

GSJ: Volume 8, Issue 3, March 2020, Online: ISSN 2320-9186

www.globalscientificjournal.com

The effect of Enset management practices on soil fertility(*Ensete ventricosunm*): The case of Enemorna Ener wereda, Gurage zone, SNNPR. Ethiopia

Author: Jemaludin Akmel kemal

Wolaita Sodo University po.Box 138, Wolaita Sodo, Ethiopia

ABSTRACT

The main objectives of the study were to evaluate the practice of enset management practices on soil fertility status of the enset farm plot with soil of the cereal farm and the grazing land use types in Enemorna Ener wereda SNNPR (Southern Nations, Nationalities and Peoples Region). Data were collected, in the year, 2017, through the use of field observation, interview, focus group discussion, questionnaires interview, PRA (participatory rural appraisal) and laboratory experimentation methods. Soil fertility parameters like total nitrogen, available phosphorus, and organic matter, soil pH, CEC and EC were evaluated to assess the differences in soil fertility caused by variations in the enset crop management systems against the cereal and grazing land use types in similar slope condition. Although, the long term sustainability of enset farming has been affected by population pressure, poor agronomic practices, decline in livestock numbers, the fertility status of the enset farm is in the better stand compared to cereal and grazing land use types. Significant differences (p<0.05) were observed among enset, cereal and grazing land use types in total nitrogen, and pH. Available phosphorus and cataion exchange capacity were also significantly different among the three land use types.

Keywords: Enset management, Soil fertility, sustainability

1. INTRODUCTION

Enset (*Ensete ventricosunm*) is a large fibrous tree like monocot which closely resembles the banana plant and it is sometimes referred as the "false banana". It is an important source of food and fiber for about 20 million people in south and south western part of Ethiopia (Merga et al., 2019);(Yemataw et al., 2014)). Since enset spans several different ethnic groups and agro-ecological zones, production techniques, plantation management and processing procedures vary greatly and its relation to household food and livelihood security in south and south western Ethiopia is characterized by diverse farming practice (Admasu, 2002). The main food types obtained from enset are the fermented mixture locally known as "*kocho*" plant of the starchy liquid called "*bulla* "and and the freshly cooked corm which is locally called "*amicho*". It is cultivated in subsistence farming system with little connection of the producer with the market. Low prices affect the amount of production and mainly for personal use (Zippel and Alemu , 1995);(Nurfeta et al., 2008).

Livestock play important role in maintaining soil fertility, providing milk and meat and as a source of cash in time of need. Farmers grow their Enset crops closet to their houses for easier fertilization with low dung and house hold refuse labor and grazing lands (Steven, 1997); (Benin et al., 2003), (Funte et.al., 2010). Observations in areas that have planted with enset for many years suggested that soils have been improved by the long-term application of manure (Funte et.al., 2010). However, enset based livelihood system faced some fundamental structural weakness, including low protein content, bacterial wilt, continual harvesting, huge demand for manure to maintain vigorous growth, the continual cultivation of the crop in the same location that threatened sustainability on enset based farming systems (Alemu, 1995).

Preliminary research made by (Funte et.al., 2010) strongly suggested that there has been a serious decline in the numbers of livestock held by farmers on a household basis. Inadequate feed supply, both in terms of quantity and quality, is the major constraint affecting livestock production in Ethiopia (Legesse., 2008). The cycle of increasing impoverishment of the livestock component in this mixed crop/livestock system is a serious concern. The multiple purposes of livestock cannot be replaced by fertilizers, and the sustainability of the enset cultivation system is a result of the tight articulation of the crop and livestock production systems (Funte et.al., 2010), (Garedew and Ayiza., 2018)

Since enset and enset-based systems have received little study attention relative to many other crops and systems, the research door is wide open. Much information considered to be base- line for other crops has not been collected with respect to enset. For example, almost little research has been conducted on the various agronomic production system and soil nutrient complication (Funte et.al., 2010), (Steven, 1997); hence, the optimal use of scarce nutrient resources is vital, yet there are no recommendations on optimal nutrient management for enset gardens available to farmers (Amde and Taboge., 2007).

Research and development initiatives can contribute towards this goal through generating use full, site specific practices of enset production and management activities, challenges on the management and use of the system, and identifying alternative sustainable production and management system taking in to consideration the local condition. This calls for concern on future sustainable production, and management system (Steven, 1997).

