Full Length Research Paper

Diversity and Distribution of *Enset* Landraces in Amaro Special District, Southern Ethiopia

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Abstract

This study was conducted, with the aim of investigating the diversity, distribution variations and major factors that influence the abundance of Enset landraces in the Amaro special district, southern Ethiopia. Both qualitative and quantitative techniques were employed to collect data in two phases. The sampled territory covered main Enset growing agro-ecological zones (1400 to 3121 masl) of Amaro district. A total of 78 households from six farmers administration (FAs) were selected following systematic random sampling method. The FAs were selected based on the amount and extent of Enset and the agro-ecological variations. The study area was stratified into highland (2001 – 3000 masl), midland (1400– 2000 masl) and lowland (<1400 masl). The data were analyzed using descriptive statistical procedures. SPSS Ver. 20 was used to analyse the data. Landrace richness, diversity, and dominance per farm were calculated using PAST software. One-way ANOVA was used to make a test of significance in mean enset landrace richness among households and studied FAs. Shannon diversity index (H') was used to measure diversity of landraces and Shannon's equitability (EH) was also used to measure the equity of diversity of landraces through finding the ratios of observed diversity to maximum diversity. A total of 40 named landraces was recorded. However, the landrace diversity was not evenly distributed throughout the district. The highest diversity was being recorded in highland FAs. The results revealed that farmers exchange planting materials extensively resulting in a fairly high variation in the diversity of Enset landraces among the selected FAs. Diversity, distribution, and evenness of the different landraces of *Enset* varied among the study sites ($P < 0.05$). These variations largely depended on the age of the household heads, altitude, agro-ecology, precipitation, availability of sucker, status of managementand presence of organic fertilizer (animal dung). The Enset bacterial wilt disease was also one of the main factors limiting Enset richness and diversity. Further research is required to know and exhaustively document the landracesand also to reduce the growing effects of *Enset* bacterial wilt.

Keywords: Diversity, Landraces, Enset, Richness, *Enset* bacterial wilt disease.

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1. Introduction

Ethiopia is the only country where *Enset* cultivation is economically important. Enset mainly grows in the Southern Highlands. It also grows in the Central and Northern Highlands around Lake Tana, the Semien Mountains, and as far north as Adigrat and in Southern Eritrea (Brandt *et al*., 1997). *Enset* is indigenous throughout tropical Africa, southward from Ethiopia to South Africa and westward from Ethiopia to the Democratic Republic of the Congo. It also occurs naturally in montane and riverine forests, often in clearings, gullies and near streams. In cultivation, *Enset* grows best between 1800 m and 2500 masl but scattered plants can be found at lower altitudes, and can also grow up to 3121masl. At higher elevations, low temperature and frost hamper its growth, thus maturation may take twice as long as or more than at lower levels. Temperatures between 16°C - 20°C are optimal, but growth is acceptable from 5°C to 25°C. Optimal growth occurs when average annual rainfall is between 1100mm and 1500mm.

*Ense*t grows well in most fertile and well-drained soils. Its optimal growth is attained in moderately acidic to alkaline soil (pH 5.6-7.3) and 2-3% organic matter. *Enset* culture is one of the four major agricultural systems in the country (Tadesse, 2002). *Enset* is mainly grown in the southern and southwestern part of Ethiopia though it is also grown in some areas of the Oromia region. Ethiopian highlands are the primary center origin for *Enset* agriculture.

Anthropologists, archaeologists, historians and other scholars have also developed theories that argue for the domestication of *Enset* in Ethiopia as early as 10,000 years ago. Stiehler (1948) stated that one of the first scholars to consider *Enset* origins believed that the indigenous gatherers of southern Ethiopia who were the first people to cultivate *Enset*. He also proposed that *Enset* agriculture is later introduced to the northern Ethiopian highlands by Cushitic-speaking peoples, only to be replaced by such crops as wheat, barley, and *teff* following the migration of Semitic-speaking groups in northern Ethiopia.

Ethiopia has a large natural diversity with a wide range of climate, which results from its topography and latitudinal position. The difference in altitude and latitude have resulted in a wide variation in climate i.e. rainfall, humidity, temperature and exposure to wind, etc. This geographical and

ecological diversity of Ethiopia, with extraordinary range of terrestrial and aquatic ecosystems contributed to the high rate of endemism and diversity (IBC, 2007; IBCR, 2009).

Enset distribution is restricted to south, southwest and central part of Ethiopia and it is not known as a food crop in the northern part of Ethiopia. The possible reasons for total disappearance of *Enset* culture in the North could be disease, drought and instability in the socio-political events between mid-1700 and mid-1800 (Brandt *et al*., 1997).

The loss of diversity in the form of traditional crop varieties or landraces throughout the world has been the subject of considerable concern in the past three decades. This disappearance of landraces termed genetic erosion has been described as a loss of plants with potential agricultural, economic value, implications for the food supply and the sustainability of both intensive as well as locally adapted traditional agricultural system (Bizuayehu and Ludders, 2003).

The extent and loss of the available diversity as well as the factors that control them in the centers of diversity are not clearly understood for many crops including *Enset*. Moreover, the status and selective significance of the individual landraces and their contribution to overall diversity are not well studied (Yemane and Fassil, 2006). The main purpose of this study is, therefore, to investigate the diversity and distribution of *Enset* landraces in Amaro district, to determine variation in diversity of *Enset* landraces and to study the major factors that influence the availability and abundance (richness and evenness) of *Enset* landraces.

