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Assessment of Farmers' Perceptions about Soil Fertility with Different Management Practices in Small Holder Farms of *Abuhoy Gara* Catchemnt, Gidan District, North Wollo

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Abstract The study was conducted at the Abuhoy Gara Catchment, which is located in the Gidan District of North Wello Zone in the ANRS in year 2014. The aim of the study was to study farmers' perceptions about assessment of soil fertility and comparing them with the criteria of soil fertility used by researchers. To address this issue, semi-structured interviews were conducted in 60 households to gain insight into soil fertility management practices, local methods used to assess the fertility status of a field, and perceived trends in soil fertility. Thirty-three farmers were then asked to identify fertile and infertile fields. Characteristics of these fields in terms of the indicators mentioned in the interviews were recorded, and soil samples were taken for physicochemical analysis in a laboratory. The collected data were grouped according to altitude, slope and type of field. A total of six indicators (soil color, texture, soil depth, topography, soil drainage, and distance from home) were found to be used by farmers to evaluate and monitor soil fertility, which were classified into three categories: Crop production, soil fertility and soil degradation). The overall result showed that there was good agreement between farmers' assessment of the soil fertility status of a field and a number of these indicators, particularly soil color and texture, which were examined in more detail. The soil physicochemical analysis also corresponded well with farmers' assessment of soil fertility. The soil attributes under improper cultivated land showed an overall change towards the direction of loss of its fertility compared to the condition of the soils under proper management. The manner in which soils are managed has a major impact on soil fertility indicators. In order to bring sustainable change in soil quality, research activities must follow scientific and participatory approaches. Therefore, to design more appropriate research and to facilitate clear communication with farmers, researchers need to recognize farmers' knowledge, perceptions about assessments of soil fertility. Because, as they included all soil factors affecting plant growth, farmers' perceptions of soil fertility were found to be more long term day-to- day close practical experience finding than those of researchers.

Keywords*: soil fertility, farmers' perceptions, indicators, soil color and texture*

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1. Introduction

The Ethiopian economy and the livelihood of its population depend heavily on agriculture; efforts to sustain and improve the sector's productivity are therefore crucial to the country's economic development and to the welfare of its people. Securing food and a livelihood is inextricably linked to the exploitation of the natural resource base (land, water and forest) in Ethiopia, where over 85 percent of the population lives in rural areas and contribute significantly to the total export value [1].

Land degradation, mainly due to soil erosion and nutrient depletion, has become one of the most important environmental and economic problems in the highlands of Ethiopia; and it was estimated that half of the Ethiopian highlands' arable lands are moderately to severely degraded and nutritionally depleted due to over cultivation, over grazing, primitive production techniques, and over dependent on rainfall [8]. According to World Bank [26], Ethiopia high lands including the study areas are most seriously affected by land degradation resulting in low and declining agricultural productivity, persistent food insecurity and rural poverty. The complex inter-linkages between environmental degradation, poverty and fast population growth have brought several changes [6]: farm holdings have become smaller and more fragmented, fallow periods become shorter, farmers cultivate fragile margins on steep slopes previously hold in pasture and woodlot, many households particularly those with large family rent in land.

In order to give a sustainable solution to all these challenges, collaborative research between researchers and farmers is very crucial. However, until recently, farmers' knowledge of soil fertility has been largely ignored by soil professionally biased researchers. Therefore, their adoption of improved techniques has been limited [23]. But with increasing use of participatory research approaches, it is becoming clear that farmers have a well-developed ability to perceive differences in the level of fertility between and within fields on their farms. They also see the actual fertility of a soil at any time as a function not only of these longer-term soil properties, but also of the current and past management regime. As such, they assess the fertility of the soil using a range of indicators which they can actually see or feel, including crop yields, soil depth, drainage, moisture, manure requirements, water source, slope, and weed abundance. Therefore the findings of this paper can build the research cooperative researches with farmers' perceptions about the assessment of soil fertility in more detail in line with the criteria of soil fertility used by researchers. Therefore, the objective of the study was to investigate farmers' perceptions about assessment of soil fertility and comparing them with the criteria of soil fertility used by researchers.

