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Evaluation of Traditional Soil Fertility Management Practices for Rice Cultivation in Southwestern Nigeria

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Abstract: Management of soil fertility is one of the major factors limiting sustainable production of rice in Nigeria. A survey was carried out to identify farmers' soil fertility management methods and its impact on soil properties, to introduce them to soil testing programme and a low cost soil fertility management method. Structured questionnaire was distributed to 55 rice famers in southwestern Nigeria. Soil samples were also taken from selected farmers' field to determine the effect of their fertility management methods on soil properties. The effectiveness of a low cost method was tested on two farmers' field using a local variety (Ofada) common with rice farmers and improved variety ITA 150. Legume treatment consisted of cowpea and mucuna planted as pre-rice crop. Four rates of Ogun phosphate rock was uniformly spread on the plots with and without legume biomass arranged in split plot design. NPK at 60kg ha^{-1} was applied as control. Result of the survey showed that soil fertility methods practiced by rice farmers interviewed can neither sustain nor improve soil fertility. There was no significant difference in rice yield between plots treated with NPK (2.96 tons ha^{-1}) and combination of legume and rock phosphate at 60 kg P ha^{-1} (2.94 tons ha^{-1}) at Ayiwere similar result was obtained with plots treated with cowpea and phosphate rock at 60 kg ha^{-1} at Ikenne. Hence the use Ogun phosphate rock as low cost P fertilizer for optimal and sustainable crop production when combined with legume biomass on slightly acidic to lightly alkaline soils is feasible.

Key words: Participatory Approach, Phosphate rock, Soil fertility, Soil testing programme

INTRODUCTION

The management of soil fertility is the first condition for sustainable crop production and poses a great challenge to farmers in Nigeria, most especially rice farmers. Local rice production was very poor due to rapid decline in soil fertility. Huge quantity and value on an annual basis stands over 1,000,000 metric tones and $300 million respectively by the Nigeria government on importation of rice in order to meet the demand of the growing populace [1]. Phosphorus deficiency has been found to be one of the major constraints to crop production in West Africa [2]. Nigeria imports about 200,000 tonnes of P fertilizer annually to augment the local production [3] which could still not go round many of the farmers. However, limited financial resources in the country cannot sustain importation or establishment of more fertilizer plant, More so recent findings have shown that the excessive use of these mineral fertilizers, due to lack of technical know-how on the part of farmers, could be detrimental to the resource base [4]. Hence, the use of mineral fertilizer as a means of maintaining soil fertility is gradually fading away. Against this background, it then becomes necessary to evaluate soil fertility management practice of rice farmers with the aim of improving fertility status of the soil on a sustainable basis in order to boost the production of rice in the country.

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METHODOLOGY

A participatory approach was used, which involves farmers' involvement right from the early stage of problem identification, to the final stage of developing viable solution. Specifically, the effectiveness of farmers' management practices on soil properties was evaluated; and they were introduced to soil testing programme and a low cost soil fertility management technology Diagnostic phase involved three parts namely: on farm assessment; assessment of farmers' fertility management method; and introduction to soil testing programme and a low cost soil fertility management practice which combines local knowledge with research based insights.

On Farm Assessment: A survey was carried out in seventeen rice growing communities viz: Obada-oko, Lala, Awado, Alapako, Ibogun ola oparun, Akodu, Akiniyi, Ibooro, Ayiwere, Lufoko, Oluwo-oke, Moloko-Asipa, Ogba-it, Wemode village, Onigbagbo, Ake and Ilogun-orile in Ewekoro, Ifo, Obafemi /Owode, Abeokuta north and Yewa south local government areas across *Egba* division of Ogun State. Fifty-five (55) rice farmers under the Ogun State Agricultural Development Project (OGADEP) were randomly selected for the study. A structured interview schedule was administered among the rice farmers to know the depth of their knowledge about soil and its management. Questions based on different types of soil, ways of identifying decline in soil fertility, factors affecting selection of farmland and their management practices were asked. OGADEP extension workers in Participatory Technology Development Progamme (PTDP) under African Rice Center, IITA, Ibadan, Nigeria were used as enumerators in administering the research instrument.

Assessment of Farmers' Soil Fertility Management Practice: Effectiveness of their soil fertility management practices was monitored by a more formal quantitative assessment such as soil sampling (0-20cm) from five farmers' fields (one in each of the local government areas). The samples collected were subjected to both physical and chemical analyses. The results of the analyses were presented to farmers in form of bar diagrams.

Soil Testing Programme (STP): The importance of soil testing programme as a key determining factor in assessing good management practice was introduced to farmers by likening management of soil fertility with a medical examination [5] using the underlisted questions as a model:

- What happens if you work without taking good and balanced food?
- What steps does a doctor take when a patient is sick
- What would happen if the doctor prescribed medicine for you without examining you?
- What would happen if a doctor gives a wrong medicine?
- Do patients have to pay for examination?

A low cost fertility management practice which involves the use of legume and indigenous phosphate rock found in southwestern Nigeria was introduced to farmers. The experiment was tested on two farmers field.

