Research Article

Assessment of farmers' indigenous knowledge of soil quality management practices in Ghana: A case study of crop farmers in Ada West District

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Abstract

The efforts to increase soil productivity has been field-based experiments with little information on farmers' indigenous knowledge of soil quality acquired through experience. This study assessed farmers' indigenous knowledge on soil quality and fertility management practices in the Ada West District of Ghana. Two hundred-and-twelve farmers from five communities (Yomlekope, Aditsirekope, Zuenor, Fantevikope and Asigbeykope) were interviewed using pre-tested questionnaire. Fifteen farmers were selected from each community identified and made to classify their soils into high, medium and low soil quality. Thirty-six soil samples were collected based on farmers' categorization and analysed to determine some physicochemical properties to determine the differences in soil quality categories. The Principal Component Analysis (PCA) was used to select effective indicators as the Minimum Data Set (MDS). Results showed that 89% of farmers' used soil amendments, out of which 71.1% combined organic and inorganic fertilizer, 19.6% applied only organic and 9.3% applied only inorganic fertilizers. The soil quality indicators used by farmers were based on visually observable indicators such as soil colour, presence of living organisms, soil moisture, vigour plant growth, crop yield, soil texture, presence of plants and weeds, erosion and thickness of topsoil. Farmers' soil quality categorization was contrary to the laboratory reports, although soils from perceived high quality soil were relatively higher than medium and low soils. In Principal Component 1 (PC_1), electrical conductivity, available phosphorus, organic carbon, organic matter, calcium, and magnesium had a higher positive loading. In PC_2, sand and silt had the highest factor loading, while clay and sodium had the highest factor loading for PC_3 and PC_4, respectively. Farmers have good knowledge of soil quality but did not know the rate of soil amendments to apply. It is suggested that farmers' indigenous knowledge should be supplemented with scientific soil information. There is a need for more training and education on the application rates of soil amendments.

Keywords: Farmers, Farm management practices, Indigenous knowledge, Principal component analysis, Soil quality indicators

INTRODUCTION

The concern of declining soil fertility, particularly in sub-Sahara Africa, a region dominated by smallholder farmers (subsistence famers with farm sizes less than 2.5 hactares) requires the introduction of new fertility management approaches. Fertility directly relates to the soil quality index (Tsozue *et al.*, 2016) and the knowledge of these key variables associated with soil resource provides essential information on the agricultural potential, thus determining the appropriate land use and fertility management practices (Nguemezi *et al.,* 2020).

Subsistence farmers benefit from useful indigenous knowledge on soil quality and fertility management practices as these tend to be more affordable and accessible at the local level.

Hitherto, many farmers in Africa use long fallows as a way of managing soil fertility. However, factors such as agricultural intensification in the face of limited land, poor land use practices and climate change impacts may render these indigenous farm-level fertility management activities ineffective unless they are adapted to current situations, including the hybridisation of indigenous knowledge and new technologies and options such as crop rotation. Improving the adoption of these new practices among smallholder farmers requires a comprehensive understanding of the indigenous perceptions of soil fertility and management practices within specific geographical and ethnic contexts (Spurk *et al.*, 2019).

Within cultures and societies, perception is critical in influencing actions aimed at addressing human problems at the local level (Jaishi *et al.*, 2018). For example, a study by Spurk *et al.* (2019) involving over 2400 smallholder farmers in four countries viz. Ghana, Kenya, Mali and Zambia concluded that many farmers did not perceive soil fertility as a major concern for farming, as they largely lacked knowledge on appropriate fertility management technologies yet hardly receive any such information from professional sources. Okumu (2013) notes that formal extension services help farmers to be more likely to perceive climate changes, though older farmers are less likely to respond to these perceived changes while attitudes, such as age, education level, may play a role (Muhammad *et al.*, 2020). Therefore, it is important to increase farmers' awareness, knowledge, and exposure to new and hybrid soil fertility management technologies, especially within the current dispensation of competition for land use. Within the Guinea Savannah ecological zone of Ghana, where soils are highly depleted, Omari *et al.* (2018) indicated that farmers primarily relied on fertilizer applications depending on their ability to access and crop performance. Additionally, indigenous indicators of soil quality and fertility were limited to visual indicators such as soil colour, tilth and texture. Thus farmers use only physical features of the soil to indicate their fertility status. The awareness of soil quality by farmers is an essential factor of production (Naboth, 2015). The good management of soil by farmers is a reflection of their understanding of soil health or quality and vice versa (Omari *et al.*, 2018). To effectively formulate and implement soil fertility policies to address soil degradation, it is essential to build the capacity of farmers through regular training on soil fertility management. It is important to incorporate the indigenous knowledge and local practice of farmers into scientific knowledge. Research reports show that the active involvement of farmers in the development of technologies, innovations, and management results in increased adoption (Dawoe *et al.*, 2012). However, most site-specific nutrient management research is on station base with little use of farmers indigenous knowledge and their view on soil health. Farmers indigenous knowledge is useful for sustainable soil management decisions (Barrera-Bassols *et al.*, 2006).

