

On-farm diversity of Enset (*Ensete ventricosum* (Welw) cheesman) Landraces, Use, Management practice and Associated Indigenous knowledge.

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Abstract

Ensete ventricosum (Welw.) Cheesman) is a widely cultivated food crop in southern parts of Ethiopia. This highly valuable crop is only domesticated in Ethiopia and adapted to the high altitude areas, of Ethiopia. The overall objective of this study is to document the diversity of enset (*Ensete ventricosum*) landraces and associated indigenous knowledge of farmer's selected sites in the Kefa Zone (Gesha, Saylem, Decha, and Adiyio) district in southwestern Ethiopia. In the study data on enset landraces and farmers' indigenous methods of naming, classification, and identification of landraces were gathered using semi-structured interviews, field observation, and focus group discussion. The selections of study districts were made purposefully uniform method based on their agroecology and accessibility; three kebeles were made from each district bringing the total number of sampled households to 120. In the study a total of 76 enset landraces were recorded from households survey and among these, landraces locally called Bejo, Shelako, Nobo, Boco, Gushiro, Yeko, Menjio, and Adiyio were found to be the most dominant, widely distributed and highly preferred landraces in the area. In the study, the highest number of landraces, 48 were recorded from Adiyio districts, and the least number of landraces 32 was recorded from Gesha districts with the relative, Simpson's Diversity index values ranging between 0.96 (Saylem) to 0.98 (Adiyio) while H' ranged between 0.91 (Gesha) to 1.94 in Adiyio. On the other hand, Sorenson's similarity index value indicated the existence of high similarity between the Saylem and Decha districts, and the least similarity value was obtained between Adiyio and Decha. For identification of different enset landraces farmers used morphological descriptors such as leaf color, pseudo stem color, midrib color, Plant size, and circumference of the Plant. Although there is a high diversity of enset landraces in the area, the production and productivity of the crop are reported to be under significant stress due to various environmental problems such as bacterial wilt and animal pests. Thus, there is a need for a multidisciplinary approach to resolve the problems, maintain the diversity of enset landraces, and ensure the long-term sustainability of the system.

1. Introduction

Agriculture in Ethiopia is characterized by diverse farming practices. Farmers with various ethnic backgrounds and cultural diversity living in the country's diverse agroecological zones have developed farming systems, characterized by a high degree of species diversity. Wild species of enset are distributed throughout much of central, eastern, and southern Africa as well as Asia, but (*Ensete ventricosum* (Welw.) Cheesman) is restricted to its native indigenous farming systems of South and South-Western Ethiopia not only the restriction but also used as a main food and fiber crop [1]. Similarly [2] noted that enset has been cultivated as a food and fiber crop in Ethiopia for several years.

According to [3] Enset in Ethiopia is arguably the most important root crop. Mostly adapted to highland areas contributes to food security and more than 20 million rural people of the country depend on it which accounts for about 65% of the total crop production. A wide adaptation within the species to altitude, soil, and climate has allowed widespread cultivation in western Bale, and southwestern Oromia, including south and east Shewa, Jima, Illubabor, and Welega [4].

Regions, where enset is used as a staple food, are usually less affected by the recurrent drought periods that occur in Ethiopia [2] Enset is suitable for sustainable agricultural systems due to its contribution to soil fertility. In addition to these enset can easily be stored without the need for refrigeration and is available throughout the whole year. It can be accessed at any time when there is a food shortage and other crops fail as a result of drought, diseases, or other factors. However, Enset has been harvested so intensively during droughts that some important clones have become extinct, thereby, reducing the genetic diversity of the crop.

Enset is a source of carbohydrate-rich food mostly in the southern and southwestern parts of Ethiopia. In addition, it is a multipurpose crop that contributes to realizing soil fertility by controlling soil erosion, providing shade for intercropping, as an ornamental crop, and as support for animal feed during drought season [1]. The major food types obtained from enset are kocho (uto), bulla (ethino), and amicho (Gej-menja). Kocho is fermented starch obtained from decorticated (scraped) leaf sheaths and grated corms. Bulla (Ethino) is a liquid that is obtained when corms are pulverized, the liquid containing starch is squeezed out from scraped leaf sheaths and grated corm and the resultant starch is allowed to concentrate into a white powder. Amicho (Gej-menja) is cooked enset corm pieces that are prepared and consumed similarly to other root and tuber crops [2]. [5] Stated that in Ethiopia, particularly in the southern nation nationalities and people regions enset is highly diversified and distributed.

However, limited documentation is available concerning the on-farm conservation practice of enset diversity, its cultural use of medicine, the preparation of locally diversified food, and the management of enset farms in different zones or ethnic groups. Due to this reason, the present study helps to fill the knowledge gap concerning farmers' traditional practices on farming enset cultivation management, and different use values of enset in Kefa Zone (Gesha, Saylem, Decha, and Adiyo) district of southwestern Ethiopia the major enset production areas in southwestern Ethiopia. Therefore, this study aimed to document the traditional and cultural uses of enset, to identify which enset diversity is preferred to prepare different local foods and medicine, tradition, and practices regarding the diversity and distribution of enset landraces on the farm level and the naming and selection criteria for different purposes concerning the production, utilization, and conservation of genetic resources.

3. Materials And Methods

3.1 Description of the study area

Keffa zone is found in the Southern Nation, Nationalities, and Peoples' regional state of Ethiopia. Geographically the study area is located about 7° 3 N, and 36°2 E south of the Gojeb River (Fig. 1). The administrative center of the Keffa zone is Bonga, it is 725km away from Hawassa and 460 k.m away from Addis Abeba. Keffa Zone is divided into 12 Woreda and 2 administrative cities such as (Bonga and Chena) The total land area of the zone is 10,602.7 square km (Census 2007). These studies were conducted in selected four districts of keffa zone (Gesha, Saylem, Decha, and Adiyo. The selected

districts have a total of 107 rural kebeles and six urban kebeles in which they were situated in different agroecology ranging 1179 – 2529 masl.

Sampling design

The sample area was selected using multistage sampling techniques first; the keffa zone was selected purposively due to the presence of the good natural resource of Enset. After conducting a reconnaissance survey of the study area, four districts were selected namely Gesha, Saylem, Decha, and Adiyo, based on the high production of enset landraces, which play economic and cultural roles. Three kebeles were selected from each district and ten households selected from each kebeles through a uniform method bringing the total number of sampled households to be 120 (Table 1).

Selection of Informants

A total of 120 informant 30 informants from per district were selected and used for the study. Of these 120 informants, 108 of the informant selected randomly (Table, 1). The remaining 12 informants were purposefully selected as key informants by using information and recommendations from the local healers, kebeles administrator, and kebeles developmental agents (DAs) to gather the details of use, methods of cultivation, and uses of enset plants. Ethno-botanical data were collected between December - March 2019 Ethnobotanical data were collected in very close interaction with informants using semi-structured questions prepared beforehand in English and translated to the language of the inhabitants during interview administration. The interviews are based on and around this checklist and some issues are raised promptly depending on the responses of an informant. All of the interviews were held in Amharic.

Table. 1 Informant's information

zone	Districts	Kebeles	General Informant	Key Informants
keffa	Adiyo	Alare - geta	9	1
		Boka	9	1
		Muduta	9	1
	Decha	Awerada	9	1
		Ermo	9	1
		Ufa	9	1
	Gesha	Ayt	9	1
		Abbate	9	1
		Kicho	9	1
	Saylem	Dino	9	1
		Miso	9	1
		Kochi	9	1
Total	4	12	108	12

3.2. Data Analysis Method

The Ethnobotanical data were analyzed using quantitative and qualitative methods of data analysis. Descriptive statistics such as percentage, frequency distribution, and graphs were used to analyze the data collected through semi-structured, open-ended, and some close-ended questions. Preference ranking was conducted for evaluating the degree of preferences or levels of importance of certain selected enset plants.