Despite its multiple uses for millions of people, the enset farming system is affected by the rapid expansion of cereal farming system against the long term sustainable enset based farming system of the area (Admasu, 2002). Hence the cereal farming system breaks the strong inherent linkage of the enset and livestock production system of the enset based livelihood system. The available open communal grazing lands and pastures were changed for cereal production at the expense of a long-term, sustainable food supply, with minimum off-farm input of the enset system (Admasu, 2002); (Funte et.al., 2010). Enset based agriculture and the underlying problem in Ethiopia have not yet comprehensively studied, particularly with respect to the nature of soil fertility patterns and complication of soil nutrients (Amde and Taboge., 2007). However, some researchers have been conducted on enset- based farming system in Sidama zone and some extent to Wolayta and Gamogofa zone (Admasu, 2002); (Dougherty, 2002), (Diro and Amede., 2005). Although (Westphal, 1975) identified that Gurages were one of the ethnic groups that depend on enset as their main staples; there were only few studies conducted on the enset based farming system with respect to fertility comparison with cereal and grazing land use types. Hence, researches conducted in other parts of the country may not show the real problems in the study area due to great variation in cultural, physical and socio-economic conditions among the various ethnic groups in enset growing regions. Therefore, this study is designed to explore the effect enset farming system on soil fertility status as compared with cereal and grazing land use types

2. MATER IALS AND METHEDS

2.1. General Description of the Study Area

2.1.1. Location

The study was conducted in the southwestern part of Sebat Bet Gurage (The term Sebat Bet or *'Seven Houses'* is also a common term, refers to a confederation of seven Western Gurage tribes) which is situated in the SNNPR Regional state, in Gurage Zone in EnemornaEner wereda Specifically, the study area is located between 7°34' and 8°13'North latitude and between 37° 36' and 38° 00' East longitude. approximate distance of 211 km south west of Addis Ababa and 42 km south west of Welkite (zonal capital of Gurage). The wereda is bordered with Endegagn wereda and Hadiya zone in the South, Gumer wereda in the East, Yem special wereda in the West and Cheha wereda and Oromiya region in the North..



Figure 1.Location of the study area

2.1.2. Topography

The wereda has an altitudinal range from 1500 to 4000 masl and covers an area of about 107,584 hectars and classified as weinadega agro climatic zone, : Dega (altitude 2500–4000 meters above sea level) estimated to account for 28.1% of the land area and habitated by 20–25% of the population, weinadega (altitude 1800–2400 meters above sea level), which accounts for 64.9% of the land area and settled by 65–70% of the population, and kolla (altitude below

1500 meters above sea level), which accounts for 7% of the land area and settled by 3–5% of the population (Agricultural Bureau of Guraghe zone., 2015)

2.1.3. Soil distribution and geology

The dominant soil types based on color is found to be Vertisols, Nitosols, Cambisols and sandy soil accordingly they constitutes 50, 31, 15 and 3% respectively. While (Muluneh, 2003) reported that soil color in the enset growing areas basically sebat bet Gurage land ranges from brown and black to red types.

(Muluneh, 2003) noted that, west Gurage land with mountainous characteristics in the north and north-east and a group of mountains which are part of three Gurage mountains runs from Acheber in the north east of the region through Wellene, Muher, Eza, Cheha, Geto and joins with mount Astere in EnemornaEner wereda which finally connect the low mountain group of Hadya and Kembata.

2.1.4. Climate and vegetation

Rain fall distribution is characterized by spring rain from March to May and summer rain from June to September. However, the wereda receives an average rainfall between 800 to 1200 per annum, the average amount of rainfall within the given area for 2000 to 2012 years at Emdbire weather station (located about 37 km from the study area) is about 870 mm. The maximum and minimum rainfall recorded is 166.4mm and 8.7mm in August and February, respectively. The annual mean of temperature of the year 2000 to 2012 was about 18.7°c and the maximum and minimum mean temperature about 27.2 and 11°c respectively.

Vegetation grown in the area found to be both plantation and natural in type. From plantation forest the lion share is covered by eucalyptus. Eucalyptus is planted along river courses, near wetlands, even on farm yards, due to its economic feasibility. The attitude of the local people is changing rapidly in favor of this species. On the other hand indigenous vegetations are highly degraded and found in pocket areas. Most of the natural vegetation is represented by small patches of remnant Junipers forests in inaccessible sites and around the church yards (Agricultural Bureau of Guraghe zone., 2015); however, there is a nationwide movement in the country in planting trees in almost all corners of the country. It is also true that there is a start to plant tree planting like *Junipers procera* and *Hagenia abyssinica* and other highland and low land trees.

2.2. Data collection and analysis

2.2.1. Source and method of data collection

The data were acquired from primary and secondary sources. The Primary data were collected through soil sample collection, field observation, interview, focus group discussion, household interview and laboratory experimentation. The secondary data were acquired from government documents, published and unpublished material from different institutions and results. The data collection were guided by structured and semi structured questionnaires prepared in the way that they allow flexibility of the interview as well as including problems which are assessed from PRA methods enables to obtain reliable information focusing on the real issues. The questioners were both open ended (to permit free responses, get in depth information and allow probing new and unclear issues) and closed ended questions (which enable to focus on issues that are relevant to the study and save time). Then data collections from local communities were carried out employing personal interview method. The information collected includes data from local communities on the practices of enset management systems from production to harvesting stage to support the laboratory comparison.

