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Original Research Article

Nutrient Status of Soils from Farmers' Maize Fields in Mid Altitude Areas of Western Ethiopia

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Abstract

Inappropriate land use can deplete nutrient contents of crop land that leads to reduce nutrient concentrations and productivity. However, monitoring nutrient status of crop land can help producer take appropriate remedial measures before significant loss occur productivity. The six farms maize field soils were clay in texture. The cation exchange capacity (CEC) before planting was highly variable among different farmers field ranged from 19.7 to 36.5 cmol^{+}kg^{-1} found in the medium to high range for crop production. The NO_3-N and NH_4-N concentrations were found in the optimum range indicated that the six farmers' fields needed lower amount of nitrogen fertilizer inputs for maize production. The soils of all farmers' fields were very strongly to moderately acidic range shows need of reclamation for the soil. Higher pH of the soils was recorded from nitrogen fertilizer-treated as compared to soil before application indicating use of nitrogen improved the pH of the soil. Total nitrogen concentrations ranged from 0.13 to 0.37 % for all six farms were in the very low, medium to high range. The extractable phosphorous ranged from 3 to 66 ppm for all farms were found in the low, medium to adequate range for crop production. The soil nutrient status was differed among farms indicating the importance site and soil test based fertilizer recommendation for sustainable maize production. Soil fertility intervention that differentiates between farm components soil fertility status in mid altitude was recommended for sustainable maize production.

Key words: Farms, Nitrogen, Phosphorous, Soil

INTRODUCTION

Soil fertility degradation is one of the major problems causing low crop productivity. Sanchez *et al*. (1997) reported soil-fertility depletion in smallholder farms is the fundamental biophysical root cause for declining per capita food production in sub-Saharan Africa. The livelihood, economic well-being and nutrition status of over 1 billion people are already adversely affected due to land degradation (FAO, 2003; Pinstrup-Andersen, 1999; Scherr, 1999). Agricultural land use can deplete soil nutrient contents without appropriate soil management and can pose challenges to food security which is creating greater challenges to most of developing countries to feeding the ever-increasing human population. The decline in soil fertility followed by land degradation and low agricultural productivity are caused by land use change particularly from natural ecosystem to agricultural lands in general and to crop cultivation under poor management practices in particular (Chimdi *et al*., 2012). An average of 660 kg N ha^{-1}, 75 kg P ha^{-1}, and 450 kg K ha^{-1} has been lost during the last 30 years from about 200 million ha of cultivated land in 37 African countries (Sanchez *et al*., 1997). Soil nutrient depletion lowers the returns to agricultural investment, which reduces nonfarm incomes at the community level through multiplier effects (Delgado *et al*., 1994). Sanchez *et al.* (1997) reported soil fertility depletion are decreased food security through lower production and resulting higher food prices, increased government expenditures on health, more famine relief, and reduced government revenue due to less taxes collected on agric-

