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Full-Length Research Article

Identification, characterization and diversity of cultivated *Ensete ventricosum* landraces in Gamo highlands, South Ethiopia

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ABSTRACT

Enset-based indigenous knowledge and associated agro-ecological niche is often confined within cultural groups of enset growing regions, limiting further expansion of cultivation and development. This study aimed to identify and characterize enset landraces using farmers' knowledge and assess extent of diversity at two of enset growing districts in Gamo zone, South Ethiopia. Six localities encompassing 1530 to 3000 m.a.s.l were sampled at Chencha and Kogota districts. Observations, semi-structured interviews and focus group discussions were employed on 204 households. Names and quantities of enset landraces in the homegardens were recorded at a 10x10m^2 quadrant laid out per household. Totally, 38 enset landraces were recorded and grouped as processing (kocho, bulla) and cooking (amicho) types on the basis of characteristics described by farmers. These were locally distinguished as 'Wodala Uhthi' or Mac'c'a' Uuthi' in Gamo language. The Shannon index ranged from 2.75 at high altitude of Chencha to 0.75 at low altitude of Kogota suggesting diversity and altitude were directly proportional. The indigenous knowledge associated with enset landraces needs to be enhanced to ensure food security and resilience of the smallholder livelihood. Conservation initiatives such as Dorze Enset Field Gene Bank and around by Arba Minch University are highly encouraged.

Keywords: Amicho; Diversity; Enset; Kocho; Landrace

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1. INTRODUCTION

Enset (*Ensete ventricosum, (Welw.) Cheesman)* is an essential food security crop serving over 20 million people in Ethiopia (Zerihun *et al.,* 2013; Dereje, 2012). Indigenous to Ethiopia, enset is predominantly cultivated in the southern and southwestern highlands (Tadessa & Masayoshi, 2016). The pseudostem and/or corm are processed into kocho and bulla or amicho - the three edible products of enset. Kocho is a fermented starch derived from scrapped leaf sheaths and milled corms. Bulla is a dehaydrated product obtained from liquid extracted of the processed leaf sheaths and corm mass before fermentation. Amicho refers to boiled pieces of young enset corm, consumed similarly to other root and tuber crops (Sirawdink et al., 2013, Admasu, 2002). Enset grows across various agroecological zones, with product characteristics influenced by different cultivars (Endale *et al.,* 2013; Brandt *et al.,* 1997). Enset thrives best at altitudes between 2000 to 2750 m.a.s.l., 1100-1500 mm of rainfall, 10–21ºC temperature and a relative humidity of 63–80% (Brandt *et al.,* 1997).

Enset production system lacks standards in agronomic management practices and is affected by biotic constraints, mainly of enset bacterial wilt (Sabura *et al.,* 2021, Zerihun *et al.,* 2017; Admasu and Struik, 2002). On the other hand, Enset is rich in genetic and phenotypic diversity (Birmeta *et al.,* 2004; Tobiaw, 2011; Admasu, 2002) and adapts to wide range of agro-ecologies. Few studies elsewhere incdicated evidence of site-specific clone suitability, suggesting strong relationship between enset clone diversity and different growing environments, and farmers' preferences (Zerihun *et al.,* 2013; Endale *et al.,* 2003; Zerfu *et al.,* 2018). However, data is yet scanty on site-specific adaptation of different landraces growing in potential enset belts in Ethiopia. To this end, agro-ecological potentials suitable for production of specific landraces and products are not exploited due to lack of demand oriented agronomic improvement studies in enset.

The various enset landraces possess high production potential and management systems, bolstered by farmers' traditional knowledge (Awol *et al.,* 2014; Taddesse *et al.,* 2003). Farmers and scholars identify and categorize enset in different ways. Melesse *et al.* (2014) reported that farmers identify and categorize enset based on use values such as human and animal medicine. Others classify enset on the basis of different food values such as for bulla, kocho, and fiber

(Zerihun et al., 2016; Temesgen et al., 2014). However, use values stated in most literature represent only limited regions and lack detail grouping of the diverse enset landraces in the country (Mengesha et al., 2022; Tesfaye et al., 2023, Zerihun et al., 2016). For example., over 600 enset landraces maintained at Areka field gene bank (Zerihun et al., 2017) have not been fully characterized for the different use values, agronomic and environmental adaptation on the one hand and lack traceable data of their original collection sites, on the other hand.

