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Impact of Cultivation Methods on Soil Fertility and Rural Livelihoods in Arsi Zone, South East Ethiopia

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Abstract

Land degradation, in the form of soil erosion and nutrient depletion, threatens food security and the sustainability of agricultural production in many developing countries.Specially, in Ethiopia soil erosion is a series problem and therefore, it's aimed to assess the impact of cultivation methods on soil fertility and rural livelihood in southeast Ethiopia. Composite soil samples were collected from five cultivation fieldswith 3 replication with the simple random sampling system. There was a higher value of BD in wheat-wheat and wheat-barley than wheat-bean and wheat-pea cropping system. The wheat-wheat and wheat-barley cropping systems didn't pose any changes in the values of pH, SOM, and Av.P. Correspondingly, as compared to the adjacent continuous wheat cultivation, wheat-barley, wheat-bean, and wheat-maize cropping system increased SOM and TN. Similarly, most households support their family from what they produce from crop rotation with an average annual income of 27450 (Birr/ha) while continues cropping is 9650 Birr/ha. Because of this about 61.64% households satisfied food security from income obtained from crop cultivation. Generally, the cultivation of wheat-bean and wheat-pea cropping systems improve the selected properties of soil while wheat-barley and wheat-maize in comparison with continuous wheat cropping systems had adverse effects on the soil fertility and owing to this the productivity of soil increase the livelihood of the farmers in the study area. Therefore, it is recommended to include legume in cropping system for sustaining the soil fertility and improve the farmer's livelihood.

Key words: CultivationSystem, Rural Livelihoods, and Soil fertility.

INTRODUCTION

Soil fertility decline has been taking place over large parts of the world. It occurs mainly through intensive and extensive cultivation as well as an inadequate nutrient replacement (Ali, 1999). Pay *et al.* (2001) stated that in the Sub-Saharan Africa nutrient mining accounts about 7% of the sub-continental agricultural gross domestic product. Similarly, soil fertility often changes in response to land use, cropping patterns and land management practices (Rahman and Ranamukhaarachchi, 2003). Therefore, repeatedly growing of the same crop on the same land can reduce soil health and at the same time it lead soil mineral depletion and change in soil structure (Fageria*et al.*, 2011). Unwise crop production and poor soil management practice have generally resulted in a reduction of SOM levels and finally result in a gradual decline of soil nutrient status. However, soil nutrient restoration has been possible with fallow lands and crop rotations (FAO, 2005). Inclusion of legumes in crop rotations increase soil health and help to add soil nitrogen, SOM content and increase organic fertility of the soil. So the cereal-legume based crop rotation shows improvement in soil fertility of most soil types (Ahmad *et al.*, 2010). Similarly, the legume-based rotations have been economically viable and acceptable to farmers as an alternative to continuous cereals cultivation (Zuhair and John, 2006). For example, soil nutrients are higher in velvet-bean-maize rotation than continuous maize, soybean-maize and cowpea-maize cropping system (Okpara and Igwe, 2014).

In Ethiopia, highland plateau have sufficient rainfall and better soil types that vary in soil nutrient status are found suitably for crop production. However, due to the higher population, the crop lands have been subjected to put under continuous cultivation. This leads to high nutrient depletion and decreasing farm sizes and fallow periods (Mati, 2006). Tamire (1997) reported that, in the dry sub-humid and semi-arid highlands of Ethiopia, the cereal mono-cropping is the most dominant farming system. Many farmers live in where do not normally practice crop rotation scheme, inter-cropping, mulching, and manure addition on their farm. However, few farmers in some part of the highland rotated cereals with lentil, field pea, faba bean and linseed (Taye and Yifru, 2010).The values of soil physico-chemical properties are affected by different factors. Studies reveal that, the extent and distribution of soil properties have been changed due to the effect of land use type (Teshome *et al.,* 2013), cereal types and biomass removal at different landscape (Ali *et al.,* 2012) and nutrient management strategies such as crop rotation with theapplication of compost, manure and mineral fertilizer effect (Ailincai *et al.*, 2008). However, infrequent information is available on the effects of cultivation methods on the soil fertility and socioeconomic properties of the households in many parts of Ethiopia including Arsi Zone. Therefore, this study is aspired at assessing the effects of cereal cultivationand socioeconomic, East Arsi Zone.

