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Assessing soil quality issues for crop production function based on farmers' perception: An experience from Itapaji Watershed in Southwestern Nigeria

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Abstract

To successfully manage soil quality for sustainable crop production, there is need to identify issues affecting it. These are problems facing the capacity of soil to perform its functions and thus reducing its productivity. In addition, the similarities and differences between farmers' perception of soil quality issues and that of soil scientist are very pertinent. This study, which was carried out at Itapaji watershed in Ikole local government area of Ekiti state, aims at identifying soil quality issues using participatory approach and conventional method. Diagnostic survey was carried out using participatory approach involving farmers' judgement using questionaires. . The resultswere analysed to identify the soil quality issues from farmers' perspectives. For conventional method, major soil types were identified and soil quality issues were identified using soil management assessment framework. The relationship between the soil issues from farmers' interview and soil analysis were established by correlation analysis at α0.05. Soil quality issues identified by farmers are soil compaction, low soil fertility, termite infestation, crop wilt, hardpan formation, erosion, poor drainage and land use intensification. Low soil fertility is the most prominent with about 36.2 % impact on crop production in the watershed. Conventionally from soil analysis, CEC and organic matter are low which indicate low soil fertility; there is high acidity, shallow soil depth with presence of plinthite and hard pan. The farmers' perception of soil quality and that of soil scientists correlate well (r = 0.70). There is therefore need for promotion of farmers' participation by providing a forum for articulation of their opinions in mitigating low soil quality.

Keywords: Soil quality issues, participatory, conventional, watershed.

Introduction

The persistent imbalance between population and food growth rate is a serious challenge facing most nations of Sub Saharan Africa (SSA); a good example is Nigeria (Rosegrant et al. 2001; USDA, 2006). This has made attainment of food sufficiency difficult in these nations. Nigeria by virtue of its prominent position as the most populous nation in the region is currently depending on food importation and this can only be eradicated by increase in domestic food production. Previous attempts to increase food production in Nigeria were tailored mainly to expansion of areas under arable cultivation rather than increasing the productivity of the arable lands. This has however led to the decline in Nigerian agricultural land area, degradation and desertification (Brown, 2005). Land use intensification is a way of increasing food

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production without extending the quantity of land under cultivation. However, this has to be accompanied with the use of modern inputs and sustainable farming practices otherwise it could also lead to continuous depletion of soil fertility, decline in productivity, loss of soil structure, soil erosion and general land degradation.

Soil is a dynamic resource that provides several essential functions to support plant, animal and human life. Soil quality is the capacity of a specific kind of soil to function within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation. Enhanced soil quality will reduce soil erosion, improve water and nutrient use efficiencies, and ensure that the soil is sustained for future use. Assessing soil quality can be likened to a medical examination of humans in which measurements of certain issues are taken. These issues are those that can affect the capacity of soils to function effectively and efficiently at present and in the future (Doran and Parkin, 1994). There are two major approaches to identifying soil quality issues: The farmers' perception and soil scientist perception. To successfully monitor and manage soil quality for sustainable crop production, there is need to identify such issues.

Itapaji watershed, located in intensive farming communities of Ekiti State, is one of the many watersheds in Nigeria with perennial water flows. The area is endowed with enormous potential for irrigation farming which makes high level of intensification possible.

This study aims at identifying soil issues in Itapaji watershed in southwestern Nigeria using participatory approach and conventional methods so as to enhance good management while intensifying land use for increased productivity.

Material and Methods

Study site

The study was carried out in Itapaji watershed in Ikole local government area (Figure 1). Ikole local government area is in Ekiti State (7.40–8.00 N and 5.20 to 5.40 E). The Itapaji watershed is in the Benin-Owena hydrological basin with agro- ecology varying from humid forest to derived savannah. The watershed is primarily agricultural and is majorly drained by the Itapaji River. The southern part of the watershed is forest ecology with cash crops and primary forest while the northern part is derived savannah with arable crops cultivation being the major occupation of the farmers. The drainage network in the watershed is not dense; aside the Itapaji river, the basins of the other rivers like Arinkin Ako, Oke Ako, Ayan and other streams have high potential for dry season agricultural activities.