2. Materials and Methods

2.1 Description of Study Area

The study was conducted in six farmers adminstrations (FAs) of Amaro District, which is located in the Southern Nations, Nationalities and Peoples Regional State (SNNPRS) (Figure 1). Kelle, is the administrative town of the district, which is 203Km far from Hawassa. The District covers 15,972 Km^2 of land and is divided into 33 rural and 1 urban administrative subdistricts called *kebeles*. It was bounded by Gamo Zone to the North; the Oromia region to the East and Northeast; Buriji district to the South; Konso and Dherashe district in the West. Its elevation ranges from 956 to 3121 masl. The district is classified into three agro-ecological zones: *Dega* (30%), *Weyna Dega* (38%) and *Kolla* (32%) (Amaro District Office of Agriculture, 2004).The area has a minimum of 735mm and a maximum of 1200 mm rainfall per annual and its annual temperature ranges from 15.1 ^{0}C to 27.5^{0}C.

There is a bi-modal rainfall pattern, the first and the main rainy season, *Belg* usually occurs from mid-March to end of April and the second one, *Maher* occurs from September to October.

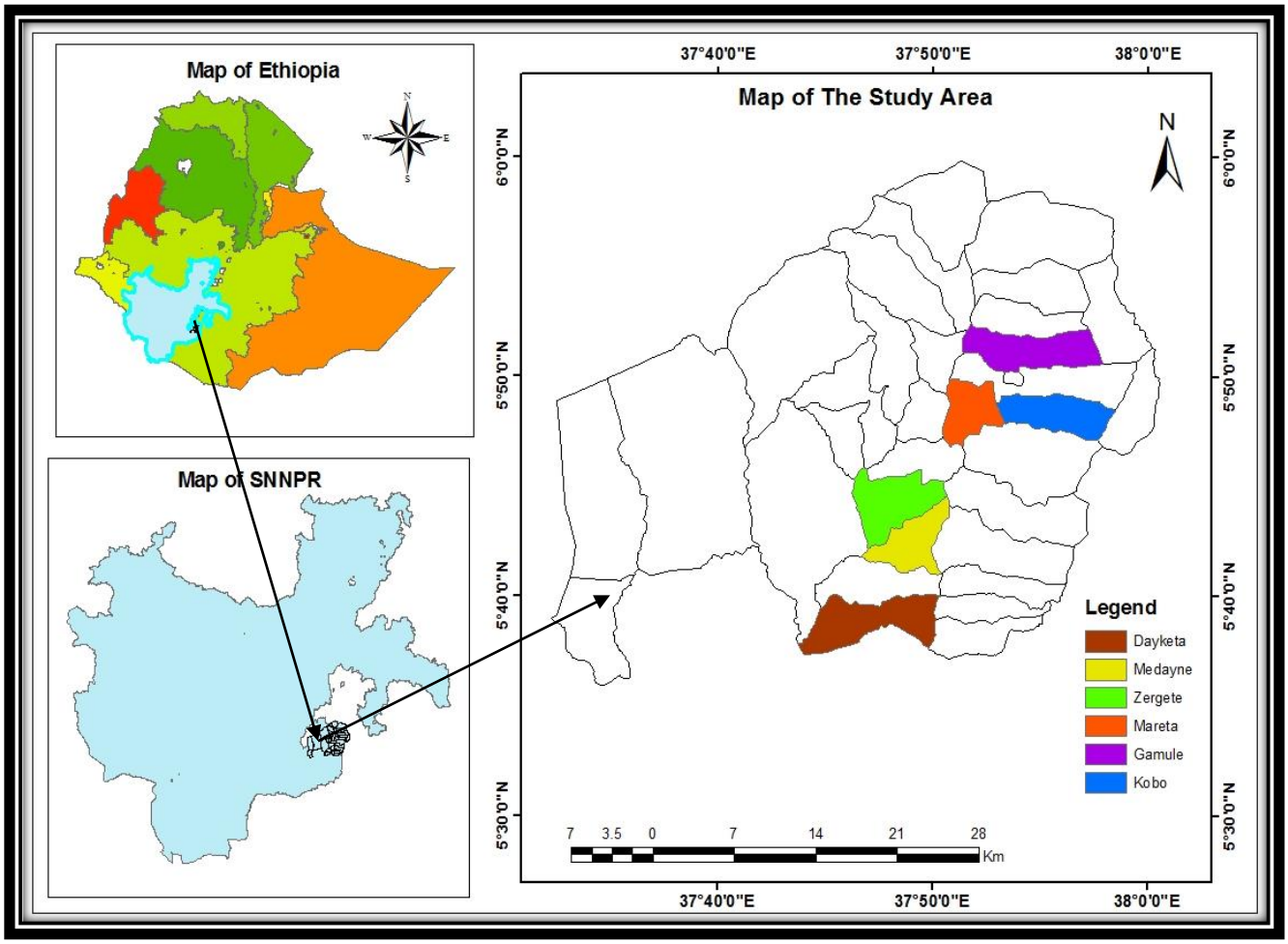

Figure 1. Map of the study area (Source: GIS and CSA Data 2016)

2.2 Research Design and Sampling

Both qualitative and quantitative methods of data collection were applied. The qualitative approaches were used to validate and triangulate the quantitative data. Six FAs were selected based on the amount, extent of *Enset* cultivation and on the basis of *Enset* growing potential and the sampled territory covered main *Enset* growing agro-ecological FAs (1400 to 3121 masl) of Amaro district. A stratified systematic random sampling procedure and multistage sampling was employed for selection of samples and for defining sampling units. Traditionally agro-ecologies are categorized into lowland (<1,500 m), midland (1,500-2,500 m) and highland (>2,500 m) above sea

level in Ethiopia (MoA, 2000). The *Enset* farming system of Amaro district was stratified in terms of elevation ranges (as Dega, Woinadega and Kolla), age of household heads (25-35 years, 36-46 years, 47-57years, and >57years). Since *Enset* was primarily cultivated in the midland and highland FAs of Amaro district and other parts of Southern Ethiopia (Tesfaye and Westphal, 2002), 2 FAs from highland, 2 from mid and 2 from lowland were selected. In the process of FAs selection, key informants comprising of agricultural officers and Development Agents (DAs) were consulted. The number of consulted key informants in all FAs was 6, but from the 6 selected FAs, a total of 78 households randomly drowns from resident booklets was considered as overall sample size for the study (Table1).