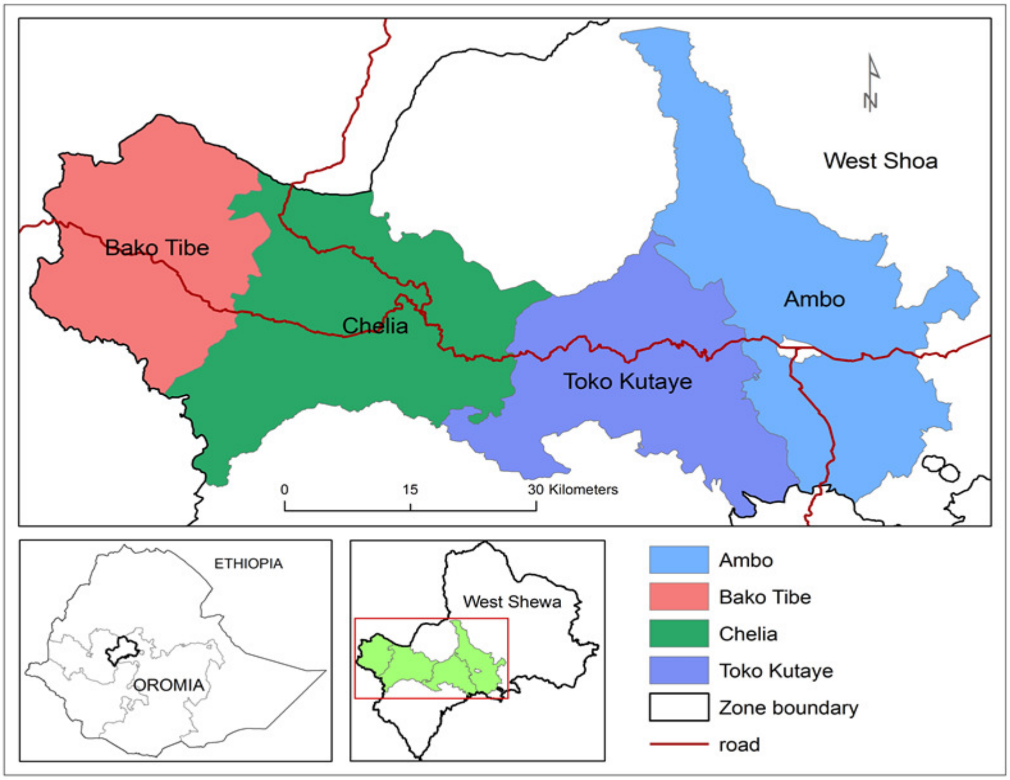

Figure 1. Study district in West Shewa Zone of Oromia, Ethiopia.

ultural goods.

Land degradation and low soil fertility are common features that aggravate the problems in large parts of sub-Saharan Africa in general and Ethiopia in particular (Vesterager *et al.,* 2008). Cobo *et al*. (2010) reported soil nutrient mining results from 57 selected studies in Africa and showed that most systems had negative N and K balances while the trend for P was less severe. Bojo and Cassels (1995) argued that the major force driving land degradation in Ethiopia is nutrient depletion of agricultural soils arising from complete removal of crop residues, crop production with low levels of nutrient inputs and lack of adequate soil conservation practices. The highest rates of nutrient depletion, with aggregated national-scale nutrient balances, are estimated to be -41 kg N, -6 kg P and -26 kg K ha^{-1} in Ethiopia (Stoorvogel and Smaling, 1990). Strongly negative N balances and positive balances or slight deficits of P were reported at Kindo Koisha district of Southern Ethiopia (Elias et. al. 1998). They reported differences in N and P balances between agro-ecological zones. Smaling *et al*. (1997) reported high nutrient depletion is due to high outputs of nutrients in harvested products and erosion and also in the relatively high inherent fertility of the soils. Nutrient depletion rates are field specific, depending on the way each particular field has been managed over decades, soil properties and the proportion of nutrients lost is normally greater in sandy soils, but the total nutrient loss is greater in clayey soils (Sanchez *et al*., 1997). Carpenter *et al*. (1998) reported that the loss of phosphorus (P) in agricultural runoff and its input to freshwater bodies is known to accelerate eutrophication. Knowing the optimum level to use will help to minimize the potential for P loss from agricultural operations (Gibson *et al*. 2000). Total nitrogen measures the total amount of nitrogen present in the soil, much of which is held in organic matter and is not immediately available to plants (Hazelton and Murphy, 2007). Therefore, knowing the total N of the soil leads to the need to know the management practices to be applied to the soil to increase availability of nitrogen for increased crop yields. The nitrogen content as measured by NO_3-N concentration is used to determine the N fertilizer applica¬tion rate (Horneck *et al*., 2011). CEC is a measure of a soil's capacity to retain and release elements such as K, Ca, Mg, and Na (Horneck *et al*., 2011). It relates information on a soils ability to sustain plant growth, retain nutrients, buffer acid deposition or sequester toxic heavy metals. Therefore, the CEC of a soil is a good indicator of soil productivity, fertility, the amount of clay and organic matter present in the soil, acidity treatment and is useful for making recommendations of phosphorus, potassium, and magnesium for soils of different textural classes. Soil texture is an important soil characteristic that drives crop production and field management. It influences the

Table 1. Mean rainfall, temperature and relative humidity Bako-Tibe site as obtained from nearby weather stations.

