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Evaluation of Soil Fertility Management among Yam Farmers in Kabba/Bunu Area of Kogi State, Nigeria

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ABSTRACT

This study aimed at identifying constraints of yam production, soil fertility evaluation and management among smallholder farmers in Kabba/Bunu area. Ten communities were purposely selected and ten yam farmers randomly selected from each community.100 questionnaires were administered to and collected from the farmers. The questions were collated and analyzed using frequency, mean and percentage. 98% of the farmers cultivate white yam and 64% are aware of the existence of improved varieties. Constraints to yam production are lack of access to finance (84%), poor market/sales (71%), availability and cost of seed yam (70%), Lack of access to improved varieties (68%), low soil fertility (64%) and lack of access to fertilizer (56%). Prominent soil fertility indicators are soil colour, crop performance, vegetation type, presence of earthworm activities and topographic position. 59% of the farmers assessed their farm soil to be fertile while 41% is non-fertile. Fertility management practices adopted among the farmers are: mulching (98%), use of legume in intercropping system (62%) and post-harvest residue management (50%). The adoption and cultivation of other varieties of yam apart from white yam, use of organic manure and post-harvest residue management of slash-and-mulch as well as intervention of government and non-governmental organization were recommended.

Introduction

Soil fertility is the capacity to receive, store and transmit energy to support plant growth. These processes require healthy soils – living, self-organizing systems with physical, chemical and biological components all functioning and in balance (Usman, 2015). Soil fertility is a complex quality of soils that is closest to plant nutrient management (Lichtfouse, 2013). Soil fertility is a manageable soil property and its management is of utmost importance for optimizing crop nutrition on both a short-term and a long-term basis to achieve sustainable crop production (FAO, 2006).

Soil health is of great importance to the African economies as farming is the main livelihood strategy for the majority of the population. (Mponela et al., 2016). Sustained agricultural production in most Sub-Saharan countries is under threat due to declining soil fertility and loss of topsoil through erosion (Hellin, 2003; Sanchez, 2002). The smallholder farmers in these countries are quite aware of the declining trends in soil fertility, the reasons for this and its impact on yields and household food security (Lyamchai and Mowo, 2000; Defoer and Budelman, 2000; Ouédraogo, 2004). Many farmers also do know to some extent how to practice judicious management of their soils, using nutrients available in their vicinity and adopting agricultural practices geared towards soil fertility improvement such as improved fallow, agroforestry and biomass transfer (Wickama and Mowo, 2001; Rwehumbiza et al., 2003). On the other hand, the many endogenous and exogenous complicating factors (Van der Ploeg, 1993; Ondersteijn et al., 2003), most of which are beyond the smallholder capability to handle, account for the continual trends in soil fertility decline (Mowo et al., 2005). Admittedly, soil fertility management is highly complex given the myriad of interacting factors that dictate the extent to which farming households invest in the fertility of their soils. These interacting factors must be understood, as judicious soil fertility management is of vital importance for sustaining food production in smallholder communities (Mowo et al., 2005).

The importance of indigenous knowledge has been realized in the design and implementation of sustainable development projects (Usman, 2015). The incorporation of indigenous soil and land resources knowledge has recently been advocated in sustainable land management. Combining both scientific and indigenous knowledge seems to be the best approach to support sustainable farming system grounded in local environment and cultural values (Osunade, 1994). Winklerprins and Sandor (2003) reported that local soil knowledge is an important source of information when designing sustainable land management strategies. Indigenous soil knowledge contain a wealth of local ecological knowledge and are at the same time the key to understanding the socio-cultural context of rural producer thus representing a way to address problem of soil fertility management for a long time (Thrup, 1989). Although research is gradually recognizing the importance of indigenous knowledge in developmental studies, the value of indigenous knowledge system in soil fertility management has received little attention (Usman, 2015).

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Yam (Dioscorea species) is an important crop to Nigerian agriculture and recorded among the oldest food crops and ranks second after cassava in the supply of carbohydrates in West Africa (Nweke et al., 1991). Nigeria is by far the world's largest producer of yams, accounting for over 70–76 percent of the world production. Nigeria produces an average of 18.3 million tons of yams from 1.5 million hectares, representing 73.8 percent of total yam production in Africa (NBS, 2012). Much of this production still remains in the hands of peasant farmers in the north central part (Niger, Benue, Kogi, Nassarawa) and rain forest zone of Nigeria who depend on the use of indigenous knowledge and local techniques (Awoniyi, and Omonona, 2006). Considering the importance of indigenous soil fertility evaluation in ensuring optimum, improved and sustainable production among famers this study was therefore conducted to achieve the following objectives:

1. Identify major yam species and varieties grown among famers in the study area;
2. Identify constraints of yam production as perceived by farmers in the study area;
3. Identify famer‘s indicators for soil fertility in the study area;
4. Identify the indigenous knowledge soil fertility management adopted by the farmers in the study area.