However, identification of different enset genotypes (or local varieties or landraces) is somewhat complex as most of them are only locally recognized and whose extent of diversity has not been exhaustively assesed and documented over the entire enset growing regions in Ethiopia. The perceived characteristics of different enset genotypes such as maturity, tolerance to biotic and abiotic stresses, yield and product quality by farmers are believed to be influenced by the growing environment and farm management. Those characteristics may vary from region to region and less known to the scientific world as knowledge related to specific landrace is confined to local conditions. This limits further improvement and expansion of its cultivation and utilization across the country and beyond (Koch et al., 2021). Using on-farm observation approach, this study therefore aimed to identify, classify and assess the diversity of enset landraces at two districts of the Gamo highlands, South Ethiopia. This would contribute to the knowledge base required to utilize the full potential of enset landraces and to improve the food security and resilience of enset-dependent farm households, besides conservation of genetic resources for sustainable use. The specific objectives this study were to: (i) identify and document locally recognized enset landraces and characterize them in terms of perceived characteristics and morpho-agronomic features, (ii) classify each enset landraces into specific use value, and (iii) determine on-farm diversity of enset landraces in the study area.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

The study was carried out in two of the major enset growing districts of Gamo zone: Chencha Zuria and Kogota. The geographic locations of the two districts are 6°9'30"N- 6°26'00"N latitude and 37° 31'30"E- 37°42'30"E longitude (Fig. 1). Total population numbers for Chencha and Kogota are 94,149 and 74,258, respectively.

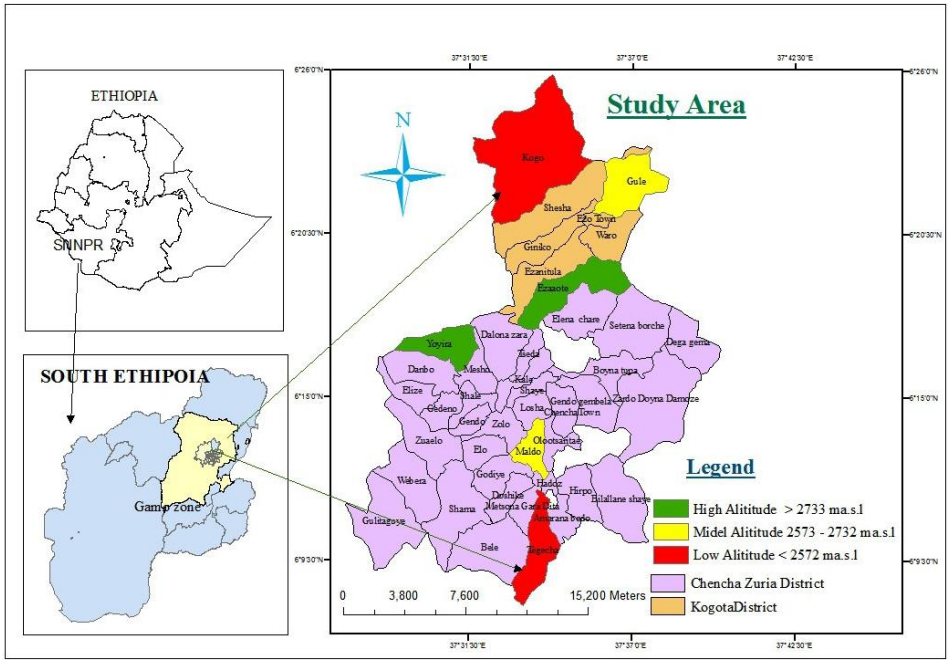

Figure 1. Map of the study area showing selected kebeles from higher, middle and lower altitude range.