2.2.3. Sampling frame, method of selection and distribution

Basically it is difficult to take samples from all the wereda reaching to all kebele Peasant administrations due to financial and time constraints. Thus, it was designed to take sample households classifying the wereda in to three stratified agro-climatic zones purposefully. Then one kebele peasant administration was selected to carry out the study from the respective agro climatic areas. Thus, accordingly, three Kebele Peasant Administration (KPA) namely, Weira, Gaharad, and Awid KPA were selected in which represented kola, wienadega and dega agro climatic zones, respectively. Sample households determined based on table results recommended for most researches and social science (Watson., 2001). Accordingly the sample households determined by taking the total household heads in the range of 2000 assuming a 95% confidence level, variability of the degree estimated as 30% the required sample households in the range found to be 158, this is more than 8% of the total household heads of the sampled kebeles. Then sample households were drawn randomly from each KPA proportional to the population in each KPA. The following table also shows the total number of household head farmers and sample distribution with proportional to the total population. Then, household interviews were conducted by the researcher and trained enumerators.

Sample kebele	Total	Total Total house hold size	
	population		distribution
Weira	2,841	523	48
Gaharad	3,561	566	52
Awid	4317	632	58
Total	1,0719	1,721	158

Table.2.1.Sampling distribution of the selected kebeles

2.2.4. Method of data analysis

Different statistical and descriptive analysis methods were employed to summarize both the quantitative and qualitative data. Hence, the data collected were analyzed to evaluate the management activities, to identify the key factors affecting the management of enset. The analyses were completed through summarizing questioners, using statistical package for social science (SPSS) and other descriptive approaches depending on the type and characteristics of the data collected. The quantitative demographic and socio-economic data were analyzed using the frequency and descriptive analysis of "SPSS" computer packages version 16.0. So as to summarize the data percentage, graphs, tables, averages, and rages were employed.

2.3. Experimental procedure

This work is carried out on the farmer's field under similar farm slop conditions to evaluate the fertility status of the enset farm plot with soil of the cereal farm and the grazing land use types. Soil fertility parameters such as total nitrogen, available phosphorus, organic matter, soil pH, CEC and EC were determined to evaluate the status of soil fertility caused by variations in the management systems. Hence the assumption was designed in the manner that, variation in soil fertility may mainly be caused by due to variations in the management practices applied to the respective land use types.

Regarding to agro climatic zones, the sample soils were collected from the weinadega zone. Since, the production of enset and cereal farming is believed to be carried out in greater scale. Soil samples were taken from farms under, Enset, cereal and grazing in similar slopes classifying the farm in to three major parts. Named as, farm near to the homestead; in the middle farm zone and farm in the lower parts or farm in the outfields from the homestead. Therefore, samples were drawn from each land use types across three different farm levels in order to have three replications following the down cultivations. Accordingly samples from near to the homestead,

773

in the middle, and in the lower farm levels were drawn at a depth of 0-30 cm by auger. All the samples were bulked in order to have one composite sample matched with the respective land use types following the contours. This was done purposefully for ease management of the data and to obtain average values that represents the fertility status of the respective land use types in comparison cross the various farm levels.

After drying samples were ground in mortar and pestle and sieved through a 2 mm sieve. Therefore a total of 26 augers were carried out and prepared 11 aggregate samples that represent the various farm levels from each land use types. Moreover, from each land use types a total of nine samples, were drawn randomly following the contour from enset and cereal farm lands (in order to obtain representative average value) as one aggregate sample representing a specific land use type as a whole from all levels. This was done because to compare the nutrient status of the respective farms as a whole other than farm at the various levels. Hence, the sample represents soils of a specific land use types in aggregates from all levels. After this, soil chemical analyses were made for the respect fertility parameters accordingly. The pH of the soil was measured in the supernatant suspension of a 1:2.5 soil: liquid mixture. (Reeuwijk, 2002). Nitrogen analysis was done using the Kjeldahl method as explained in (Taye and Sahlemedhin., 2000). Available phosphorus was determined by Olsen methods (Olsen SR, 1982) as explained in (Taye and Sahlemedhin., 2000).SOC is determined following the wet digestion method used by Walkley and Black (Taye and Sahlemedhin., 2000), (Reeuwijk, 1992). Organic matter was computed from organic carbon content by multiplying each value of OC by 1.724.The ammonium acetate extraction method was applied for CEC determination of the soil (Taye and Sahlemedhin., 2000)).

3. RESULT AND DISCUSSION

3.1. The farming system and land use patterns

The survey indicates, mixed type of farming system has been practiced in the area. None of the sampled farmers solely carried out crop production or livestock raring. Farmers grow both annual and perennial crops .They practice a sedentary life based on agriculture. Ensete is their main staple food crop. Cash crops like Chat and coffee also dominated in the weinadega and lower portion of the wereda while annual crops especially barley more dominated in the dega parts. However, in all parts of the wereda enset is the most staple food crop it is grown as a pure stand, or can be intercropped with coffee and other food crops near the homestead (Table 3.1).