Months	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**Total**
Rainfall (mm)	6.83	12.7	40.07	57.63	138.87	265.36	261.75	251.46	132.88	60.18	25.66	12.22	1266
Temperature (0c)													mean
Minimum	11.48	11.6	13.42	13.79	14.63	14.49	14.67	14.77	14.39	13.81	12.72	11.02	13.4
Maximum	30.37	31.84	31.92	31.57	29.5	25.83	24.65	24.43	25.3	27.75	28.91	29.84	28.49
Mean	20.93	21.72	22.67	22.68	22.06	20.16	19.66	19.6	19.85	20.78	20.81	20.43	20.95
Relative humidity (%)	49	46	47	51	53	65	64	62	64	55	53	50	54.8

drainage, water holding capacity, aeration, susceptibility to erosion, organic matter content, cation exchange capacity (CEC), pH buffering capacity and tilth of a soil. Posadas *et al*. (2001) stated that particle size distribution reflects the relative balance of weathering and pedogenetic processes.

Monitoring of nutrient status for assessing the degree of nutrient mining in an agro-ecosystem is very crucial. The change in soil nutrient stocks over time has to be measured in order to quantify the extent of nutrient mining and institute ways of maintaining the cropping system for sustainable crop production. Thus, there is a need for a more targeted approach to soil fertility intervention that differentiates between farm component, agro-ecological zone and socio-economic group (Elias *et al.,* 1998). However, such fundamental information is not available in maize based farming system of western Ethiopia. Quantitative estimation of plant nutrient depletion from soils is useful for

comprehending the state of degradation and for devising corrective measures (Adu-Gyamfi *et al.,* 2007). Furthermore, field or farm level nutrient budgets are useful tools for assessing the sustainability of cropping systems (Smalling *et al.,* 1993). Assessing soil nutrient status is not only important to identify plant nutrient deficiency but also potential contribution of nutrient to environmental pollution (Oyedele *et al.,* 2006). Geissen *et al*. (2009) stated soil nutrient evaluation is a leading key for describing and understanding the status and qualities of the major nutrients in soils. Assessing soil physicochemical properties are used to understand the potential status of nutrients in soils of different land uses (Wondowosen and Sheleme, 2011). Knowing the nutrient status of different farmers' fields is crucial to management interventions for sustainable maize production and reduction of environmental pollution. Hence, the objective of this study was to nutrient status of soils in maize based farming systems and to recommend management practices required for sustainable crop production in western Ethiopia.

MATERIALS AND METHODS

Description of the study site

The study was executed on six farmers' fields around Bako-Tibe districts that located in mid altitude agro-ecosystem of western Oromia National Regional State, western Ethiopia. The area lies between 8'59'31"N to 9'01'16 N latitude and 37'13'29 E to 37°85'E longitude and at an altitude ranging from 1727 to 1778 meters above sea level, receiving mean annual rainfall of 1266 mm with unimodal distribution (Table 1) (MBARC, 2014). It has a warm humid climate with the mean minimum, mean maximum and average air temperatures of 13.4, 28.49 and 20.95oC, respectively (Table 1). The soil type is a brown clay loam Alfisol (Mesfin, 1998).

Soil sampling and analysis

Three farmers' field in 2013 and 2014 cropping season were selected for planting of maize. The selected farmers' fields were prepared for planting of maize using oxen plough. Factorial combination of five maize varieties and two nitrogen rates were done on total of six farmer's field in 2013 and 2014 cropping seasons. Composite soil samples were collected from the plow layers of each experimental site before the application of the treatments and after treatment application at harvesting of maize varieties. The soil samples were collected in 2013 and 2014 cropping seasons from three farmers' fields per season. The soil samples were collected before planting and treatments applications, and after harvesting. Before planting of maize and applying any treatment, soil samples were randomly collected from 10 points at the depth of 20 cm and mixed to a composite sample for selected soil physicochemical analysis. After harvesting of maize, soil samples were collected in three replications per plot and treatment and composited to a sample. The soil samples were prepared following standard procedures and analyzed at Holetta and Debre Zeit Agricultural Research Center soil Laboratories. Determination of soil particle size distribution was carried out using the hydrometer method (Day, 1965; Dewis and Freitas, 1984), whereas the soil pH was measured with digital pH meter potentiometrically in the supernatant suspension of 1:2.5 soils: distilled water ratio. Organic carbon was determined following wet digestion method as described by Walkley and Black (1934), whereas the Kjeldahl procedure was used for the determination of total nitrogen (N) as described by Jackson (1958). How

Table 2. Soil particle size distribution of maize farmer's field before planting maize and nitrogen application in Bako-Tibe district, western Ethiopia.

