Indigenous Knowledge on Land Evaluation and Soil Fertility Management among Rubber Farmers in Southern Nigeria

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Abstract: Understanding farmers' indigenous knowledge on land evaluation and soil fertility management practices means understanding local realities that are crucial for sustainable agricultural productivity. This study was conducted in three rubber growing communities in southern Nigeria to evaluate the perception of rubber farmers on traditional land evaluation and soil fertility management practices through direct and indirect interviews. The major local methods of evaluation adopted by majority of the farmers include the vigour of native vegetation, presence of certain indicator plants and visual appraisal. Fertility ranking of the farmers correlated with values of Organic carbon (r = 603* p < 0.05) and Available P. (r = 647* p < 0.05) obtained from laboratory analysis. Though a large proportion (72 %) have applied chemical fertilizers (mainly to arable crops) at one time or the other, cultural methods such as multiple cropping (intercropping) and cover cropping are employed to manage soil fertility in the rubber plantations. Rubber farmers demonstrated significant knowledge of their soils and the environment acquired by experiences that have been tested by many years of living close to the farmland. In view of the importance in applying a holistic approach to study land evaluation, local soil knowledge provides key linkages between ancient and modern soil management.

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Introduction

Sustainable management of land for agricultural and non agricultural purposes requires basic understanding of the resources to be managed (Paradzayi and Ruther 2002). Land resource surveys and the subsequent soil survey interpretation - qualitative and quantitative land evaluation- have been used to classify and quantify land classes with soil characteristics or attributes that control agricultural productivity as well as vulnerability to degradation (Lin *et al* 2005). In developing countries such as Nigeria, information from land inventories rarely gets to the farmer; rather they are most times filtered through the extension agents.

The optimism that greeted the FAO framework for land suitability classification (FAO 1976, 2007) has gradually given way to a realization that its focus on static land use planning is not appropriate to today's network society where multiple stake holders negotiate land use (Barrera-Bassols *et al.,* 2001). Also, according to Bacic *et al.* (2003), some important questions that remain unanswered by soil inventories and land evaluation reports include the usefulness to the clients (in this case, farmers) and if the information supplied land evaluation reports are actually being used for land use planning.

A common fault in current land evaluation systems worldwide is that interpretations of technical data are rarely tailored to the specific needs of individual decision makers and are usually carried out according to fixed evaluation systems (Ryder, 2003). While maps are usually presented in scales of 1:25,000 or smaller, implying a minimum delineation of 2.5 ha, farmers' fields in many cases are no more than 0.5ha. While the methodology evaluates general land utilization types (LUTs) and physical aspects of land suitability, farmers use a variety of technologies including soil conservation practices, multiple cropping, relay intercropping, etc. to grow a wide range of crops taking decisions based on available resources and their experience or 'local knowledge'.

The knowledge that people in a given community or environment have developed over time and continue to develop is often referred to as 'indigenous' or 'local' or 'traditional' or 'indigenous technical knowledge' (Cools *et al*, 2003). It is a body of knowledge built up by a group of people through generations of living in close contact with nature. It includes a system of classification, a set of empirical observations about the local environment, and a set of self-management that govern resource-use. Local people have significant knowledge of soils and environments, acquired by experiences that have been tested by many generations living close to the land which is crucial for success or failure of any type of agriculturally- based development (WinklerPrins, 1999; WinklerPrins and Sandor, 2003).

There has been little or no use of land evaluation information among rubber farmers in Nigeria due to lack of access, or technical knowhow to understand the conventional reports. This study was designed to understand the farmers' indigenous knowledge on land evaluation with respect to rubber farming and quantify their perception on the management of soil fertility.

Materials and Methods

Structured questionnaires were administered to 100 rubber farmers in three farm settlements in Edo and Delta states in Southern Nigeria. The farm settlements are located at Mbiri, Utagbuno and Iguoriakhi (Fig. 1). The questionnaires have 31 questions divided into 5 parts namely: (i) Personal/ general information, (ii.) Land use/land characteristics (iii.) Indigenous land evaluation methods (iv.) Soil fertility management and (v.) Interaction with relevant agencies.