Crop	Awid	Тор	% of	Gaharad	Тор	% of	Weyra	Тор	% of
cult.	(dega)	ranked	distributio	(weinadega)	ranked	distribution	(kola)	ranked	distribution
Enset	Х	1	100	Х	1	100	Х	1	100
Chat	Х		rare	Х	2	100	Х	3	100
Coffee	Х	-	100	Х	3	100	Х	2	100
Maize	Х	-	rare	Х		rare	Х	5	100
Wheat	Х	3	100	Х	4	rare	-		no
Barley	Х	2	100	Х		mid	-		no
potato	Х	4	100	Х		mid	-		no
Teff	Х	-	no	Х	5	mid	Х	4	100
Taro	-	-	no	-		rare	Х		100
Banana	-	-		Х		rare	Х		rare
Cabbage	-	-	100	Х		mid	-		mid
Bean	Х	5	no	Х		mid	Х		mid
Avocado	Х			Х		mid	Х		mid
Mango	-	-		-		no	Х		
	-								

Table 3.1.Crop grown in the various agro climatological zone of the area

Where: Rare the crop cultivated by 5-25 % of the respondents and mid the crop cultivated by at least >25% of the respondents but not fully carried out by all farmers.

3.2. Reasons for cultivation

Farmers in the area cultivated enset for various purposes. The result indicates that 76.4 % of the respondents said that, they prefer it because it has the ability to tolerate unexpected drought whereby other food crops cannot exist in the period. Farmers strongly argued that, drought tolerance ability of enset attracts the majority of farmers in the past historic periods as well the current generations both for human and livestock feed sources in the area (Table 4.6). While 51.9% and 48.7% of the respondents argued that they cultivate it because it has no cost for chemical fertilizer in process of production and by its unique ability to be harvested at any stage of growth and at any time of a year, respectively. Farmers report that enset is said to be a life giving plant in the area in the harsh drought condition both for human and livestock feeds. On the other hand, 48.5% of them are attracted by its ability to provide high yield when compared to other food crops including even root and tuber crops cultivated in the area. Some others still mention its historical extension as a cultural practice in the area and due to its ability to increase soil fertility raised from the farming system itself made them confide to cultivate enset as a staple food crop in the area (Table 3.2)

	Household heads in different agro climatic zones						
Reason for cultivation	Awid (dega)	Gaharad (weinadega)	Weyra (kola)	Total			
It provides high yield	Count	28	23	21	72		
	%	48.3	44.2	43.8	45.6		
It has high drought tolerance	Count	43	41	36	120		
ability	%	74.1	80.4	75.0	76.4		
It can be harvested any time	count	23	26	28	77		
	%	39.7	50.0	58.3	48.7		
	count	34	23	25	82		
No cost for fertilizer	%	58.6	44.2	52.1	51.9		
	count	9	3	6	18		
Others	%	15.5	5.8	12.5	11.4		

Table 3.2.Reason for cultivation by percent of household distribution

3.3. Livestock possession and relation with enset farming

The livestock holding capacity of the areas is expressed in terms of Tropical Livestock Unit (TLU) which is 250 kg live mass (Jemimah et al., 2011). The survey indicates that, 63.3% of the respondents fall under in the value of <5.00 TLU and 36.7% of them fall under in the range of >5.000TLU. The proportion of farmers possesses large number of livestock found in the weinadega, and kola zone. Accordingly, they constitute 50%, and 43.8% within the agro climatic zones respectively (Table 3.3)

Number of live percent of resp	estock holding in TLU pondents	by		Agro-climatic zones		
			Awid (dega)	Gaharad (weinadega)	Weyra (kola)	Total
Number of	<3.000 TLU	Count	28	18	19	65
livestock		%	48.3	34.6	39.6	41.1
	3.000 - 5.000TLU	Count	19	8	8	35
		%	32.8	15.4	16.7	22.2
	>5.000TLU	Count	11	26	21	58
		%	19.0	50.0	43.8	36.7
Total		Count	58	52	48	158
		%	100.0	100.0	100.0	100.0

Table 3.3.Number of livestock holding in TLU in different agro climatic zone

The response of farmers on the reason for rearing livestock shows that, 89.3% and 85.7% are keeping them for the purpose of manure and milk production, respectively (Table 4.14). While, 31.3% of them responded for the purposes of farming, transportation, or earning income in the

system. Some others also reported that they reared livestock they are considered as one of the social prestige in the area (Table 3.3).