Farms	Clay	Silt	Sand	Texture
		%		
Farm-1	58.75	22.50	18.75	Clay
Farm-2	58.75	27.50	13.75	Clay
Farm-3	51.25	27.50	21.25	Clay
Farm-4	63.75	22.50	13.75	Clay
Farm-5	61.25	22.50	16.25	Clay
Farm-6	48.75	22.50	28.75	Clay

Farm 1-6=Takele Uluma, Adisu Fufa, Adisu Likessa, Mulatu Shukar, Tesfaye Tsgaye and Gutu Tolera.

did you determine CEC The available phosphorus (P) was measured by the Olsen method as described by Olsen *et al* (1954) and available potassium (K) was measured by flame photometry. The steam distillation method was used for determination of NO3 and NH4 as described by Keeney and Nelson (1982).

RESULTS AND DISCUSSION

Soil texture

The particle size distribution results of different farm soils are indicated in Tables 2. All the six farm soils were clay in texture indicting soils of different farm fields have medium organic matter contents and CEC, and have good moisture holding capacity. Odeh *et al*. (2003) reported soil texture to be the most important attribute affecting physical and chemical processes in a soil. The silt to clay ratio in the maize farm fields was low. A similar result was reported by Chimdi *et al*. (2012) stating that higher clay fraction and lower silt to clay ratio recorded in the cultivated land attributed to the impacts of farming practices. The soil texture distributions were varied among farms. Similarly Chimdi *et al*. (2012) found soil physical properties changes with the change in land use systems and its management practices.

CEC, NO_3 and NH_4-N concentration of the soil

The cation exchange capacity (CEC) before planting was highly variable among different farmers field that ranged from 19.7 to 36.5 cmol$^+$kg^{-1} (Table 3). According to tropical soil fertility classifications, the CEC of all farmers' fields were in the medium to high range (Landon 1991). This implied the soils of all farmers' fields had adequate to high nutrient holding capacity. The high clay and organic matter contents of the farmers' fields can be attributed to the high CEC of the farmers' field (Table 1). The different farm soils varied in nutrient holding capacity and organic matter contents based on the CEC of the soils. The soil of the maize fields was showed highly weathered and presence of more 1:1 clay minerals. Similar results reported by Chimdi *et al.* (2012) suggesting soil CEC is expected to increase through improvement of the soil OM content. Therefore, the six farms require different soil fertility management practices for crop production.

The NO_3-N and NH_4-N concentrations among the different farmers' fields before planting were quite different that ranged 30.17 to 66.38 ppm for NO_3-N and trace to 12 ppm for NH_4-N (Table 3) , being in the high to very high range (Bashour, 2002; and FAO, 2006) or excessive range (Marx *et al.,* 1999). The NO_3-N values indicated that the six farmers' fields needed lower amount of nitrogen fertilizer inputs for maize production. Soil tests can determine NO_3-N and NH_4-N concentrations at the time of sampling but do not reflect future conditions (Horneck *et al.,* 2011). The low concentrations of NH_4-N indicated that the predominant available form of N is NO_3-N because of the nitrification process in well aerated Alfisol of the study areas. The NH_4-N concentrations in the present study is a typical for such soils that fluctuate depending soil microbial activities, soil moisture and temperature (Horneck *et al.,* 2011; Marx *et al*., 1999). Overall, the NO_3-N and NH_4-N concentrations were found in the optimum range for production.

Soil pH

The pH of soils varied within and among farmers' fields, before and after nitrogen fertilizer application (Tables 4, 5 and 6). The pH of the soils ranged from 4.63 to 5.92 for all farms (Tables 4, 5 and 6). The soils of all farmers' fields were very strongly to moderately acidic (Jones 2003; and Landon, 1991). The result was in agreement with Chimdi *et al.* (2012) for western Ethiopia in cultivated fields. The lower value of soil pH under the cultivated land may be due to the depletion of basic cations in crop harvest and due to its highest microbial oxidation that

Table 3. Some chemical properties soil of maize farmer's field before planting maize and nitrogen application in Bako-Tibe district, western Ethiopia.