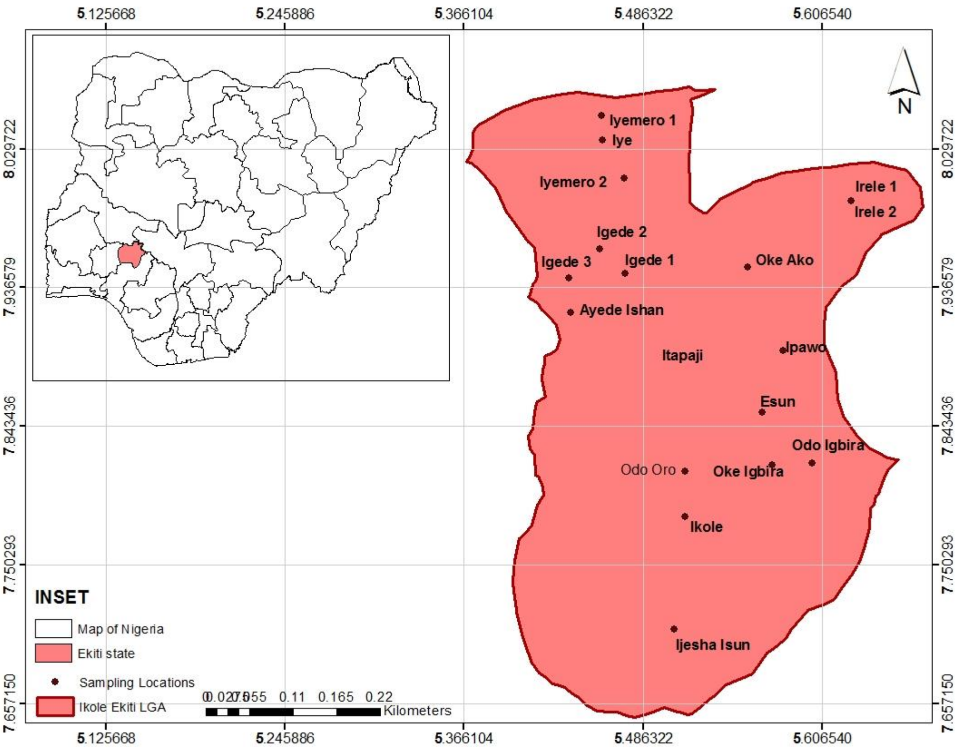

Figure 1. Map of Ikole Local Government showing the study sites

The temperature across Itapaji watershed ranged between 28.8 ^{0}C – 35.1^{0}C while minimum temperature of 19.5 ^{0}C is possible during the dry harmattan season. Average rainfall within the watershed is 1234±74.7mm with a bi-modal peak observed in the month of June and September. Reference evapotranspiration (ETo) within the watershed is highest in March (5.11mm/day) and lowest in August (3.41mm/day) (Ayoade, 2002; NIMET, 2007). The soils are formed on Crystalline Basement Complex rocks with granite gneiss as the dominant parent rock. There is a very strong geological and geomorphological influence on the pattern of soil distribution in the study sites. Vegetation also contributes to the pattern of soil development in the area. The farming system is mainly yam-based. Other crops include African yam bean, pepper, maize, sorghum, tomatoes, cowpea, cassava, leafy vegetable and groundnut. The most prominent crop combination in the watershed is maize/cassava/yam.

Field work

A farm survey was conducted in farming communities located within the watershed. A total of 200 farmers were selected through multi-stage sampling technique from Ikole Local Government Areas (LGA) identified as the location of the watershed. The list of villages located along the course of the main water bodies were obtained from the Agricultural Development Programmes in the state while the list of farmers in each of the villages were obtained from the village head and contact farmers. Ten villages were randomly selected from the list of villages located along the main water bodies in the states. Twenty (20) farmers were randomly selected from the list of farmers in each of the villages. Personal interview was conducted with the aid of structured interview schedule designed to elicit information on the soil quality issues being faced by farmers. Also, information were obtained on crop production practices, crop combination, land use pattern, soil fertility maintenance and conservation practices, water bodies available for farm production and their uses, water management practices, crop yield, production constraints and the training needs. These were analysed to identify the soil quality issues from the farmers' perspectives.