Table 3.4. Household responses by reason for rearing livestock

3.4. The Fertility Statues of the Soil

The various management efforts they applied over years created a clear soil fertility gradient in the enset and other land use types. There was a change in the amount of the soil fertility

Reason for rearing livestock		Awid	Gaharad	Weyra	Total
		(Dega)	(Weinadega)	(Kola)	
For their manure	Count	52	46	43	142
	%	89.7	88.5	89.6	89.9
For milk production	Count	47	49	39	135
For farming purpose	%	81.0	94.2	81.3	85.4
	Count	12	8	9	29
	%	20.7	15.4	18.8	18.4
For social security in	Count	8	4	7	21
the time of danger	%	13.8	7.7	14.6	13.3
They are assign of	Count	4	2	1	7
prestige	%	6.9	3.8	2.1	4.4

parameter (total nitrogen, soil pH,) observed between enset, cereal and grazing land use types (Appendix Table, 1 and 2). Though, available phosphorus, cataion exchange capacity and the amount of organic carbon found to be higher near the homestead, there was no significant change observed across the various land use types in comparison. But there was a general decline in the amount status for the cereal and grazing land use types. Sandy loams to loamy sand type of textural classes were found in the enset and cereal farm plots. While loamy sand type of textural classes were observed in the grazing land and the aggregated case of grazing and cereal land use types. This pattern of textural arrangement may be the result of selective transportation of clay materials to the down farm plot following the gradual declining of slope line

Farm levels	РН	EC	TN	%	CEC	Available P	Soil
	(H2O)		%	OC		(ppm)	texture
		(ms)			$(\operatorname{cmol}_{c}^{kg-1})$	mg/kg soil	
					soil		
Enset near the homestead	6.5	0.1	0.406	21.2	36.2	12.54	Sandy loam
Enset in the middle farm	6.4	0.4	0.476	1.794	35.4	4.78	Sandy loam
plot							
Enset in the lower farm plot	5.7	0.4	0.434	5.304	28.4	1.56	Sandy loam
Cereal in the top level	5	0.1	0.35	3.237	28.4	1.54	Sandy loam
Cereal in the middle level	4.9	0.1	0.35	3.925	26.4	1.32	Sandy loam
Cereal in the lower level	5.2	0.1	0.308	4.524	31.2	0.7	Sandy loam
Grazing land in the top	5.1	0.3	0.322	2.886	20.4	0.66	Sandy loam
Grazing land in the middle	5	0.1	0.392	3.861	31	0.78	Loam Sand
level							
Grazing lower	5.2	0.1	0.35	3.939	27.4	0.5	Loam Sand
Cereal mixed in all level	4.9	0.1	0.294	3.744	25.8	1.38	Loam Sand
Enset farm mixed in all level	6.5	0.2	0.462	4.797	31.8	6.42	Sandy loam

Table 3.5. Laboratory result for the various land use types across the various farm level

3.4.1Soil total nitrogen status

As shown Table 3.6, the distribution of total Nitrogen is greatly varying across the various land use types. The change was significant (p<0.05) levels of degree of significance towards the cereal and grazing land use types (Table 3.6) while no significant change was observed between the cereal and grazing land use types. This change resulted from the management aspects they apply for the respective land use types and the sustainability of the farming system in general. Farmers regularly use manure and house waste as a basic source of fertilizer for the enset farm plot and inorganic fertilizers for the cereal farm plot (See also table 3.5)

Table 3.6. Mean comparison in the amount of total nitrogen statues among enset, cereal and grazing land use types.

Treatment	Mean TTN	Mean pH
Enset	0.44 a	6.20 a
Cereal	0.34 b	5.03 b
Grazing	0.35 b	5.10 b

Means followed by the same letter in a column are not significantly differ at (P<0.05)

However, the N concentration near to the homestead was found to be lower in the case of enset farm plot when compared with the middle and lower farm (far from the homesteads) plots .This is may be because of the area near the homestead commonly allocated for sucker production by which the area is vulnerable for erosive rainfall and exposed to direct sunrays at least 3to5 months, owing to less canopy coverage of the farm in at the beginning of the rainy season and from the time of land preparation for propagation to until the emergence of suckers, makes the soil more vulnerable to leaching and out ward loss of N compared to the high canopy coverage of the middle and the out ward lower farm zone of the enset. Moreover as the researcher personal observation, the general configuration of the farm land of the area is declines in slope level from the homesteads to the out ward lower farm zone. Hence, N was more susceptible to leaching and down ward erosion of the nutrients as compared to the middle and lower farm plots. A minimal change in the amount of N concentration was explained by change in slope level from the homestead to down to the out ward lower farm plot, resulted in a small shift in the amount of N concentration in the various farm levels. The result agreed with the explanation of (Funte et.al., 2010) who noted that leaching losses of plant nutrients, particularly nitrogen, may be reduced by

enset as compared to annual crops. This should be possible because of the continuous soil occupation by the roots. At the beginning of the rainy season and after maturation, annual crops have little root proliferation and little effect on nutrient leaching. For established enset, roots already proliferate the soil profile at the beginning of the rainy season. The large mass of the plant should serve as a storage reserve, reducing the availability of the nutrients in the soil by leaching.

3.4.2. Soil Available phosphorus content (ppm)

The result indicated that the mean amount of phosphors in enset farm plot was higher than the cereal and grazing land use types. The result showed that the amount of phosphors in cereal and grazing land use types were only 37.1 and 9.7% of the enset farm plot respectively (Table 3.7). Moreover, Soil phosphorus content was higher in the homesteads and successively decline to the lower farm level. The P content of the cereal farm in the top level (farm land situated in similar contour line west to east from the homestead) and enset in the lower farm level (the most lower out ward farm from the homestead) level was only 12% of the P content of the homestead in the enset farm.(see also table 3.5). Further the result indicated that the N concentration of the outfield was adequate, but P was the major nutrient in deficit in the outfield followed by potassium.