Materials and Methods

Description of the Study Area: The study was carried out in Kabba/Bunu local government area of Kogi state. It is bounded in the North by Lokoja Local Government and by Ijumu Local Government to the South, Yagba-East and Mopa/Amuro Local Government share boundary with the Local Government to the west and to the East by Okehi Local Government Area. The area has a land mass of 2,706 km2 and a population of 145,446 (NPC, 2006). The area is within the Guinea Savannah zone with thick forest and experience the wet and dry seasons. The wet begins from April and ends in October while the dry season is between November and March. The annual temperature varies between 27°C and 37°C with relative humidity between 30% and 40% in January and rising between 70% and 80% in July to august. The area belongs to the basement complex region of Nigeria and have soils formed from igneous and metamorphic rocks. The major crops cultivated in the area are maize, cassava, sweet potato, bambara nut, sorghum, yam, citrus, oil palm, coffee, plantain/banana, okra and vegetables.

Sampling Procedure and Data Collection: A total of ten communities were purposively selected from the two districts of Kabba/Bunu Local Government Area for this study. Kakun, Egbeda, Ayedun, Kabba and Okedayo, were selected in Kabba district while Ayetoro-Kiri, Ayede, Oke-bukun, Iluke and Apaa were selected in Bunu district. They were purposively selected because of their high level of involvement in yam production in the local government area. Ten respondents among registered yam farmers identified through the Ministry of Agriculture, Kabba office were randomly selected from each of the ten communities to have a grand total of 100 respondents for the administration of the questionnaire. Well-structured questionnaires were used for the collection of primary data. The questionnaire contains information on type of yam cultivated, constraints to yam production, soil fertility indicators/assessment and soil fertility management methods. The questionnaire was self-administered to non-literate farmers. The literate farmers were however allowed to fill the questionnaire themselves. Agricultural extension agents were also involved in collecting relevant information where appropriate.

Method of Data Analysis: Data collected from the respondents were analyzed using frequencies, means, and percentages.

Results and Discussion

Types of Yam Cultivated: The result on type of yam cultivated (Table 1) showed that 98% of the farmers in the study area cultivates white yam (*Disocorea rotundata*), 60% cultivates water yam (*Disocorea alata*), 39% cultivates yellow yam (*Disocorea cayanensis*), 30% cultivates bitter yam (*Disocorea dumentorium*), and 21% cultivates aerial yam (*Disocorea bulbifera*).

Awareness and Access to Improved Varieties: Result on awareness and access to improved varieties (Table 1) showed that 64% of are aware of the existence of improved varieties of yam while 30% are not aware. Several improved varieties have been developed by International Institute for Tropical Agriculture such as TDr 89/02565, TDr 89/02665, TDr 8/02461, TDr 200/412, TDr 89/02660, TDr 89/02475 and TDr 95/19158 with multiple pest and disease resistances and have been released in Nigeria (IITA, 2009; IITA, 2013; Mignouna et al., 2014). Although yam is widely cultivated among farmers in the study area, it appears that there is less awareness of the availability of improved varieties by Agricultural extension agents and other related agencies. Also, the new varieties do not have any friendly local name that can make farmers to be aware and familiar with them.

Majority of the farmers 62% do not have access to improved yam varieties. Mignouna et al. (2014) reported that no released improved varieties were observed in their field survey study of yam production in Nigeria. They further pointed out the following reasons for poor access to improved varieties:

i. Failure of relevant agencies in yam seed multiplication and distribution of certified seeds.

ii. Lack of minimum requirement of cultivable land for demonstrators.

iii. Continuous seed multiplication which might have affected the improved varieties released so that they can no longer be easily distinguished form a wide range of local genotypes.

Table 1. Distribution of farmers on Type of Yam Cultivated, Awareness and Access to Improved Varieties.