Table 1. Names of farmer administrations, study sites, altitude range, total households and sampled households

Agro-Ecology	FAs	Altitude (masl)	Total HHs	Sampled HHs
Kolla (lowland)	Kobo	1230-2092	375	15
	Gamule	1208-3027	325	13
Weyna-Dega (Midland)	Mareta	1851-3119	275	11
	Zergete	1330-2852	250	10
Dega (Highland)	Dayketa	956-2629	400	16
	Medayne	1279-2652	325	13
	Total		1950	78

Source: Amaro District Office of Agriculture

2.3 Methods of Data Collection

The major primary sources of data were farmers or households through interview and personal observation. These sources helped the researcher to acquire first-hand information and to draw inferences. The secondary data was obtained from different institutions like Amaro district agricultural and natural resource development office reports, FAs administration offices. Moreover, personal communication, literatures on *Enset* reviewed from published and unpublished documents were also used to strength the data obtain through questionnaire, interview, and focus group discussion.

Data were collected by a combination of methodologies for the acquisition of local knowledge, including focus group discussion (FGD), interview, questionnaire and observations (Ambrose *et al*., 1997). FGD was held in each of the selected FAs involving members from community elders, key informant farmer groups and a full consent of collaboration based on the principle of free prior informed consent was granted (Perrault, 2004). Individual interviews were carried out together with trained enumerators, who are DAs, working closely with the communities in the respective selected FAs. Open ended questions were used to gather information on *Enset* landraces, in particular to assess farmers' perception of landrace diversity, vernacular naming, and meaning of names. Interviews were conducted during drinks and coffee times in homes or home gardens.

2.4 Data Analysis

The data were analysed using descriptive statistics (frequencies, percentages, and mean) using SPSS Version 20. Landrace richness and diversity were calculated using *PAST* software and Microsoft excel 2016. Frequency was estimated as the number of occurrences of each landrace in the sampled households. Two components of *Enset* landrace diversities (richness and heterogeneity) were measured according to Magurran (1988). Richness was measured as the number of different types of landraces at each household and heterogeneity. Heterogeneity was calculated according to Shannon (1949) diversity index. The index was computed for landrace diversity of each household. It was calculated using the formula,

$$H' = \sum_{i=1}^{s} \text{pi ln pi} \qquad \text{(Kent and Coker, 1992)}$$

Where

H' = Shannon diversity index

$\sum$ = Symbol of summation

S= the number of species

P_i = the proportion of individual or abundance of the i^{th} species expressed as a proportion of the total cover.

ln= log base n (natural logarithms).

Evenness was defined by the function E = H'/lnS

Where

H'= Shannon index and

S = the number of landraces described in each *kebeles*.

Landrace diversities were measured separately for each FAs. Based on Brown's scheme for classifying alleles, *Enset* landraces have been arbitrarily grouped into two major categories on the basis of their distribution and abundance. These are (I) common (occurring with a frequency greater than 10% at least in one site), and (II) rare (never occurring with a frequency greater than 10%).The commonly occurring ones are further grouped into widespread (occurring at >2 sites), sporadic (occurring at 2 sites) and localized (occurring in only one site). Similarly, the rare varieties are grouped into widespread and localized. In addition, the relationships between abundance and distribution of *Enset* landrace were correlated by using Pearson correlation coefficient.The landraces evenness or equitability (EH) that measures the equity of landrace was calculated from the ratio of the observed diversity to maximum diversity using the equation: Shannon's equitability (EH) or evenness was calculated as follows:

$EH = H^1/Hmax$ (Kent and Coker, 1992).

Equitability of landrace in a given sample households was represented by 0 and 1 where 0 indicates the abundance of a single landrace and 1 indicates that all landraces are equally abundant.

3. Results and Discussion

3.1 Socioeconomic characteristics of respondents

Most of the respondent households (93.6%) were male headed and about 6.4% were female headed. The average family size of *Enset* based farming communities was 5.6 that was higher than the national average of 5.4 persons per household (CSA, 2005). Nearly 34.6% of respondents were illiterate, 57.6% have formally educated, and 7.7% were only able to read and write. Of the total respondents, 10.3% of the household heads had age between 20-35 years old, 25.6% of the household heads had age between 36-50years old, while a little above half of the household head (62.8%) had age between 51-75years old, and 1.3% of the household heads had age above 75 years old. Of the total respondents, 66.7% of the household heads had farming years between 36-50years, 32.1% of the household's heads had farming years between 20-35, while 1.3% of the household heads had farming years between 51-75 (Table 2). Amare and Daniel (2016) found that out of the total respondents 20.8% of the household heads had age between 20–35 years old, while a little

below half of the household head (42.4%) had age between 36–50 years old, 28% and 8.8% of the household heads had age between 51–75 and above 75 years old, respectively.