For the conventional method, major soil types in the watershed were identified through site and soil characterization. Free survey method was employed for mapping of the area. As movements were made along the road and footpaths, incursions were also made into the land to examine the soil for identification of soil types, characterization, classification and soil type boundary placement. Changes in vegetation cover, land use, physiography, soil surface form and stoniness, micro-relief, etc. were noted and also used as clues to arrive at changes in soil types and establishment of soil boundaries. Placements of boundaries were further achieved by grouping similar auger examination points and modal soil profile pits were dug based on the most representative auger examination points for each of the identified soil types. On the whole, eight (8) major soil types were identified. All necessary environmental information relating to the site characteristics and the soil morphology were recorded. The soil profiles were described according to the FAO guideline (FAO, 2014) and soil samples were collected. Soil samples collected were analyzed in the laboratory, classified using Murdoch et al. (1976) and Soil Survey Staff (2014); and soil quality issues (as well as their impacts on crop production) were identified by modifying the approach of Andrews et al. (2004) known as soil management assessment framework. This is based on critical values of each parameter and the level of importance of each parameter (relative weight) to crop production. Any indicator that is not able to meet the critical value is scored less and thus becomes soil issue affecting crop production. The level of importance (i.e. the relative weight) of the indicator indicate the level of impact of the issue on crop production (Table 1 and 2). Digital soil map of the site was produced in GIS environment.

The relationship between the soil issues from farmers' interview and soil analysis were established by rank correlation analysis at $\alpha_{0.05}$.

Table 1. Soil quality ındicators, their critical values/range and their relative weight

Indicator	Critical Value/Range	Relative Weight
Available Phosphorus	10 – 15mg/kg	0.085
Total Nitrogen	1.6 – 2.4g/kg	0.10
Available Water Capacity	8 – 20 %	0.08
Organic Carbon	10 – 20g/kg	0.15
pH(H_2O)	5.5 – 6.5	0.085
Cation Exchange Capacity	6 – 8 cmol/kg	0.145
Exchangeable Sodium Percentage	13 %	0.065
Bulk Density	1.3 – 1.5g/cm^3	0.112
Total Porosity	0.15 – 0.18m^3/m^3	0.062
Texture	Sandy clay loam	0.05
Effective Soil Depth	100 – 150 cm	0.066

Table 2. Soil quality indicators values and their scoring

Indicators	Average Actual Values	Scoring (%)	Critical Value
Availaple Phosphorus (mg/kg)	13.16	60	10 – 15
Organic Carbon (g/kg)	14.10	60	10 – 20
Total Nitrogen (g/kg)	1.00	40	1.6 – 2.4
pH	6.83	40	5.5 – 6.5
Exchangeable Sodium Percentage	13.49	40	13
Cation Exchange capacity (cmol/kg)	4.46	40	6 – 8
Bulk Density (g/cm^3)	1.29	50	1.3 – 1.5
Total Porosity (m^3/m^3)	0.47	40	0.15 – 0.18
Available Water Capacity (%)	14.40	50	8 – 20
Texture	Sandy Loam	50	Sandy clay loam
Effective Soil Depth (cm)	119	50	100 - 150

Results

The soil types encountered at the watershed are shown on Figure 2. The soils are Egbeda series (Typic Kandiudalf), Eruwa series (Typic Paleudalf), Fashola series (Oxic Haplustept), Matako series (Udic Kanhapludalf), Ofiki series (Arenic Paleudalf), Olorunda series (Dystric Eutrudept), Shante series (Arenic Eutrudept) and Temidire series (Oxic Paleudalf). Table 3 shows the chemical properties of the soils encountered at the watershed. The soils are moderately acidic with pH in water and KCl ranging from 4.21 to 6.88 and 5.31 to 7.14 respectively. The basic cations are adequate and this is reflected in the high values of base saturation indicating that the exchange sites are adequately occupied by basic cations. Organic carbon is very low and decreases down the profile in all the soils encountered. Total Nitrogen is also very low and follows the same trend as organic carbon. Cation Exchange Capacity (CEC) is also very low indicating low rate of ion exchange. Available phosphorus is low to moderate. Exchangeable sodium percentage (ESP) is moderate and tending towards high indicating that the soils may be tending towards sodicity. The physical properties of the soils encountered are shown on Table 3. The soils are sandy in texture with clay fraction increasing down the profiles. Bulk density is high in some of the soil profiles (1.56 to 1.80 mg/m^3) which is an indication of soil compaction. Available water capacity and porosity are also low.