3.2.1. Diversity Analysis

Simpson's diversity index (D) is a measure of diversity. It measures the probability that two individuals randomly selected from an area will belong to the same species [6] and hence, as D increases, diversity decreases. Richness and evenness of categories of abundance were conducted based on [7]. The index was, therefore, transformed as 1-D so that greater diversity corresponds to higher values: The formula for calculating D is presented as: $D = \frac{n_i (n_i - 1)}{N (N - 1)}$, or $(1 - D) = 1 - \{\sum n_i (n_i - 1) / N (N - 1)\}$

Sorenson similarity index was employed to assess differentiation or beta (b) diversity [8], and it compares the similarity of species (landrace) diversity among the study districts. The expected variation in landrace composition that exists between the study districts was computed using Sorenson's similarity coefficient

(Cs) [8]. $Cs = 2a/2a + b + cb$ Sorenson's similarity coefficient ranges in value from (0) (no similarity) and (1) (complete similarity).

3.2.2. Preference Ranking

Each informant was asked to arrange a group of items according to a given criterion such as the landrace of enset in their 'kocho', 'bulla', 'amicho', fiber, and medicinal quality. Each item was then assigned a value, with the most important, preferred one ranking the highest value, while the least important, or preferred one ranked the lowest value. Therefore, in this study, different use values of enset species were short-listed and ranked by informants following the procedure explained by [9].

3.2.3. Priority ranking.

Priority ranking is made to compare the results of Preference ranking of different enset landraces for the preparations of local foods and medicinal use and look for commonalities concerning which diversity of enset is high, medium, least, and the types of challenges listed in the given criterion and rank order based on their perceived importance or significance.

4. Results And Discussion

4.1. Diversity of Enset Landraces

In the present study, a total of 76 enset landraces were recorded from 12 different selected kebeles (4 districts). The highest number of landraces recorded per farm was 18. Among the farms listed 14 – 18 landrace were recorded in (20%), 7 – 13 landrace were recorded in (45%) and 4 - 6 landrace were recorded in (35%) in their yards. The study area was found between mid-land and high land altitude range 1179 - 2590 masl. Due to the presence of wild forest, wild enset (Epo) was found near the district or the study kebeles, in Decha District (Awraada kebeles) and Adyo District (Alari – geta kebeles) with the altitudes 1963 and 2460 masl respectively. The present study is in line with [10], who described 146 landraces from three zones of SNNPR (52 landraces from Sidama, 55 landraces from Wolaita, and 59 landraces from Hadiya) recorded.

Table 2. Enset landrace expressed richness, evenness, and unique clones to each district concerning their elevation.

Study districts	S	H	E	1-D	Unique	Altitude
Gesha	32	0.91	0.2	0.97	2	1179 - 2338
Decha	38	1.09	0.21	0.98	2	1617 - 2220
Sylem	41	1.81	0.22	0.96	6	2222 - 2387
Adyo	48	1.94	0.23	0.98	17	2393 - 2529

4.2. Distribution and Abundance of Enset Landraces

Some landraces had a rather irregular distribution, i.e. there was a very high local abundance at one or two locations and almost absent from the other areas. For example, Tambo and Mecho enset landraces were only found in two kebele (Awurada and Boka). The most widely distributed and dominant landraces in the study area include Bejo, Shelako, Bocho, Areko, Nobo, Gushiro, Chella - bejo, Eno, Adyo, Necha – bocho, and Menjio. The first six landraces were highly cosmopolitan and needed highly in the community. Those landraces with the highest distribution and abundance were highly cultivated for their quality in kocho, bulla, fiber, and amicho.

Table 3. List of enset landraces grown by farmers and their richness at four administrative districts.

Gesha destriect			Decha destriect		
No.	Enset landrace	no respondent grown	No.	Enset landrace	no of respondent grown
1	Achacho	2	1	Achacho	6
2	Adyo	10	2	Adyo	2
3	Areko	12	3	Akbaro	1
4	Ataro	5	4	Areko	13
5	Bejo	28	5	Bano	1
6	Benesho	1	6	Bejo	19
7	Boco	19	7	Boco	21
8	Bumbo	7	8	Bongo	7
9	Buri	1	9	Bumbo	4
10	Bushiro	4	10	Buri	1
11	But	4	11	Chamero	4
12	Chara -Kosho	1	12	Chela-bejo	1
13	Chella- Bejo	3	13	Chongo	5
14	Chikaro	3	14	Choro	4
15	Eno	12	15	Debiyo	1
16	Epecho	5	16	Eno	2
17	Epo	1	17	Epecho	1
18	Genji	1	18	Epo	1
19	Geyo	1	19	Genji	4
20	Gushiro	10	20	Geno	7
21	Kechi	3	21	Geyo	4
22	Kekero	1	22	Gunji	2
23	Maratichi	1	23	Gushiro	9
24	Mechadami	2	24	Kochitato	5
25	Mecho	5	25	Mechadami	1
26	Menjecha	1	26	Mecho	2
27	Muchaye	1	27	Necha -bocho	3

28	Necha-Bejo	4	28	Nech-bejo	1
29	Necha-Bocho	1	29	Nobo	27
30	Nobo	30	30	Shede	3
31	shelako	20	31	Shelako	10
32	Shikmari	1	32	Shime	2
33	shime	1	33	Shishemo	2
34	Shitalli	1	34	shuri	1
35	Tafaro	1	35	Tambo	1
36	Tayo	21	36	Tayo	2
37	Tebeno	2	37	Tebeno	1
38	Uchabo	3	38	Tuli	1
39	Uturo	8	39	uchcafo	1
40	Wango	2	40	Uturo	13
41	Wuiro	3	41	Wango	2
42	Wuo	1	42	Wuiro	8
43	Yeko	12	43	Yeko	4

Saylem district

Adiyo district

No.	Enset landraces	no respondent grown	No.	Enset landraces	no. respondent grown
1	Adyo	16	1	Achacho	3
2	Areko	3	2	Adyo	3
3	Ataro	1	3	Ageno	5
4	Bedado	3	4	Areko	19
5	Bejo	16	5	Bedado	13
6	Bergecho	5	6	Bejo	13
7	Boco	11	7	Boco	18
8	Bumbo	4	8	Botecho	1
9	Bushiro	2	9	Chikaro	9
10	But	3	10	Choro	4
11	Chella- Bejo	1	11	Epecho	1

12	Chikaro	7	12	Epo	1
13	Dolli	9	13	Genji	1
14	Eno	17	14	Geno	1
15	Epecho	2	15	Geyo	5
16	Genji	1	16	Gushiro	11
17	Geno	9	17	Kello	2
18	Geto	1	18	Korendo	2
19	Gushiro	14	19	Matecho	3
20	Kechi	1	20	Menjio	24
21	Kekero	5	21	Nobo	1
22	Kello	1	22	Shede	3
23	Ketanno	12	23	Shelako	1
24	Mechadami	3	24	shiko	1
25	Mecho	13	25	shuri	3
26	Nech -bejo	2	26	Tambo	7
27	Necha -bocho	6	27	Wuiro	6
28	Nobo	28	28	Wuo	3
29	shelako	19	29	Yah - bejo	7
30	Shuri	2	30	Yeko	2
31	Tayo	6			
32	Uchabo	1			
33	Wango	4			
34	Wuiro	1			
35	Yeko	18			

Depending on this classification, the landraces in the study area showed variation in distribution and abundance (fig 2). From the total landraces recorded 76, (64.4%) of them were common. Of these common enset landraces, (56.6%) of them were widespread, (5.3%) were sporadic and (2.6%) were localized. In the second category, the rare landraces comprised 31 (35.5%). Of these rare landraces (9.2%)

were widespread, (10.6%) were sporadic and (15.7%) were localized. This study was in line with [2] identified that there was a significant association between the distribution and abundance of enset landraces in the Aleta Chuko district.