Assessment of the size of the land that the respondents possessed indicated that the majority (70.5%) of the respondents had 0.5 hectares, whereas 26.9 % had 1 ha and only 2.6% of the respondents had 0.25 ha. The maximum size of land possessed by the household was 1 ha while the minimum was 0.25 ha. The sizes of *Enset* farm are generally small and on average farmers cultivated about 0.25 hectares per farmer. Similar studies of Amare and Daniel (2016) found that the majority (68%) of the respondents possessed 1–2 hectares, whereas 26.4% had less than two ha and only 5.6% of the respondents had more than two ha. The maximum size of land possessed by the household was three hectares, while the minimum was half ha.

3.2 *Enset* Landrace Richness

Out of the total households 35.9% had 6 landraces, 14.1% possessed 22 landraces, 12.8% had 23 landraces, 16.7% had 29 landraces and 20.5% of the households had 26 landrace.

Table 2. Demographic characteristics of sampled households

Demographic characteristics	Number of households	Percentage of households
Age		
20-35	8	10.3
36-50	20	25.6
51-75	49	62.8
Above 75	1	1.3
Gender		
Males	73	93.6
Females	5	6.4
Educational status (grade)		
Illiterate	27	34.6
1-4	26	33.3
5-9	15	19.2
9-10	4	5.1
Above 12	0	0
Read and write only	6	7.7
Size of land in hectares(ha)		
0.25(1/4)	2	2.6
0.5(1/2)	55	70.5
1	21	26.9
Farming years/Experience		
20-35	25	32
36-50	52	66.7

51-75	1	1.3
Above 75	0	0
Number of landraces		
6	28	35.9
22	11	14.1
23	10	12.8
26	16	20.5
29	13	16.7

3.3 Status and Importance of *Enset* Cultivation

Enset cultivation occupies a central position in the agricultural systems of the Amaro District, and every farming households cultivates *Enset* in their home gardens. In the study area, *Enset* were maintained in home garden (*Ozza*) ring in poly-varietal perennial plantations without any crop-rotations and land-fallowing. Sometimes, farmers maintain *Enset* landraces intercropped with perennial tree crops, such as coffee (*Coffee arabica* L.), avocado (*Persea americana* Mill.), guava (*Psidium guajava* L.), annual and biennial crops, such as maize (*Zea mays* L.), Ethiopian kale (*Brassica carinata* A. Braun), and yam (*Dioscorea* spp.) (Figure 2).

Figure 2. Intercept of *Enset* in the Amaro District

When asked about the importance of *Enset*, farmers indicated *Enset* as a multi-purpose crop available all year-round, and that needs only household produced inputs for its production. The farming communities define *Enset* as the most important crop for livelihoods and food security in the study area (Table 3).

Table 3. Farmers' reasons for considering *Enset* as an important crop in their livelihood and agricultural systems

Reasons	Importance
Socio-cultural significance as status symbol	Very important
High household material culture benefits	Very important
Flexibility in farming systems as an intercrop with annual, and perennial crops	Very important
Drought tolerance	Very important
Suitability for preparation of staple and high social values dishes	Very important
Storability of *enset* products for long periods	Very important
Possibility of harvesting at any time of the year	Very important
Use for integration of crop-livestock system	Very important
Use for production of high quality fiber	Very important
Use as a water source from pseudo stem	Important
Use as firewood source mainly from dried plant parts	Important
g income from sales of propagates, processed food products and fiber	Important
Medicinal purposes for humans and livestock (e.g. abortifacient, Use for placenta delivery)	Important

3.4. Extent of *Enset* Diversity

A total of 40 vernacularly named *Enset* landraces under cultivation were recorded. Therefore, this may shown that the Amaro District holds a good repository of *Enset* landrace diversity in the home gardens. Likewise Yemane & Fassil (2006) reported a total of 65 locally known *Enset* landraces in Bonga, Ethiopia. Moreover, Bizuayehu & Lu¨dders (2003) recognised 79 local *Enset* landraces in Sidama. Apart from a regional variation among farmers in their knowledge to distinguish enset landraces, characters associated with growth and adaptation (Solomon, 2008; Genet, 2004), climatic variations, availability of germplasm or cultural history and the degree of dependency on enset as a food source (Genet, 2004) could account for variations in a number of enset landraces found in the present study and the same reported from previous studies (Bizuayehu & Lu¨dders 2003; Genet, 2004, Yemane and Fassil, 2006).

In relation to the agro-ecological distribution of landraces recorded in this study, a total of 12 landraces from highland, 22 from midland and 6 from lowland were found. A total of 40 *Enset* landrace vernacular names known to the Amaro district, farming communities were identified (Table 4). According to the respondents, some of the landraces have been rare; many more are not cultivated any more. Six landraces, namely *Shanna*, *Amale Shanna, Boxi Kafile, Zoo Kafile*, *Ganiticho*, and *Bazaze* were shared and widely distributed across the 3 agro-ecologies and 11 landraces were locally extinct. In other related studies, many landraces as identified by vernacular names, showed a narrow and unique pattern of distribution, for example, 39 (41%) landraces known

to the Wolaita community were commonly reported at least by 3 of the 5 studies (Haile and MY, 2014). Although it is impossible to make a direct comparison of diversity values with the results of previous surveys due to differences in the size and method of sampling, the number of landraces recorded in this study was considerably comparable to the 48 landraces reported for Sidama (Makiso, 1996), and 40 &70 landraces reported for Ethiopia (Bezuneh and Feleke, 1966). Table 4 refers to the landrace distribution in six of the studied FAs (i.e., *Medayne*, *Dayketa*, *Mareta*, *Zergete*, *Kobo* and *Gamule*).