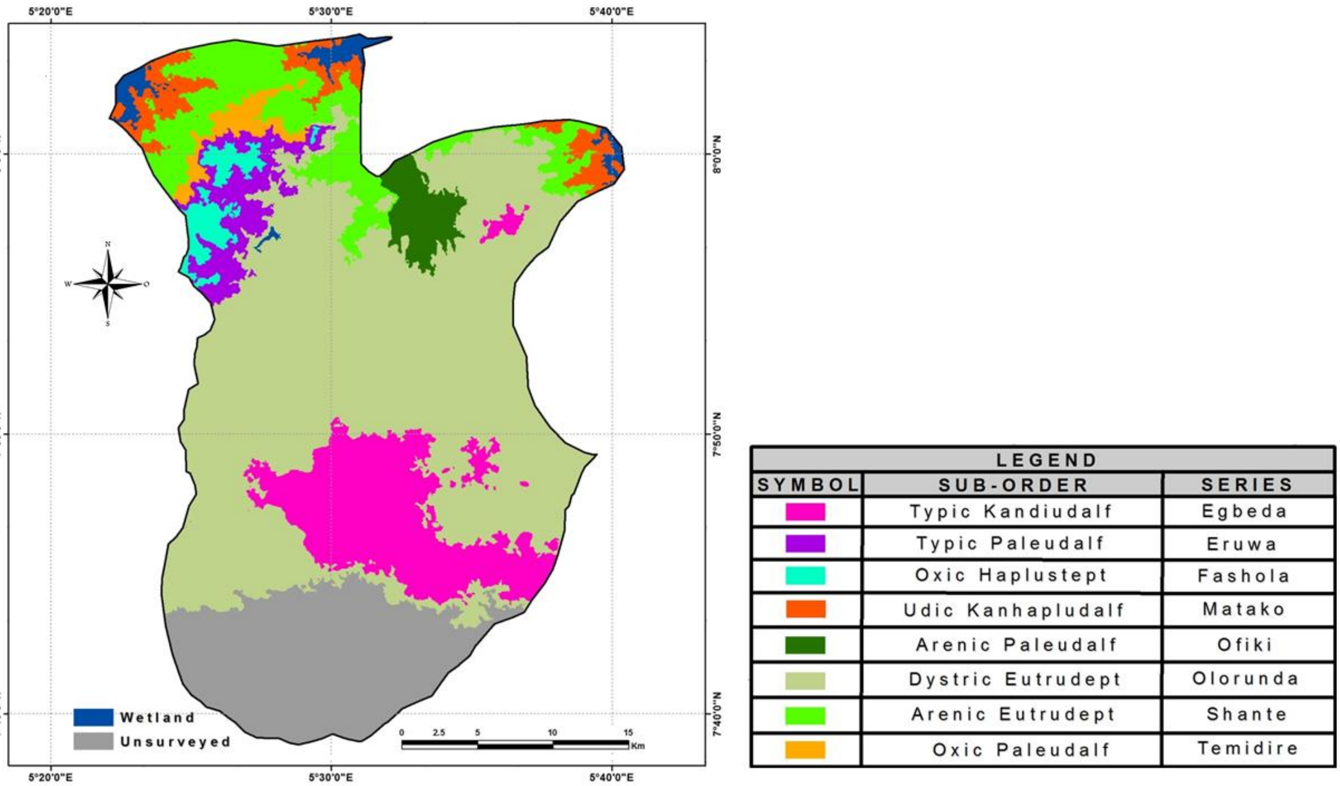

Figure 2. Soil Map of Itapaji Watershed, Nigeria

Table 3. Chemical and Physical properties of the soils encountered in the area

Horizon Design	Depth (cm)	Exchangeable bases (cmol/kg) Ca^{2+}	Mg^{2+}	K^{+}	Na^{+}	H^{+}	pH (H_2O)	pH (KCl)	BS (%)	ESP (%)	CEC	OC (g/kg)	T.N (g/kg)	CEC Clay	Av.P (mg/kg)
Olorunda Series (Dystric Eutrudept)															
A	0-17	0.37	2.31	0.24	0.53	2.03	5.64	6.06	62.96	6.66	5.48	13.0	1.10	29.5	10.04
B1	17-31	0.16	1.86	0.14	0.46	0.13	5.54	5.53	95.14	5.81	2.76	5.0	0.45	12.7	11.32
B2	31-54	0.14	1.65	0.14	0.50	0.15	5.81	5.26	94.28	5.25	2.57	8.0	0.78	15.1	14.43
B31	54-105	0.11	1.80	0.18	0.43	0.15	5.42	5.31	94.55	3.95	2.66	5.0	0.40	11.0	0.73
B32	105-140	0.09	1.77	0.18	0.46	0.12	5.02	5.85	95.50	3.44	2.62	4.0	3.80	11.0	11.96
Eruwa Series (Typic Paleudalf)															
A	0-21	0.46	2.56	0.48	0.63	0.09	5.78	6.23	97.66	10.9	4.23	15.5	1.50	19.2	68.84
B1	21-43	0.12	2.01	0.36	0.53	0.10	5.06	6.13	96.68	3.83	3.13	10.7	0.90	14.9	26.48
B2	43-66	0.07	1.42	0.36	0.53	0.11	4.97	5.95	95.46	2.61	2.49	16.1	1.50	11.7	13.79
B3	66-94	0.12	1.97	0.46	0.59	0.12	4.87	5.86	96.42	3.52	3.27	26.1	2.50	16.7	11.05
B4	94-148	0.15	2.17	0.38	0.56	0.09	4.21	6.29	97.15	4.46	3.36	4.1	0.38	12.0	8.58
Fashola Series (Oxic Haplustept)															
A	0-15	0.31	2.60	0.32	0.56	0.09	5.87	6.35	97.61	7.85	3.88	12.2	1.20	24.6	10.32
B1	15-40	0.03	1.47	0.20	0.50	0.06	6.03	6.88	97.08	1.33	2.26	3.8	0.35	23.3	8.34
B2	>40	0.04	1.87	0.69	0.66	0.08	5.78	6.45	97.33	1.05	3.34	3.4	0.30	24.0	19.63
Matako Series (Udic Kanhapludalf)															
A	0-19	0.44	2.54	0.36	0.59	0.09	6.13	6.31	97.65	10.90	4.04	14.1	1.40	49.2	48.98
Bt	19-50	0.07	1.68	0.30	0.53	0.13	5.97	5.62	95.23	2.41	2.70	5.8	0.45	23.9	9.04
B1	50-80	0.02	0.83	0.24	0.50	0.07	4.97	6.74	95.62	1.20	1.67	3.7	0.34	14.7	6.85
