implication of this is that majority of farmers in the study area are aged. Only 32.4% of the respondents are in the productive age of 40 years and below. Among rural development strategies for Nigerian youths, to motivate them into farming business and curb their exodus from the rural areas to urban centres in search of non-existing white-collar jobs as suggested by Umar et al. (2007) is the creation of rural-based productive projects. Just 6.7% of the farmers had tertiary education as against 30.9% with either primary or secondary education. Over half (51.9%) of the respondents had no formal education while 10.5% claimed to have some knowledge of western education and Arabic education through evening and Arabic lessons respectively. The fact that more than half of the farmers are illiterate implies the possibility of having poor access and disposition to modern land use management techniques. Ability to source for fund either through the bank (7.1%) or cooperative societies (4.8%) was also adversely affected due to their illiteracy.

A large percentage of the respondents depended on personal savings (75.7%) hence limiting the hectares they can open-up for cultivation. Only 2.9% of the farmers had well over 16 hectares of land cleared and put to cultivation, while high percentage of them (63.8%) cultivate between 0 and 5 hectares. This has a direct positive relationship with the farmers' poor access to source of capital and their low level of education. A greater percentage of the respondents (61.9%) have more than 16 years of experience in agriculture while only 4.8% joined the profession in the past 5 years. This is an indication that farming profession is not that attractive yet in southwestern Nigeria. Table 4 shows the summary of soil properties of selected fields in the study area in 2008. The soil pH varied from 6.20 to 6.75, indicating a slightly acidic soil. The soil texture was generally sandy. The organic carbon (OC) were range, (11.16 to 15.86 g kg^{-1}) with manually stumped farms having significantly ($P < 0.05$) highest value of OC while the bulldozed field had the least mean value. Different effects of human activities may have impacted negatively on soil qualities. Agboola and Omueti (1982) observed reduction in OC level of a similar land cleared and put under continuous cropping. Total Nitrogen (TN) mean values were range, (0.96 to 1.68 g kg^{-1}). The TN from the manually stumped field was significantly ($P < 0.05$) higher than in completely burnt and bulldozed farms but not significantly different from TN in slash and burn farms. A direct positive relationship was observed between the OC and TN. This agreed with the earlier findings of Agboola and Corey (1973) that NO_3^- of the humid tropical soils is in the organic form. Also, available phosphorus mean values were range, (12.88 to 33.36 kg^{-1}) with fields where complete bush burning method was used had the lowest

Table 3. Summary of socio-economic characteristics of farmers in Ibarapa area.

Variable	Frequency	Percentage distribution
Sex		
Male	165.0	78.6
Female	45.0	21.4
Age (years)		
Below 30	25.0	11.9
31-40	43.0	20.5
41-50	83.0	39.5
51 and above	59.0	28.1
Marital status		
Married	172.0	81.9
Single	38.0	18.1
Level of education		
No education	109.0	51.9
Primary	36.0	17.1
Secondary	29.0	13.8
Tertiary	14.0	6.7
Others (Adult evening lesson, Arabic lesson etc.)	22.0	10.5
Years of experience in Agric-business		
0-5	10.0	4.8
6-10	20.0	9.5
11-15	50.0	23.8
16-20	68.0	32.4
21 and above	62.0	29.5
Hectares cleared (Ha)		
0-5	134.0	63.8
6-10	50.0	23.8
11-15	20.0	9.5
16 and above	6.0	2.9
Source of capital		
Personal savings	159.0	75.7
Loan from bank	15.0	7.1
Cooperative society	10.0	4.8
Others (Assistance from Government, NGOs, money lenders)	26.0	12.4

Field survey, 2008.

values. Native fungi that help to enhance phosphorus availability could have been adversely affected. To substantiate this, Atayese (2005), and Salami and Osonubi (2006) working on 'undisturbed' Nigerian soils reported the possibility of *Arbuscular mycorrhiza* fungi enhancing the availability of phosphorus for plant uptake. The ECEC mean values were range (10.96 to 15.82 cmol kg^{-1}) with bulldozed fields having the least mean value. Manually stumped fields had highest ECEC mean value of 15.82 cmol kg^{-1}. The ECEC of the humid tropics has positive correlation with the soil organic matter (Agboola and Corey, 1973). Probable reason why soil OC from the bulldozed fields was the least could be the effect of bulldozer used in land clearing. The scrapper blade of the bulldozer might have scrapped part of the topsoil, the power house of the ECEC.