Table 4. *Enset* landrace vernacular names, distribution, and their agro-ecology in the Amaro district

VN	DIST	AE	VN	DIST	AE
Akkula	Medium	M,H	*Ganiticho*	Wide	L,M,H
Bazaze	Common	L,M,H	*Gola*	Unique	H
Bubure	Medium	M,H	*Golibo*	Unique	H
Boseto	Unique	M	*Nipo*	Narrow	M,H
Boyxhole	Unique	M,H	*Mayicha*	Unique	H
Canga	Medium	M,H	*Qixha,Nipo*	Unique	H
Calike	Unique	NI	*Shanna*	wide	L,M,H
Cicirika	Medium	M,H	*Amale Shanna*	wide	L,M,H
Comale	Narrow	M,H	*Shaya*	Unique	M
Danbale	Unique	NI	*Sitete*	Narrow	M,H
Denigo	Medium	M,H	*Tameto*	Narrow	M,H
Dumule	Medium	M,H	*Tsila*	Narrow	M,H
Fooze	Medium	M,H	*Wujhaqa*	Medium	M,H
Fiile	Narrow	M,H	*Zarigula*	Medium	M,H
Gaje	Unique	M,H	*Zinika*	Medium	M,H
Goriposho	Unique	H	*Jhiliqa*	Unique	NI
Jolola	Medium	M,H	*Boxi Kafile*	wide	L,M,H
Jhila	Narrow	M,H	*Zoo Kafile*	wide	L,M,H
Koribo	Unique	M	*Sorfa*	Unique	NI
Charbo Nipo	Unique	NI	*Canga Shanna*	Unique	NI

Vernacular names = VN, Distribution= DIST Agro-ecology= AE, L=low, M=medium, H=high in altitude
Landrace names reported only in 1,2 study *kebeles* = Unique; 3 studies *kebeles* = Narrow; 4 studies *kebeles* = Medium; 5 studies *kebeles* = Common; and 6 studies *kebeles* = wide/common. Distribution across traditional agro-ecologies in Ethiopia viz: lowland (L) (<1,500 m); midland (M) (1,500-2,500 m) and highland (H) (>2,500 m) above sea level.

3.5 Identification, Naming and Classification

The local farmers of Amaro district perceived each local *Enset* landrace as clearly distinguishable. The farmers use three processes of indigenous biosystematics for their landrace under cultivation i.e., identify, name and classify landraces. For identification, local farmers used 11 descriptors (Table 5). Those descriptors are related to morphological characteristics (pseudo stem color, midrib

color, and petiole patches/strips colors), agronomic characteristics (reaction to drought, reaction to disease and pests, maturity time). If in doubt, farmers also use sap color for identification. Various authors (e.g., Olmsted, 1974; Huffingil, 1961; Bayush, 1991) reported that *Enset* varieties have been characterized based on color (dark green, green, light green, red and blue) and height (tall, medium, short and very short).

The local farmers use combinations of descriptors. They referred first to the morphological characters of a landrace. Character descriptors related to the use-value (uses for food, fiber, fodder, and medicinal) and agronomic characteristics came only after morphological characteristics. Depending on the landraces cultivated in the home gardens, the most frequently mentioned descriptors for identification were leaf color, plant size and pseudo stem color. Sap color as descriptor was used specifically for landrace *Gaje*, which means 'the bleeding', referring to the milky sap color of *Gaje* as compared to the watery sap color of most of the other landraces. Sap color and corm characteristics were less frequently quoted descriptors for the identification of *enset* landraces in the study FAs. Different landraces are recognized to have characteristic adaptation to edaphic factors, reveal an individual response to time of seeding, and have typical days of maturity, height, nutritive value, use, and other properties (Bizuayehu and Lu¨dders, 2003; Bizuayehu, 2008). Disease reaction is specifically considered for bacterial wilt disease (*Xanthomonas campestris* PV *Musacearum*) which is common in the FAs. .

Table 5. Farmer's descriptors of *Enset* landraces in Amaro district

Identification & characterization criteria	**Criterion category**	**Examples of representative landraces**
Plant morphology		
Pseudo stem color	Green	*Shanna, Jhila, Bubure, Jolola, Dumule, Golibo*
	Red	*Ganiticho, Danbale ,Gola, Tameto, Comale, Cicirika, Shaya, Akkula, Bazaze, QixhaNipo, Zarigula, Tsila*
	Dark-Red	*Fiile, Denigo, Nipo, Sitete, Zinika, Boseto,Gaje*
	White	*Shanna, Boxi -Kafile, Charbo-Shanna*
Leaf color	Green leaves	*Jhila, Shanna, Fiile, Ganiticho, Zarigula, Comale Zinika, Danbale,Golibo, Bubure, Denigo*
	Purple leaves	*Ganiticho, Shaya, Tsila*
	Green-Red	*Tameto*
Leaf shape and pattern	Narrow erect	*Jolola, Shaya, Boseto, Tameto, Gola, Tsila, Nipo Comale, Sitete, Gaje*