While self identification was optional, distribution was by personal contact with RRIN extension officers and the questionnaires were collected on the second visit. Answers to structured questions were entered into Microsoft Excel spreadsheet (Microsoft Corporation, 2007) and the proportions of respondents for each answer were summarized with simple statistics and percentages.

Group interviews and transect walks were held at Mbiri and Iguoriakhi farm settlements as a follow up to the questionnaires during which farmers were allowed to allocate the land by their perceived fertility assessment to a scale of 0 to 10- 0 being the poorest and 10 being the most fertile. A transect each cutting across the physiographic landscape were laid at the two farm settlements and bulked composite soil samples from 0-20 cm depths were collected from three locations representing the upper slope, middle slope and lower slope positions along the transect for laboratory analysis. The soils were air dried, sieved through 2mm aperture and were subjected to routine soil analysis using standard procedures. Particle size analysis was by the Hydrometer method described by Day (1965). Soil pH was determined at 1:2.5 soil/water ratio, by a glass electrode digital pH/conductivity meter. Organic carbon was determined by the Chromic Acid Wet oxidation method while total nitrogen was estimated by the micro-Kjedhal procedure of Jackson, 1978. Exchangeable cations (Ca, Mg, K and Na) were extracted with normal ammonium acetate at pH 7. Na and K were determined by flame photometry method while Ca and Mg were determined by atomic absorption spectrophotometer. Exchangeable acidity was extracted with normal KCl and titrated with NaOH. Available P was extracted with Bray 1 solution and P content assayed by the Molybdate blue colour method. Effective Cation Exchange Capacity (ECEC) was computed. Farmers' fertility ranking was correlated with the values three major soil chemical fertility indices namely organic carbon, Total N and Available P.

Results and Discussion

Demographic characteristics of rubber farmers

Table 1 shows the personal characteristics of the rubber farmers in the three farm settlements. Rubber production in this part of the country is almost exclusively by men. With 100 % male recorded at Mbiri, Utagbuno and Iguoriakhi farm settlements. This is probably a cultural issue as in most rubber producing areas in Nigeria; women are not permitted by tradition to own lands.

In terms of age distribution, more than half of the rubber farmers in the three farm settlements are well above 50 years with 34.60 % between the ages of 55-65 while 14.30% are above 65 years. More than 60% of the farmers At Utagbuno, are 55 years and above. This has been observed by Abolagba (2004) who reported that most rubber farmers in Nigeria are above 50 years in age. Most of the rubber farmers are married. 97.1 % overall. Apart from a farmer who did not respond to the marital status question at Utagbuno and one respondent who is widowed, at Mbiri, all other respondents from the three farm settlements reported that they are married. The educational level showed that only 2.90 % of responding rubber farmers had no formal education signifying that the farmers are mostly literate. Though only 7.2 % overall had post secondary education (some of which are actually retired civil servants or Teachers) it is commendable that the rubber farmers are over 90% literate having one form of training or the other. 80.63 % of the total respondents have rubber farming as their primary occupation; Utagbuno had about 90% primarily engage in rubber cultivation meaning that many households in the study areas make their likelihood through rubber cultivation.

Table 1: Characteristics of the rubber farmers in three farm settlements in southern Nigeria

Characteristics	Number of respondents (%)			
	Mbiri	Itagbuno	Iguoriakhi	Combined
		Gender		
Male	100	100	100	100
Female	0	0	0	0
		Age		
24-35	9.60	0.00	0.00	2.90
36-45	19.10	3.60	30.00	15.70
46-55	32.90	14.30	30.00	24.40
56-65	33.40	42.90	25.00	34.60
65 and above	4.8	21.4	15.00	14.30
No response	0.0	17.9	0.0	7.20
		Marital Status		
Single	0.00	0.00	0.00	0.00
Married	98.60	96.40	100.00	97.10
divorced	0.00	0.00	0.00	0.00
Widowed	4.8	0.00	0.00	1.40
No response	0.00	3.60	0.00	1.40
		Education		
No formal education	4.80	3.60	5.00	2.90
Adult Education	0.00	7.10	5.00	4.30
Vocational training	19.00	28.60	15.00	1.40
Primary	71.40	57.10	45.00	58.0
Secondary	19.00	28.60	25.00	24.6
Post Secondary	4.80	3.60	15.00	7.20
		Primary Occupation		
Rubber farming	72.40	90.80	69.50	80.63
Others	27.60	7.20	15.00	