METHODS AND MATERIALS

Study Area Selection and Soil Sampling Methods

For this study, Gonde peasant association in hetosa woreda was purposively selected from Arsi Zone due to legume-based cereal cropping system is commonly practiced in this area. Prior to collecting soil samples, contacts with Agricultural Office expertise and discussions were made in order to acquire information about the cultivation and cropping system in the area. Then after, a reconnaissance field survey was carried out and the croplands with continuously cultivated cerealsand rotated with others without the addition of inputs in the past one year on nearly the same topographies and slope. Subsequently, the study area was purposely stratified into wheat-wheat, wheat-barley, wheat-pea, wheat-bean, and wheat-maize cropping system. Based on the above criteria, to achieve the intended objective, the adjacently situated cultivation land of cereals cropping system in which, continuous cropping system taken as control were selected. Afterward, composite soil samples were collected from the 5 cultivation fields with 3 replications. A total of 15 soil samples were brought for laboratory analysis with the simple random sampling system. Two techniques were used to obtain soil samples within the plots. These were undisturbed and disturbed soil sample from each sampling depth using 2 cm diameter stainless steel sampling auger. For each composite soil samples, soils composed from 10 sampling points were cautiously mixed with a plastic bag. The well-mixed soils sample were stored in zip-lock plastic bags and placed in a cooler to keep the samples at a moderate temperature. Besides, each disturbed soil sample was air-dried and sieved with stainless steel of 2-mm mesh sieve in order to remove stones, roots, and large organic residues before conducting analyses for soil characteristics.

Analysis of Soil Properties

Particle size distribution was determined by the hydrometer method (Houba*et al.*, 1989). Soil bulk density was determined by using undisturbed core sampling method after drying the soil samples in an oven at $105^{o}{}_{C}$ to constant weights (Blake and Hartge, 1986). For bulk density calculation, the mass of each empty core (*a*), and the mass of each core with its dry soil (*c*) were used as follow:

$$\text{Bulk Density (gm/cm3)} = \frac{\text{Weight of Oven dry soil in gm}[c-a]}{\text{Volume of core in cm3}}$$

Soil pH (H_2O) was measured using the glass electrode method with in a supernatant suspension of 1:2.5 soils: liquid ratio (IITA, 1979). The SOC was determined by using Walkley and Black wet digestion method. Following the standard practice that SOM was composed of 58% C (Nelson and Sommers, 1996.The Av.P content of the soil was analyzed using 0.5M sodium bicarbonate extraction solution (pH 8.5) of Olsen method in case of alkanity or Kurtz method incase of acidity(Van Reeuwisk, 1992). TN was identified using the Kjeldahl digestion, distillation and titration method, based on the principle that the SOM is oxidized by treating the soil with 96% concentrated 0.1N H_2SO_4. During the oxidation, nitrogen in the organic nitrogenous compounds being converted into NH_4SO_4. The acid traps NH_4^+ ions in the soil, which are librated by distilling with 0.1N NaOH solution. The liberated NH_4^+ is absorbed in H_3BO_3 and back titrated with standard H_2O and K_2SO_4 is added to raise the boiling point as described by Bremmer (1996).

Socio-Economic Information

Both primary and secondary data sources were used for socioeconomic information. The primary data was collected on the cropping system, major land-use type, land use system and source of income, household's characteristics, and annual income from continues cultivation and crop rotation. This information was collected through a household survey, focus group discussions and key informant interviews. The total sample size for the household interview was determined using probability proportional to sample size-sampling technique (Cochran's 1977).

$$no = \frac{Z^2 * (P)(q)}{d^2}$$

Where;

Z = standard normal deviation (1.96 for 95% confidence level)

P = 0.05 (proportion of population to be included in sample i.e. 5%)

q =is 1-P i.e. (0.95)

d =is degree of accuracy desired (0.05)

The total number of household in the watershed is 511. Based on Cochran's techniques, 73 households were randomly selected for the interview. Structured and semi-structured questionnaire were prepared to collect the information.

Statistical Analyses of Data

The data were analyzed using SAS software version 9.2 for mean comparison (SAS, 2008) and the livelihood analysis by SPSS version 16. The ANOVA were used to compare the effects of cereals cropping systemson soil properties and farmers livelihood. The least significance difference (LSD) was used to separate considerably differing treatments mean when significant effects were found at P<0.05.