	Wide and dropping	*Ganiticho,Gaje, Dumule, Bubure, Denigo, Zarigula, Zinika, Danbale,Golibo*
Midrib dorsal color	Red Purple	*Zarigula, Akkula, Bazaze,Cicirika, Nipo, Dumule, Tsila*
	Green	*Shanna,Jhila,Fiile,Bubure,BoxiKafile,Denigo Jolola, Sitete, Zinika, Golibo, Danbale*
Petiole blotch and patch color	Black	*Shanna, Jhila, Fiile, Bubure, BoxiKafile, Zinika Ganiticho, Danbale*
	Brown	*Akkula, Nipo, Jolola, Dumule, Boseto, Shaya, Gola QixhaNipo, Tameto, Sitete, Gaje, Tsila, Golibo*
Sap color	Milky	*Gaje*
	Watery	*Ganiticho, Golibo, Gola, ZooKafile, BoxiKafile Bubure, Denigo, Fiile, Zarigula, Mayicha, Sorfa Jolola, Shanna, Amale Shanna, Sitete, Bazaze etc*
Plant cycle		
Maturity	Early	*Jolola, Shanna, Amale Shanna, Sitete, Bazaze*
	Late	*Ganiticho, Golibo, Gola, ZooKafile, BoxiKafile Bubure, Denigo, Fiile, Zarigula, Mayicha, Sorfa*
Plant vigor		
Plant size/height	Vigorous	*Ganiticho,BoxiKafile,ZooKafile,Denigo,Jhila,Nipo Zarigula, Bubure, Goriposho, Shanna, Akkula, Amale Shanna*
	Tiny	*Jolola, Wujhaqa,Tameto,Nipo,Fiile,Comale*
Plant reaction to biotic factor		
Disease and pest	Resistant	*Ganiticho, BoxiKafile, ZooKafile, Denigo, Shanna, Golibo, Wujhaqa*
	Susceptible	*Sitete, Akkula, Bazaze, Cicirika, Nipo, Shaya, Boseto, Tameto, Gola, Comale, Ganiticho Tsila, Bubure, Fiile, Zarigula, Mayicha, Sorfa Amale Shanna, Canga*
Plant reaction to abiotic factor		
Drought	Resistant	*Ganiticho, BoxiKafile, ZooKafile, Shanna, Sitete Amale Shanna,Canga, Gola*
	Susceptible	*Akkula, Bazaze, Cicirika, Nipo, Mayicha, Sorfa, Fooze, Shaya, Boseto, Tameto, Comale, Fiile, Zarigula, Tsila, Bubure,*

3.6 Names and Naming System of *Enset* Landraces

Local farmers gave a separate vernacular name for each landrace they grow. The names are often descriptive and reflect variations of landraces in their morphology, agronomic and cooking characteristics. Most of the landrace names are single expressions, but three of the identified landrace names are structured to 'secondary' names by adding modifiers which further describe the

landrace. For example, landrace names such as *Boxi-Kafile and Zoo-Kafile* are derived from 'primary' landrace named *Kafile* and the additional modifiers describe the color of the *Kafile* landrace. On the hand, *Amale Shanna*, *Canga Shanna*, and *Shanna* are landrace names derived from 'primary' landrace name *Shanna* and the additional modifiers in these names describe the color and taste of the *Shanna* landrace. In addition to these, landraces named *QixhaNipo*, *Charbo-Nipo*, and *Nipo* derived from 'primary' landrace name *Nipo* and the additional modifiers describe the color of the pseudo stem of the *Nipo* landrace. Bizuayehu (2008) reported different characters such as morphological, physiological, chemical and vegetative cycle used by farmers in the identification of *enset* varieties in Sidama which are almost similar to the findings of this study.

Table 6. Sub-variety nomenclature of *Enset* landraces in Amaro district

Landrace variety level nomenclature	Landrace sub-variety Level nomenclature	Meanings and implications of sub-variety level names
Shanna	*Shanna, Amale-Shanna*	Color of leaf, tip midrib red.
	Canga Shanna	Sour, leaf color green, but wide.
Kafile	*Boxi Kafile*	Pseudostem and leaf midrib throughout green.
	Zoo Kafile	Pseudostem and leaf midrib throughout red.
Nipo	*QixhaNipo*	Pseudostem red.
	Charbo Nipo	Pseudostem white color and sometimes black in color.

3.7 Classification of *Enset* Landraces

The people in Amaro district use landraces classification systems for their *Enset* landraces in which different categories of classification overlap. Four criteria were used in classifying *Enset* landrace domestication status, gender, use-value, and agro-ecological adaptability (Table 7).

Table 7. Classification of *Enset* landraces in Amaro district

Landrace Classification bases	Characteristics of landrace in each category
Domestication status	Vegetative propagated:

	it occurs in home garden under farmers' management.
	Early maturing and with edible corms, taste, quality, less fibrousness and tolerance.
Gender's of landrace	Late maturing, fibrous, vigorous, stress tolerant, with non-edible corms, higher yieldand disease tolerance.
Use-value of landrace	Mainly used for *Enset* based foods,
	a source for fiber, and medicine.
Eco-geographic (Altitude) adaptability	*Bubure,Jhila,Nipo,Sitate,Zariguila,Fiile, Denigo,Akkula,Gola,Golibo,Gaje,*and *Fooze* are specifically adapted to highland altitude .
	All landraces are grown.
	Shanna, Amale Shanna, Boxi Kafile, Zoo Kafile, Bazaze, and *Ganiticho* landrace grown in lowland.

Cultivated *Enset* is located in human settlements near dwellings (*Ozza*) as a home garden crop (Figure 2). Cultivated landraces are distinguished further by their 'gender', use-values and eco-geographic adaptability. According to FAO (1999), gender-specific roles and responsibilities are often conditioned by household structure, access to resources, and ecological conditions. Farmers classified *Enset* landraces into two major sex categories: 'female' *Enset* (*Macca shuncha*) and 'male' *Enset* (A*ttuma shuncha*). The distinction as 'male' and 'female' is not related to the biological reproduction of the landraces. Farmers consider early maturing landraces with high edible corm quality (less fibrous and tender corm), with thin and weak pseudostems, as *macca Shuncha,* and late maturing fibrous landraces, with corms of poor cooking qualities, as *attuma Shuncha* (Table 8). Of the total 40 landraces identified, 15 were classified as 'female', 13 as 'male' and the remaining 12 landrace had an ambiguous sex designation, some farmers claiming them as a 'male' and others claiming them as a 'female'. Based on indigenous use-value, farmers classified *Enset* landraces in one comprehensive use groups: is cultivated mainly for food. Although all *Enset* landraces can be used both for food and non-food uses, there are preferences for specific landrace among communities for particular purposes. In the study *kebeles* the majority of landraces were primarily planted for food uses, livestock feed, and animal and human medicinal requirements.