B2	>80	0.05	1.40	0.26	0.50	0.08	4.85	6.41	96.12	2.18	2.29	3.4	0.30	21.4	9.04
Shante Series (Arenic Eutrudept)															
A	0-13	0.69	2.65	0.48	0.59	0.13	6.57	5.53	97.06	15.20	4.55	13.8	1.35	45.1	61.91
B1	13-42	0.63	2.58	0.36	0.53	0.08	6.72	6.57	98.04	15.10	4.18	9.8	0.95	32.2	29.49
B2	42-71	0.06	1.92	0.28	0.50	0.11	6.71	6.07	96.26	1.92	2.86	2.3	0.20	25.3	9.95
B3	71-135	0.08	1.39	0.36	0.53	0.10	6.58	6.11	95.73	3.05	2.46	4.1	0.38	136.6	10.59
B4	>135	0.11	1.48	0.30	0.46	0.09	6.88	6.27	96.03	4.29	2.45	0.8	0.20	52.0	19.45
Temidire Series (Oxic Paleudalf)															
A	0-19	0.33	2.44	0.30	0.59	0.11	5.96	5.86	96.91	8.59	3.78	12.2	1.20	37.8	11.61
B1	19-43	0.01	0.53	0.26	0.46	0.11	4.59	5.88	91.59	0.72	1.38	6.1	0.58	11.9	9.95
B2	43-84	0.02	0.51	0.26	0.43	0.09	5.08	6.21	92.49	1.14	1.32	5.6	0.52	18.8	6.31
B3	84-109	0.03	0.59	0.20	0.40	0.10	5.82	6.15	92.18	2.28	1.32	5.7	0.50	19.1	6.66
B4	>109	0.04	0.94	0.18	0.40	0.09	5.98	6.34	94.36	2.12	1.65	2.4	0.20	22.0	6.03
Egbeda Series (Typic Kandiudalf)															
A	0-21	0.82	2.65	0.51	0.53	0.09	6.12	6.22	97.85	17.70	4.60	23.8	0.24	28.7	58.52
AB	21-47	0.40	2.22	0.26	0.40	0.12	5.87	5.67	96.24	11.70	3.41	10.5	1.00	60.9	44.01
Bt	47-65	0.44	2.35	0.32	0.43	0.13	5.91	5.56	96.41	11.80	3.67	19.8	1.96	20.2	25.56
B1	65-76	0.36	2.17	0.32	0.40	0.08	5.96	6.59	97.57	10.80	3.33	11.2	1.10	18.5	11.78
B2	76-113	0.27	2.11	0.26	0.40	0.08	5.81	6.45	97.18	8.65	3.12	5.1	0.48	16.6	10.13
B3	113-156	0.21	1.88	0.20	0.36	0.07	5.75	6.79	97.31	7.52	2.27	10.1	0.98	14.5	23.01
Ofiki Series (Arenic Eutrudept)															
A	0-15	0.94	2.82	0.75	0.56	0.08	6.42	6.67	98.48	18.30	5.14	33.6	2.90	25.7	7.94
B11	15-33	0.61	2.76	0.59	0.50	0.05	6.13	7.14	98.82	13.60	4.50	16.7	1.55	88.3	18.53
B12	33-61	0.63	2.76	0.51	0.43	0.06	6.04	6.93	98.54	14.40	4.39	17.7	1.60	78.3	18.53
B2	61-143	0.63	2.69	0.32	0.36	0.07	6.27	6.87	98.35	15.40	4.07	5.1	0.48	42.4	5.84