Table 4. Soil properties of the study fields in 2008 planting season.

Treatment	pH	Organic carbon g kg^{-1}	Total nitrogen g kg^{-1}	Available phosphorus mg kg^{-1}	ECEC cmol kg^{-1}	Textural class
Bulldozing	6.20 ± 0.25	11.16 ± 0.15c	0.96 ± 0.08c	24.17 ± 0.15b	10.96 ± 0.35c	Sandy
Manual stumping	6.75 ± 0.15	15.86 ± 0.24a	1.68 ± 0.10a	33.36 ± 0.10a	15.82 ± 0.18a	Loamy sand
Complete bush burning	6.50 ± 0.20	13.07 ± 0.13b	1.14 ± 0.15b	12.88 ± 0.14d	12.55 ± 0.25b	Sandy
Slash and burn	6.75 ± 0.15	14.25 ± 0.15a	1.49 ± 0.10a	20.99 ± 0.15c	14.06 ± 0.45a	Loamy sand
Chemicals	NA	NA	NA	NA	NA	NA

Means with the same letter are not significantly different by Duncan's multiple range test at $P < 0.05$, NA = not available.

Table 5. Soil properties of the study fields in 2009 planting season.

Treatment	pH	Organic carbon g kg^{-1}	Total nitrogen g kg^{-1}	Available phosphorus mg kg^{-1}	ECEC cmol kg^{-1}	Textural class
Bulldozing	6.20 ± 0.20	11.05 ± 0.20b	0.73 ± 0.05b	21.98 ± 0.26b	8.74 ± 0.15b	Sandy
Manual stumping	6.70 ± 0.15	13.88 ± 0.15a	1.24 ± 0.15a	30.84 ± 0.35a	14.79 ± 0.25a	Loamy sand
Complete bush burning	6.50 ± 0.20	11.92 ± 0.10b	0.88 ± 0.10b	10.36 ± 0.18c	8.89 ± 0.46b	Sandy
Slash and burn	6.70 ± 0.15	14.00 ± 0.20a	1.16 ± 0.20a	20.35 ± 0.25b	13.38 ± 0.33a	Loamy sand
Chemicals	NA	NA	NA	NA	NA	NA

Means with the same letter are not significantly different by Duncan's multiple range test at $P < 0.05$, NA = not available.

In 2009 however, most of the soil properties remained the same or reduced when compared with the results of 2008 (Tables 4 and 5). Effect of different variables of land clearing methods and nutrients' uptake due to cassava plants are probable reasons for this observation.

CONCLUSION AND RECOMMENDATION

The study identified manual stumping as the land clearing technique adopted by most farmers in Ibarapa area of Oyo State, Nigeria. This is a big challenge to every stake-holder in agric-business since a relatively small portion of land can be opened-up for agriculture using manual labour. Lack of food, low level of education and poor government intervention to boost farm operations are identified variables that can propel agriculture out of its present subsistence level to commercialized level. However, while trying to embrace the use of the bulldozer to open-up large hectares of land, the fragile nature of soils of the humid tropics must be carefully handled for better protection of soil ecosystem. Drastic reduction in chemical properties of the soil once opened up for agricultural purposes confirms its fragility.

The three tiers of government (Local, State and Federal) need to embark on aggressive awareness campaign to sensitize people about the need to carefully manage soil nutrients right from the land clearing stage. Better results could be achieved through radio jingles, posters and handbills in local languages for good understanding of all. The governments, through enlightenment campaign in local languages could further educate the general public about the importance of agri-cultural cooperative societies to farmers. The activities of these agricultural cooperative societies must however, be closely monitored by relevant and tested organs of the government. Finally, if agriculture could be made very attractive through sound government policy in the area of easy access to land, loan, farm input and organized markets; many young school leavers, especially those with agriculture and agriculture related disciplines could be attracted to it rather than looking for non-existing white-collar jobs.

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