Within the Ada West District, agriculture has become a major economic activity, employing about 42% of the population. A significant number of farmers cultivate cassava, maize, and vegetables such as tomatoes, shallots, garden, onions, eggs, and pepper, carrots, okra and water melons. Dwindling fisheries is causing more people to move into agriculture for sustenance amidst competing land uses and climate change impacts. There is, however little information about how farmers manage their land and their knowledge on soil fertility and its management as this is crucial for the sustainability of small-scale agriculture in the district. This study sought to assess farmers' indigenous knowledge on soil quality and fertility management practices in the Ada West District of Ghana to formulate policies and programmes aimed at promoting agricultural livelihoods.

MATERIALS AND METHODS

Study area

The study was conducted in five farming communities (Yomlekope, Aditsirekope, Zuenor, Fantevikope and Asigbeykope,) within the Ada-West District in the Greater Accra region of Ghana (Fig. 1). The District is located on the south-eastern coast of Ghana between latitude 5°45'S and 6°00'N and longitude 0°20'W and 0°35'E. It is bounded to the North by the North Tongu District, to the East by the Ada East District, to the South by the Atlantic Ocean, and to the west by the Ningo Prampram District. The area generally has a gentle relief, undulating and a low-lying area with an elevation not exceeding 60 meters (200 ft.) above sea level. The key relief features include the Anyamam boulders which are scattered irregularly over the sea rising from about 240 meters (800 ft.) above sea level. Most parts of the district are characterized by coastal savannah vegetation made up of shrub and grassland supporting a viable livestock rearing in the area. The average minimum and maximum temperatures are 23°C and 33°C, respectively, with an annual average rainfall of about 750 mm (GSS, 2014). The soil type in the study area is classified as Gleyic solonetz (FAO, 1974). About 57.5 % (6,689) of households in the district are predominately engaged in agricultural activities, making farming a major economic activity (Ghana Statistical Service, 2010). Crops cultivated in the area include cassava, maize and sorghum. Fruits and vege-
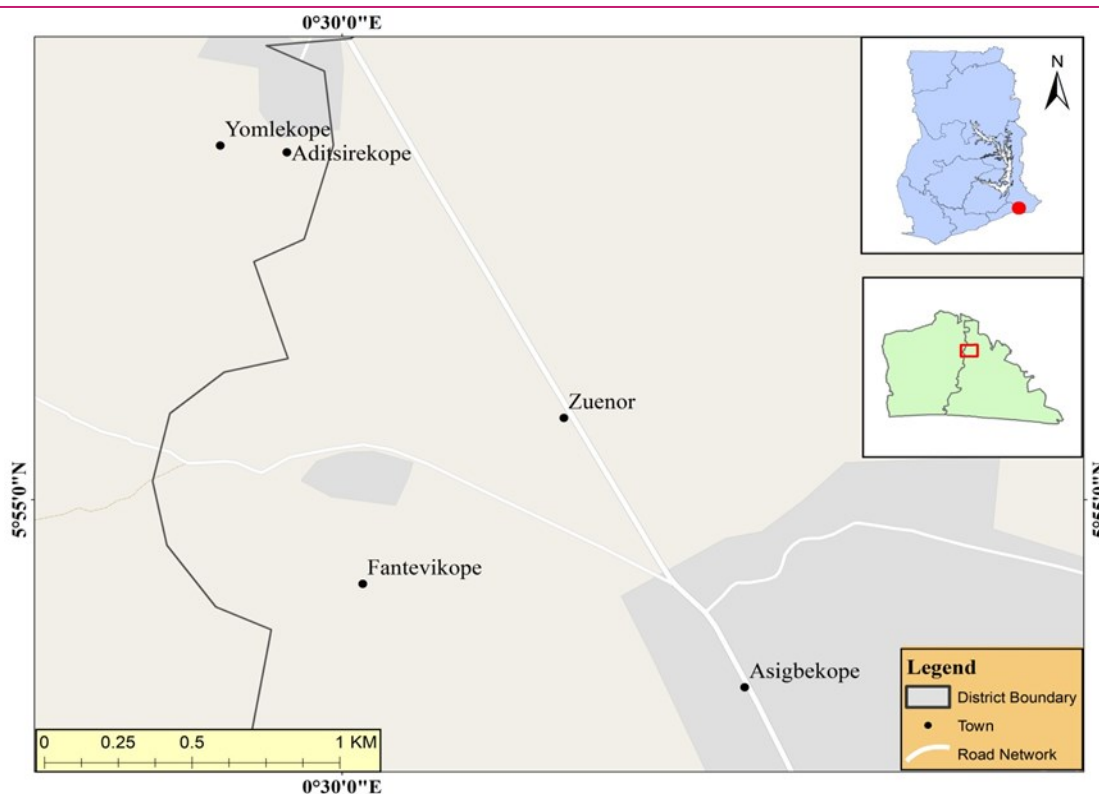
Fig. 1. *Map of the study area showing study communities at Ada West District.*