2.2 Sampling Strategies

The two districts were stratified into three elevation zones (Fig.1): High Altitude (>2733 m.a.s.l.), Middle Altitude (2573 - 2732 m.a.s.l.) and Low Altitude (<2572 m.a.s.l.) which represent major enset production belt. Three representative kebeles/localities were selected from each district, each two localities belonging to two districts falling within each of the three altitude range. Total household size at each locality was obtained from the list of locality agriculture office. From the total of 2098 households at the six localities, 204 enset farms/respondents were determined for the entire study (Table 1) using sample size determination formula (Yamane, 1973) in equation 1.

$$n = \frac{N}{1+N} X\ (e^2) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(Equation 1)}$$

Where n is number of required samples or enset growing households interviewed, and N = Total number of households of the districts obtained from list of households in each locality agriculture office and ‘e’ stands for the marginal error, i.e., 0.07 (93% confidence interval).

Table 1. Selected localities, altitude ranges and sample size used for the study.

District	Kebele/locality	Altitude class	Altitude range (m)	Household size	Sample size
Chencha	Yoyira	High	2733-2909	429	44
	Lakana Maldo	Mid	2573-2597	224	28
	Tegecha	Low	1788-2320	365	30
Kogota	Ote	High	2750-3000	350	38
	Gule	Mid	2620-2732	370	35
	Kogo Ayira	Low	2500-2572	360	29
Total				2098	204

2.3 Data Collection

Field surveys were conducted in the sampled households during mid September to November 2022. Data collection employed interviews using semi-structured questionnaire designed for this purpose and administered to each household, focus group discussion and observations. Farmers were asked to tell the names of the landraces cultivated in their farms and distinct names were recorded. Information on the use values: Kocho, bulla, amicho, and medicinal of each recorded landraces were obtained from farmers. In addition, information on adaptation areas, maturity status and general plant size of each landrace were collected. Furthermore, names and quantities of enset landraces were enumerated per farm using a $10x10m^2$ quadrant laid out along a transect representative of enset home garden (one quadrat per household). Key informant interviews and focus group discussions were also held especially to cross-check landraces names, use values and if duplicate names exist for certain landraces at different districts and localities. Handheld GPS (Garmin 72) was used to record the geographic coordinates of each sampled household farm.

2.4 Data Analysis

Shannon-Wiener diversity (H') and evenness (E) indices were first computed using the formula suggested by Hennink & Zeven (1990).

$H' = -\sum pi \ln pi$ .....(Equation 2)

Where, pi represents the proportional abundance of the i^{th} landrace; lnpi is the natural logarithm of pi.

Evenness was calculated as a measure of the observed diversity to the maximum diversity (H'max) and defined by the function E = H′ ln S .....(Equation 3) where H′ is the Shannon index and S refers to the number of landraces described in each locality.

Richness was determined by counting the total number of respective landraces occurred in a district or locality.

The similarity or variation of enset clones composition between the districts and localities were determined using Sorenson's similarity coefficient (Sorensen, 1948) per the equation below:

$$Cs = \frac{2c}{a+b} \quad \text{..... (Equation 4)}$$

Where Cs represents Sorenson's coefficient, 'a' is the number of landraces at locality A, 'b' is the number of landraces at locality B, and 'c' is the number of landraces common to both localities. The values obtained from the above calculations were analyzed using SPSS Version 20. Diversity, richness and evenness values among locations and altitude groups were determined using analysis of variance and statistical significance was tested using LSD at 5% level of significance.

The uses of enset landraces were grouped into three main categories based on their similarity in use value: Kocho and Bulla, Amicho, and medicinal value and associated characteristics and frequency and percentages were computed.

3. RESULTS AND DISCUSSION

3.1 Naming and characterization of Enset Landraces in Gamo highlands

In the study area, 38 distinctly named enset landraces were recorded and explanations were associated with each named landrace (Table 2). The names of landraces were recorded in Gamo language, which is dominantly spoken by the Gamo ethnic group in the study area. Physical characteristics of the specific landraces, suitability for food uses/quality, resemblance of landraces characteristics to names/nature of other objects, original location of a landrace were used in naming of specific landraces. Furthermore, other characteristics such as the plant's ecological adaptation (high, middle and low altitude), maturity and plant size especially height were used to distinguish one landraces from the other (Table 2). This study agrees with Bizuayehu (2008), who reported that names of enset landraces were related to plant

characteristics, locality, names of objects, persons, social groups, etc. per the knowledge of farmers in that region.