2. Research Methods

2.1. Description of the Study Area

The study was conducted at *Abuhoy Gara* catchement in *Gidan* district (Figure 1) which is found in North Wollo Zone of Amhara National Regional State. Gidan is bordered by Tigray Region in the North; Gubalafto district in the North east; Meket district in the south east and Lasta district in the south and south west. Astronomically, it is located between $11^0$53’-$12^0$16’ North and $39^0$10’_$39^0$35’ east. Muja is the administrative town of the district and is situated at about 595km from the capital city, Addis Ababa. The total area of *Abuhoy Gara* catchement is about 615 hectares (250 hectares cultivated and 365 hectares none cultivated lands).

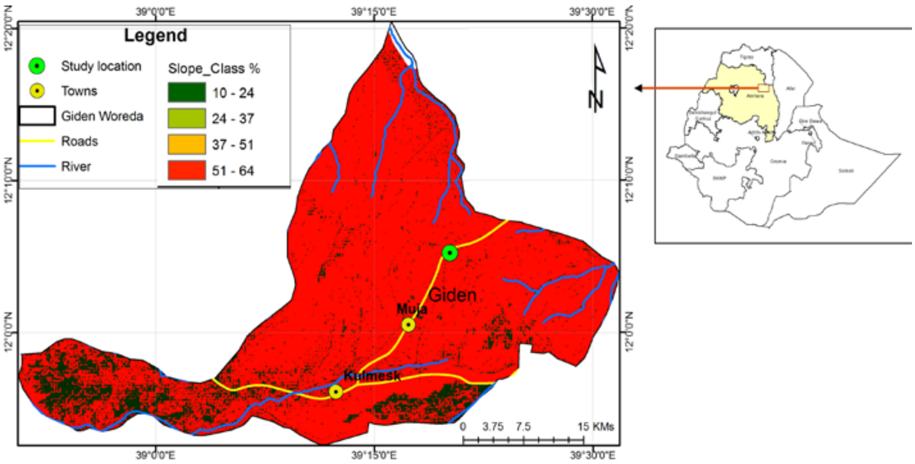

Figure 1. Location map of the study area

The topography of the catchment is mountainous having steep slopes; full of hills, mountains and deeply dissected gorges. The altitude ranges from 3089 to 3559 m.a.s.l. The topography of the area, both in terms of slope and ruggedness, is difficult for cultivation, infrastructure development and irrigation. According to the the district Agricultural office report, the population of the catchment is 580 people of whom 420 are male and 160 are female. The area is known for intensive agricultural production having two distinct growing season *viz., ‘Ganna’* (March-July) and *‘Bona’* (August-December). The annual mean rainfall is 1100 mm with the annual mean maximum and minimum temperature of 21.23°C and 9.57°C, respectively.

2.2. Methods of Data Collection

Field Observation and Household Interviews:

At the beginning, a general visual field survey of the area was carried out to have a general view of the study area. Global Positioning System readings were used to identify the geographical locations and the coordinate system where data could be taken, and clinometers were used to identify slopes of the sampling sites. In order to capture the local indicators and farmers' perception of soil fertility on the study site, participatory rural appraisal tools were conducted using namely direct observation, formal and informal discussion, focus group interviews and key informants. Some limited field work was also undertaken to verify some of the information and data gathered during the discussions and interviews. Issues that immerged from observation were used to guide interviews and discussions with selected farmers. On the identification of the local indicators of soil fertility through interviews with local people, the soils were broadly categorized into two groups: fertile (good) soils and infertile (bad) soils with respect to crop yields. Indicators were related to management induced changes in the soil which includes only those properties relevant to the soil types, farming system, and land uses of the areas.