tables cultivated in the study area include tomatoes, onions, shallots, garden eggs, pepper, carrots, okra, watermelon and mango.

Social survey and soil sampling

A social survey was conducted using pre-tested semi-structured questionnaires and focus group discussion from April to May 2018, where 212 farmers were randomly sampled from five farming communities (Yomlekope, Aditsirekope, Zuenor, Fantevikope and Asigbeykope). The communities selected were predominantly farming communities where cereal crops, leguminous crops, vegetables and root tubers are cultivated. The criteria for the selection was based on major economic activities of the people (in this case, farming) and the type of farming (subsistence). Four focus group discussions were also carried out to corroborate the survey on farmers indigenous knowledge on soil fertility and management practices employed to maintain soil fertility or soil health. Pre-tested structured and semi-structured questionnaires were used in the survey. Groups of fifteen (15) farmers were selected from each community and made to do a transient walk to the field to identify and classify soil which they considered to be high in fertility (productive), medium and low (High, medium and low in fertility) within 0 -20 cm soil depth. Composited soil samples were taken from the different soil quality classification into well-labelled plastic bags and sent to the Ecological Laboratory of the University of Ghana. A total of 30 soil samples were collected (12

samples from each soil classification (high, medium and low)). In each farm, two quadrats of size 80 × 80 m were measured. Five (5) core soil samples were randomly sampled at depth 0–20 cm using a soil auger. The soils were composited, well mixed and sub-samples were taken. A replicate of two soil samples was collected from each farm.

These analyses were done to confirm the farmers' perception of soil quality or soil health.

Soil analysis

The soil parameters analysed included pH, Electrical conductivity (EC (ds/m)), Total Nitrogen (N (%)), available Phosphorous (P (mg/kg)), Cation Exchange Capacity (CEC) (K^+ Ca^{2+} Na^+ and Mg^{2+} ($cmol_c$/kg)), soil particle size distribution (%), organic carbon (%) and organic matter (%). The soil pH and electrical conductivity were determined in a 1:1 soil to distilled water ratio (McKeague 1978; McLean 1982) using microprocessor pH Meter. The total nitrogen was determined using the Kjeldhal Digestion method (Anderson and Ingram, 1993) while available Phosphorus (P) was determined by the Bray 1 method. Similarly, the soil organic carbon (SOC) was determined using the modified procedure by Walkley and Black (1934). The Bouyoucos Hydrometer method modified by Day (1965), was used to determine the particle size distribution whilst the exchangeable cations (K^+ Ca^{2+} Na^+ and Mg^{2+}) were determined using the method described by Fosu-Mensah *et al.* (2016).