Variables	Frequency	Percentage (%)
Type of Yam Cultivated*		
White yam	98	98
Water yam	60	60
Yellow yam	39	39
Bitter yam	30	30
Aerial yam	21	21
Awareness of Improved Varieties		
Yes	64	64
No	36	36
Access to Improved Varieties		
Yes	48	48
No	62	62

* Multiple responses, Source: Field Data, 2018

Constraints of Yam Production: Result on constraints of yam production is presented in Table 2. Lack of access to finance with percentage score of 84%, poor market/sales (71%), availability and cost of seed yam (70%), lack of improved varieties (68%), low soil fertility (64%) and lack of access to fertilizers (56%) are the major constraints of yam production in the study area. Other constraints identified by respondents include pest and disease infestation (47%), limited access to suitable land (40%), high cost of labour (40%), lack of awareness on improved production practices (31%) and lack of efficient post-harvest storage methods (27%). This result is in agreement with the findings of Ayanwuyi et al. (2011), Ibitoye and Attah (2012), Ibitoye and Onimisi (2013) who all asserted that low soil fertility, lack of improved yam varieties, poor access to fertilizers, high cost of seed yam, poor access to finance, pest and diseases were among the constraints of yam production in Nigeria. These constraints according to Madukwe et al. (2000), Agwu and Alu (2005) and International Institute for Tropical Agriculture (2002) have led to decline in land area under yam cultivation and total yam output.

Table 2. Distribution of farmers on Constraints of Yam Production.

Variables*	Frequency	Percentage (%)
Limited access to suitable land	40	40
Availability and cost of seed yam	70	70
Low soil fertility	64	64
Lack of improved varieties	68	68
Lack of awareness on improved production practices	31	31
Pest and disease infestation	47	47
Lack of access to fertilizer	56	56
High cost of higher labour	40	40
Lack of efficient post-harvest storage methods	27	27
Lack of access to finance	84	84
Poor market/sales	71	71

* Multiple responses, Source: Field Data, 2018

Soil Fertility Indicators/Assessment: Major indicators identified for fertile soils in the study area (Table 3) include black/dark colour with percentage score of 72%, good crop performance (71%), presence of broad leaves in vegetation (54%) and abundance of earthworm activities (42%). Others include middle and lower slope (36%), deep depth with non-stony and non-hard layer (21%), ease of tillage (20%).

Major indicators for non-fertile (Table 3) soils are yellow and red or light coloured soils with percentage score of 69%, stunted growth of crops (57%), low yield (44%), high presence of grasses in vegetation (44%). Others are upper slope soils (33%), compacted soils (30%) and presence of rocks and stones (21%). The result of this study showed that farmers' criteria for assessment of soil fertility can be ranked in the following order: colour > crop performance > vegetation > yield >presence of earthworm activities> Topography > stoniness. This result is in agreement with the reports of Corbeels et al. (2000); Ayalew (2015) and Taylor-Powell et al. (1991), they all established that colour is an important criterion for farmers; soil colour is a reflection of presence of organic matter, Fe oxides and hydroxides and leaching of soils through high weathering intensity. Topography was also used by Raji et al. (2011) as criteria for the study of indigenous soils knowledge among farmers in Kaduna State in which the lowland soils was classified to be more fertile that the upland soils. Yakubu et al. (2011) reported the use of type of plant and presence of earthworm activities for assessing soil fertility among Gbagyi people of Paiko Southern Guinea Savannah of Nigeria, he reported the presence of plants such as *Pennsetum pedicellalum* and *Andropogon gayanus* is a manifestation of the soils ability to supply sufficient nutrient and moisture and the presence of *Striga spp* indicates poor fertility. Also, the presence of earthworm cast in the soils is a pointer of a fertile soil.

It is clear that farmers in the study area can classify their land in relation to productivity. They are concerned about the quality of their land and its ability to produce. Based on the indicators identified by the respondents, 59% of the farmers assessed the soil of their farmland to be fertile while 41% assessed theirs non fertile (Table 3).

Table 3. Distribution of Farmers on Soil Fertility Indicators and Assessment.