4.3. Identification, Naming, and Classification of Enset Landraces by Farmers

Farmers used different morphological characteristics to identify their landraces, these colors (pseudo stem, midrib, and leaf), time of maturity, disease resistance, yield, leaf number, corm, and pseudo stem circumference (lower leaf sheath) were widely used. During the observation of the home garden of farmers, the frequently used identification mechanisms were pseudo stem color, midrib color, leaf color, the circumference of enset, the height of enset, and the presence of white spots on the leaf and whole body of enset were considerably used. In the case of identification and naming the landraces women were better than men due to everyday practice inside their home garden for different purposes and processing activities of the enset. Females were better in naming as well as identifying the landraces, but those males had better information on the way of cultivation and transplanting the sucker of enset. A similar study conducted by [11], indicated that farmers to identify distinct enset landraces in Wolaita used morphological characteristics of enset.

4.3.1. Naming of Landraces

Farmers in the study area gave specific or local names for each landrace available in their locality. Names often result from particular characteristics of the material, such as unique morphological characteristics, agronomic qualities, and place of foundation or special uses (Table 3). Some of the landrace names had implied meaning to the community. Farmers named varieties and classification systems offered valuable indications for selecting a suitable, more in-depth characterization method. This study was in line with [11], farmers had indigenous knowledge in naming the enset landraces locally and he also identified that the names of landraces were taken from different sources like, place of origin, distinct morphology, and agroecology

Table 4: Naming sources of a few enset landraces in the study area

No	Names	Sources
1	Necha - bocho	Bocho Presence of the white spot on its leaf and the color of kocho are white.
2	Adyo	Place of origin from Adyo district.
3	Chella- Bejo	The red color of the pseudo stem and the kocho color are like red.
4	Kochitato	It is known as the king of kocho and high yield of kocho.
5	Shiko	Known as neighboring, The origin is from Sheka zone.
6	Shuri	Because of medicinal value and the red part of both the Leaf and pseudo stem.
7	Tuli	Known as very thin, Grows as thin and less production.
8	Shelako	In terms of length, corm size, and duration of maturation time.
9	Nobo	Late maturation, Hard in processing, and resistant to disease.
10	Bejo	White kocho and Bulla color.
11	Epo (Wild)	Known as enset of the devil, found in the forest and the black color of kocho.
12	Ketanno	This means wider, by looking at lower Pseudo stem circumference and corm.

4.3.2. Classification of enset

Farmers in the study area used different criteria to classify the different landraces of enset. The criteria used for classification are indicated in (Table 4). They classify enset as male and female based on above-the-ground plant size, corm size, early maturing, late maturing, and response to disease, processing work. Farmers considered early maturing landraces with sweet corn and easy to harvest as female (Mache) and that late maturing, hard for decortications scraping were grouped as males (Anamo). Gushiro, Yeko, Wango, Epecho, Mecho, Achacho, Dolli, But, Eno, Tuli, Wuo, and Choro were female landraces while Chella - Bejo, Shelako, Nobo, Boco, Ketanno, Geno, Uchafo, Chongo, Genji, Tambo, and Matecho were considered as males. However, there were some landraces, which were selected as males in some farmers and females in others Tafaro, Tuli, and Wuo. This indicated that classifying enset landraces based on their sex made an ambiguity for designation. This study was similar to [4] who described that Sideman people classify enset landraces as female (Meyate) and male (Labbaahu) depending on criteria such as maturation time, plant size, and its hardness to process and a similar report was described by [12] in Gurage. The outcome of this study was consistent with findings reported by [13], and [14] reported three categories of enset local varieties; male, female, and intermediate categories.

Table 5: Farmer's Folk classification of enset based on farmer's perception of sex (not Biological)

Characteristics	Female (Mache)	Male (Anamo)
Aerial plant size	Smaller	Larger
Corm size	Smaller	Larger
Processing work	Easy	Difficult
Texture	Softer	Tougher
Response to disease	Vulnerable	Strong
Fermenting time	Short	Long
Vulnerable to predators	Yes	No
Maturity	Early maturing	Late maturing
Average yield	Lower	High

4.4. Similarities of Landraces between the Study Sites

The proportion of landraces shared between pairs of sites ranged between 0.49 and 0.53 respectively. The two most similar sites were Sylem and Dacha (0.53) and the two less similar sites were Decha and Adyo (0.44). The reason for the high similarity between Sylem and Decha might be due to altitude, temperature, soil, and their relative exchange of planting materials in the marketplace. A similar study conducted by [3] indicated that there was a high sharing of landraces between adjacent Woredas' in Kembata zones. The findings were in line with [4], who studied diversity and regeneration of enset in Sidama.

Table 6: Sorenson's similarity index values for enset landraces composition in the study district.

Study districts	Gesa	Sylem	Decha	Adyo
Gesa		0.49	0.52	0.46
Sylem			0.53	0.47
Decha				0.44
Adyo				

5. Enset as a Food Value

Enset was of high significant value in the day-to-day activity of peasants who cultivated this plant. Every part of it was used, not only for food and fodder for animals but also it had several non-food functions. All the farmers in the study area responded that enset leaves were used for baking bread, wrapping, shade or protection from heat and rain, production of string and rope, tying, making mats and sheets on which to sleep, sit, house, and fence construction, mattress production. The findings were similar to studies done by [2]. During enset harvesting; enset leaves were used to line the ground where processing and fermentation took place. Enset fibers were used to make sacks, bags, ropes, mats, construction materials, sheets, and sieves, in addition to this enset was green every time. This is consistent with the [15] report that enset is ornamental, used as a windbreak that protects the house from strong wind, giving pleasure to the household and visitors. All the farmers surveyed reported that enset was extremely used for consumption purposes. For its multipurpose use, farmers cultivated in their gardens for its food advantage. Almost all the farmers in the area produce many enset clones that are used for different purposes. A similar study conducted by [12] reported that some landraces were best for Kocho while others were selected for Bulla, Amicho, and fiber. In general, the study by [5] described that enset was produced mainly for food consumption throughout enset cultivated part of Ethiopia and this was consistent with the present study in which farmers in the study area including key informants stated that enset was used for food consumption. kocho (Uto), bulla (Ethino), amicho (Gej -menja) were food products of enset, and Fiber (Gyio) was the by-product.

Kocho (Uto) was the one that was frequently used as food and served the whole household in their everyday food consumption. It was prepared for breakfast, lunch as well as dinner. Depending on the wealth of the household, this diet might be supplemented with other foods such as dairy products, meat, and vegetables. The age of the landrace, harvesting season, the landrace type, and its fermentation period were factors that affect kocho quality in addition to this hygiene of processors decreases the quality of kocho. In the study area we have selected twelve key informants to compute their preference of enset landraces used for the preparation of kocho based on that Shelako, Nobo, and Areko were preferable to the other landrace because this landrace had high Kocho production in both quality and quantity, and also generate income for farmers, and Menjio and Bejo had the least preference enset landrace type to prepare Kocho.