Table 2: Methods of determining land suitability and perceived effects of soil on rubber yield as perceived by rubber farmers in three farm settlements in southern Nigeria

Methods	Number of respondents (%)			
	Mbiri	Itagbuno	Iguoriakhi	Combined
Visual appraisal	42.9	57.10	40.00	48.50
Indicator plants	19.00	39.30	20.00	28.40
Vegetation vigour	28.60	50.00	80.00	52.20
Cropping history	9.50	17.90	0.00	10.10
Recommendation from agencies	0.00	3.60	25.00	13.90
Others	6.9	7.10	10.00	6.81
Soil type				
Sandy	9.50	0.00	5.00	4.3
Loamy	76.2	89.30	90.00	85.5
Clayey	14.30	3.60	0.00	5.8
Gravelly	0.00	0.00	0.00	0.00
Swampy	0.00	7.10	0.00	2.90
Others	0.00	0.00	5.00	1.4
Perceived effect of soil on rubber yield				
Positive effect	47.60	50.00	55.00	50.70
No effect	47.60	46.40	45.00	46.40
No response	4.80	3.60	0.00	2.90

Indigenous land evaluation methods

Land suitability determination among rubber farmers and the perceived effect soil and land systems on their rubber yield is presented in Table 2. This classification is not limited to rubber as many of the farmers also practice arable farming inside and outside their rubber plantations. It should be pointed out here that many of the percentage responses may not add up to 100 because some employed more than two methods to classify the suitability of their lands for rubber. About 48.50 % of the farmers rely on visual appraisal to determine the suitability of their lands for rubber and other agricultural use. The highest number of respondents (57.10 %) relying on visual appraisal is from Utagbuno while 42.90% and 40 % use this method at Mbiri and Iguoriakhi respectively. Use of indicator plants is also higher at Utagbuno (39.30%) compared with the 19% and 20 % at Mbiri and Iguoriakhi respectively. The use of indicator plants and visual appraisal require some experience. During the follow-up interview it was discovered that some of the indicator plants that identify a good soil are *Chromolaena odorata*, (Awolowo weed) and *Andropogon gayanus* (which they refer to as elephant grass) while *Imperata cylindrical* (spear grass) is indicative of a poor soil. Majority of the farmers at Iguoriakhi (80 %) estimate the suitability of land for rubber through the vigour of the native vegetation. According to one of the farmers, it is logical to believe that where other trees that look like rubber are growing well, the land will be able to support rubber. Very few farmers rely on cropping history (17.9 % at Utagbuno) and it was only in Iguoriakhi that an appreciable number of farmers obtain advice from some agencies. While many of the farmers categorized their soils (surface soils) as loamy, spot checks on field texture by hand feel method at Mbiri and Iguoriakhi showed that the surface soils range from loamy sand (LS) to sandy loam. However, about half of the farmers believe that rubber yield (latex and coagula) is not related to the nature of the land.

Table 3 shows some selected properties of soil samples collected from the catenary positions in the farmer's farms by laboratory analysis Table 4 shows the correlation between local soil fertility and laboratory analysis of some nutrient elements.

Table 3: Selected physical and chemical properties 0-20cm) of some soils at Mbiri and Iguoriakhi with the fertility indication by farmers

Farm settlement	Catenary position	Farmers description	Fertility* rating	Sand	Silt	clay	Texture**	pH	Org C	Total N	Available P
				g kg^{-1}				(H_20)	g kg^{-1}		mg kg^{-1}
Mbiri	Upper slope	Red soil/ loamy	8	828.40	21.20	150.40	SL	4.70	2.20	0.57	6.20
	Middle slope	Red soil/ loamy	5	836.20	2.20	156.00	SL	4.50	7.90	1.25	5.60
	Lower slope	Brown soil / sandy	3	846.20	2.20	146.00	LS	5.20	1.10	0.44	5.60
Iguoriakhi	Upper slope	Black soil/ loamy	9	810.20	3.40	186.40	SL	4.70	20.40	2.40	18.18
	Middle slope	Black soil/ loamy	6	840.80	40.60	118.60	LS	4.80	7.90	1.25	4.40
	Lower slope	White sand	6	862.40	12.80	124.80	LS	3.87	11.30	1.00	12.51