RESULTS AND DISCUSSION

Effect of Cultivation Systems on Soil Properties

The results of the study presented in table 1 indicated that there was a significant (P<0.05) variation in soil particle distribution due to the cropping systems except for sand fractions. The mean value of silt fraction under wheat-maize land was significantly varied from the entire cropping system except wheat-pea. The clay content of the soil in the wheat-wheat cultivated area was significantly different from wheat-bean, wheat-pea and wheat-maize but non-significant from wheat-barley cropping systems. The higher (43.18 %) and lower (42.03%) mean values of clay were found in wheat-pea and wheat-wheat cropping system respectively. This result was in line with the report of Adamu and Maharaz (2014) who reported that, the clay content in soils under sole cropping was lower than in soil under mixed cropping. Furthermore, (Rafael *et al.*, 2001) reported that, the use of legumes in a cropping system lead to improve the soil structure. The textural class of the soil under all cropping systems was silt clay. Concerning the effect of cropping systems on soil BD, the result exhibited that soils cultivated with wheat-bean significantly differed from wheat-maize, wheat-barley and wheat-wheat cropping systems but, non- significantly varied from wheat-pea (Table 1).

Table 1. Cropping system effect on selected physical properties (BD, Sand, Silt, Clay) of the soils (α=0.05) and mean ± SEM.

Cropping system	BD(g/cm3)	Sand (%)	Silt (%)	Clay (%)	Soil textural class
	Cropping system				
Wheat-wheat	1.27±0.03[a]	16.51±0.38[a]	41.46±0.29[a]	42.03±0.09[c]	Silt clay
Wheat-barley	1.27±0.01[a]	16.40±1.02[a]	41.16±1.03[a]	42.44±0.29[bc]	Silt clay
Wheat-bean	1.08 ±0.10 [b]	16.18±1.22[a]	41.20±1.03[a]	42.63±0.39[ab]	Silt clay
Wheat-pea	1.11±0.07 [b]	16.15±1.00[a]	40.67±0.04[ab]	43.18±1.04[a]	Silt clay
Wheat-maize	1.24±0.04[a]	16.90±1.01[a]	40.02±0.46[b]	43.08±1.02[a]	Silt clay
LSD	0.1121	0.820	0.972	0.5816	
P.V	***	ns	**	***	

N.B: BD= Bulk density, P.V= P-value, C.V = Coefficient of variation, LSD = Least significant difference. Mean ± SEM (standard error mean). The same values of letters are non-significant. * shows P ≤0.05, **P≤0.01, ***P≤0.001 and **** P≤0.0001.

The cultivation of wheat-bean reduces the value of BD by 14.96%. This lower mean value of BD under wheat-bean was observed due to the higher SOM formation from the residue whereas the higher BD under wheat-wheat was resulted due to use of wheat crop residue for animal fodder. Correspondingly, Pravin*et al.* (2013), mentioned that, the BD was mainly determined by OM contents. The significantly higher mean value of BD was found at the subsurface (1.28g/cm^3) than surface (1.09 g/cm^3) layer. This showed that the investigated soils had a compacted layer in the subsurface. Similarly, the finding of Awdenegest *et al.* (2013) explained that, the higher BD in subsurface soil was due to the effects of the weight of the overlying soil and the corresponding decrease in SOM content.

The pH of the study area soil ranges from 7.11 to 8.04 (Table 2). Although, the area received 827 mm rain fall, according to the soil pH fertility rating established by Brindha and Elango (2014), the soil varied from neutral to moderately alkaline. The basic value of pH was achieved as a result of calcareousness nature of soil in the rift valley where the buffering capacity of clay, CEC and OM were high. Similarly, Sule and Mustafa (2007) explained that the presence of calcium carbonate in calcareous soil could result in an increment in a value of pH. The soil pH in the wheat-maize (7.28) cropping system was significantly (P<0.05) differed from the whole cropping system. The cultivation of wheat-pea (7.51) and wheat-bean (7.52) were insignificantly varied from each other (Table 3). The value of soil pH in wheat-bean cropping system was increased by 5.8% probably due to residues left in the cultivated field;in which the decomposition of this residue enables mineralization of SOM to boost the basic cations that allow the raising of the soil pH in the area.Correspondingly, Murphy *et al.* (2008), indicate that, the highest pH value appeared in the wheat-legumes than wheat-non legumes crops. The mean values of SOM showed in table 3, had a significant ($P<0.05$) variation across different cropping systems. The SOM in the wheat-bean and wheat-pea cropping system were significantly different compared with wheat-barley, wheat maize and wheat-wheat cropping system at $P<0.05$. But the cultivation of wheat-wheat was not significantly varied from wheat-barley and wheat-maizecropping system. According to the classification of SOM as per the ranges suggested by Tabi*et al*. (2013), the soils of the area were found in the range of medium (2-4.2%) to a high rate (4.2-6%).The soils cultivated with wheat-bean cropping system had the higher value of SOM (4.23%) and the lower (3.59%) were in the wheat-wheat cropping system (Table 2). Similarly, Rafael *et al.*, (2001) reported that, soils in which legumes have been grown tend to have a higher level of SOM, which improves soil fertility.