Table 7: Preference ranking of enset landrace on Kocho quality

Landrace of enset	k1	k2	k3	k4	k5	k6	k7	k8	k9	k10	k11	k12	Total	Rank
Bejo	5	4	4	3	5	3	4	5	5	3	5	5	51	4
Nobo	5	5	2	5	4	5	5	5	5	4	4	4	53	2
Areko	4	5	4	5	4	5	4	4	5	4	5	5	54	3
shelako	5	5	5	4	4	5	5	4	5	5	5	4	56	1
Menjio	4	4	4	4	5	5	4	4	4	4	4	3	49	5

Bulla: - was graded as the first from the products of enset used as food and locally they called (Ethno). It was considered the best quality of enset food and was obtained mainly from fully matured enset plants. Bulla was prepared as a pancake. Twelve key informants were used to select the most bulla quality enset landraces; informants used different criteria presented to them to prefer landraces on Bulla. Based on that Yeko, Boco, and Areko were high-quality enset landraces used to prepare bulla because this landrace had a white color and had medicinal value for humans for feeding and drinking as '*Atmit*' in Amharic and Bejo and Menjio enset landraces have low Preference by the farmer for the preparation of Bulla.

Table 8: Preference ranking of enset landraces on Bulla quality.

Landrace of enset	k1	k2	k3	k4	k5	k6	k7	k8	k9	k10	k11	k12	Total	Rank
Boco	3	3	4	4	5	4	3	4	5	5	4	4	48	2nd
Bejo	5	4	4	4	3	4	3	4	3	3	3	5	45	5th
Areko	4	5	2	2	5	5	4	4	2	5	5	4	47	3rd
Menjio	4	4	2	4	5	4	5	5	3	3	4	5	46	4th
Yeko	3	5	3	5	3	5	5	5	5	4	5	5	53	1st

Amicho (*Gej - menja*). Was the fleshly inner portion of the enset corm, which might be cooked and eaten separately, and the taste similar to a potato. The way of preparation of amicho (*Gej-menja*) was the same as other root and tuber crops in which its corm was simply boiled and consumed without any processes. Most enset landraces had not equal value in Amicho (*Gej – menja*) quality. Of five commonly distributed landraces, *Areko* and *Gushiro* had the best for amicho quality. These landraces had the sweet test for food on the other hand Bejo, Adyo, and Shuri did not have better tests in these cases less preferred enset landraces for the preparation of amicho.

Table 9. Preference ranking of enset landraces for Amicho quality.

Landrace of enset	k1	k2	k3	k4	k5	k6	k7	k8	k9	k10	k11	k12	Total	Rank
Bejo	1	1	1	1	5	1	1	1	5	1	5	1	24	5
Areko	5	5	3	4	5	5	5	5	2	5	5	5	54	1
Gushiro	5	3	1	4	1	5	1	2	3	5	5	5	40	2
Adyo	1	1	1	1	5	5	5	5	2	1	2	1	30	3
Shuri	1	3	3	3	4	4	4	1	1	1	1	1	27	4

5.1. Medicinal and other uses of Enset

Some landraces of enset had effective characteristics and were used to cure both human and livestock ailments. Farmers in the study area suggested that landraces that had medicinal values were Cultivated in their home gardens. Enset landraces like *Shuri*, *Choro*, and *Areko* were valued for their medicinal use in the study area. Similarly, studies by [12] described that “*Astara*” and *Qibnar*” enset landraces in Gurage were used to cure both human and animal disease, and other studies [16] explained that particular clones and parts of enset plants are used medicinally for both humans and livestock to treat bone fractures, broken bones, and childbirth problems. The part of enset corm, leaves, and pseudo stem of *Shuri*, *Choro*, *Areko*, and *Gushiro* enset landraces are used to treat both animals and humans ailments. But, *Nobo*, *Menjio*, *Shelako*, and *Boco* enset landraces highly preferred by farmers and cultivated at their homes for their medicinal uses.

5.2. Use of Enset as Fiber

The pseudo stem is the most valuable, as the basal part contains the starch, and the remaining fiber is used for making strong ropes, twines, and sacks. In the study area, enset landrace was not had an equal quality of fiber. The enset landrace like *Nobo*, *Boco*, *Menjio*, *shelako*, and *Adyo* have the best fiber quality, these enset landrace have long and strong fiber for the preparation of string and rope.

6. Constraints of Enset Production

Enset diseases caused by Bacteria, Fungi, and Nematodes, as well as pests such as the attack from Molerats and Porcupines were among the many other factors causing less productivity. All Farmers in the study area reported that way of poor land management and climate change caused a great problem of enset productivity. During the survey, Farmers identified different enset diseases but, the most common widespread enset diseases identified are yellow leaves, and entire leaves wilted caused by bacteria (Fig 7, A and B). The respondents especially those who had molerats and bacterial wilt in their enset farm claimed that it was a serious problem for our landraces (Figure 9B). Traditionally farmers have different practices for avoiding and minimizing the transmission enset disease from infected enset to the other

healthy enset landraces by stopping of sharing of sharp materials, removing infected enset landraces from the farm, and burning infected enset landrace to minimize the spread of bacterial wilt, but this has no permanent protection mechanism. Some farmers reported that they lost several landraces due to this problem. A similar study conducted in Gurage by [17] revealed that the most constraints of enset in Gurage were a shortage of land and climatic change. The result of this finding was similar to [3] described that almost all farmers' reported that Enset *Xanthomonas* wilt (EXW) had the greatest impact on enset production in the Kembata Tembaro zone.

Table 10. The current status of enset landraces in the study site.

District	lost Enset varieties	Major constrain of enset	Resistance to Bacterial wilt	Enset landrace susceptible to Bacterial wilt	
Gesha	Ayearo	Bacterial wilt	Nobo	Achacho	But
	Bumbo	porcupine	Yeko	Adyo	Chara -Kosho
	Busiro	Molerates		Areko	Chikaro
	Kello	Frost		Ataro	Eno
	shuri			Bejo	Genji
	Tayo			Bejo	Gushiro
	Yeko			Benesho	Kekero
				Boco	Mechadami
				Bumbo	Mecho
				Buri	shelako
				Bushiro	Tayo
				Uochab	Wuo
				Uturo	yeko
Saylem	Agicho	Bacterial wilt	Gushiro	Adyo	Genji
	Areko	Molerates	Nobo	Areko	Geno
	Bergecho	porcupine		Ataro	Geto
	Chikaro	Frost		Bedo	Gushiro
	Dolli			Bejo	Kekero
	Mechadami			Bergecho	Kello
	Shelako			Boco	Ketanno
	Shitalli			Bumbo	Mechadami
	Shuri			Bushiro	shelako
	Tayo			But	Shuri
	Yoto			Chikaro	Tayo
				Dolli	Wango
				Eno	Wuiro
				Epecho	Yeko
Decha	Choro	bacterial wilt	Nobo	Achacho	Gunji