Field Experiment: The field trials was established on two farmers' sites in southwestern Nigeria (Ikenne and Ayiwere) Land clearing method used by farmers concerned was adopted. Composite samples were taken before cropping and subjected to both physical and chemical analysis. Legume treatment consisted of cowpea (IT98K-356-1) and mucuna as agreed by rice farmers in Ogun state and were planted as pre-rice crop in a spacing of 25cm by 50 cm. Four rates of P (0, 30, 60 90 Kg P ha^{-1}) as Ogun phosphate rock was applied in triplicates before planting legume. Cowpea seeds were harvested three months after planting while its biomass and mucuna plant remain on the field and later incorporated into the soil plot by plot a month before planting rice. Farmers favorite rice variety (Ofada: four month duration crop) was used along side with an improved rice variety (ITA150: three month duration crop). The rice seeds was planted in a spacing of 20 cm by 20 cm. NPK at 60 kg P ha^{-1} was used as control. Grain yield per plot at 14% moisture content was recorded. Two border rows was removed from each side of plot for yield recording.

RESULTS

Diagnostic Survey

Farmers Perspective of Soil: About 87% of 55 rice farmers interviewed were male, the rest female. The result showed that 91% of the farmers used the fertility status of the soil as a major criterion for selecting farm land, while others used length of fallowing and type of crop to be planted. They all depended on physical features like presence of earthworm cast, plant indicator as shown in Figure 1 to assess fertility status of a soil. All the farmers interviewed agreed to the importance of maintaining soil fertility for crop production. Analysis of various methods

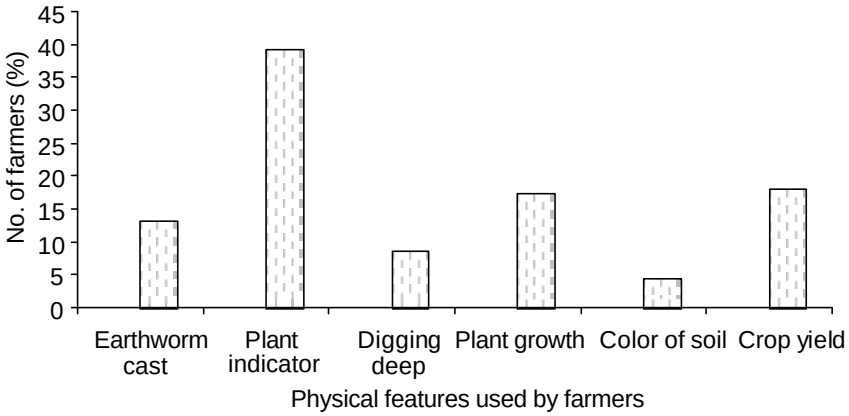

Fig. 1: Methods Farmers used to identify fertile soils

Table 1: Cropping system practiced by five selected farmers after five year fallow period

Location	Local Govt. Area	Cropping practice	Cropping period
Moloko Asipa	Abeokuta North	Sole cropping	2years
Ilaho	Ifo	Maize/cassava/rice	3years
Iperu	Yewa South	Sole cropping	2 years
Wasimi	Ewekoro	Cassava / rice	3 years
Ayiwere	Obafemi / Owode	Sole cropping	2 years

Table 2: Various methods used by Rice farmers to maintain soil fertility

Method	Percentage
Fallowing	42.9
Planting of cover crop	19.0
Decay of leaves on the farm (Mulching)	9.5
Fertiliser application	9.5
Planting of Potato	4.8
Shifting cultivation	4.8
Hoeing (Minimum Tillage)	4.8
Melon leaves	4.3

showed that greater number of them believed that fallowing is the best method to maintain soil fertility, some farmers adopted the use of cover crop, mulching (Table 2). Survey also revealed that farmers' record keeping was poor, cropping practices differ from one local government area to another (Table 1). Seminar delivered on the importance of soil testing programme was revealing, about 90% of the farmers present signified willingness to have soil testing carried out on their farm land before planting. Results of the chemical analysis carried out on soil samples taken from the five farmers' field before planting after five year fallow (Table 3) showed slightly acidic to slightly alkaline soils (soil pH range from 5.5 to 7.3). Soil organic mater content ranged between 2.40 and 4.06 g kg^{-1}. The nitrogen content ranges from 0.094 to 0.14 g kg^{-1}, available P value varied widely from 5.8 to 21.2 mg kg^{-1}. Exchangeable cations varied slightly across the five locations, ranging from: Ca (2.9-8.0 cmol kg^{-1}), K (0.1 to 0.4 cmol kg^{-1}) and Mg (1.1 to 1.8 cmol kg^{-1}). Fe content was highest in Ilaho (31 kg ha^{-1}) and lowest in Wasimi (19.2 kg ha^{-1}).