Data analysis

The survey data were processed and subjected to descriptive statistics such as frequencies, percentages, mean, minimum and maximum values. The bivariate analysis was used to determine the associations between dependent variables such as application of soil amendments and independent variables such as gender, age, education, and crop types farming experience. The physical and chemical parameters of the soil samples analysed were subjected to a One-way Analysis of Variance (ANOVA) to compare soil parameters from the different soil quality categories using SPSS 23.0. The least Significant Difference (LSD) pairwise comparison of means was used to identify significant differences between the different soil quality categories. Factor analysis was done using the Principal Component Analysis (PCA) to determine factors with high loadings.

RESULTS

Demographic characteristics of respondents

Table 1 presents the demographic characteristics of the respondents. Out of the total 212 respondents, 46.7% were males and 53.3% were females. The majority (49%) of the respondents had age ranging from 25 - 45 years, while 34.5% of them had age above 45 years, with only 0.5% below 15 years. Similarly, the majority (66%) of the farmers were married, with 18.4% being single while the rest were divorced or widowed. The majority of the respondents had basic education (51.4%), with 2.9% having tertiary education. On the other hand, 34.9% had no formal education. A total of 88.2% of respondents were Christians, 7.6% were traditionalists while 1.4% were Muslims and others 2.8%. Most of the farmers interviewed (49.5%) had years of farming experience ranging from 5 to 20 years, with 37.8% of them having farming experience of over 20 years. The demographic information of the respondents from the different communities was not significantly different. Hence the five communities were treated as a single population.

Farmers soil fertility management practices and use of soil amendments

The farm management practices used by respondents in order to improve the soil fertility of their farms were land fallow, moving to different land (shifting cultivation), applying soil amendments, changing crop or planting a different crop, change seed variety, mixed cropping, and crop rotation (Figure 2).
A majority (89%) of the respondents applied soil amendments to improve the fertility of the soil, followed by moving to different land (shifting cultivation) and crop rotation with percentages of 89, 65% and 62%, respectively. Changing seed variety was the least

(16%) management practice by the respondents. Out of the 89% of respondents who applied soil amendments, 71.1% combine organic and inorganic amendments, while 19.6% applied only organic amendments and 9.3% apply only inorganic fertilizer. The inorganic fertilizer predominantly applied were nitrogen (N), phosphorus (P) and potassium (K) fertilizers and mostly used as a basal application while sulphate of ammonia was applied as a top dress. The farmers who practised bush fallow, crop rotation and shifting cultivation did not apply soil amendments. On the other hand, the organic fertilizers applied were compost, animal manure, rice husk and farm waste (data not shown). When respondents were asked the reasons for the choice of soil management practice, farmers who practised the combination of organic and inorganic fertilizer application reported that inorganic fertilizer release nutrients fast and increase crop yield. On the other hand, organic fertilizer was reported to be good in binding the soil particles together, improving soil structure, build-up plant nutrients while sustain soil fertility for longer period and improve on crop yield. Those who choose only inorganic fertilizer stated the fast release of nutrient and high crop yield being the reason, while farmers who applied only organic fertilizer gave build-up of soil organic matter and high crop yield as the season.

### Farmers perception and indigenous knowledge on soil quality indicators

Farmers had good knowledge of soil fertility and its influence on crop productivity. All the farmers asserted that they were able to identify the types of soil on their farmlands. Figure 3 presents farmers' perceptions of the types of soil on their farms. The majority of the farmers described their soils to be sandy (61.8%), followed by Loamy soil (20.3%), with 0.5% stating that the soil is silt (Figure 3). A total of 99.5% of the farmers used indigenous soil quality indicators to assess the soil quality of their soil, whilst only 0.5% of them tested their soils in the laboratory to decide on management practices. The farmers predominantly used soil quality indicators such as soil colour, presence of the living organisms, soil moisture, plants growth and development, crop yield, soil texture, presence of some types of plants, soil erosion and thickness of topsoil to determine the quality of their farm soils (Table 2). Farmers ranked crop yield (45.3%) as the most important and most used soil quality indicator, followed by the vigor of plant growth and development (23.6%) and soil colour (10.8%), respectively (Table 3). The thickness of topsoil was the last (0.5%) in the ranking. Farmers who used plant growth and development as an indicator of soil quality described the vigorous growth of these plants as a sign of good soil quality, while patched growth meant poor soil quality. Similarly, farmers used darker colour soils and soil with living organisms such as earthworm

Table 1. Demographic characteristics of respondents (n=212).