Table 3.7. Amount	of mean OC,	CEC and	available	phosphors	among	enset	cereal	and	grazing
land use types									

Land use types	Mean %OC	Mean CEC cmol c ^{kg} soils	Mean Available Phosphors (ppm) /mg/kg soil
Enset	9.4	33.3	6.2
Cereal	3.9	28.7	2.3
Grazing	3.7	26.3	0.6



Figure 3.1 Available phosphorus across the various land use and farm levels

3.4.4. Soil organic matter content (%)

Similarly, the mean amount of OC in enset was higher than the cereal and grazing land use types. The result showed that the amount of OC in cereal and grazing land use types were only 41.5 and 39.4 % of the enset farm plot respectively (Table 3.5 and fig 3.2). Moreover, there was a decrease in organic matter with distance from the homestead in the enset farm plot. The amount of OC in the lower portion of the enset and cereal farm is about 20% and 15% of the homestead in the enset farm, respectively (Table 3.5). But, the amount of organic matter concentration in the middle farm plot was lower than with that of the lower portions. This may be due to change in the declining of slope levels from the homestead to the far out lower zone of enset farm resulted

in continual removal and accumulation of soil organic carbon from the high sloppy area of the middle zone to the lower out field of enset farm.

However, the organic matter concentration of the cereal farm plot and the grazing land use type increased down to the lower zone (farm lands the far out filed from the homestead), as one move from the top farm (farm near the homestead). From the ongoing explanation, the gradual decline of OC in the middle of enset farm and in the other land use types resulted from change in slope towards the down cultivation (from the homestead ,down to the outfield of lower zone), since there is a small relocation of the above nutrients towards the lower zone because of surface erosion. Though, there is change in the amount OC observed in all land use types, the change is interrupted in the case of enset and the process is continuing increased for the other land use types. This implies that erosion is minimal in the case of enset farm and relatively higher in the other land use types. Moreover, farmers frequently apply manure to the enset farm than cereal land use types in the system. The above results were agreed with the finding of (Diro and Amede., 2005), who noted that the major plant nutrient in the enset farm shown a declining trend from the homestead to the out fields. They reported that organic matter in the outfield was only about 40% of the homestead. They farther noted that the NPK content of the plant tissues grown in the outfield was significantly higher, in some case up to 150% than those planted in homestead and they concluded that growth reduction in the outfield was not directly related to NPK deficiency, but it could have been caused by off-season moisture stress in the outfields, manifested by low soil organic matter content.



Figure 3.2. Mean organic matters across the various land use types

3.4.5 Cataion exchange capacity

As shown in figure 3.3 the mean Cation exchange capacity was differing among enset farm cereal and grazing land use types by which the former one expected to be received special treatment in the system. On the other hand, there was a general decline of cataion exchange capacity towards the cereal and grazing and use types as compared with the enset farm system, although no significant variations were observed among land use types.

The overall assessment showed that, the higher CEC was recorded under enset farm while the lower under the grazing land (Table 3.5). Accordingly, the highest and the lowest mean values were 33.3 and 26.2 cmol $_{c}$ kg soils in the enset and grazing land respectively. But across the various farm levels the higher value was 36.2 for enset farm plot in the homestead and the lowest

20.4 in the top farm of the grazing land. Once again, the amount found to be higher near to the homesteads than the middle and the lower out field of the enset farm plot. On the other hand, the values are higher in the lower outfield than close to the homestead (the top farm) for the rest of land use types following the down slope (Table 3.5)

The above conditions are partially explained by two possible situations. In the first case the various ingredients or nutrients that affect the CEC of the soil relocated towards the down zone due to surface erosion a raised from the farming system itself. This indicated that in the case of cereal and grazing land use types, the farmer's management level and the sustainability of the farming system to minimize surface erosion and improving the overall fertility status of the soil is low. While in the case of enset farm land use types, the effect of surface erosion was minimal and it is not exceeding the second farm level in which the enset plants effectively checks surface erosion. Moreover, the frequent use of organic fertilizer contributes a lot for the occurrence of such soil fertility variations under comparison, observed between the various land use types. Hence, farmers use manure frequently for the enset farm and apply periodic management cares timely, as it was close to the homestead and the homestead fields being rich in major plants nutrients. Farmers report showed that, due to shortage of manure they were forced to restrict manure application close to the homesteads than the far out farm plots. This agreed with the idea of (Diro and Amede., 2005) who reported that the limited transfer of manure to the outfield in the Enset systems of Areka was as because of the limited manure available. Households, with no/few animals, lack access to manure as it become an increasingly valuable resource, and not even keen ship or local market can guarantee a supply of it (Eyasu, 2000).