Data and information on farmers' perceptions about the fertility status of their fields were collected at watershed, village, and household and farm field using formal interviews with 60 sampled households who owning crop lands of which plots are in the four slope categories/villages (steep slope, higher slope, intermediate slope, and lower slope) of the watershed as indicated in Table 1 below. The sampled households were randomly selected from a list of total households collected from the representatives of each village/slope (includes: household details and farming system, soil and land classification, crop and animal production, technology access, etc) to gain insight into soil fertility management practices, local methods used to assess the fertility status of a field, and perceived trends in soil fertility. Special care was taken to ensure that the most experienced member of the household is being interviewed. Fields that were rented out to other farmers, or fields that were being rented by the interviewee, were excluded from the discussions to minimize errors due to a possible lack of knowledge regarding the management of these fields. To increase the validity and reliability of data, focus group discussions (composed of elders, male and female farmers and community leaders) and informal interviews with developmental agents and district agricultural experts were carried out. Secondary sources of data were gathered from published and unpublished documents, official reports from relevant government offices, non-governmental organizations, and research center.

Table 1. Characteristics of intervened farmers *Abuhoy Gara* catchment (60 households)

Characteristics of farmers	Number of respondents
Number of men households interviewed	43
Number of women households interviewed	17
Average farm land size holding (hectares)	0.45
Average experience of interviewee(years)	15
Number of households interviewed based crop land distribution watershed:	
-Steep/Top slope (51-64%)--	12
-Higher slope (37-51%)--	16
-Intermediate slope (24-37%)---	16
-Lower slope (10-24%) --	16

Soil Sampling:

From those interviewed, a subset of 33 farmers were selected at random and asked to indicate their most fertile field and their most infertile field. Each of these fields and its surrounding environment was then characterized according to its distance from the household, its size, terrace height, tree shade, stoniness, aspect of crops, and hardness of the soil felt when sampling. Representative soil sampling sites were purposely selected based on cultivation history and indigenous local indicators of soil fertility groups using farmers' perceptions'**.** Soil samples were collected by flexible gridding system throughout the field at two depths, surface (0-15 cm) and subsurface (15-30 cm) soil layers [20]. The number and distribution of soil samples were determined using Global Positioning mapping system based on the identified soil fertility groups. Before sampling, forest litter, grass, dead plants and any other materials on the soil surface were removed; and during collection of samples, field/terrace edges, furrow, old manures, wet spots, areas near trees, compost pits, fields used as kitchen gardens and fertilizer bands were excluded. Soil sampling was based on the identified soil fertility groups. In each soil group, a composite soil sample of 10 sub-samples was taken from each soil depth (0-15 and 15-30 cm). From the 42 composite soil samples major soil fertility parameters were analyzed.

2.3. Method of Data Analyses

2.3.1. Soil Laboratory Analysis

The samples were air-dried, homogenized and sieved to pass a 2 mm mesh sieve for physical and chemical analyses. Particle-size distribution was determined using the pipette methods or hydrometer method [18]. Soil pH was determined in water and 1 M KCl in a soil to solution ratio of 1: 2.5 soil water solution [13] using glass electrodes after reciprocal shaking for 1 hour. The exchangeable acidity was extracted with 1 M KCl and it can be determined by the titration method using 0.01 M NaOH [24]. Total nitrogen was determined using Kjeldahl method [4,17] and total carbon in soil was determined by the wet digestion method of Walkley and Black [16]. Available phosphorus was determined by the Bray II method [11]. Exchangeable cations (K, Ca, Mg and Na) were extracted with 1 M NH4OAc buffered at pH 7. The concentrations of K, Ca, Mg and Na in the solutions were measured by AAS (Shimadzu AA-6800). Cation Exchange Capacity (CEC) was determined by 0.05 M K2SO4 using the soil used for the basic exchangeable cation determination or by the neutral ammonium acetate (CH3COONH4) saturation method [19]. The exchangeable bases in the ammonium acetate filtrates collected above were measured by atomic absorption spectrophotometer [19].