Variables	Frequency (F)	Percentage (%)
Gender		
Male	99	46.7
Female	113	53.3
Age		
Below15yrs	1	0.5
15-24yrs	34	16.0
25-34yrs	59	27.8
34-45yrs	45	21.2
45yrs & above	73	34.5
Marital Status		
Single	39	18.4
Married	140	66.0
Divorced	8	3.8
Seperated	4	1.9
Widowed	21	9.93
Education		
No Formal	74	34.9
Basic	109	51.4
Secondary	23	10.8
Tertiary	6	2.9
Religion		
Christian	187	88.2
Islamic	3	1.4
Traditional	16	7.6
Others	6	2.8
Farming experience		
Less than 5	27	12.7
5-10years	57	26.9
11-15years	25	11.8
16-20years	23	10.8
Over 20 years	80	37.8

Where n= sample size

as higher organic matter and rich in soil nutrient. For example, farmers used the presence of *Panicum maximum (megathyrsus maximus), Azadirachta indica, Pennisetum purpureum, Digitaria Sanguinalis and Panicum minimum* to predict good soil fertility. On the other hand, soils dominated by *Cyperus rotundus* were considered poor soils (Table 4).
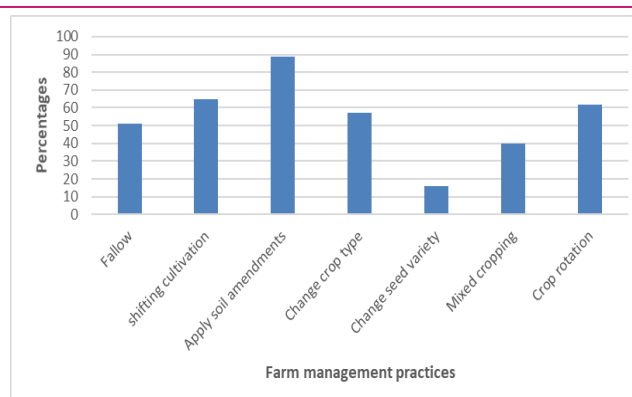
Fig. 2. *Farm management practices by respondents at Ada West District.*
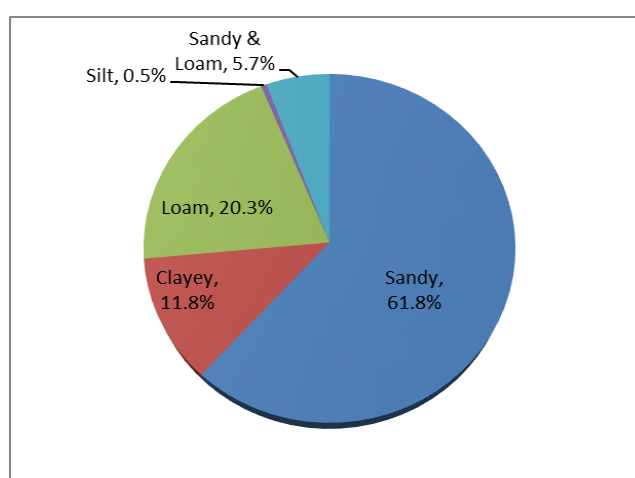
Fig. 3. *Farmers' perception of soil types on farms at Ada West District.*

Farmers categorised their soils into high, medium and low quality. Soils that were perceived to be of high quality were described as supporting high crop yield, high water holding capacity, vigorous growth of plants and weeds and dark in colour. Similarly, soils that farmers' classified to be of medium quality were described as soils with the intermediary characteristics of high and low quality. The farmers described the characteristics of low soil quality as poor water holding capacity, producing poor crop yields and patched plant growth.