Conventionally, Most of the soil quality indicators assessed were scored below 50 % when their actual average values were compared with the critical values (Table 2). This is an indication their values are low and will result into overall low quality and this automatically makes them become issues that will affect crop productivity. Soil quality issues identified from the physical and chemical indicators of the soils assessed are low CEC, low organic matter, low soil fertility, high acidity, high bulk density, high rate of compaction, shallow soil depth with presence of plinthite and hard pan (Table 3). Out of all these, low soil fertility (which encompasses low available P, low Nitrogen and available water) has the greatest impact on crop production based on their relative importance (wieght) to crop production.

Soil quality issues identified by farmers in the watershed are also shown on Table 4. The issues include soil compaction by cattle overgrazing, low soil fertility, termite infestation, crop wilt, hardpan formation, erosion, poor drainage, flooding, decreased crop yield and high land use intensity. Among all these issues, low soil fertility is the most prominent with about 36.2% impact on crop production in the watershed. There is a high positive relationship (r=0.70) between farmers' perception of soil quality and the conventional method. This is an indication that the methods can be used interchangeably in the watershed.

Discussion

The soil, in addition to providing anchorage for plant roots, stores water and nutrients required for plant growth. Healthy soil is essential for the production of crops and perceptions of what constitute a good soil vary and depend on the requirement of individual crops or land use. While intensive agriculture can cause nutrient depletion and wide-scale soil erosion, over-application of fertilizers and pesticides leads to soil and water contamination. However, many farmers are choosing sustainable agricultural techniques such as conservation tillage, crop rotation and organic fertilizer application in order to protect this valuable soil resource.

Table 3. (continue)