	Mecho	Molerates	Boco	Achacho	Gushiro
	Shuri	porcupine		Adyo	Kochitato
		Frost		Adyo	Mechadami
				Akbaro	Mecho
				Areko	Shede
				Bejo	Shelako
				Boco	Shime
				Bongo	Shishemo
				Bumbo	shuri
				Buri	Tambo
				Chamero	Tayo
				Chongo	Tebeno
				Choro	Tuli
				Debiyo	uchcafo
				Eno	Uturo
				Genji	Wango
				Geno	Wuiro
				Geyo	Yeko
Adiyo	shuri	Bacterial wilt	Bedado	Achacho	Gushiro
	Matecho	Moderates	Bejo	Adyo	Kello
		porcupine	Boco	Ageno	Korendo
			Nobo	Areko	Matecho
				Bedado	Shede
				Bejo	Shelako
				Botecho	shiko
				Chikaro	shuri
				Choro	Tambo
				Epecho	Wuiro
				Genji	Wuo

	Geno	Yah - bejo
	Geyo	Yeko

Status of Enset Cultivation in the Study Area:-Enset was the staple food crop in the study area, nowadays The richness and diversity of enset landraces were decreasing from time to time because of Bacterial wilt, Porcupines, Molerats, climate change challenges, and other factors. According to the findings from the group discussion, the perception of farmers towards enset cultivation was decreasing from time to time. Accordingly, farmers rank the current status of enset cultivation as decreasing by 55.46%, increasing by 48.4%, and no change by 17.14% the percentage indicated that the response of farmers to the status of enset cultivation currently decreased due to the above-listed factors (Fig.8). Similar study conducted in Gedebano Gutazer Welene district by,[12] indicated that cultivation of enset was decreasing from time to time and similarly the research [18] identified that the current status of enset landraces was decreasing in household level in Gurage zone.

7. Cultivation and Management Practice of enset by Local Farmers

In our survey, we observed that farmers practice similar ways of enset management, even though the farm size of every farmer was different. Almost all farmers agreed that enset plantation or propagation took place during the rainy season. They claimed that the farm of enset in which the new enset landraces could be planted was prepared before transplantation. During the time of surveys, we were able to observe practices such as land preparation, propagation, weeding, transplanting, and manure application. A cultivation technique of enset was time-consuming and needed huge human effort. Almost all the farmers practiced dense mono-cropping practice throughout four districts and they stressed that enset cultivation requires high experience but very few of them carry out the intercropping farming system during the first year (ukko) and second year (Acho) stage they cultivate maize, cabbage, and taro with enset. This was similar to the study by [15], which indicated that enset cultivation requires careful nurturing. There should be a very intimate relationship between the whole household and the enset plant in the homesteads.

7.1. Application of manure and weed-controlling mechanism

All farmers reported they use manure in enset production and apply it throughout the year, they spread the waste products of cattle, horses, and donkeys simply by carrying it into the home garden where enset was planted and spread it using their hands around the bases of two adjacent enset planted. Maximum manure was applied in the rainy season compared to the dry one. All respondents (98%) reported that manure was life for enset and in turn for us because the production of enset was highly dependent on organic manure application and as it was our staple food crop. Weeding took place a bit later in the rainy season because it was hard to remove all the weeds in the presence of water and not only this but also the way of removing weeds itself was tedious and needed large human labor. Farmers practiced hand

and tool weed-controlling mechanisms, but all farmers agreed that the frequency of weeding decreased as the plant aged and its size increased. The majority of farmers (90%) reported that the frequency of weeding could be three to four times throughout the year mainly from December to September depending on the amount of rain received and enset canopy formation. Activities were done by men in men-headed households, and most of the time application of manure was done by women in the study area. Cultivation was done during the rainy season once a year, which was common to all areas growing enset as the main food crop.

7.2. Harvesting and Processing of Enset

In the present study area harvesting of enset took place at any time depending on the presence and absence of food for consumption as well as the presence of mature enset plantation in their home yard. Almost all farmers in sampled kebeles agreed that the quality of kocho and bulla became high when enset with inflorescence was used in its full maturation. These maturities did not work for the usage of Amicho (Gej- menja), the enset landrace used for Amicho could be uprooted in its early stage. During the survey we observed that the method of storing kocho and bulla squeezing practices throughout four districts were similar, Processing of enset was mainly done by women. The duty of men during the time of processing was cutting the upper part of the leaf, uprooting the corm, and transporting it to the place of processing when necessary. According to the information from the women, enset could be harvested at any time of the year, but for quality, it was better to harvest it in the dry season. Women also claimed that in the rainy season, the quality of kocho (uto) and bulla (ethino) became less due to the high content of water inside the pseudo stem of the landraces. According to [19], food loss implies a decrease in the quantity or quality of food that was originally intended for human consumption. Farmers in the study area reported that different cultural instruments can be used during processing some of them were, a wooden plate to hold the pseudo stem firmed, a scraper which was made from metal and serrated as a sickle used to decorticate or scrape the pseudo stem to separate the pulp from the fiber and the other material used was cattle bone to grate the corm which is similar to the study [13]. As it was seen in the survey from 76 enset landraces 12 of them were highly dominant or cosmopolitan present almost in the majority of households. From our group discussion with farmers and key informants on the selection criteria of enset landraces, they categorized their use value as kocho, bulla, amicho, and fiber and Medicinal value

8. Conclusions

The findings of this study showed the presence of high enset landrace diversity in the study area practiced by all the farmers. Based on identification, naming, and classification farmers used different descriptors of morphological characteristics' to identify one landrace from the other. All farmers correlate this identification with its local name. In the case of classification, enset landraces were classified based on their gender locally given to them as female (Mache) and male (Anamo) by local farmers. From the total surveyed households 76 enset landraces were recorded in four districts in this study area indicating that the district has high enset landrace distribution as a whole. The variation of enset landraces at the

household level was 4 – 18 enset landraces. Farmers were selective during enset cultivation for different purposes in this district. Due to this some landraces were highly dominant and widely distributed throughout the district the leading ones could Bejo, Shelako, Bocho, Areko, Nobo, Gushiro, Chella - bejo, Eno, Adyo, Necha – bocho and Menjio. The first six landraces were highly cosmopolitan and preferred in the community in the study area. The study also showed that nowadays the richness and diversity of enset landraces in the study area was decreasing from time to time due to enset diseases caused by Bacteria, Fungi, Nematodes, as well as pests such as the attack from Molerats and Porcupines among the many other factors causing less productivity.

The results of the present study also confirmed that farmers in the study area have potential indigenous knowledge on the cultivation, propagation, transplantation, harvesting, and processing activities of enset landraces. Farmers have their planting material, including its propagation and management system. Dense plantation of enset and wide mono-cropping practice was observed in the study area but few farmers used inter-cropping of enset during the first year (ukko) and second year (Acho) stage to cultivate maize cabbage and taro with enset. Enset is one of the staple food crops for farmers in Gesha, Saylem, Decha, and Adiyo districts even though the other cereal crops and tuber crops were used at a minimum in the study area.

Declarations

Availability of data and materials

All data generated or analyzed during this study are included in this research.

Ethics approval and consent to participate

The permission for this study was supported by Hawassa University and with respective local administrative of districts. The objective of the study is present to the participants to collect relevant information on local knowledge of farmers on enset landrace use, cultivation, and management practice.

Competing interests

The authors declare that they have no competing interests.