Farmers soil quality assessment versus measured soil quality

Table 5 presents the mean values of the physicochemical parameters of laboratory measurement of soil samples. Particle size distribution was similar for all three soil quality categories (High, medium and low). Soils within the perceived high-quality category were found to contain a mean of 88% sand, 7% silt and 5% clay. Those within the perceived medium soil quality category also had mean values of 88% sand, 8% silt and 4% clay content, whereas those within the perceived low

Table 2. Soil quality indicators used by farmers.

Soil quality indicators	Percentage (%)
Soil colour	56
Living organism	45
Soil moisture	69
Plant growth and development	58
Crop yield	96
Soil texture	48
Presence of plants and weeds	72
Erosion	37
Thickness of topsoil	23

Table 3. Farmers ranking of soil quality indicators by importance.

Indicator	Frequency (f)	Percent (%)
Soil Colour	23	10.8
Soil living organisms	4	1.9
Soil moisture	11	5.2
Plant growth & development	50	23.6
Crop yield	96	45.3
Soil Texture	3	1.4
Plants & weeds	22	10.4
Erosion	2	0.9
Thickness of topsoil	1	0.5
Total	**212**	**100.0**

Table 4. Plants and weeds used as soil quality indicators.

Common name	Local Name	Scientific Name
Guinea grass	Go nga	*Panicummaximum (megathyrsus maximus)*
Nut grass	Fie nga	*cyperus rotundus*
Neemtree	Bodetso	*Azadirachta indica*
Elephant grass	Gla	*Pennisetum purpureum*
Crabgrass	Tolile	*Digitaria Sanguinalis*
	Zue	*Panicum minimum*

soil quality category recorded mean values of 89% sand, 7% silt and 4% clay. There was no significant difference ($p > 0.05$) in the means for the various soil quality categories (high, medium and low) and types (sand, silt and clay). The soil pH did not differ significantly between the different soil quality categories. However, the high soil quality category recorded the highest pH value of 6.6, with the lowest pH value of 5.8 recorded in the low soil quality category. The mean value (0.047(ds/m)) of soil conductivity was significantly ($p < 0.05$) higher at the high soil quality category compared to the medium and the low. The low soil quality category recorded the lowest conductivity value (0.022ds/m). However, there was no significant difference (p > 0.05) between the medium and the low soil quality categories. Available phosphorus (P) and exchangeable Ca were not significantly different ($p > 0.05$) for the different soil quality categories (High, medium and low quality). However, the high soil quality sample recorded the highest value for available P (48.683 mg/kg) and exchangeable Ca (2.539 cmol$_c$/kg) compared to the medium and low soil quality categories. Similarly, the total Nitrogen value (0.134%) was higher in the high soil quality category compared to medium (0.128%) and low (0.124%). However, these differences were not statistically significant ($p > 0.05$). Soil organic carbon (OC) and organic matter (OM) were significantly higher ($p < 0.05$) at high and medium soil quality categories compared to the low category. However, there was no significant difference ($p > 0.05$) in Mg, Na and K between the different soil quality categories. The values were in the decreasing order of High > Medium >Low except for Na in the medium soil quality category, which recorded values lower than the low-quality category.

The pH of the soil ranged from moderately acidic to neutral. With reference to Proffitt (2014), exchangeable cations (Ca, Mg, Na, and K), EC, OC and total nitrogen in the soils fell within the low soil category. However, the OM content of the soil ranged from low to medium and the available P for all the soils was within the low range of soil quality category. Analysis of variance showed that the pH, EC, OC and OM differed significantly among the soil quality categories (high, medium and low) at 95% confidence level ($p <0.05$). However, available phosphorous, sodium, magnesium, potassium, sand, silt, and clay did not differ significantly ($p > 0.05$).

Soil variability using Principal component analysis
To reduce the dimensions of the soil quality attributes and to understand which variables best explain the variation, Principal Component Analysis (PCA) was employed with an eigen value greater than 1. Table 6 gives a summary of the principal component analysis. In the principal component analysis, 13 components were used. The first four PCA accounted and explained 85.36% of the total variance. PC$_1$ accounted for and explained 49.91% of the total variance and EC, P, OC, OM, Ca, K and Mg had a higher positive loading, hence termed soil nutrient factor. The second component (PC$_2$) accounted for 16.36% of the total variance and was significantly loaded on sand and silt and termed soil texture. The third component (PC$_3$) explained

Table 5. Physical and chemical indicators of soil quality categories.