The study result indicated that among the wheat-based cropping system, the TN found under the wheat-wheat (0.20%) cropping system was significantly ($P<0.05$) varied from the all cropping system. However, the TN content in the cultivation of wheat-bean (0.24%) and wheat-pea (0.24%) as well as wheat-maize (0.21%) and wheat-barley (0.21%) cropping system, had no significant variation (Table 2). The values of TN in wheat-bean and wheat-pea were increased by 20%, whereas wheat-barley and wheat-maize cropping system increased by 5%; in comparison with land cultivation with continuous wheat. This higher value of TN was probably related to the higher N-fixing capacity of wheat-bean and wheat-pea cropping system. The report of Okpara and Igwe (2014) also showed that, the velvet-bean-maize cropping system had a higher value of TN than cowpea-maize. The analytical result presented in table 2 showed that, the mean value of Av.P (5.10ppm) measured under wheat-maize cropping system was significantly ($P<0.05$) different from wheat-bean (5.99ppm) and wheat-pea (5.78ppm) cropping system but had no significant variation from wheat-barley (5.06ppm) and wheat-wheat (5.01ppm).

Table 2. Cropping system effect on selected chemical properties (pH, OM, TN, Av.P) of the soils (α=0.05) and mean ± SEM.

Cropping system	pH (H_2O)	OM (%)	TN (%)	Av. P (ppm)
		Cropping system		
Wheat-wheat	7.11±0.03^{c}	3.54±0.18^{b}	0.20±0.01^{c}	5.01±0.27^{b}
Wheat-barley	7.19±0.08^{c}	3.56±0.28^{b}	0.21±0.01^{b}	5.06±0.45^{b}
Wheat-bean	7.52±0.24^{a}	4.23±0.70^{a}	0.24±0.03^{a}	5.99±0.92^{a}
Wheat-pea	7.51±0.22^{a}	4.21±0.48^{a}	0.24±0.03^{a}	5.78±0.71^{a}
Wheat-maize	7.28±0.13^{b}	3.67±0.44^{b}	0.21±0.02^{b}	5.10±0.63^{b}
LSD	0.085	0.4394	0.0021	0.663
P.V	***	***	***	**

N.B: pH, OM= Organic matter, TN= Total nitrogen, Av.P= Available phosphorus, P.V= P-value, C.V = Coefficient of variation, LSD = Least significant difference. Mean ± SEM (standard error mean). The same values of letters are non-significant. * shows P ≤0.05, **P≤0.01, ***P≤0.001 and **** P≤0.0001.

The lower Av.P content in the wheat-wheat cropping system was resulted, because of the smaller biomass contribution and low OM content, which released phosphorus during its mineralization. Likewise, Ailincai*et al.* (2008); Sarwar*et al*. (2008) discussed that, the pea-wheat-maize-sunflower-legumes cultivation land contains the higher value of mobile P while the lower was in wheat-maize, but wheat-continuous cropping had the medium P-value, because Av.P was controlled by soil pH, clay, calcareousness, and SOM. Moreover, in agreement with this finding, Allen and David (2006) explained that, the SOM hinders phosphorus sorption, thereby enhancing availability. Humic and organic acids often reduce phosphorus fixation through the formation of complexes with Fe^{3+}, Al^{3+}, and Ca^{2+}.