***** Fertility rating as described by farmers ******SL = Sandy Loam, LS = Loamy sand

Table 4: Correlation matrix between farmers' fertility ranking and laboratory analysis

	Org C	Total N	Avail. P
Local	.603*	.515ns	.647*
Org C	1.	.824**	.603*
Total N		1.	.221ns
Avail P		.	1.

*Correlation is significant at the .05 level;
**Correlation is significant at the 0.01 level

Table 5: Soil fertility management among rubber farmers, effects on rubber yield in three farm settlements

	Mbiri	Itagbuno	Iguoriakhi	Combined
	Number of respondents (%)			
Fertilizer application				
Applied fertilizer	38.1	92.90	80.00	72.50
No Fertilizer	61.9	3.60	20.00	26.10
Fertilizer Type				
NPK	38.1	92.90	80.00	72.5
Rock Phosphate	0.00	0.00	0.00	0.00
Organic Manure	0.00	0.00	0.00	0.00
Urea	0.00	0.00	0.00	0.00
MOP	0.00	0.00	0.00	0.00
SSP	0.00	0.00	0.00	0.00
Others	0.00	0.00	0.00	0.00
Effect of fertilizer on yield				
Improved	38.10	96.4	80.00	73.90
No improvement	4.80	0.00	0.00	1.40
No response	57.1	3.60	20.00	24.60
Rate of improvement due to fertilizer				
0-5 %	0.00	0.00	0.00	0.00
5-15%	0.00	14.30	5.00	7.2
15-30 %	28.60	25.00	20.00	24.60
30-50%	0.00	10.70	20.00	10.10
Above 50%	0.00	0.00	0.00	0.00
No response	71.40	50.00	55.0	58.00
Other fertility management practises				
Animal dung	0.00	7.10	5.00	4.40
Liming	0.00	0.00	0.00	0.00
Household waste	0.00	7.10	0.00	2.90
Intercropping	33.30	64.30	15.80	41.20
Cover cropping	4.8	17.90	63.20	17.60

Soil fertility management

Many local rubber farmers rely predominantly on the recycling process of natural fallow to rejuvenate their soil fertility. In the three locations studied 72.5% have applied fertilizers at one stage or the other in their rubber farms (Table 5). This comprised of 38% at Mbiri, 92.9 % at Utagbuno and 80 % at Iguoriakhi. Almost all respondents that applied fertilizer applied

NPK in the three study sites. While the awareness and availability of chemical fertilizers were identified as major constraints to fertilizer practices by many farmers, interview showed that many of them actually applied other forms of manure such as household wastes, wood ash and poultry droppings as soil amendments which they did not regard as fertilizers at the time of filling the questionnaires. By analyzing what constitutes soil fertility management in practice, the internal differentiation of local soil management and knowledge can be brought to the surface. The impact of farming practice on soil dynamics can be thereby better understood. Interview revealed that those who are educated and seemed to have more access to fertilizer supply, apply too much fertilizer relative to the nutrient demand of the rubber and accompanying subsistence crops. Consequently, some practices in subsistence plots result in excessive macronutrient levels without consideration of the possibility of nitrate and phosphate pollution. In all the farm settlements, 73.90% of rubber farmers agreed that there was an improvement on their rubber yield as a result of fertilizer application with the highest at Utagbuno (96.40%). The response on rate of improvement in the yield of rubber due to fertilizer application which is somewhat quantitative showed an interesting result. While 58% of the rubber farmers showed no response (Consisting mostly of those who have never applied).

Conclusions

The study on indigenous knowledge could facilitate a framework for an effective interactive research approach on soil fertility management as an alternative to the top-down approach that has often led to failure of introduced soil fertility management innovations.

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