Names for most of the cultivated enset landraces in literature from different regions have been only locally recognized as there have been only six released cultivars (Zerihun et al., 2012). In this study, farmers reported that most of the landraces (25; 66.8%) adapt in the highlands and the rest (13; 37 %) to have adapted in the mid and lowlands. Other sort of classification was based on maturity and plant size, 25 landraces (65.8%) and 13 landraces (34.2%) were grouped under early and late maturing, respectively. It was also reported that early maturing landraces were generally said to be smaller whereas late maturing landraces were perceived to be vigorous. Farmers' preferences for cultivating most of the early maturing landrases suggest their role in closing the food gaps which may occur due to changing climate. However, such categorization by farmers may vary from place to place as farmers and often based on long-years of practical experience over generations. As empirical evidence is very limited on agronomic characteristics of the available enset landraces in the farmers' fields and at Areka field gene bank (Zerihun et al., 2012; Zerihun et al., 2017), more field trials are needed to prove the perceived characteristics for efficient utilization of enset genetic resources under different environmental contexts.

Table 2. Naming of enset landraces and their perceived characteristics in Chencha and Kogota districts, Gamo zone.

No	Vernacular name	Explanations about naming	Agro-ecology	Maturity	Plant height
1	Beshera	Sweet and soft corm when boiled	High	Early	Smaller
2	Bodha	Sweet and soft corm when boiled, bigger corm	High	Late	Vigorous
3	Bora	Thicker landrace	High	Early	Smaller
4	Boroda Maze	Named after original location (Boroda area)	High	Late	Vigorous
5	Botha Zinke	Named after pale green pseudostem, not other colorations	Mid & low	Early	Smaller
6	Botha	White pseudostem	High	Early	Smaller
7	Bundo	Remains plentiful when eaten	Mid & low	Early	Smaller
8	Chamise/chamo	Bitter amicho when eaten	High	Late	Vigorous
9	Checho	After distinctive brownish-spotted appearance	High	Early	Smaller
10	Dokaze	Derived from "Doko" area, where it was originated	High	Late	Vigorous
11	Gena	Highly valued for Kocho preparation, may also be related to plant size	High	Late	Vigorous
12	Godare	Named after skin color of hyena as the pseudostem resembles	Mid & low	Late	Vigorous
13	Halako	Crispy and sweet corm, especially in dry season	High	Ealy	Vigorous
14	Halanga/Alanga	Known for long and strong fibre	High	Early	Vigorous
15	Haliee	Not explained	Mid & low	Early	Smaller
16	Haranbo	Not explained	Mid & low	Early	Smaller
17	Hoe	Not explained	High	Late	Vigorous
18	Karga/charga	Its corm is hard	Mid & low	Early	Smaller
19	Katane	Is fast growing	High	Early	Smaller
20	Katise	Stress tolerant	High	Early	Smaller

Table 2 continued

No	Name	Explanations about naming	Agro-ecology	Maturity	Plant size
21	Kelo	Not explained	Mid & low	Early	Smaller
22	Kunka	Used during periods of food scarcity	High	Early	Smaller
23	Loffe	Pink appearance, also used as a medicinal, ornamental	Mid & low	Early	Smaller
24	Loza	Not explained	Mid & low	Early	Smaller
25	Masa Maze	After 'Massa", a person who brought, has also a laxative property	High	Late	Vigorous
26	Maze	Bitter amicho, originated from Doko Mesho area	High	Late	Vigorous
27	Orgozo	Thick and large plant	High	Late	Vigorous
28	Pallake	Can feed more people	High	Late	Smaller
29	Patate	Not explained	High	Early	Smaller
30	Phello	Sought after for Amicho	High	Early	Smaller
31	Shina	Named after a cursed place, name also associated with its taste	Mid & low	Early	Smaller
32	Sorghe	Its Kocho ferments and spoils quickly	High	Late	Vigorous
33	Suite	Named after blood like fluid (sap) that comes out of midrib	High	Early	Smaller
34	Tadesa- Utha	Named after Tadese, a person who brought the plant to the area	Mid & low	Late	Vigorous
35	Wosayife	Narrow leaves resembling banana leaf, has medicinal value	High	Early	Smaller
36	Yila	Not explained	Mid & low	Early	Smaller
37	Zinkie	Delicious corm with crispy mouthfeel	High	Early	Smaller
38	Zoo Zinke	Deep red midrib and pseudostem	Mid & low	Early	Smaller