On the one hand the intercropping system of the enset farm also contributes positively for the better fertility status of the enset farm as compared with the mono cropping system of the cereal and the untreated of grazing land use types.

The above all conditions showed that, although, enset cultivated for a long period of time in the same plot of lands, still the fertility status of the soil and the sustainability of the farming system found to be stands in a better condition than the other land use types in comparison





Differences in the amount of organic matter concentration and other soil nutrient status under comparison in the different land use types resulted in effects in soil pH status between the various land use types and across the various farm levels within the specific land use type. Regarding to the general rating, according to (Metson, 1961) the soil pH ranges from strongly acidic in the crop land to slightly acidic in the enset farm plot; accordingly the value is reducing from 6.50 to 4.9 from the homestead in the enset farm to the middle zone of the crop farm (Table 3.5). Similarly soil pH found to be declining away from the homestead in the enset farm plot and for the other land use types progressively. In the enset farm the highest value is 6.5 and the lowest is 5.7 near to the homestead and distant farm from home respectively. There is no major soil pH change within the various farm levels of enset. However when it is compared to the three land use types there is a significant mean variation (p<0.05) observed in the amount of soil pH changes towards the cereal and grazing land use types from the enset farm plot (Table 3.6) But the change is not significant in the case of cereal and grazing land use types in comparison During group discussion farmers reported that for cereal production they were used inorganic fertilizer and manure for enset production. Therefore in cereal farming system doe to shortage of manure and periodic loose occupation of the soil with crop/plant root made the system vulnerable for erosive erosion and leaching process. Moreover, the researcher believed that the mono use of inorganic fertilizer and the method and application they were used resulted in a low

pH status. The highest pH value (6.5) was recorded in the homesteads of enset farm and the lowest soil pH (4.9) in the middle of cereal farm. This variation is mainly resulted from change in the management system they were adopted, like in terms of fertilizer use and amendment, the cropping pattern in the system resulted in change in soil pH in the respective land use types (Figure 3.4). The soil pH is mainly affected by organic matter content of the soil and other nutrients concentration in the system. Because of the frequent use of animal manure and management variations, the result indicates the enset farm found to be in a better pH status which is close to neutral. As a result acidity found to be lower in the enset farm than the other land use types.



Figure 3.4.Mean pH across the various land use types

Conclusion

The survey result interestingly pointed out that the fertility status of the enset farm was found to be in the better stands, because of the management practices tied with the inherent sustainable system of enset farming, as compared with the cereal and grazing land use types.

Recommendations

From the study result the following recommendations can be suggested to keep the sustainability of farmig system Attention should be given to improve animal health status and mounting veterinary services at the farmers' level, improve pastures and increase the quality and types of forage resources available in the area. Adopting and implementing effective family planning programs to maintain optimum house hold family size in order to minimize the effect of population pressure on the long term sustainability of enset farming system is required. Introducing and expanding other food crops which are friendly growing with enset crops taking in to account the nutrient status of the enset farm in order to supply additional food values for the local community and minimizing immature enset consumption in households is essential. Adopt and implement different conservation measures increasing the soil organic matter content of the middle and far out lower fields of the enset farm plot and reduce the loss of moisture through mulching, low quality crop residues, tree litters, diversifying enset clones and the like.

Referances

- Admasu. 2002. On Indigenous Production .Genetic Diversity and Crop Ecology (*Enset-ventricosum*), PhD thesis Wogagin University.2002.
- Agricultural Bureau of Guraghe zone. 2015. The Basic Information of Agricultural Development of the zone. Department of Agricultural Extension. Guraghe zone. Wolkite, Ethiopia. pp.58. 2015.
- Alemu K., and Zippel, K. 1995. A Field Guide to Enset Landraces of North Omo, Ethiopia. FRP Technical Pamphlet No 9. Addis Ababa: FARM Africa(http://www.africa ufa.edu/sq/vs./v6i/as.htm).1995
- Amede T. and Diro M. 2005. Optimizing soil fertility gradients in the Enset (*Ensete ventricosum*) systems of the Ethiopian highlands: Trade-offs and local innovations. In Bationo et al. (eds) Improving Human Welfare and Environmental Conservation by Empowering Farmers to Combat Soil Fertility Degradation. African Highlands Initiative (AHI), Working Papers No. 15, 1-10 p.2005
- Asnakech Weldetensay .1997. The Ecological and Production of (*Enset-ventricosum*) in Ethiopia. Doctorial thesis Department of Soil Science Swedish University of Agriculture Science Uppsala. 1997
- Benin et al. 2003. Benin S., Ehui S. and Pender J. 2003. Policies for Llivestock Development in the Ethiopian Highlands. Environment, Development and Sustainability. 5: 491-510. 2003.