Very few, such as *Gola* were grown for fiber production and food uses, respectively. The other classification criterion farmers used was eco-geographical adaptability of landraces. The Amaro district farmers describe major *Enset* ecosystems by altitude regimes: low altitude, mid altitude, and high altitude; they assign a set of *Enset* landraces to specific altitude niches. Although landraces adapted to highlands can be cultivated in lowlands e.g. *Shanna, Amale Shanna, Boxi-Kafile, Zoo-Kafile, Bazaze, and Ganiticho* and vice versa, all landraces are adapted in mid altitude (e.g. *Bubure, Jhila, Nipo, Sitate, Zariguila, Fiile, Denigo, Akkula, Gola, Golibo, Gaje,* and *Fooze*) are specifically adapted to highland altitude.

Table 8. Difference between male and female *Enset* plants based on farmers perceptions

Factors	Late maturing	Early maturing
Fibrosity	Strong, high in quality and quantity.	Low strength, low in quality and quantity.
Size	Big	Smaller
Susceptibility to diseases and pests.	Resistance	Susceptible
Corm	Fibrous(unpalatable)	Delicious, low fiber
Kocho	Ferments slowly	Ferments quickly
Leaves	Hard and stiff	Soft
Pseudostem and leaf sheaths	Hard and stiff	Soft
Average yield	High	Lower

3.8. Medicinal Roles of *Enset* Landraces

The *Enset* plant and its parts contribute to indigenous ethno-medicinal values of the Amaro district. Although all the respondents in the study FAs know and believe that *Enset* was medicinally important, only a few people use it for medicinal purpose. Traditional healers in the FAs confidentially keep ethno-medicinal knowledge of *Enset* landraces. It is mostly administered in the form of food products. Traditional *Enset* medicines include (i) *Tameto* landrace for healers wound; *Kafile* and *Zarigula* strengthening women after delivery, and healing bone fractures for humans, respectively; (ii) *Cicirika, Wujhaqa, Gaje, Sitete, Bazaze, Comale,Canga, Jolola,* and *Kafile* landraces, to feed cows to facilitate placental expulsion and bleeding after delivery. Those landraces that are reported to heal bone fractures are used for treating diarrhea and during child delivery, i.e.,

assisting the discharge of the placenta. Most reports of medicinal uses of *Enset* indicate that farmers' intentionally maintain the landraces together with other landraces. Likewise Addis *et al*.(2006) reported a number of different *Enset* landraces to have medicinal significance for preventive treatment, healing and other therapeutic purposes.

3.9 Organized Assemblage and Arrangement of Landraces

There are specific arrangements and placements for each landrace in the *Enset* home gardens of Amaro District. Farmers assemble landraces in a specific order for different purposes. Medicinally important landraces are planted in unsightly corners for 'preserving healing powers'. Colorful landraces are planted along the side-lines for ornamentation. The organized assemblage of landraces helps *Enset* farmers to easily communicate the landraces they own to fellow farmers which in turn helps to exchange and maintain landraces. In the community, well organized landraces in home gardens indicate symbolic values for the household, which again motivate farmers to maintain and manage more diversity in their home gardens. Specific arrangement and organization of landraces in the home garden was one of the ways that the Amaro district employs to maintain and manage on-farm *Enset* diversity (Table 9).

Table 9. Planting arrangements of *Enset* landraces in home gardens of Amaro district

LR U/Ch	Ex. LR	PS	JPS
Orna LR	*Tameto*	Alongside-lines of farms	For ornamentation of home gardens
VigG LR	*Ganiticho,BoxiKafile,ZooKafile,Denigo,Zarigula,Bubure,Wujhaqa,Akkula,Jhila,Nipo,Goriposho,Shanna,Amale Shanna*	Home garden fringes	As symbol of status
LR WF PST	*Ganiticho,BoxiKafile,ZooKafile,Denigo,Zarigula, Bubure,Jhila,Shanna* and *Amale Shanna*	Along home garden paths	For ease of water fetching their Pseudo stem
MI LR	*Tameto*, *Boxi-Kafil*e, *Zoo-Kafil*e and *Zarigula* (humans), *Cicirika*, *Wujhaqa*, *Gaje*, *Sitete*, *Bazaze*, *Comale*, *Canga*, *Jolola*, and *Kafile* landraces (animals).	Unsightly corners inside the plantation	For medicinal value in addition to other values

LR = landrace, Ex. LR = example landraces, Orna.= ornamental, MI = medicinal importance, WF = water fetching PST=pseudostem, VigG=vigorous growth

3.10 Numbers, Distribution, and Abundance of Landraces

The number of landraces/richness recorded per households varied between 6 and 29, the mean landrace richness being 15. The number of landraces recorded at a given FA rose steeply at the beginning, and then slowed down as more and more households were surveyed. A further increase

in diversity was to be expected on enlargement of the household sample size. It's also realized that only16 households were needed to capture 72.5% (29) of the total 40 landraces recorded in this study. Informal exchange between farmers in traditional societies was often considered to be confined within family groups and close neighbors and thus limited in its scope and range (Sperling and Loevinsohn, 1993).