3.2 Farmers' Classification of Enset Landraces

3.2.1 Classification on the basis of use values

The cultivated enset landraces studied were classified as processing types (kocho and bulla) and cooking types (amicho), but also grouped as those used for both kocho and amicho and medicinal purposes (Table 3). This means farmers cultivate different landraces for various purposes, but kocho and amicho were the main food products as most landraces were grouped under these two products. However, among the 38 enset landraces identified in this study, majority (60.5%) belong to processing types, most common ones include Maze, Tadesa-Utha, Bodha, Falake, Sorghe, Gena, Beshera and Katise (Table 3). It was also perceived that high yield and good quality kocho would be obtained from matured plants. Since bulla is obtained via squeezing the processed enset mass to be fermented for kocho, landraces said to be used for kocho can also yield bulla, although which landraces were not separately identified for bulla in this study. On the other hand, 23.7% of landraces were known as cooking or amicho types and the most preferred ones in this group were Katane, Zoo Zinke, Halako, Bundo, Phello and Botha Zinkie in the study area (Table 3). The best amicho types were distinguished by their delicious corm with crispy mouth feel (neither too moist nor too hard) after cooking. The processing and cooking types were also distinguished by their perceived characteristics, the processing types being late maturating and having larger biomass while the amicho types being faster maturity and smaller biomass. This implies that processing and cooking type landraces would interact differently with environment, as there is high phenotypic plasticity in enset with implication on yield (Sabura, 2022; Admasu and Struik, 2003).

There were also enset landraces, which can serve both for kocho processing and amicho cooking. However, the suitability of the landraces for amicho in this group depends on plant age with good amicho cooking and sensory quality achieved at later age compared to common amicho types, which are often harvested at younger ages. Therefore, the harvestability of enset at any time when needed ensures the uniqueness of enset crop for household food security especially during food shortage. However, farmers in the study area perceive that the sensory qualities of amicho depends not only on type of landrace, but also on farm management (Sabura et al., 2021) which necessitates further agronomic and nutritional study to prove such hypothesis and to promote diversified enset-based foods to a larger community.

In line with our finding, studies in other enset regions in Ethiopia showed that some landraces are best for Kocho and bulla while others were preferred for Amicho (Kedir, 2016; Tesfaye et al., 2023; Zerihun et al., 2014). Moreover, the study by Tesfaye et al. (2023) showed that some amicho types were superior in proximate and minerals contents, which may highlight their role in repairing bone fractures. Therefore, similar nutritional profile studies are needed on the enset landraces identified in the study area to support their use values with scientific evidences.

Table 3. Characterization and classification of enset landraces based on use values according to indigenous knowledge at Chencha and Kogota districts, Gamo zone.

No	Uses	Characteristics	# landraces (%)	Landrace within the use group
1	Kocho & Bulla	high yield; large, thick pseudostem, big corm, late maturing	23 (60.5)	Maze, Tadesa-Utha, Sorghe, Palake, Karga, Origozo, Halango, Haranbo, Haliee, Bora, Boroda Maze, Patate, Botta, Godare, Kunke, Shina, Yila, Hoe, Loza, Kelo, Katise, Masa Maze, Chamise
2	Amicho	Tasty and crispy corm, fast cooking, small corm, short in stature, early maturing	9 (23.7)	Bundo, , Phello, Zinkie, Botha Zinkie, Checho, Dokaze, Katane, Zoo Zinke, Halako
3	Kocho & Amicho	Can be processed & boiled	4 (10.5)	Beshera , Bodha, Gena, Wosaiye
4	Medicinal	Treatment of disorders	2 (5.3)	Suite, Loffe