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Figures

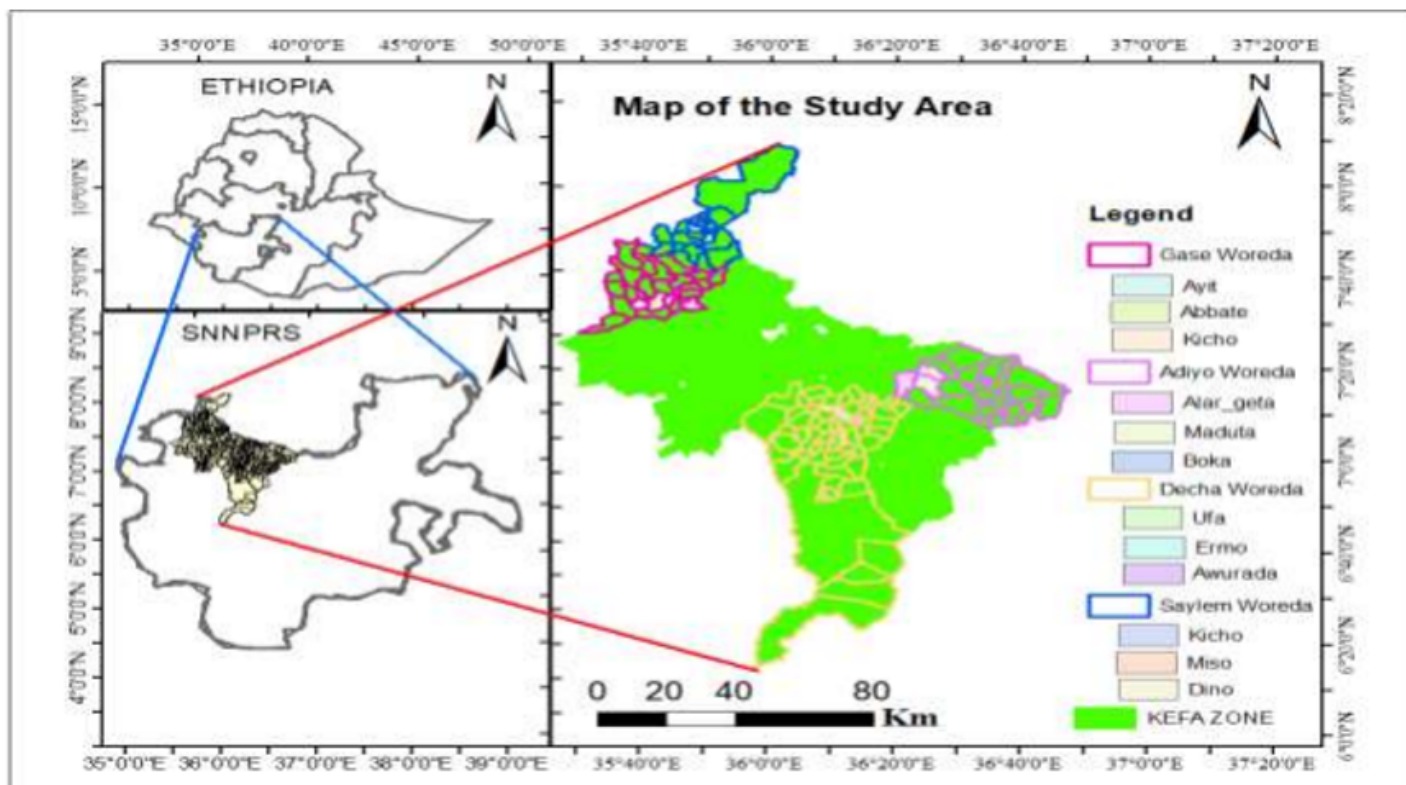


Figure 1

Map of the study area

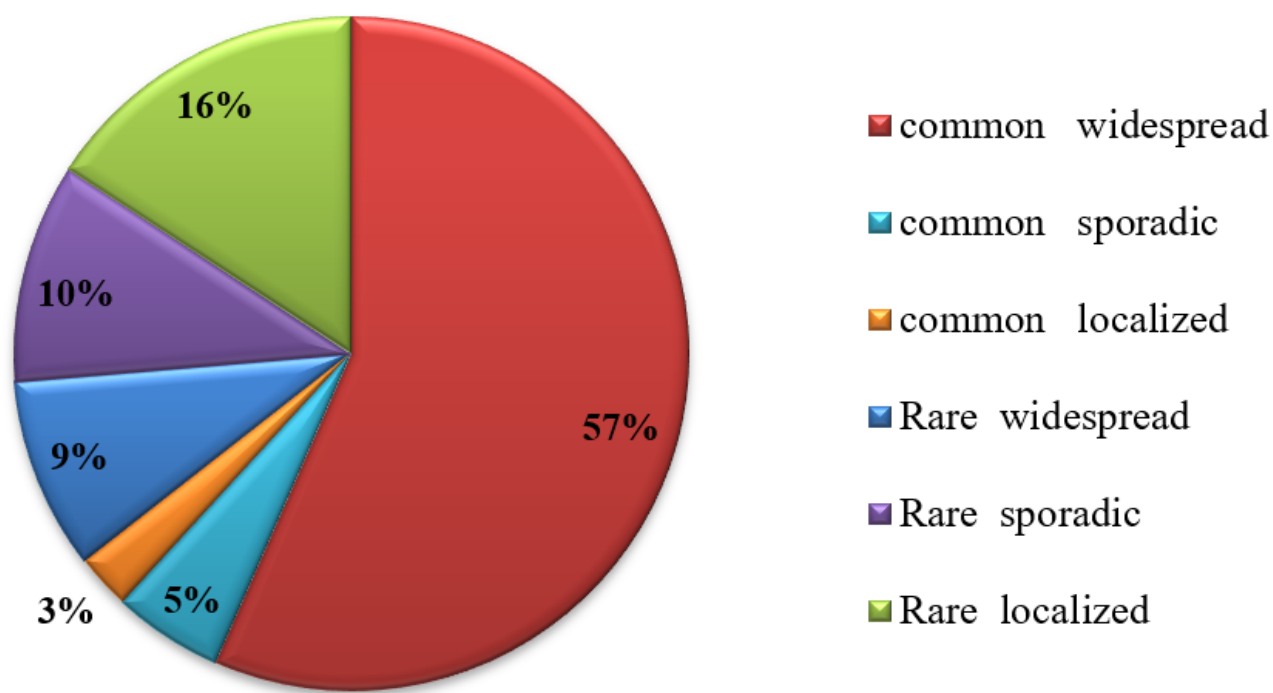


Figure 2

Classification of enset landraces based on distribution range and population size