Soil parameters	Soil Quality Category		
	High	**Medium**	**Low**
Sand (%)	88a	88a	89a
Silt (%)	7a	8a	7a
Clay (%)	5a	4a	4a
pH	6.6a	6.1b	5.8b
EC (ds/m)	0.047a	0.028b	0.022b
Avail. P (mg/kg)	48.683a	44.617a	47.875a
Ca (cmol$_c$/kg)	2.539a	1.857a	1.656a
TN (%)	0.134a	0.128a	0.124a
OC (%)	0.814a	0.657a	0.472b
OM (%)	1.403a	1.132a	0.814b
Mg (cmol$_c$/kg)	0.704a	0.778a	0.441a
Na (cmol$_c$/kg)	0.034a	0.026a	0.053a
K (cmol$_c$/kg)	0.136a	0.057a	0.055a

Table 6. Factor loadings of soil physicochemical parameter.

Soil quality attribute	Principal component, PC[a,b,c]				Communalities
pH	0.626	0.345	0.161	0.269	0.609
Electrical Conductivity	0.840	0.033	0.35	0.22	0.877
Available Phosphorus	0.930	0.135	-0.146	-0.092	0.913
Total Nitrogen (TN)	0.462	-0.539	0.189	0.186	0.574
Organic Carbon (OC)	0.741	-0.137	0.144	0.566	0.909
Organic Matter (OM)	0.741	-0.137	0.144	0.566	0.909
Calcium (Ca)	0.967	0.063	0.062	0.063	0.948
Magnesium	0.937	-0.043	-0.127	0.011	0.897
Sodium (Na)	0.026	0.079	0.094	-0.882	0.794
Potassium (K)	0.879	0.151	0.198	0.098	0.845
Sand	-0.198	-0.742	-0.597	0.073	0.951
Silt	0.195	0.928	-0.124	-0.057	0.918
Clay	0.038	-0.095	0.971	-0.032	0.954
Eigenvalues	6.488	2.126	1.462	1.021	n.a.
% of Variance	49.908	16.355	11.244	7.856	n.a.
Cumulative of Varaiance	49.908	66.263	77.506	85.362	n.a.

Rotation method: Varimax with Kaiser normalisation. b. Boldface factor loadings are considered highly weighted. c. PC1 is soil nutrient factor, PC2 is soil texture factor, PC3 is soil texture factor, and PC4 is Sodium factor. n.a.: not applicable

11.24% of the variance in soil quality and had a high positive loading on clay and termed soil texture factor. The last component (PC$_4$) explained 7.86% and had a high negative loading on Na and was therefore termed as sodium factor. All other variables which had a factor loading or scores below ± 0.7 were observed as not significant.

Association between demographic characteristics and soil amendments used

A bivariate analysis to determine the association between demographic characteristics of farmers and soil amendments used showed that gender and type of crops cultivated significantly ($p < 0.05$) influenced the use of soil amendments by farmers (Table 7) while age,

Table 7. Association between demographic characteristics and the users of soil amendments.

Variables	x^2	P Value
Gender	4.73	0.03*
Age	2.02	0.73
Marital Status	3.78	0.44
Education	7.03	0.71
Number of years Farmed	6.08	0.63
Type of crops cultivated	20.23	0.00**

marital status and years of farming experience did not significantly ($p > 0.05$) influence the use of soil amendments.

DISCUSSION

The farmers showed high knowledge of soil organic matter (SOM) and its role in soil productive maintenance. However, they could not tell the quality of these amendments needed per hectare. This might be due to the low level of education. This finding is in line with the findings of Diiro *et al.* (2015) and Dawoe *et al.* (2012), who reported high usage of soil amendments by farmers in Ethiopia and Ashanti Region of Ghana respectively. In addition, this finding is in line with the findings of Omari *et al.* (2018), who concluded that farmers' application of soil amendments stemmed from its ability to produce high yield and its accessibility. The high percentages of respondents (19.6%) who applied only organic fertilizer might be due to the presence of ORM4 Soil (Farmer-Driven Organic Resource Management to Build Soil Fertility Research) project, which was ongoing within the study area. The ORM4 Soil project specifically sought to promote the use of organic soil amendments. The respondents who did not apply soil amendments stated that the types of crops cultivated did not require fertilizer application in addition to the high cost of inorganic fertilizer. Most of these farmers cultivated cassava and cowpea.