Horizon Design	Depth (cm)	Particle size (g/kg)					Bulk density (mg/m³)	AWC	Total Porosity	Textural Class
		Gravel	CS	FS	Silt	Clay				
Olorunda Series (Dystric Eutrudept)										
A	0-17	133	614	180	20	186	1.50	0.155	0.39	SandyLoam
B1	17-31	154	633	130	20	217	1.49	0.185	0.35	SandyClayLoam
B2	31-54	500	620	170	40	170	1.53	0.159	0.32	SandyLoam
B31	54-105	529	449	180	130	241	1.62	0.165	0.31	SandyClayLoam
B32	105-140	375	221	340	200	239	1.65	0.166	0.34	SandyClayLoam
Eruwa Series (Typic Paleudalf)										
A	0-21	60	540	220	20	220	1.56	0.119	0.48	SandyClayLoam
B1	21-43	56	490	260	40	210	1.69	0.022	0.35	SandyClayLoam
B2	43-66	39	438	280	70	212	1.80	0.023	0.30	SandyClayLoam
B3	66-94	400	364	390	50	196	1.79	0.072	0.44	SandyLoam
B4	94-148	200	340	300	80	280		0.067	0.40	SandyClayLoam
Fashola Series (Oxic Haplustept)										
A	0-15		562	160	30	158	1.31	0.118	0.47	SandyLoam
B1	15-40	562	653	190	30	97	1.36	0.112	0.39	LoamySand
B2	>40	154	561	240	60	139		0.124	0.40	SandyLoam
Matako (Udic Kanhapludalf)										
A	0-19	72	778	120	20	82	1.40	0.118	0.42	Sand
Bt	19-50	200	737	120	30	113	1.42	0.114	0.39	LoamySand
B1	50-80	182	617	220	50	113	1.61	0.112	0.33	LoamySand
B2	>80	83	533	240	120	107		0.114	0.35	SandyLoam
Shante Series (Arenic Eutrudept)										
A	0-13		769	110	20	101	1.08	0.206	0.46	LoamySand
B1	13-42		710	150	10	130	1.37	0.145	0.45	LoamySand
B2	42-71	77	697	170	20	113	1.45	0.108	0.39	LoamySand
B3	71-135	36	642	260	80	18	1.48	0.115	0.37	Sand
B4	>135	39	678	235	40	47		0.143	0.42	Sand
Temidire Series (Oxic Paleudalf)										
A	0-19		740	150	10	100	1.27	0.123	0.40	LoamySand
B1	19-43	23	704	150	30	116	1.41	0.129	0.45	LoamySand
B2	43-84	13	655	215	60	70	1.51	0.116	0.33	LoamySand
B3	84-109	71	711	160	60	69	1.60	0.123	0.35	LoamySand
B4	>109	167	695	190	40	75	1.76	0.123	0.38	Sand
Egbeda Series (Typic Kandiudalf)										
A	0-21	231	590	240	10	160	1.13	0.129	0.50	SandyLoam
AB	21-47	286	409	400	135	56	1.59	0.073	0.37	LoamySand
Bt	47-65	643	277	161	380	182	1.80	0.063	0.33	Loam
B1	65-76	550	346	184	290	180	1.76	0.082	0.33	SandyLoam
B2	76-113	333	161	391	260	188	1.43	0.007	0.45	SandyLoam
B3	113-156	182	182	350	280	188	1.26	0.017	0.51	SandyLoam
Ofiki Series (Arenic Paleudalf)										
A	0-15	143	590	190	20	200	1.14	0.184	0.63	SandyLoam
B11	15-33	167	419	400	130	51	1.44	0.134	0.43	LoamySand
B12	33-61	111	474	360	110	56	1.53	0.167	0.38	LoamySand
B2	61-143	21	704	160	40	96	1.85	0.216	0.31	LoamySand

The essence of this study is to identify issues that can affect the capacity of soils to function effectively at present and in the future. Using the farmers' perception, the issues identified are compaction, erosion, low soil fertility as a result of low nutrient availability and retention, termite infestation, crop wilt, hardpan formation, poor drainage, flooding, high land use intensity without proper management and all these have resultant effect of decreased crop yield or low roductivity. According to Adeyolanu and Ogunkunle (2017), compaction, alkalinity, soil dryness, acidity, salinity/sodicity and low organic matter are six of the major soil problems affecting productivity. Similarly, NRCS (2005) identified erosion and compaction as two serious problems facing urban soil quality. According to them, erosion is accelerated when soil is disturbed or left bare and exposed to wind and/or water. Compaction occurs when soil particles are compressed, causing soil bulk density to increase and pore space for air and water are reduced. Apart from causing reduction in water intake and movement through the soil, compaction also limits root growth and the biological diversity of the soil. These problems are compounded with low soil organic matter content.

Table 4. Conventional and Farmers' identified soil quality issues and their impacts on crop production

Conventional Method		Participatory Method	
Soil quality issues	% impact on productivity	Soil quality issues	% impact on productivity
Low CEC	14.5	Over grazing	6.9
Low Organic matter	15.0	Gravelly Hardpan	6.9
High Acidity	8.5	Insect pests	8.6
High bulk density	11.2	Crop wilt	8.6
Compaction	11.2	Low Soil Fertility	36.2
Shallow depth	6.6	Termite Infestation	8.6
Low soil fertility	26.5	High Land use Intensity	17.8
Sodicity	6.5	Poor drainage, flood and erosion	6.4

Among the soil issues identified by farmers, low soil fertility is the most prominent with about 36.2 % impact on crop production in the watershed. For conventional method also, low soil fertility has major impact on crop production with low CEC and low organic matter content as the major cause. CEC and organic matter are indicators that are relevant to nutrient availability/retention process for crop production function in the soil. Therefore, with their low values, other soil quality indicators will be severely affected and crop productivity will be impaired. Soil organic matter plays key roles in soil function; determining soil nutrient status, water holding capacity and susceptibility of soil to degradation (Giller and Cadisch, 1997; Feller et al., 2001). Negassa (2001), Solomon et al. (2002) and Merrington et al. (2006) also reported that a change in organic matter content of the surface soil significantly influenced other key soil properties. In addition, soil organic matter may serve as a source or sink of atmospheric CO_2 and an increase in the soil carbon content is indicated by a higher microbial biomass and elevated respiration (Sparling et al., 2003). It is also the principal reserve of nutrients such as N in the soil and some tropical soils may contain large quantities of mineral N in the top 2m depth (Havlin et al., 2005). Chen et al. (1998) found that soil organic matter is a primary factor affecting topsoil bulk density for a range of cultivated soils. Increased soil organic carbon levels improved soil structure by decreasing bulk density, improving aggregate stability, pore size and air-filled pore space. In terms of biological indicators, any decline in soil structure is also frequently associated with decreases in microbial biomass and activity as a result of low organic matter (Neves et al., 2003).