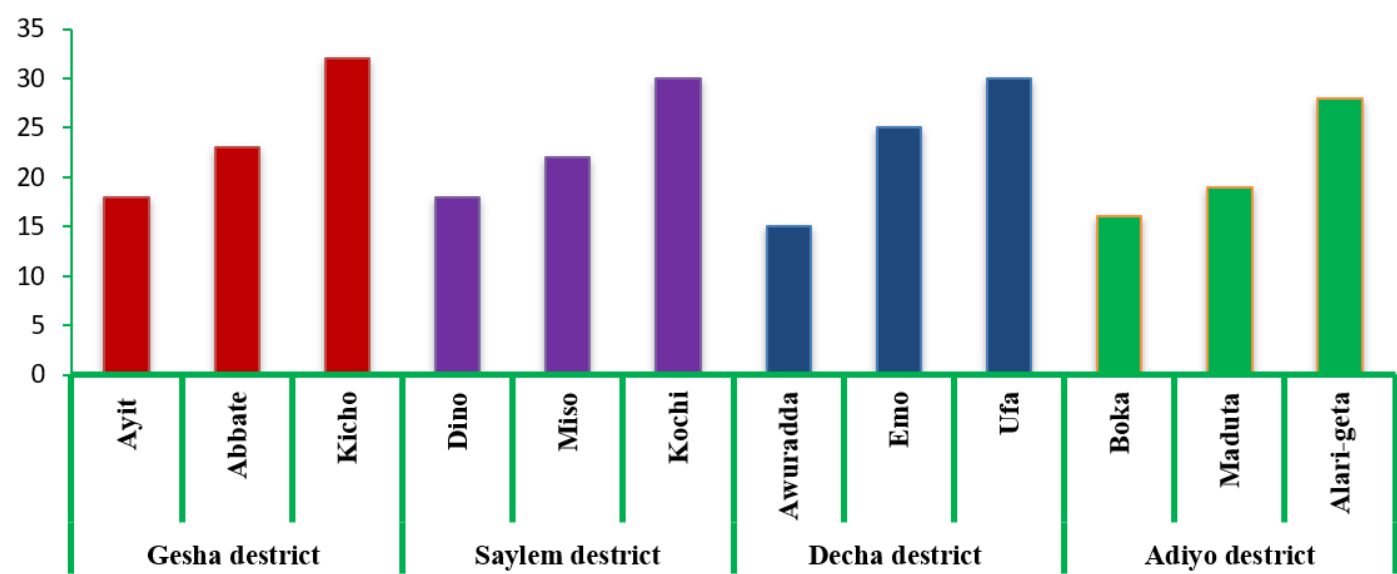


Figure 3

Number of Enset landraces grown at the study districts.

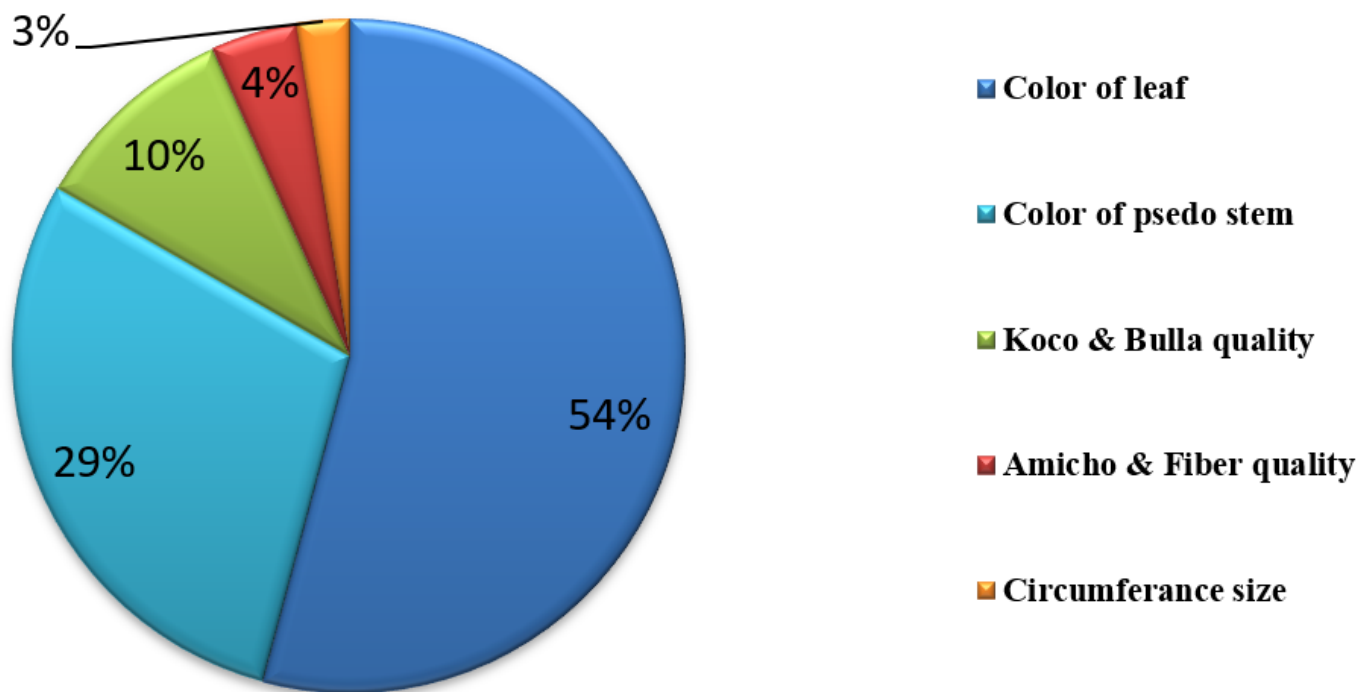


Figure 4

Identification criteria of landraces enset by respondents

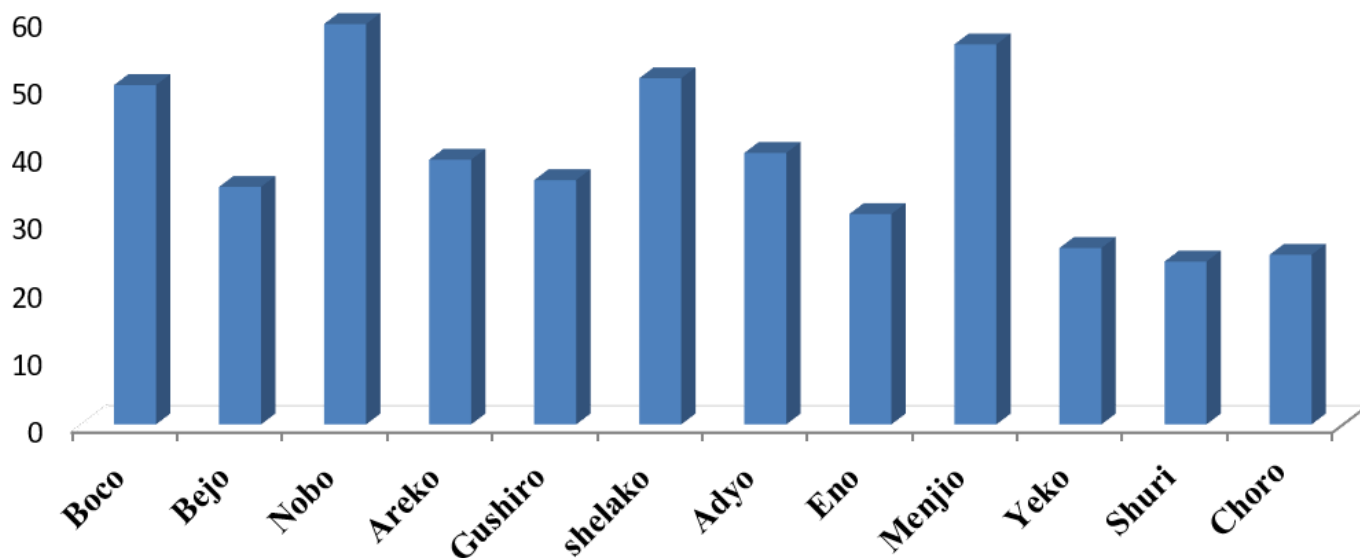


Figure 5

Preference ranking of enset landraces for Medicinal uses.