Table 3. Summary of household characteristics

HH characteristics	N	Min	Max	Mean	Percent
Age classes(no)	73	23	50	36	100
Family size (no)	73	2	10	5	100
Landholding size(ha)	73	0.75	12	4.99	100
Cultivated land	37	0.5	9.5	7.93	50.68
Grazing land	27	0.2	1	0.70	36.99
Degraded land	9	0.1	0.5	0.2	12.33
Education level	73				100
Illiterate	28	19	9	12	38.36
Read and write	20				27.40
Grade 1-8	16				21.92
Grade 9-12	9				12.33

Wealth status	73	100
Medium	33	45.21
Poor	22	30.14
Rich	18	24.66

N=Total number of respondent, Min=minimum, Max=maximum

Effect ofCropping SystemonSocioeconomic Of the Farmers

Household Characteristic (HH)

As it is indicated in Table 3, the majority of the sample households have large family size. The family sizes of the households were oscillated with the largest family size of 10 and the smallest one is 2. The average family size is about5. While, considering the age composition of the households, the average size is 36 which very much productive age class.The assessment analysis result also exhibited that of the total respondents;about 44.5% and 29.1% of the sampled population was found medium and poor wealth status respectively. Moreover, the landholding size per household ranged from a minimum of 0.75to a maximum of12. This makes the households'memberfamily to be unfit with the need to have land for their family. But due to sustainable utilization of the land, from the total land holding in the study area, degraded land (12.33%) takes the smallest percentage. This is because; the land-use system is maintained by leaving the land for grazing and cultivation.

Farmers cropping system

As the result indicates, about 47.95% of the land was under cultivation whereas 27.40% is mountain and shrub and 16.44% is grazing. Only 8.22% of the land was put under the forest. The practice of fallowing, crop rotation, and alley cropping were the dominant cropping system types which practiced by households. Assessment on cropping system shows that household preference to continuously cultivation of wheat (41.10%), fallowing (10.96%), alley cropping (17.81)% and crop rotation (30.14%). This is owing to the contribution of legume crop in alternation with cereal crop put organic input to the soil and increase productivity. Accordingly, Okpara and Igwe, (2014) state that soil nutrients were higher in velvet-bean-maize rotation than continuous maize, soybean-maize and cowpea-maize cropping system. This result indicates that, there was less displacement of cultivation land by fallowing as well as crop rotation system (Table 4). Majority of the farmerhas preferred cultivation without any break; this is because wheat cultivation consumes less labors and time for plowing, sowing and harvesting. Moreover, About 41.10% of the respondent prefer continues cultivation by wheat than another cropping system due to the conduciveness of the cultivation by machinery, whereas, 30.14% of the respondent prefer crop rotation due to scarcity of land for small holding and perform the activity by human power. There is a variation in the overall concentration of nutrientswith land use types (Awdenegest *et al.,* 2013).

Table 4. Major land use type, and cropping system.

Major land use types	Respondents	Percent's
Cultivation land	35	47.95
Grazing land	12	16.44
Forest land	6	8.22
Mountain and shrub land	20	27.40
Cropping system	73	100.00
Continues wheat	30	41.10
Crop rotation	22	30.14
Wheat-bean	8	10.96
Wheat-pea	5	6.85
Wheat-maize	3	4.11
Wheat-barley	3	4.11
Wheat-teff	2	2.74
Wheat-sorghum	1	1.37
Fallowing	8	10.96
Alley cropping	13	17.81

According to table 5, the main croptypes in the area were wheat, maize, barley, pea, bean and sorghum. Comparatively, the highest (42.47%) numbers of the respondents were cultivating wheat, while small numbers of respondents (2%) utilizing sorghum in their cropping system. This is due to its easiness and agro-ecological effectiveness of the crops. The survey result also shows about 61.64% households satisfied food security from income obtained from crop cultivation (Table 5) andof the total households 1.37% households prefer to sale fuel and charcoal in the case of emergency as compared to crops and livestock. Moreover, small holder farmers use,off-farm activity (8.22%) to the minimum of a month to a year to be self-sufficient in supporting the family.Whenever the soil gets a decline in productivity in the area, the community use different alternative to preserve soil fertility with the organic system then inorganic.