The enset plant and its parts contribute to indigenous ethno-medicinal values in the study area district. According to respondents, the part of enset corm, leaves, and pseudo stem of Loffe and Suite enset landraces were used to treat both animals and humans' aliments (Table 3). Similarly, studies by Kedir (2016) described that "Astara" and Qibnar" enset landraces in Gurage were used to cure both human and animal diseases. More information on ethnno-medicinal values of Enset landraces were also described in literature (Mikias and Mengistu, 2023; Gizachew et al., 2022; Addis et al., 2006). Further research should give attentions to the biochemistry and clinical tests to prove/disprove this hypothesis and help provide homegrown solutions for health and nutrition, for

e.g., research on role of enset for orthopedics is recently initiated at Armauer Hansen Research Institute, Ethiopia (personal communication, Prof. Milkias Endale).

3.2.2 Characteristics of 'male' and 'female' enset landraces

In the study area, enset landraces preferred for kocho and bulla products were easily distinguished as 'male' clones while those for amicho were called 'female' clones as characterized in Table 4. 'Male' and 'female' landraces were respectively known as '*Wodala Uuthi'* or '*Mac'c'a Uuthi'* in Gamo language. It should not be misleading that such distinction as 'male' and 'female' is not related to the biological reproductive behavior rather based on suitability for kocho processing and corm cooking, maturity period, yield and product quality as well as level of stress tolerance. Of the total 38 landraces identified, 23 processing types (Table 3) were classified as 'male' and 11 (9 amicho types +2 medicinal types) were identified as 'female' landraces, while the rest four landraces were perceived to share the characteristics of both 'sex' groups. Similarly, enset clones sharing 'male' and female' characteristics as in our study were classified as soft and hard in Guji area of Oromia region (Wendawek et al., 2022). Bizuayehu (2008) reported similar mode of classification of enset landraces as female (Meyate) and male (Labbaahu) depending on criteria such as maturation time, plant size, and its hardness to process by Sidama people. More such like reports from other regions is also available in literature (Temesgen et al., 2014), although empirical evidence on such characteristics is scanty and needs agronomic research and testing enset-based products quality (sensory, nutritional profiles, medicinal and bioavailability) among landraces to satisfy growing consumer need and markets. Moreover, future research should focus on fast maturing amicho types which may perform at mid and low altitudes to enhance food security and resilience.

Table 4. Perceived characteristics of male and female enset landraces based on farmers' indigenous knowledge in Gamo highlands.

Characteristics	**'Male'**	**'Female'**
Maturity	Late maturing	Early maturing
Amicho product	Hard & not suitable for amicho	Suitable for amicho (loose textured corm falls apart into small pieces after cooked
Kocho and bulla product	High yield & slow fermentation	Low kocho yield, ferments quickly
Fibre	Strong, high in quality & quantity	Low strength, low quality & quantity
Plant size	Bigger	Smaller
Reaction to biotic stress	Tolerant	Susceptible
Leaves	Hard and stiff	Soft
Leaf sheath	Hard and stiff	Soft
Average yield	Higher	Lower

3.2.3 Diversity and abundance of Enset landraces at different altitude categories

In this study total of 38 locally named enset landraces were recorded (Table 5). Admasu (2002) described 52, 55 and 59 Enset landraces from Sidama, Wolaita, and Hadiya, respectively. Thus, landraces in our study area seem fewer compared to other regions. Less number of landraces in the present study may be due to inclusion of limited geographies (i.e., only two districts) compared to other regions. Table 5 indicated that the diversity indices, Shannon (H') index, richness and abundance decreased with decreasing altitude. 'H' ranged from 0.75 at Kogota lowland to 2.75 or 2.55 at Chencha or Kogota highland (Table 5). The result also revealed significance difference in 'H' among the three altitude ranges.

Table 5. Diversity indices of Enset landraces across different altitudes of Chencha and Kogota districts, Gamo zone.