The farmers in the study area used indigenous knowledge to assess the quality of their soils. They however used only observable soil quality indicators. The use of vigorous plants growth as a sign of good soil quality is in line with the findings of Dawoe *et al.* (2012) and Omari *et al.* (2018) in Nepal and Guinea Savannah Agro-Ecological Zone of Ghana, respectively. Similarly, farmers used observable indicators such as darker colour soils and soil with living organisms such as earthworm as indicators of fertile soil in line with the report by Buthelezi-Dube *et al.* (2020). The use of the presence of some plants as such *Panicummaxi-*

mum (Megathyrsus maximus), Azadirachta indica, Pennisetum purpureum, Digitaria Sanguinalis and Panicum minimum to predict good soil fertility is in line with the findings of Fujii (2007) and Omari *et al.* (2018). The ability of farmers to describe the characteristics of soil quality and their functions is in line with the findings of Buthelezi-Dub *et al.* (2020); Laekemariam *et al.* (2017); and Abera and Belachew (2011); in eastern South Africa and southern Ethiopia, respectively.

Results showed farmers could not accurately assess the quality of their soil using physical indicators. It was revealed in the poor agreement between measured parameters and farmers perceived soil quality. There was generally low cation (Na, K, mg, Ca), total N and OC content of soils in all farmers soil quality category, with none of the measured parameters falling within the high category (Proffitt, 2014). This is in line with the report by Buthelezi-Dube *et al.* (2020), who stated that farmers could not accurately identify yield- limiting nutrients on their farms. On the other hand, this finding is contrary to that of Tesfahunegn *et al.* (2011) where the measured parameters fell within the soil quality categories perceived by the farmers. Though the mean values for the soil parameters measured were generally low, the mean values in the high soil quality category were relatively higher than those in the medium and low categories. Thus, showing an increasing trend with increasing soil quality category (low-high), which is similar to the findings of Dawoe *et al.* (2012); Tesfahunegn *et al.* (2011); and Buthelezi-Dube *et al.* (2020). The sandy nature of the soil might have accounted for the low level of cations and organic carbon. This could be attributed to their poor retention of nutrients and water (Roy *et al.* 2006), hence influencing the use of soil fertilizers, which is unfortunately not backed by much knowledge on their application rate.

Results showed that four PCA accounted and explained 85.36% of the total variance. In PC_1 EC, P, OC, OM, Ca, and Mg had a higher positive loading, while in PC_2, sand and silt had the highest factor loading. Clay and Na had the highest factor loading for P3 and P4, respectively. This means that these parameters are the most important indicators in assessing the soil quality in the study area. The result of the study is in line with the findings of Ghaemi *et al.* (2014) in the Astan Quds-east of Mashhad- Iran. Similar findings were reported by Yao *et al.* (2013), who used five soil properties (Na, SOC, Cl, EC and water table, of groundwater) for soil quality assessment of salt-affected farms. The communalities of the soil attributes in this study imply that the four derived components explained about 50% to 90% of the variance of the soil attributes. The OC, OM, Mg, K, Sand, silt, Clay, Available P and EC contributed more than 80% each of the total variance in the soil quality categories.

Conclusion

This study assessed soil management practices and farmers knowledge on indigenous soil quality indicators among five farming communities in Ada West District of the Greater Accra region of Ghana. The study revealed that farmers are equipped with some ingenious knowledge of soil quality indicators. The soil types identified by the farmers conformed to laboratory results. However, farmers could not accurately assess the quality of their soil using only physical indicators as there was disagreement between farmers' soil quality assessment and laboratory measurement. Knowledge of the application rates of organic amendments is low. There is the need to supplement farmers' knowledge by providing periodic laboratory soil testing at subsidised prices for farmers. There is a need for more training and education on site-specific organic nutrient (crop residues, weeds) management.

Conflict of interest
The authors declare that they have no conflict of interest.

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