Large differences were evident between landraces in their abundance and distribution as indicated in Table 10. *Enset* bacterial wilt caused by *Xanthomonas campestris* PV *Musacearum* was the most important biotic constraint to *Enset* cultivation (Tesfaye, 1997). Many farmers complain that there is no support from the formal sector for combating *Enset* bacterial wilt disease. In order to alleviate this biotic stress, farmers integrate EXW tolerant landraces in their farms. The *kocho* yield of these disease tolerant landraces was however below average.

Table 10. Kebeles (sites) and Number of landraces (%) distribution ranges of Amaro district *Enset* landraces

Sites(kebeles)	**Number of landraces (%)**
Kobo	6 (15)
Gamule	6 (15)
Mareta	6 (15)
Zergete	3 (7.5)
Dayketa	7 (17.5)
Medayne	12 (30)

Some landraces had a rather patchy distribution, i.e., they had a very high local abundance at one or two FAs and disappeared virtually from the rest. Examples are *Golibo*, *Gola, Boseto, Mayicha, QixhaNipo, Shaya, Goriposho,* and *Koribo*. Other landraces such as *Calike, Danbale, Jhiliqa, Sorfa, Charbo Nipo,* and *Canga Shanna* have totally disappeared currently. On the other hand, six landraces were dominant in *Enset* production at district levels. These were *Shanna* (19%), *Amale Shanna* (17.7%), *Boxi-Kafile* (7.6%), *Zoo-Kafile* (5.1%), *Bazaze* (7.6%) and *Ganiticho* (3.8%). Other numerically important landraces in descending order of abundance were *Bubure*, *Jolola*, *Denigo, Zarigula*, *Canga*, *Fooze*, *Zinika*, *Dumule*, *Akkula*, *Wujhaqa*, *Cicirika,* and *Boyxhole.*

Using Brown's (1978) scheme for classifying alleles, *Enset* landraces have been arbitrarily grouped into five categories on the basis of their distribution and abundance. These are i) common (occurring with a frequency greater than 10% at least in one sample) and ii) rare (never occurring with a frequency greater than 10%). The commonly occurring ones are further grouped into widespread (occurring at > 2 sites), sporadic (at 2 sites) and localized (in only one site). Similarly, the rare

varieties are grouped into wide-spread and localized. Localized common and rare varieties make up a substantial portion of Amaro district *Enset* landraces.

3.11 Variations in Landrace Diversity

The diversity was lower at low altitudes, reached a maximum at the high altitude (3121 masl), and decreased slightly afterwards (Table 11). In terms of landrace number, the greatest concentration was found at the three mountainous sites (Mareta, Dayketa and Medayne), which accounted for more than 85% of landraces recorded in the study area. Besides, relative geographic isolation, marginal growing conditions and lack of access to markets have been suggested as major factors that account for the high diversity of crop plants that was commonly associated with mountainous regions (Brush, 1986). The details of landrace diversity variations are presented in Table 11.

Table 11. Landraces diversity in the Amaro district six sites expressed as richness (R), Percentage, Shannon (H'), Evenness (E) diversity indices

Sites	R	%	H’	E
Qobo	6	15	2.701	0.7931
Gamule	6	15	2.553	0.7884
Mareta	22	55	2.393	0.9955
Zergete	23	57.5	2.294	0.9526
Dayketa	26	65	2.595	0.8535
Medayne	29	72.5	2.509	0.9474

There was a significant positive correlation ($r = 0.72$; $P < 0.05$) between the diversity of *Enset* landrace and altitude. About 72.5% of landraces were recorded at Medayne (2620 masl) followed by Zergete and Dayketa. Bizuayehu and Ludders (2003) reported that the number of landraces reached a maximum at the highest altitude (2620 masl) in Sidama. There was a significant positive correlation ($r = 0.83$, $P < 0.01$) between the age of households and the number of landraces.This could be due to the fact that as the age of the households increase, their knowledge to distinguish *Enset* landraces also increase. This might help to increase tshe diversity of *Enset* landraces (Temesgen, 2007). The relationship between size of land in ha and number of landraces maintained by each household was also positively correlated ($r = 0.78$, $P < 0.05$) (Figure 6). As the size of land increases, there will be more space to cultivate a number of landmarks. Amare and Daniel (2016) also found that the size of land was one of the factors that affect the diversity of *Enset* landraces.

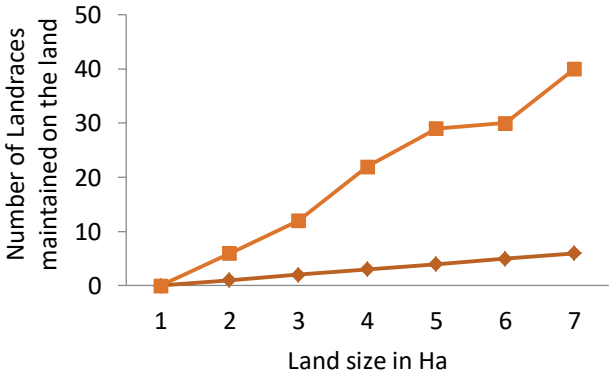

Figure 6. Relationship between size of land in hectares and number of landraces maintained in the land ($r = 0.78$, $P < 0.05$)

Conclusions

A considerable number of *Enset* landraces was recorded in this study. A total of 40 named *Enset* landraces were identified. Richness, diversity and evenness of *Enset* landraces were different across the sites. Variations in the composition of *enset* landraces among the different sites were documented. The landrace diversity was affected by morphological characters, agronomic traits and use value. Moreover, the existence of *Enset* varieties/landraces largely depended on elevation, climate, availability of sucker, status of management and presence of organic fertilizer/manure. Land scarcity, diseases (bacterial wilt), population pressure, poor management practices and wealth status of farmers are also directly or indirectly affecting the diversity of *Enset* landraces in the study area.

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