2.3.2. Data Analysis

Analysis of variance (ANOVA) using the general linear model procedure of the statistical analysis system (SAS) was performed to detect soil physicochemical properties differences on the surface soils (0-15 cm) and subsurface soil (15-30 cm) of bad and good soil groups. The data generated by structured questionnaires was analyzed using descriptive analysis to describe and investigate the characteristics of the farmers' perception.

3. Results and Discussion

3.1. Farmers' Perceptions about Soil Fertility

Farmers in the study area have almost common criteria to evaluate and identify their soils. Usually, fields were characterized as fertile (good /high) or infertile (bad/low). They used soil color, texture, soil depth, soil drainage, topography and distance from home as criteria to classify into different groups. Based on these criteria farmers of the catchment categorized their soils into: *infertile (Derek) and fertile (Lem).*

Table 2. Soil types identified by farmers using possible indicators (soil color)

Local Indicators	Good/fertile	Bad/infertile
Yellow/white and red	5	55
Black ('*Koticha)*	53	7
Light black	39	21
Brown *Dalacha'* soil	31	29

Soil color is an important criterion for farmers, whereas with respect to soil texture, farmers preferred heavy soils (clay soils) to sandy soils because of their high water holding capacity and nutrients of plants. Sandy soils are mostly highly weathered and their physical, chemical and biological attributes of soil fertility are extremely limited [3]. According to farmers response, farmers' fields were characterized as fertile (good) where it comprise black color, Cracks during dry season, Good crop performance, vigorous growth of certain plants, presence of plants in a dry environment, abundance of earth worms whereas infertile (bad) where it shows yellow/white and red colors, compacted soils, stunted plant growth, presence of bracken ferns and presence of rocks and stones .

3.2. Soil Classification by Farmers

During the interviews, six major indicators were mentioned by farmers as common tools they used in assessing the fertility of their soils (Table 3). The main properties of these different soils were stated by farmers to be crop productivity, the soil fertility and soil degradation (Table 3). The principal indicators with these soil properties were mentioned by farmers by 56.8 % very important, 20.2% important, 13.8% undecided, 8.7% least important and 5.6% not important.

Similar to Corbeels *et al.* [5], farmers were found to classify their soils very importantly according to their colour rather than texture (Table 3 and Table 4). The term white soil indicates that these soils are, in fact, very dark in colour, but are called white because of small shiny mica grains that become apparent when the soil is getting high rain splash. So, among sixty interviewed farmers only five farmers said that white/grey soil is fertile (Table 2). On the other hand, fifty five farmers said that white and red soils were most commonly used to describe infertile/bad soil. The reason was because of its low water holding capacity; making it less productive in low rainfall years and low nutrient retention capacities. According to farmers in the area, due its high amounts of organic matter or clay content, its high water holding capacity, the black or dark color soils give better yield than other soils at times of low rainfall. The major limitation of dark soil is sticky when wet and hard when dry; making it difficult to till. The occurrence of light and red-colored soils is related to very low organic matter content and significant amounts of Fe and Al oxides and hydroxides in the soil [3]. These red and light-colored soils have acidic soil reactions and low percent base saturation.

Table 3. Local methods used to assess the fertility status of a field, and perceived trends in soil fertility (60 respondents)