Farms	Soil chemical properties					
	(meq 100 g soil^{-1})			Exchangeable acidity	(ppm)	
	CEC	K	Na		NO_3-N	NH_4-N
Farm1	21.26	0.71	1.68	0.21	43.98	trace
Farm 2	19.7	0.13	2.40	0.17	53.05	8.84
Farm 3	21.32	0.85	2.40	0.17	41.13	8.81
Farm4	38.12	0.85	1.68	0.08	30.17	6.03
Farm 5	22.74	0.99	2.16	0.24	66.38	9.05
Farm 6	36.5	0.56	1.44	0.12	41.13	11.75

Farm1-6=Takele uluma, Adisu Fufa, Adisu Likessa, Mulatu shukar, Tesfaye Tsagaye and Gutu Tolera.

Table 4. Effects of nitrogen application to maize varieties on chemical properties soil of maize field at harvesting in Bako-Tibe district, western Ethiopia.

Treatment	Farm 1				Farm 2			
	pH	N (%)	P (ppm)	OC (%)	pH	N (%)	P (ppm)	OC (%)
BH-540(50 %RR)	5.02	0.30	3	2.74	5.04	0.26	4	2.70
BH-540(100 %RR)	5.17	0.37	4	2.81	4.97	0.30	6	2.69
BH-543(50 %RR)	5.06	0.31	3	2.48	5.03	0.25	4	2.64
BH-543(100 %RR)	4.95	0.34	4	2.77	4.96	0.21	4	2.03
BH-661(50 %RR)	4.91	0.36	7	2.37	5.06	0.30	4	2.53
BH-661(100 %RR)	5.06	0.35	6	2.47	5.15	0.20	5	2.39
BH- 660(50 %RR)	5.08	0.31	3	2.94	5.06	0.29	6	2.65
BH-660(100 %RR)	4.95	0.30	4	2.87	5.17	0.29	4	2.56
BH-140(50 %RR)	5.06	0.25	3	2.48	5.06	0.27	4	2.88
BH-140(100 %RR)	5.05	0.23	3	2.17	5.23	0.18	4	2.78
BH-543	5.01	0.21	3	1.59	4.9	0.29	5	2.40
Before planting	4.86	0.22	5.02	2.69	4.63	0.22	5.43	2.53

Farm 1-2= Takele Uluma, and Adisu Fufa

Table 5. Effects of nitrogen application to maize varieties on chemical properties soil of maize field at harvesting in Bako-Tibe district, western Ethiopia.

Treatment	Farm 3				Farm 4			
	pH	N (%)	P (ppm)	OC (%)	pH	N (%)	P(ppm)	OC (%)
BH-540(50 %RR)	5.38	0.21	10	4.11	5.92	0.33	66	4.31
BH-540(100 %RR)	5.33	0.20	9	4.17	6.25	0.30	28	4.34
BH-543(50 %RR)	5.43	0.19	6	3.84	6	0.26	43	4.41
BH-543(100 %RR)	5.48	0.21	12	4.34	5.02	0.22	14	4.03
BH-661(50 %RR)	5.57	0.21	6	4.20	5.02	0.29	4	4.01
BH-661(100 %RR)	5.54	0.23	9	4.33	5.6	0.24	16	4.23
BH- 660(50 %RR)	5.75	0.21	11	4.33	5.21	0.16	6	3.83
BH-660(100 %RR)	5.91	0.17	10	4.31	5.02	0.14	3	2.77
BH-140(50 %RR)	5.74	0.25	9	4.36	5.03	0.26	7	3.01
BH-140(100 %RR)	5.57	0.32	14	4.56	5.45	0.25	16	3.02
BH-543	5.68	0.27	6	4.41	5	0.32	4	2.64
Before planting	5.45	0.23	7.52	2.77	5.40	0.17	6.27	2.07

Farm 3-4 Adisu Likisa, and Mulatu Shuker

produces organic acids, which provide H ions to the soil solution lowers its soil pH value (Chimdi *et al.,* 2012). Moreover, Frossard *et al.* (2000) reported the acidic nature with low soil pH obtained from all the representative land uses may be attributed to the fact that, soils were derived from weathering of acidic igneous

Table 6. Effects of nitrogen application to maize varieties on chemical properties soil of maize field at harvesting in Bako-Tibe district, western Ethiopia.