Table 5. Crop type, income source and soil fertility management system in study area

Crop type	73	100.00
Sorghum	2	2.74
Barley	13	17.81
Wheat	31	42.47
Peas	4	5.48
Beans	7	9.59
Teff	9	12.33
Maize	7	9.59
Income source of the HHs	73	100.00
Crop production	45	61.64
Animal husbandry	21	28.77
Off farm activity	6	8.22
Fuel and charcoal	1	1.37
Soil fertility management	73	100.00
Crop rotation	27	36.99
Manuring	21	28.77
Composting	2	2.74
Fallowing	20	27.40
Gay system	3	4.11

Therefore, the majority of the farmer use crop rotation (36.99%) for their cultivation land management while few households use compost (2.74%) as a management means. This shows a great tendency was to crop rotation due to the need of the farmers to produce a variety of crop to fill for their interest. Similarly, the value fertility indicator in 2-year wheat-pea cropping system has the higher value than 2-year wheat-fallow cropping system. These variations of values are resulted due to SOM content (Murphy *et al*., 2008). Moreover, Yahaya *et al.,* (2014) stated that, the mean values of exchangeable cations show that the fallow land is very rich in the basic elements than mono cropping and mixed cropping.

Effect of cropping systemto the livelihood of farmers

According to table 6,each community was fortuitous to crop production. However, the production level differs among households. Average annual production of household belongs to continues wheat, wheat-beans and wheat-peas, showed 2.15qt, 9.65qt and 6.69qt respectively. The assessment result showed that most households support their family from what they produce from crop rotation with average annual income of 27450(Birr/ha) while continues cropping is 9650 Birr/ha. Moreover, the average annual income satisfying the need of the HHs from crop rotation is higher (57.53%) in comparison with continues cropping (42.47%). This implying to cultivate crop in rotation because it satisfy each individual households need and get variety need satisfaction.Annual production crops without input were aimed to manage the soil fertility with organic system with low cost. This is because leguminous residue decomposed faster because of low C: N ratio increased the mineral N pool in soil (Mohammad *et al.,* 2012). Similarly, Dolan *et al*., (2006) stated that, crop productivity higher in the surface layer of no-tillage than cultivation land. This is due to the accumulation and turning down of crop residue to a cultivation land.

Table 6.Crops productivity per hectare at household level.

Activities	**N**	**Min**	**Max.**	**Mean**	**Total**	**%**
Average productivity per ha(without inputs) (Qt)	73					100
Continues wheat	7	2.00	2.43	2.15		9.59
Wheat-Beans	29	9.02	15.5	9.65		39.73
Wheat-Peas	14	6.33	8.59	6.69		19.18
Wheat-Barley	12	3.01	3.81	3.46		16.44
Wheat-maize	11	3.30	3.96	3.85		15.07
Average annual income from continues cropping (Birr/ha)	73	9020	15500	9650		100
Average annual income from crop rotation (Birr/ha)	73	25730	31190	27450		100
Average annual income satisfying the need of the HHs from continues cropping	73	10	21	14	31	42.47
Average annual income satisfying the need of the HHs from crop rotation		13	29	19	42	57.53

N=Total number of respondent, Min=minimum, Max=maximum

SUMMARY AND CONCLUSION

The cultivation systems were power the content and distribution of soil quality and socioeconomic properties of the farmers in the study area, due to the current crop management system. Among the farming system, the bulk density was higher in continuous cropping of wheat and wheat-barley than wheat-bean and wheat-pea cropping system. The value of silt in wheat-maize was different from the total cropping system apart from wheat-pea. Furthermore, the value of soil pH, SOM, and Av.P, in wheat-bean was different from wheat-wheat, wheat-barley, and wheat-maize except wheat-pea cropping system. The main cropping system in the study area continued cultivation (41.10%), crop rotation (30.14%), alley cropping (17.81%) and fallowing (10.96%). Average annual production of household belongs to continues wheat, wheat-beans and wheat-peas, showed 2.15qt, 9.65qt and 6.69qt respectively. The assessment result showed that most households support their family from what they produce from crop rotation with an average annual income of 27450 (Birr/ha) while continues cropping is 9650 Birr/ha. Moreover, the average annual income satisfying the need of the households from crop rotation is higher (57.53%) in comparison with continues cropping (42.47%). Hence, crop rotation was superior to continuous wheat cropping for the improvement of soil fertility in this study area. Thus, it preserves soil fertility through adequate organic residue left after harvest that keeps SOM at the optimum level and improves the livelihood of the farmers through increasing crop productivity. Therefore, it is recommended that; farmers in the study area have to use cereal with legume rotation system than wheat-wheat, wheat-maize and wheat-barleywhich enhance the loss of soil nutrients and secure modification of farmer's livelihoods.

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