		Production			
Rank	**Very important**	**Important**	**Undecided**	**Least important**	**Not important**
Soil Colour	55	-	5	-	-
Soil Texture	35	10	6	9	-
Soil Depth	28	11	3	8	10
Topography	31	12	6	4	7
Soil Drainage	17	13	20	7	3
Distance from home	42	8	-	9	1
Rank percentage	**208/360= 57.8%**	**54/360=15%**	**40/360= 11.1%**	**37/360=10.27%**	**21/360=11.7%**
		Soil Fertility			
Soil Color	51	8	1	-	-
Soil Texture	39	10	7	4	-
Soil Depth	33	15	2	5	5
Topography	27	19	4	10	-
Soil Drainage	20	17	18	3	2
Distance from home	39	9	2	7	3
Rank percentage	**209/360=58%**	**78/360=21.7%**	**34/360=18.9%**	**29/360=8.05%**	**10/360=2.8%**
		Soil Degradation			
Soil Color	43	7	10	-	-
Soil Texture	18	27	9	5	1
Soil Depth	39	13	3	5	-
Topography	55	5	-	-	-
Soil Drainage	11	22	13	11	3
Distance from home	31	12	6	7	4
Rank percentage	**197/360=54.7%**	**86/360=23.9%**	**41/260=11.4%**	**28/360=7.8%**	**8/360=2.2%**
Mentioned by %	**56.8 %**	**20.2%**	**13.8**	**8.7%**	**5.6%**

3.3. Farmer Indicators of Soil Fertility

The principal indicators mentioned by farmers were soil colour (mentioned by 82.8% of the farmers), soil texture (62.8%), Soil depth (55.6%), Topography (51.1%), soil drainage (26.7%), and distance from home (6.1%) as very important below Table 4. Past studies show that fields closer to the household are fertile but farmers in *Abuhoy Gara* Catchemnt, distance from home is least important than others. The reason of the farmers was improper management, for instance modified by human beings by addition of manure and ashes or polluting materials make the soil bad/polluted.

Table 4. Indicators rank based on their importance

Indicators	Rank based on farmers' perceptions				
	Very important	Important	Undecided	Least important	Not important
Soil color	149/180=82.8%(1st)	15/180=8.3%	16/180=8.9%	-	-
Soil Texture	113/180=62.8%(2nd)	36/180=20%	10/180=5.6%	14/180=7.8%	7/180=3.9%
Soil Depth	100/180=55.6%(3rd)	39/180=21.7%	8/180=4.4%	18/180=10%	15/180=8.3%
Topography	92/180=51.1%	47/180=26%	22/180=12.2%	18/180=10%	1/180=0.6%
Soil Drainage	48/180=26.7%	52/180=28.9%	51/180=28.3%	21/180=11.7%	8/180=4.4%
Farm distance	112/180=6.1%	29/180=16.1%	8/180=4.4%	23/180=12.8%	8/180=4.4%

3.4. Farmers Perceptions Based Laboratory Results

Soil Texture:

There were no significant differences in sand and clay particle size distribution among /between the two soil groups (fertile and infertile), but the highest mean sand fraction and clay fraction were observed in bad/infertile and good/fertile soils, respectively (Table 5). The increasing of clay fraction and decreasing of sand fraction indicates that these have positive correlation with soil fertility. This is apparent because the clay particles unlike the sand particles, have substantial exchange surface areas, and therefore adsorb and stabilize organic matter and soil nutrients [21,22].

Table 5. Selected soil physical characteristics of farmer designated bad (infertile) and good (infertile) soils

Variables	Sand %	Silt %	Clay %
	Farmers' Perception		
Bad soil	60.00a	16.25a	23.75a
Good soil	59.17a	16.25a	24.58a
LSD (0.05)	**NS**	**NS**	**NS**
SEM (+)	**29.1667**	**3.4722**	**15.9722**
CV (%)	**9.0640**	**11.4670**	**16.5374**
	Soil Depth		
0-15 cm	57.92a	18.33a	23.75a
15-30 cm	61.25a	14.17b	24.58a
LSD (0.05)	**NS**	**2.633**	**NS**
SEM (+)	**29.1667**	**3.4722**	**15.9722**

*Values with the same letter are not significantly different ($P \leq 0.05$); SEM = Standard Error of Mean; LSD = Least Significance Difference

Table 6. Interaction effects of farmers' perception and soil depth on selected soil physical properties