Treatment	Farm 5				Farm 6			
	Ph	N (%)	P(ppm)	OC (%)	pH	N (%)	P (ppm)	OC (%)
BH-540(50 %RR)	4.81	0.21	8	4.17	5.55	0.18	4	3.98
BH-540(100 %RR)	4.97	0.17	6	4.17	5.34	0.18	7	4.10
BH-543(50 %RR)	5.18	0.19	5	4.15	5.22	0.23	5	3.97
BH-543(100 %RR)	4.97	0.20	5	3.87	5.17	0.19	4	3.87
BH-661(50 %RR)	5.08	0.20	6	4.22	5.23	0.16	5	4.02
BH-661(100 %RR)	5.09	0.17	4	4.08	5.18	0.17	6	4.38
BH- 660(50 %RR)	5.05	0.18	6	3.60	5.23	0.18	4	4.17
BH-660(100 %RR)	4.95	0.18	4	3.87	5.17	0.17	4	4.20
BH-140(50 %RR)	5.09	0.20	7	4.07	5.19	0.18	6	3.87
BH-140(100 %RR)	5.05	0.18	4	4.17	5.24	0.18	7	3.99
BH-543	5.19	0.19	4	4.22	4.95	0.15	3	3.71
Before planting	4.71	0.2	4.18	2.46	5.44	0.18	5.67	2.22

Farm 5-6= Tesfaye Tsegaye, and Gutu Tolera

granites and leaching of basic cations such as K, Ca and Mg from the surface soil. Higher pH of the soils was recorded from nitrogen fertilizer-treated plots as compared to soil before treatment application, except for farm 3 (Tables 4, 5 and 6). Tolera *et al.* (2009) N-P amendment significantly increased pH of the soil. Lime application, planting of acid tolerant crops or integrated use of lime and organic fertilizer can be used to alleviate the soil acidity problem of Alfisol in the study areas.

Total Nitrogen

The total nitrogen concentration of the soil was differed among farms, before and after nitrogen fertilizer application to each farm (Tables 4, 5 and 6). Total nitrogen concentrations ranged from 0.13 to 0.37 % for all farms (Tables 4, 5 and 6). The total N concentrations for all six farms were in the very low, medium to high range (Landon, 1991). This might be due to the crop harvest removal of crop residue and continuous cultivation. Similarly the lower total N in cultivated land was in agreement with the findings of (Abbasi *et al.,* 2007; Jaiyeoba, 2003; Heluf and Wakene (2006). In the Alfisol the total N was in medium range and the soil has a good potential for agricultural crop production.

Total phosphorous

The extractable phosphorous concentrations of soils in the different farms varied among farms and between treatments (Tables 4, 5 and 6). The extractable phosphorous ranged from 3 to 66 ppm for all farms (Tables 4, 5 and 6). The extractable phosphorus concentrations of were in the low, medium to adequate range (FAO, 1990; and Landon, 1991). The continuous cultivation crop may affect the P concentrations of the farm fields. Similarly Paulos (1996) found variations in available P contents in soils are related with the intensity of soil disturbance, the degree of P- fixation with Fe and Ca ions. Similarly results were reported by Tekalign and Haque (1987); and Dawit *et al*. (2002) the availability of P in most soils of Ethiopia decline by the impacts of fixation, abundant crop harvest and erosion. The lower, medium and higher extractable soil P contents of different farms were a good indicator of the soil P supply for agricultural crop production in three different soils in the various farm fields. The different farm fields need different rates of phosphorous fertilizer application and management practices to get the potential yields of crops.