With high intensity and crop combination that comprises of crops that are great nutrient miners (maize/cassava/yam), the soil fertility depletion is the expected consequence. High land-use intensity with crop combination devoid of legume in the rotation provides for no soil nutrient replenishment through, for instance, nitrogen fixation.

The high positive relationship (r=0.70) between farmers' perception of soil quality and the conventional method is an indication that the two methods can be used interchangeably in the watershed. In soil quality assessment, two major approaches (qualitative and quantitative) have been established. Qualitative approach makes use of descriptive indicators and is farmers-oriented while quantitative approach makes use of laboratory data. Also, high positive relationship has been established between the two approaches (Aikore, 2002; Adeyolanu and Ogunkunle, 2016). Those authors also submitted that the approaches of soil quality assessment can be used interchangeably depending on the level of information required from soil quality assessment and the soil function of interest. Therefore, if methods of soil quality assessment of farmers and scientists are used interchangeably, their perception of soil issues can also be used interchangeably since soil issues occur as a result of depletion or deterioration in the level of soil quality indicators.

Soil degradation is better prevented than 'cured', so there is need to be pro-active by assessing and monitoring soil quality before land use and management is imposed so as to have a reference point. Chen and Hseu (1997), submitted that the most effective way to maintain soil quality is to maintain high soil organic matter, or soil organic carbon pool in the soil. Planting of cover crops or green manuring is a way of improving organic matter in the soil. Cover crops usually provide a canopy for seasonal soil protection from erosion and improvement of soil fertility for the production of main crops. Leguminous cover crops have the additional benefit of fixing atmospheric nitrogen for the benefit of crop that follows (Ibewiro et al., 2000). Other benefits from cover crops include protection of the soil from water and wind erosion, improved soil tilth and suppression of soil-borne pathogens (Gugino et al., 2007). Are et al. (2011) also submitted that vegetative cover crop is necessary to protect the soil surface from raindrop impact, runoff, erosion and rapid desiccation. Another way of soil protection or organic matter build-up is by plantation crops in form of agroforestry where food crops are grown with permanent tree crops before the canopy is closed up. The tree crops naturally produce relatively large amount of above and below ground biomass, and because of their perennial nature, there is continuous addition of organic matter and biomass to the soil. Paudel et al. (2011) found out that perennial vegetation enhances soil organic matter accumulation, has minimum disturbance to the soil and has positive impact on the soil quality and ecosystem at large. To further support this, an experiment conducted to assess soil quality under intensive cultivation and tree orchards showed that soil quality indicators (organic carbon, enzymatic activities, microbial biomass, functional and bacteria diversity, electrical conductivity) were negatively impacted by intensive cultivation while tree orchards positively impacted the levels of these indicators (Bonanomi et al., 2011).

Traditional cropping system has been found to be effective in maintaining soil quality and needs to be emphasized in our farming systems. Due to the method of land preparation which encourages minimum tillage, observations have shown a reduced erosion incidence, improved soil structure, increase in microbial activities, improved organic matter content, as well as infiltration rate and reduced bulk density (Adesodun et al., 2007).

Conclusion

From this study, it was shown that crop production in Itapaji watershed takes place under high land-use intensity characterized by shortened fallow period. Also the crop combination is devoid of legume rotation and this depicts opportunity for soil nutrient replenishment through natural process of nitrogen fixation. For enhanced soil intensification and increased productivity without damaging the resource base, there is need to incorporate legume rotation in the cropping system. The farmers' perception of soil quality and that of soil scientists correlate well. There is therefore need for promotion of farmers' participation so as to provide a forum for articulation of their opinions in mitigating low fertility and soil quality. Also, traditional cropping system has been found to be effective in maintaining soil quality and needs to be emphasized in our farming systems.

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