Variables	Sand %		Silt%		Clay%	
	Soil Depth (cm)		Soil Depth (cm)		Soil Depth (cm)	
	0-15	15-30	0-15	15-30	0-15	15-30
Bad soil	58.96a	60.63a	17.29c	15.21bc	23.75a	24.16a
Good soil	58.55a	60.21a	17.29a	15.20ab	24.17a	24.58a
LSD (0.05)	**NS**		**3.723**		**NS**	
SEM (+)	**29.1667**		**3.4722**		**15.9722**	
CV (%)	**9.0640**		**11.4670**		**16.5373**	

*Values with the same letter are not significantly different ($P \leq 0.05$); CV = Coefficient of Variation。

Soil Chemical Properties:

According to farmers' perception, fields can be classified as bad (infertile) and good (fertile) based on different local indicators. There was significance difference in soil exchangeable cations (Ca, Mg,K), CEC, total nitrogen, organic carbon and available phosphorous between soils classified as bad and good by farmers, while no significance difference in soil exchangeable Na and acidity and pH (Table 7). Considering the two soil groups (bad and good), the higher mean values of Ca (7.88cmol(+) kg^{-1}), Mg (1.97cmol(+) kg^{-1}), K (0.78cmol(+) kg^{-1}), Na (0.29cmol(+) kg^{-1}), CEC (15.57cmol(+) kg^{-1}, pH-H_2O (6.01), total nitrogen (0.116%), organic carbon (1.583%) and Available Phosphorous (8.33 ppm) were observed within the good soils while the highest mean value of exchangeable acidity (0.263 cmol(+) kg^{-1}) was observed on bad/ infertile soils (Table 7). According to the classification of soil chemical properties as per the ranges suggested by FAO [7], Jones [10], Landon [12], Tekalign [25], Barber [2] and Murphy [15], the soils of *Abuhoy Gara* Catchment was moderate content in Ca (5-10 cmol(+) kg^{-1}), CEC (12 – 25 cmol(+) kg^{-1}), K (0.3–0.7 cmol(+) kg^{-1}), Mg (1–3 cmol(+) kg^{-1}), pH-H2O (5.6-6.0), whereas low in Na (0.1–0.3 cmol(+) kg^{-1}), total nitrogen (0.05–0.15%), available phosphorus (1-9 ppm), and organic carbon (1 - 2%). Thus these all results showed that there was no significantly difference between both perceptions of researchers and farmers.

Table 7. Selected soil chemical characteristics of farmer designated poor soil (infertile) and Good soil (infertile)

Variables	Exchangeable (cmol(+) kg^{-1})									
	Ca	Mg	K	Na	Exa.A	CEC	pH-H_2O	TN %	OC%	Av. P(ppm)
	Farmers' Perception about soil fertility									
Bad soil	5.98b	1.75b	0.44 b	0.27a	0.263a	13.90b	5.90a	0.100b	1.228b	6.67b
Good soil	7.88a	1.97a	0.78a	0.29a	0.215a	15.57a	6.01a	0.116a	1.583a	8.33a
LSD (0.05)	0.620	0.188	0.120	NS	NS	0.558	NS	0.010	0.074	0.692
CV (%)	6.3358	7.1494	13.9288	20.2556	14.1280	2.6826	1.4578	6.9612	3.7491	6.5295
	Soil Depth									
0-15 cm	6.71a	1.76b	0.57a	0.27a	0.251a	14.48a	5.93a	0.112a	1.365b	7.25a
15-30 cm	7.12a	1.96a	0.65a	0.29a	0.227a	14.99a	5.98a	0.104a	1.447a	7.75a
LSD (0.05)	**NS**	**0.188**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.074**	**NS**

*Values with the same letter are not significantly different ($P \leq 0.05$); Ex. acidity = exchangeable acidity; NS = not significant; TN = total nitrogen; OC = Organic Carbon; Av.P = Available Phosphorous