No	Altitude	Districts	Shannon index	Richness	Evenness	# of unique clones
1	High	Chencha	2.75^{a}	18^{ns}	0.8^{a}	2
		Kogota	2.55^{a}	23^{ns}	0.9^{a}	6
2	Mid	Chencha	1.95^{ab}	14^{ns}	0.7^{b}	1
		Kogota	1.65^{b}	15^{ns}	0.8^{b}	0
3	Low	Chencha	1.15^{b}	19^{ns}	0.7^{b}	0
		Kogota	0.75^{c}	5^{ns}	0.8^{b}	0

Values in small letters within columns show significant differences ($P < 0.05$) according to F- test between altitudes and between districts.

The higher enset clonal diversity with increasing altitudes may be related to the agro-ecological suitability as precipitation and humidity increases with rising latitudes in the study area. Moreover, it indicates higher dependence of highland communities on enset as major source for household food security. In addition, highlanders had better knowledge about the uses of different enset landraces so they maintain diverse landraces in their farms. On the other hand, less Shannon index in farms of low-lying communities suggest less contribution of enset to food security and livelihood at present. This may be associated with the fact that enset farms shift to annuals at middle/lower altitudes. Increasing enset diversity at highlands is in line with literature (Zerfu et al., 2018; Admasu, 2002; Awol et al., 2014; Melesse et al., 2014). Lower diversity indices with decreasing altitude in our study may also be linked to lack of own clean planting materials as communities at lower elevation ranges in this area often rely on passing sellers from highlands due to poor extension efforts on enset (Vantyghem, 2018). Relationship between species diversity and altitude gradient in vegetation may vary with type of vegetation and altitude levels, but species diversity increases from highland to midland in trees and shrubs (Fikadu et al., 2019) as opposed to enset.

Table 6 summarises Sorenson's similarity coefficient for pair of localities. The result showed similarities in landraces between localities but with different intensities. The similarity index ranged from 0.2 (between Ote and Kogo-Ayira) and 0.9 (between Yoira and Lakana Maldo). The similarities in landraces between pairs of locations were attributed to proximity and/or similarity in altitude category (Fig. 1, Table 1). For instance, both pairs of locations: Ote and Kogo-Ayira; and Yoira and Lakana-Maldo were located close to each other, but fall under different altitude ranges. For par of locations under similar altitude, the Sorenson's coefficient ranged from 0.5 (Kogo Ayira

vs Lakana-maldo) to 0.8 (Yoyira and Ote). This indicates nearby locations share similar landraces suggesting that farmers obtain planting materials within their neigbourhoods or obtain from local markets. Common landraces observed for locations under similar altitude range may indicate adaptation of similar landraces to certain altitude range, with implications on genotype - environment suitability in enset. Less similarity of landraces between pair of locations in a close distance may be due to the fact that preference for landraces may differ from farmer to farmer perhaps depending on soil type and access to type of planting materials. Enset is said to adapt to wide range of environments and adaptation is often mentioned in literature as one of the criteria for selection of landraces. Our data show proximity and environment influences diversity and composition of enset landraces. However, literature dealing with agro-ecological adaptation of specific enset landraces is scanty; hence, further research to identify genotypes more performing in a certain environment is crucial to ensure sustainable intensification of enset cultivation, particularly in the era of climate changing.

4. CONCLUSIONS

Indigenous knowledge about enset accumulated over generations can contribute to advancing enset farming and efficient utilization of its genetic resources in Ethiopia and beyond. This study provided first-hand information generated from farmers' experiences from Gamo highlands. Enset is recently attracting national and global attentions in terms of research, food security, commercialization and environmental resilience. In this regards, documentation of the available genetic resources and associated indigenous technical knowledge is essential for sustainable intensification of enset cultivation for various use values and applications. Accordingly, our study showed that enset landraces in Gamo highland were classified into different categories such as product use value (processing in to kocho or for direct use as cooked amicho, for both kocho and amicho, or medicinal purposes). Moreover, agro-ecological suitability of landraces, maturity period and plant vigor (size) were considered by farmers as important criteria to classify enset landraces. We conclude that this accumulated indigenous knowledge played a significant role in mainiating enset landraces diversity and food system. Therefore, it is recommended that designing systematic field experimentations, enset-based products development and commercialization need to account for such knowledge base to ensure sustainable intensification of enset farming system in the region. In this context,

conservation efforts such as Dorze Enset Field Gene Bank initiatives by Arba Minch University are duly appreciated.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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