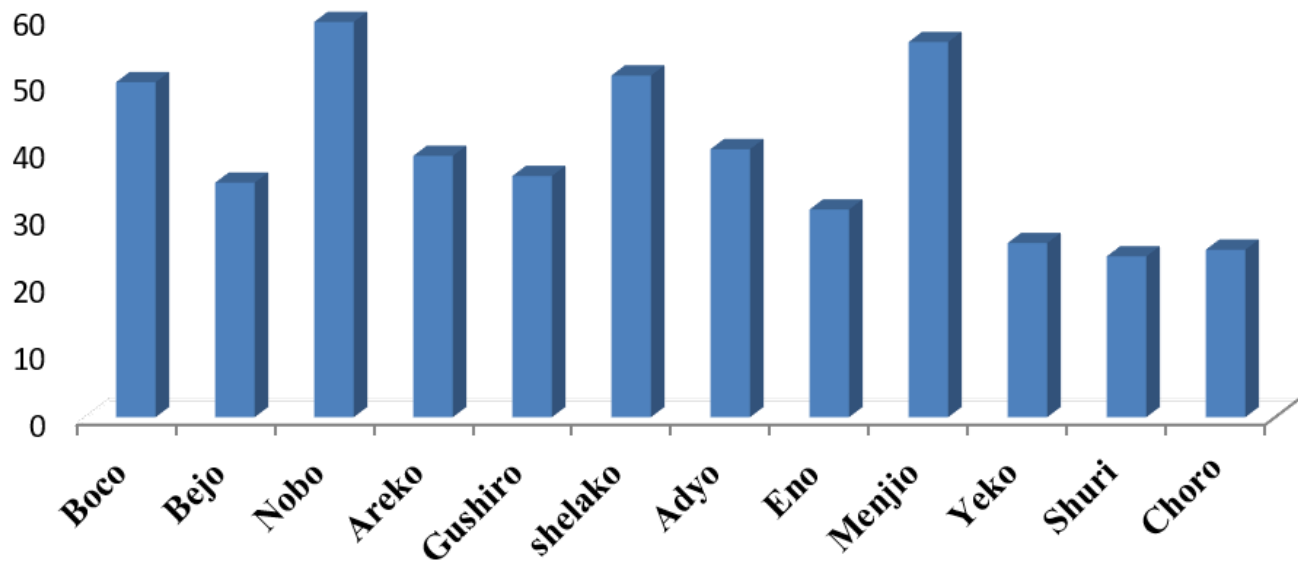


Figure 6

Preference ranking of enset landraces for fiber quality.



Figure 7: A.



Figure 7: B.

Figure 7

A. Entire leaf wilted by bacterial

B. Yellow leaf by bacterial wilt

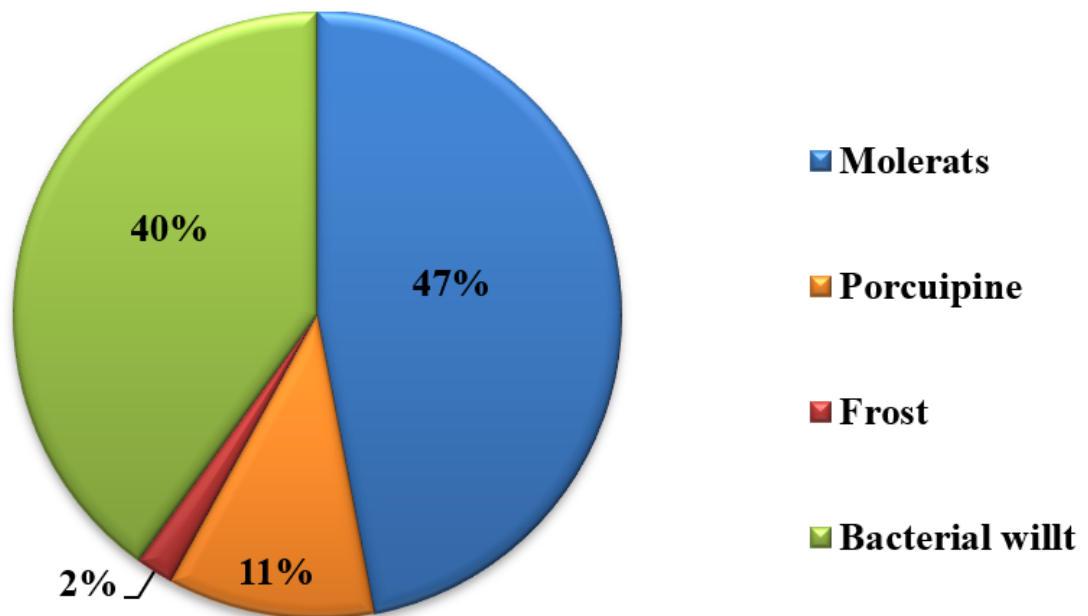


Figure 8

Percentages of onset constraints identified by local farmers in the study area

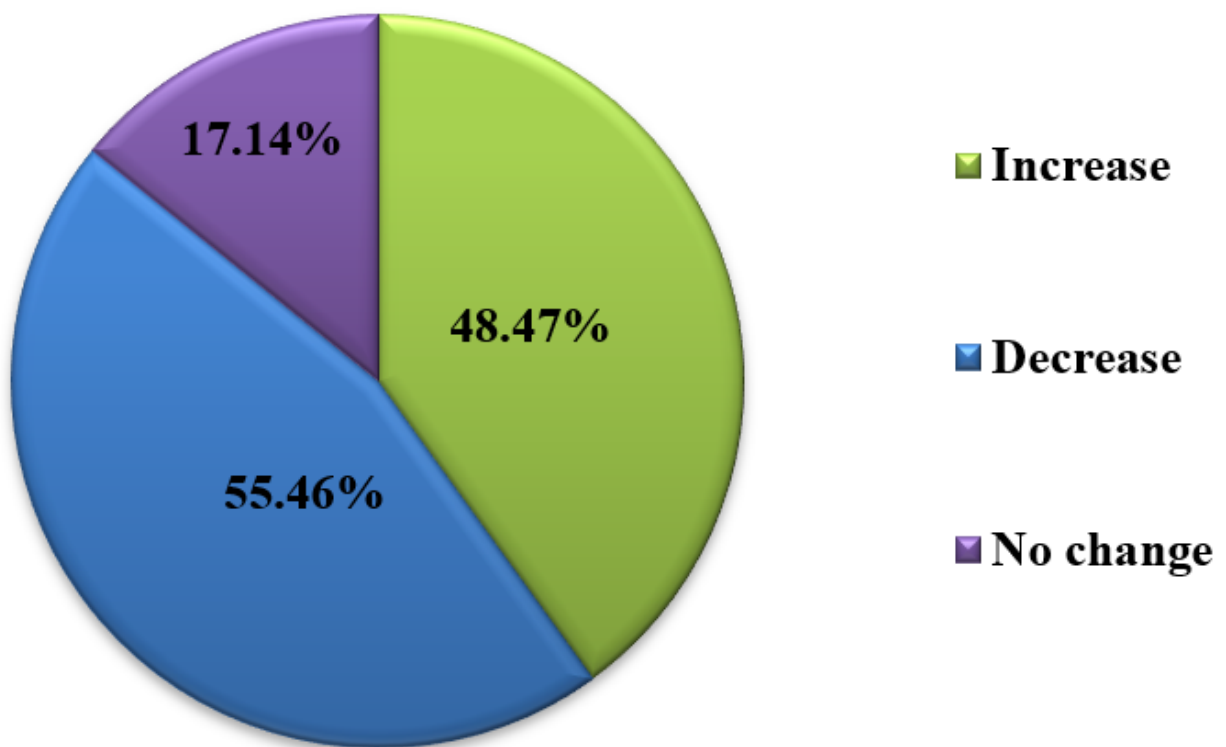


Figure 9

Farmers' response on the status of enset cultivation