Table 8. Interaction effects of farmers' perception and soil depth on selected soil chemical properties

Variables	Exchangeable (cmol(+) kg^{-1})											
	Ca		Mg		K		Na		Exa.A		CEC	
	Soil depth (cm)											
	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30
Bad soil	5.95b	6.02b	1.72b	1.79b	0.43b	0.44b	0.27a	0.28a	0.27a	0.26ab	13.59b	14.22b
Good soil	7.47a	8.29a	1.81b	2.13a	0.71a	0.86a	0.27a	0.31a	0.23ab	0.19b	15.37a	15.77a
LSD(0.05)	**0.877**		**0.266**		**0.169**		**0.113**		**0.067**		**0.790**	
SEM (+)	**0.1928**		**0.0177**		**0.0072**		**0.0032**		**0.0011**		**0.1562**	
CV (%)	**6.3358**		**7.1494**		**13.9288**		**20.2556**		**14.1280**		**2.6826**	

Variables	pH-H_2O		Total Nitrogen %		Organic Carbon %		Available Phosphorous (ppm)	
	Soil depth (cm)							
	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30
Bad soil	5.88a	5.92a	0.103b	0.097b	1.168c	1.289b	6.34b	7.00b
Good soil	5.99a	6.04a	0.121a	0.111ab	1.562a	1.604a	8.17a	8.50a
LSD (0.05)	**NS**		**0.015**		**0.105**		**0.978**	
SEM (+)	**0.0075**		**0.0001**		**0.0028**		**0.2398**	
CV (%)	**1.4578**		**6.9612**		**3.7491**		**6.5295**	

*Values with the same letter are not significantly different ($P \leq 0.05$)

These all physical and chemical properties of the soils were linked with the farmers' soil fertility management practices of the study sites**.** Farmers used oxen to pull the local plough '*Maresha*'. Most of the farmers in the study areas cultivate their land 2-3 times before planting cereals. The study area has two cropping seasons *'Ganna'* and *'Bona'* and only few farmers divided their land into *'Ganna'* and *'Bona'* cropping land. The main reasons raised by farmers for not using the land for double cropping was fear of soil fertility depletion as a result of double cropping.

Farmers of the study area are well aware of the advantage of returning crop residues to soil fertility. But, only few farmers around 12% retain most crop residues in their field. This is because crop residues are used as construction material, fuel and source of animal feed. Moreover, farmers used low rate of mineral fertilizers due to the current escalating prices of chemical fertilizers. 75% farmers broadcast/ apply only 50 kg DAP/ha for cereals. This rate is by far lower than the blanket recommendation (100 kg DAP and 50 kg Urea) for the area.

The major practice followed by farmers in this area is to rotate barley and wheat on the same piece of land. However, few farmers in some part of the highland rotated cereals with leguminous crops (e.g. field pea, Chick pea, and lentil). Despite the fact that farmers know the benefit of fallowing to restore soil fertility, the study also clearly showed due to the ever increasing population pressure, long term fallowing was not practiced in the study area. Currently, the common practice in the area is seasonal fallowing i.e. leaving the land fallow for one or two seasons.

4. Summary and Conclusions

The results presented in this paper indicate that there is good agreement between assessment of soil fertility by farmers in *Abuhoy Gara* Catchemnt and scientific indicators of soil fertility such as exchangeable cations, cation exchange capacity, soil organic carbon content, total nitrogen and pH. This result is agreement with other studies, for instance, Murage *et al.* [14] found in Kenya that productive soils, as identified by farmers, had significantly higher soil pH, effective cation exchange capacity, exchangeable cations, extractable P, and total nitrogen than non-productive soils. The names the farmers give to soils do not necessarily correlate to the scientific classification because their classification and indicators rely on soil characteristics that they can practically experience. Nevertheless, both farmers and researchers have common objectives, mainly to ensure that the soil resources are sufficient and sustainable to meet the needs of farmers at present and in the future. As stated by Pawluk *et al*. [18], researchers need to understand and use indigenous knowledge systems, which need to be viewed, not as opposing, but rather as complimentary to their own way of thinking**.** Therefore, it is important that both farmers' perception and researchers' scientific methodology of soil fertility assessment are used.