Variables	Frequency	Percentage (%)
Fertile soil*		
Black/dark colour	72	72
Good crop performance	71	71
Presence of broad leaves in vegetation	54	54
Abundance of earthworm activities	42	42
Ease of tillage	20	10
Deep depth with non-stony and no hard layer	21	21
Middle and lower slope soils	36	36
Non-fertile soil*		
Yellow and red or light coloured	69	69
Compacted soils	30	30
Stunted growth	57	57
Low yield	44	44
High presence of grasses in vegetation	44	44
Presence of rocks and stones	21	21
Upper slope	33	33
Assessment of the current fertility status farmers farmland		
Fertile	59	59
Non-fertile	41	41

* Multiple responses, Source: Field Data, 2018

Soil Fertility Management Methods: The data collected on fertility management methods among the respondents (Table 4) revealed that 98% of the farmers practice mulching, 62% use legume intercrop system, 50% adopt post-harvest residue management, 25% adopt inorganic fertilizer, 12% use farm yard manure while 10% use legume rotation system.

Mulching is a common practice among farmers in West Africa (IITA, 1995; Maduakor et al., 1984; Iyang, 2005). It involves the use of dry crop residue or grass materials to cover the surface of the soil. It has been reported to reduce soil particle detachment and transport (Iwuafor et al., 1990; Opara-Nadi, 1993), improve organic matter content and soil fertility, soils water storage and infiltration rate (Mbagwu, 1991; Obatolu and Agboola, 1993; Opara-Nadi, 1993; Owaiye, 1993; Ogban et al. 1999).

Post-harvest residue management in yam in the study area involves farmers harvesting the tubers and leaving other plant parts to decay into the soil. However, most farmers don't usually wait for the plant residue to decay before land clearing for further cultivation. Also, they usually pack the debris and burn (Slash-and-Burn). Bush burning increases cations in soil; however it has adverse effects on soil fertility by burning beneficial organism and loss of volatile soil nutrients such as nitrogen, sulphur and phosphorus. Ogban and Ekerette (2001) recommend the slash-and-mulch rather than the slash-and-burn residue management system.

Legume intercrop system is more practiced than legume rotation system. This could be as result of the fact that intercropping is an ancient practice among farmers in the sub-Saharan Africa (Agboola and Shittu, 2002). The beneficial effects include: derivation of maximum benefit from the land, prevention of pests and diseases, increase in soil fertility, reduction in fertilizer uses and control of weeds (Agboola and Shittu, 2002).

The use of farmyard manure is very low among farmers in the study area. This could be as a result of its low availability (Ogundare, et al. 2016) and demerits attached to organic manure (Ogboru and Ayeni, 2015) which include the bulkiness, foul odour and late nutrient mineralization.

The use of fertilizer is also low in the study area and this is in agreement with reports of Vlek (1990), Andre (1989) and Daramola (1989) in West Africa. It was attributed to thin fertilizer market that precludes socially profitable domestic investment in fertilizer, high cost and irregularity of supply due to poor road infrastructures and physical distribution facilities, lack of finance and poor distribution of government subsidized fertilizer.

Table 4. Distribution of Farmers on Soil Fertility Management Methods.

Variables*	Frequency	Percentage (%)
Post-harvest residue management	50	50
Mulching	98	98
Legume in rotation system	10	10
Legume in intercrop system	62	62
Use of farmyard manure	12	12
Use of inorganic fertilizer	25	25

* Multiple responses, Source: Field Data, 2018

Conclusion and Recommendations

The following conclusions were made:

1. Yellow yam, bitter yam and aerial yam are not commonly planted among farmers in the study area.
2. Farmers in the study area do not have adequate access to improved varieties of yam.
3. Yam production is constraints by; lack of access to finance, high cost of seed yam, low soil fertility and poor access to fertilizer.
4. Farmers understand the soils of their farmland and can access the level of fertility with their indigenous knowledge.
5. Post-harvest residue management of slash-and-burn is common among farmers in the study area.
6. There is low use of farm yard manure and inorganic fertilizer in yam production among farmers in the study area.

Based on the findings the following recommendations were therefore made:

1. Adoption and cultivation of other yellow yam, bitter yam and aerial should be encouraged among farmers in the study area.
2. There is need to strengthening the indigenous knowledge of soil fertility assessment among farmers in the study area. This will enhance strategies for fertility evaluation and management for yam farmer’s farm land in the study area. Also this knowledge should be well documented, conceptualized and preserved in order for it to be passed to younger generations.
3. Farmers are advised to apply organic manure on their farm to enhance crop performance as well as planting leguminous crops.
4. Farmers should be encouraged and assisted to access credit facilities in order to increase yam production in the study area.
5. Post-harvest residue management such as slash-and-mulch should be adopted by farmers in the study area.
6. There is need for government and non-governmental agencies intervention in the distribution of improved yam seeds in the study area.

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