Table 3: Chemical properties of the soil samples from five farmers field taken before planting

Parameters	Moloko Asipa	Ilaho	Iperu	Wasimi	Ayiwere
pH (H_2O)	5.4	6.0	6.5	7.3	5.6
Org.C (g kg^{-1})	3.26	4.06	2.44	3.07	2.58
Total N (g kg^{-1})	0.10	0.13	0.14	0.10	0.11
Avail. P (mg kg^{-1})	5.8	20.2	12.8	21.2	7.5
Exchangeable cations (cmol kg^{-1})					
Ca	3.5	6.2	5.4	8.0	2.9
K	0.2	0.4	0.1	0.3	0.2
Mg	1.1	1.1	1.3	1.8	1.2
Al	0.0	0.3	0	0	0
Micronutrient					
Fe (kg ha^{-1})	30	31	27	19.2	23.4

Table 4: Comparative evaluation of the effect of combination of legume and Ogun phosphate rock on rice yield across the two sites with the two rice varieties

Site/variety	Rice yield (tons haG^{1})
Ikenne	2.68a
Ayiwere	2.08b
ITA150	2.54a
Ofada	2.22a

†Within a column means followed by the same letter are not significantly different according to Fisher's LSD at 0.05 probability level.

Table 5: Effect of the treatments on Rice yield

		Rice yield (tons haG^{1})	
Treatments			
Legume	P rates (kg haG^{1})	Ayiwere	Ikenne
Mucuna	O	1.38cde	2.98ab
	30	2.33abc	2.6abc
	60	2.94a	2.96ab
	90	2.63ab	2.80abc
Cowpea	O	2.31abc	2.64abc
	30	2.23abc	2.44abc
	60	2.18abc	3.48a
	90	1.85bcde	3.11ab
No legume	0	0.93e	1.96bc
	30	1.06de	1.66c
	60	2.02abcd	2.04bc
TSP (40 kg haG^{1})	90	2.96a	3.49a

†Within a column means followed by the same letter are not significantly different according to Fisher's LSD at 0.05 probability level

Plots treated with NPK produced the highest rice yield (3.94 and 2.96 tons haG^{1} at Ikenne and Ayiwere respectively)though not significantly different from plots treated with combination of legume biomass and Ogun phosphate rock but a significant increase was observed over plots treated with phosphate rock alone (Table 5). There was no significant difference in grain yield with the two rice varieties (Table 4). Among legume treatments, plots treated with mucuna performed better in Ayiwere while cowpea treatment performed better at Ikenne (Table 5).

DISCUSSION

This research used the Participatory Technology Development approach to introduce farmers to a low input soil fertility management practice that will combine local knowledge with research based insights to make the most effective use of locally available resources with little or no detrimental effect on the resource base. The fact that majority of rice farmers interviewed (91%) used fertility status of a soil as a major criterion for selecting farmland is a clear indication of how highly they value soil fertility. The outcome of the meeting held with rice farmers in Abeokuta when soil testing programme (STP) was introduced was revealing where 90% the farmers present agreed to the importance of STP as a tool for good soil fertility management practice. This confirms the fact that participatory approach of disseminating new technology to farmers is viable as observed by Ramaru *et al*. [5].The participatory technology approach brings scientists and farmers to share ideas and plan together unlike former approaches of passing down information to farmers where farmers participation in research was very poor. The soil test results from the analysis of soil samples taken randomly from the farmers' field showed that their management method can neither improve soil fertility nor sustain crop production. Fallow periods of five years maintained by most of them is too short to ensure adequate replenishment unless external input is introduced and very few farmers had access to mineral fertilizer. The result of this survey clearly revealed the urgent need for a low cost and sustainable soil fertility management method. Plots treated with mucuna and phosphate rock at 60 kg haG^{1} performed comparably well with NPK treatments at Ayiwere while plots treated with cowpea and phosphate rock at 60 kg haG^{1} at Ikenne. The highest value recorded with plots treated with NPK could be as a result of its high solubility and fast rate of P release to crop compared with phosphate rock. A significant difference observed with the two legume crops could be attributed to differences in their chemical properties as confirmed by Tian *et al*. [6]. Significant differences in rice yield from these sites could partly be attributed to inherent physical and chemical properties of the soils coupled with the fact that Ikenne was formed on a sedimentary rock while Ayiwere soils was formed on basement complex as reported by Moormann, [7]. Positive results obtained from OPR treatment when combined with legume on soils that are not acidic could have been as a result of modification of soil conditions through the decomposition of legume which releases organic acids and nutrients. Evidences confirmed so far suggest that these acids can enhance the dissolution of elements from minerals due to their acidity and to a greater extent by a complex formation. Consequently, the increased solubility of less reactive

OPR could be attributed to the action of the products of decomposition of legume biomass. Chelation of Ca from OPR resulting in increase P release [8] which will contribute to grain yield could be another probable reason for the significant positive effect observed on rice grain. There was no significant difference in rice yield with Ofada, a four months duration crop and ITA 150, a three month duration crop. it is therefore envisaged that planting ITA 150 would give a better economic return to farmers however there is need for further confirmation.

CONCLUSION

Participatory technology approach in disseminating research results to farmers proves a viable tool for passing down new research findings to farmers. Result of the diagnostic survey showed that soil fertility methods practiced by rice farmers interviewed can neither sustain nor improve soil fertility. The present study indicated that the Ogun phosphorite in combination with legume has dual purpose to give adequate amount of nitrogen to the growing crop and as a potential source of natural P fertilizer.

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