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Appendices

Appendix 01. Questionnaire

Name of the enumerator---------------------Date------------------------ Sig.------------------Sample No. -----------
Name of peasants association (PA)--------------------Location of the PA: District -----------------Zone--------------------
Total population of the PA-------Total area of the PA ---------Agro-climatic zone/Altitude -----------------------------

Section A. FARM HOUSEHOLD CHARACTERISTICS

1. Name of the household head………………………Sex: 01 Male ---------02 Female----------------
Religion: (01) Muslim --- (02) Orthodox--- 03 others specify……………………………………………
Level of education :(01) Illiterate (02) Read and write (03) Basic Education (04) secondary
Wealth rank: (01) Poor (02) Rich (03) Medium Age -----year
Marital status: 01) married 02) single 03) divorced 04) widow
Social position in the Kebele: (01) Member of the council (02) Religious leader (03) Others---
2. Household Family Size: total number of families with age and sex category: ---*Male =01; female=02
3. Total land size (Ha)……………………………………………………………………………….
4. Who is supporting the family financially?..
5. Is farming your major source of income? Yes, No
6. What are your other sources of income? A. Government subsidy…………B. Employment subsidy………………C. Donations………………………………………………
7. Is your farm organic or conventional? …………………………………………………………
8. Do you use scientific or traditional methods? ....
9. Are you farming for marketing or subsistence?...

Section B: Soil Classification

10. Do you classify your soils? Yes…………No…………

11. If yes, how do you classify them? (I.e. which of the following soil properties do you Consider?)

Parameters	Fertile			Infertile		
	1 rank	2 rank	3 rank	1 rank	2 rank	3 rank
Organic matter roots/residue						
Soil Erosion						
Water holding capacity						
Soil drainage infiltration						
Crop condition						
Soil color						
Soil texture						
Soil depth						
Topography						

12. Do you know the effects of topography on soils along a land position? Yes……………………No…………..
If yes, can you briefly tell those effects?...

13. Rank the classification categories in order of importance for the following factors. The factors are production, soil fertility and land degradation.

Production					
Rank	**Very important**	**Important**	**Undecided**	**Least important**	**Not important**
Soil Colour					
Soil Texture					
Soil Depth					
Topography					
Soil Drainage					
Distance from home					
Soil Fertility					
Soil Colour					
Soil Texture					
Soil Depth					
Topography					
Soil Drainage					
Distance from home					
Soil Degradation					
Soil Colour					
Soil Texture					
Soil Depth					
Topography					
Soil Drainage					
Distance from home					

Section C: Soil Perspective

14. How do you identify soils (i.e. which of the following soil properties do you consider?) and why?
Soil color Soil depth
Soil moisture Soil texture

15. How do you determine soil fertility?
a. Do you use visual inspection? If yes, how?..
b. Do you use physical measurements? If yes, how?...
c. Do you use crop performance (i.e. growth rate or output in terms of yield)………………………

Section D: Crop production

16. Is crop production determined by soil type? If yes, which soils are good for which crops and Why?...

17. Which management practices do you practice?
a. Crop rotation____
b. Intercropping____
c. Any other____

18. Soil description
(a) How would you determine soil characteristics relevant for crop production (theoretically and practically if possible),
- Soil Depth……………………….……………………………………..………………
- Color…………………………………………………………………………...….
- Fertility…………………………………………………………………………….

(b) How do you then decide on which crop to plant………………………………………..
(c) Farmers critique of the scientific approach……………………………………………….

***What else can you tell me about the property that you think is significant for soil quality? Or what other concerns or problems have you experienced with regard to soil quality**?