Organic carbon

The organic carbon (and organic matter) contents of soils of different farms varied among farms and between the different treatments. The organic carbon concentrations ranged from 1.59 to 4.56, % for all farms (Tables 4, 5 and 6) and these were in the very low, low to medium range (FAO, 1990; and Landon (1991). This might be due to cultivation increases soil aeration which enhances decompositions of SOM. In addition the SOM produced in soils of cultivated land removed with harvest causing for its reduction in values of OC content. The result was in agreement with Chimdi *et al.* (2012). Similarly studies conducted by Lal, (1996); Mandiringana *et al.* (2005) and Michel *et al*. (2010) indicated the lower percentage of soil OC content in cultivated land. Based on organic carbon concentration the different farm fields' soils require different soil fertility management practices to get the potential yield of a given crop. The nutrient retention capacity of the six farm soils was very low, low to medium and low in microbial population. Therefore, knowing the soil organic carbon and organic matter contents is important in efforts to design management practices for each soil.

The nutrient concentrations of soils in the different farmers' fields of maize varied among farms which might be due to continuous cultivation of the fields.. Similarly Tittonell *et al*. (2012) found that nutrient variability between farms is attributable to differential soil management between farms and fields over time. Continuous cultivation can negatively affect soil nutrient levels was reported by (Chimdi *et al*., 2012). The length of land use was also one of the most probable reasons for the variation in some of the nutrient concentrations presently observed. History of soil use influenced variability in soil C, available P, and exchangeable K^+ (Tittonell *et al*., 2012). The present assessment revealed differences in soil fertility status and management systems applied to different farms during cultivation. Tittonell *et al*. (2012) found heterogeneity in soil fertility in these smallholder systems is caused by both inherent soil-landscape and human-induced variability among farms differing in resources and practices. The variations in soil nutrients are also derived from differences in the composition of the parent material and from fluxes of matter and energy into or from soils over geologic time or management (Helmke, 2000, Rawlins *et al*., 2012). Similarly, Tittonell *et al*. (2010) reported a large portion of the variability in soil properties at farm scale to be associated with inherent features of each site as well as with within-farm variability. Towett (2013) reported soil nutrient levels can either be described as total nutrients or plant-available nutrients and both forms give a much better indication of the nutrients that a particular soil type is likely to contribute to plants over the crop cycle. In contrary, total nutrient content is not a satisfactory index for measuring nutrient availability due to the different and complex distribution patterns of the elements among various chemical species or phases in soils (Chen *et al*., 1996). Towett (2013) argued the total levels of nutrients in the soil are of less interest from an agronomic viewpoint, as they are often poorly correlated with plant availability. Another reason is also because not all of the total nutrients in the soil are immediately available for use by plants and microorganisms (Towett, 2013). Monitoring the dynamics of the total and plant-available nutrients would promote their efficient use by crops and prolong the productive life of the soils (Wong *et al*., 1991). Knowledge about an up-to-dated status of soil physical and chemical properties of different land use systems plays a vital role in enhancing production and productivity of the agricultural sectors on sustainable basis (Chimdi *et al*., 2012). Therefore evaluating soil nutrient status of different maize farm fields are very crucial for sustainable maize production and reducing negative effects of nitrogen fertilizer to the environment.

CONCLUSION

The nutrient concentrations in soils of different maize farms in the of Bako-Tibe area of western Ethiopia were diverse. The nutrient analysis showed soil fertility difference among maize farms. The CEC of the soil was found from medium to high levels in the different maize farms before planting. The soil reaction in all six farms was found to be in the very strongly acidic to moderately acidic range before and after planting of maize varieties with nitrogen application. Soil fertility variations were observed among six farms based on nutrient concentrations. The NO_3-N and NH_4-N concentrations of the soils before planting were in the optimum range for sustainable maize production. The total N and extractable P status of the soils were found to vary from very low to medium and low to adequate range for soil analysis results at harvesting of maize. There is a need for a more targeted approach to soil fertility intervention that differentiates between maize farm component, agro-ecological zone and socio-economic group. Knowing the optimum nutrient concentration levels was helps to minimize the potential for N and P loss from agricultural operations by applying the required amounts in maize producing areas of western Ethiopia. Managing plant nutrient to increase productivity of crops with responsibility to protect environment is a desirable option for maize production. Therefore, soil test-based fertilizer recommendations should be promoted for sustainable maize production since farm soil fertility heterogeneity is very common due to inherent soil fertility status and management practices applied.

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