- Dougherty M., 2002. Gendered Scripts and Declining Soil Fertility in Southern Ethiopia African Studies Quarterly 6, no.1: http://web.africa.ufl.edu/asq/v6/v6i1a5.htm
- Elias, Eyasu .2000.Soil enrichment and deletion in Southern Ethiopia. Pp 65-82. In: Hillhorst, T. and Muchena, F. (editors). Nutrients on the move: Soil fertility dynamics in African farming systems. 146p.2000
- FAO (Food and Agriculture Organization). 1995. Energy and Protein Requirements. Report of Joint Expert Committee. Rome: FAO 1995.
- Funte, S.; Negesse, T.; Legesse . 2010. Feed Resources and Their Management Systems in Ethiopian Highlands: The case of Umbulo Wacho Watershed in Southern Ethiopia Tropical and Subtropical Agro ecosystems, Vol. 12, Núm. 1, enero-abril, 2010, pp. 47-56 Universidad Autónoma de Yucatán México 2010
- Garedew, B., and Ayiza, A. 2018. Major Constraints of Enset (*Ensete ventricosum*) Production and Management in Masha District, Southwest Ethiopia. International Journal of Agricultural Research, 13, 87-94. http://doi.org/10.3923/ijar.2018.87.94, 2018.
- Jemimah N., Jane P., Nancy J., Isabelle B., Pamela P., Zaibet L. and Samuel M. 2011.Genders, Livestock and Livelihood Indicators. International Livestock Research. Institutes ILRI October, 2011 pp"10-13.2011
- Legesse G. 2008. Productive and Economic Performance of Small Ruminants in Two Production Systems of the Highlands of Ethiopia. PhD Dissertation, University of Hohenheim, Stuttgart, German. 2008.
- Merga, I. F., Tripathi, L., Hvoslef-Eide, A. K., and Gebre, E.2019: Application of genetic engineering for control of bacterial wilt disease of enset, Ethiopia's sustainability crop. Frontiers in Plant 560 Science, 10, 1-8, https://doi.org/10.3389/fpls.2019.00133, 2019.2019.
- Metson reven.E.W.1961. Standardization of soil nutrient rating. Soil Sci. Soc. Am. J. 51:599-604. 1961.
- Muluneh Weldetsadik .2003.Impact of Poppulation Pressure on Landuse /Land Cover

Change, AgriculturalSsystem and Income Diversification in West Gurageland,

Ethioppia Department of Geography, Faculty of Social science and Technology

Management, Norwegian University of Science and Technology,

NTNU, Trondohein.pp. 359.2003

Nurfeta, A., Tolera, A., Eik, L. O., and Sundstøl, F.2008: Yield and mineral content of ten enset (Ensete ventricosum) varieties. Tropical Animal Health and Production, 40, 299-309. https://doi.org/10.1007/s11250-007-9095-0, 2008.

- Olsen SR, Sommers LE. 1982. Phosphorus. In A.L. Page, R.H. Miller, & D.R. Keeny (Eds.), Method of Soil Analysis. II. Chemical and Microbiological Properties, Agronomic Monograph P. 9 (2nd edn). SSSA, Madison, Wisconsin.PMid:6919581 1982.
- Van Riemsdijk, van der W.H. 1992. Protocol phosphate saturated soils. Department of soil science and plant nutrition, Agricultural University, Wageningen, The Netherlands.1992
- Van Riemsdijk, van der W.H.. 2002. Role of Eh and pH on phosphorus geochemistry in sediments of Lake Okeechobee. Soil Sci. Soc. Am. J. 48:541-544.2002.
- Watson, Jeff .2001. How to Determine a Sample Size: Tipsheet #60, University Park, PA: Penn State Cooperative Extension.2001
- SNNPR. 1997. Agricultural Office of SNNPR.1997.Cultivation of Enset Plant, (Amharic version), extension manual Awasa. 1997.
- Steven. 1997. Steven A. Brandt, Anita Spring, Clifton Hiebsch, J. Terrence McCabe, Endale Tabogie, Mulugeta Diro, Gizachew Wolde-Michael, Gebre Yntiso, Masayoshi Shigeta, and Shiferaw Tesfaye.1997. "Tree Against Hunger" Enset-Based Agricultural Systems in Ethiopia American Association for the Advancement of Science With Awassa Agricultural Research Center Kyoto University Center for African Area Studies And University of Florida1997.
- Sahlemedhin Serstu and Taye Bekele. 2000. Procedures for soil and plant analysis: Technical P. 74. National Soil Research Center and Ethiopian Agricultural Research Organization, Addis Ababa, Ethiopia.2000.
- Watson, Jeff .2001. How to Determine a Sample Size: Tipsheet #60, University Park, PA: Penn State Cooperative Extension2001.
- Westphal. 1975. Westphal, E. 1975. Agricultural Systems in Ethiopia. Wageningen: Centre for Agricultural Publishing and Documentation. 1975.
- Yemataw et al. 2014. Yemataw, Z., Mekonen, A., Chala, A., Tesfaye, K., Mekonen, K., Studholme, D. J., and Sharma, K.: Farmers' knowledge and perception of enset Xanthomonas wilt in southern Ethiopia. Agriculture and food security, 6, 1-12. https://doi.org/10.1186/s40066-017-0146-0, 2017. 2014.