On-farm Diversity and Characterization of Barley (*Hordeum vulgare* L.) Landraces in the Highlands of West Shewa, Ethiopia

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Research

Abstract

Barley has a long history of cultivation in Ethiopian highlands. In Dandi and Jeldu districts, barley is the major staple crop and it is deeply rooted in the socio-cultural lifestyle of the communities. Over centuries, natural and human selection resulted in a huge diversity of landraces. This diversity, however, is subject to serious genetic erosion. A survey was carried out to record the status of barley landraces. In total, 14 landraces were described by farmers. However, only four of them are still cultivated. Environmental factors, e.g., degradation of soil fertility, were main factors for the loss of diversity. Preservation of landraces is influenced by their end-use, market demand and price. Recently, some more input demanding landraces which are usually grown around homesteads were replaced by potato. Regeneration of soil fertility, re-introduction of lost landraces and improvement of landraces are suggested for the restoration of barley diversity in Dandi and Jeldu districts.

Introduction

Barley (*Hordeum vulgare* L.) is one of the cereal founder crops, domesticated about 10,000 years ago in the Fertile Crescent (Lev-Yadun *et al*. 2000). In Ethiopia, the long history of cultivation and the diverse agro-ecological and cultural practices have resulted in a wide range of barley diversity. Vavilov (1951) declared that nowhere else in nature he has observed such a diversity of forms and genes. Therefore, he proposed Abyssinia (the former Ethiopian Empire) as a center of origin of cultivated barley. The diverse series of endemic botanical varieties may be the result of either an independent domestication or independent development after an introduction from southwest Asia at an early date (Harlan 1969, Negassa 1985, Orabi *et al*. 2007). Today, Ethiopia and Eritrea are at least considered as centers of barley diversification. Ancient methods of tillage, sowing, harvesting, threshing (Figure 1), winnowing, dehulling and processing as described by Harlan (1969) in the late 1960s are still practiced by the majority of subsistence farmers in the Ethiopian highlands.

World-wide, barley is mainly produced for feeding and malting. In Ethiopia, however, barley is a main staple crop and human consumption is in the limelight. Barley is the predominant cereal in the high altitudes (>2000 m.a.s.l.) and cultivated in some regions in two distinct seasons: **belg** which relies on the short rainfall period from March to April, and **meher** which relies on the long rainfall period from June to September (Bekele *et al*. 2005, Lakew *et al*. 1997). Barley is the most dependable and desirable crop for the resource-poor highland farmers where poor soil fertility, frost, water logging, soil acidity and soil degradation are the major yield limiting factors, and where other cereals fail to grow. In such areas, barley is the major source of food, home-made drinks, animal feed and cash. Barley grain is used in a diversity of traditional recipes and the preparation is deeply rooted in the culture and tradition of rural people's diets. The straw is used for feeding livestock, especially in the dry season, for construction of houses, thatching of roofs or use as bedding.

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Figure 1. Threshing of barley at high elevation areas in Ethiopia using horses. Usually threshing of cereals is carried out by oxen.

The greatest frequency and diversity of barley landraces occurs in the northern and central highlands (Asfaw 2000, Bekele *et al*. 2005, Lakew *et al*. 1997, Yirga *et al*. 1998).

As one of the oldest cereal crops cultivated since ancient times in Ethiopia, barley has passed through the processes of farming which in turn have been affected by the complex socio-cultural attitudes of communities and the prevailing environmental changes. Information concerning the impacts of socio-cultural conditions of farmers on the maintenance of crop genetic resources is rare in Ethiopia. In most cases, the conservation and maintenance of landraces as part of cultural heritage of a region or country has received too little attention (Zeven 1998). Landraces are in many ways comparable with monuments, traditional costumes and folk songs as examples of cultural heritage. In Ethiopia native barley varieties are suffering serious genetic erosion (FAO 1998, Worede *et al*. 2000). Brush (1999) defined genetic erosion as the loss of variability from crop populations in diversity centers, i.e., areas of domestication and secondary diversification. Hammer *et al*. (1996) defined it broadly as the loss of particular local landraces expressed as the ratio of the number of landraces currently available to their former number. Anyway, genetic erosion is associated with the loss or change of frequency of genes, alleles or allele combinations which might result in a species' fitness, long-term viability and ability to adapt to changing environmental conditions. The present study was conducted in order to document the local knowledge and status quo in regard to barley diversity, to estimate the extent of loss, and to evaluate how socio-cultural lifestyles of farmers affected on-farm maintenance of barley landraces in the West Shewa zone of Oromiya region, Ethiopia.

Methods

Four **kebele** (peasant communities) of Jeldu and Dandi **woreda** (district), two in each district, were studied. The communities were Chilanko and Edensa Gelan from Jeldu district, and Galessa Koftu and Galessa Kota Geshir from Dandi district. These communities are located within the central highlands of Ethiopia, in the West Shewa administrative zone (Figure 2) and are known for their diverse, high potential and large-area barley production. Dandi

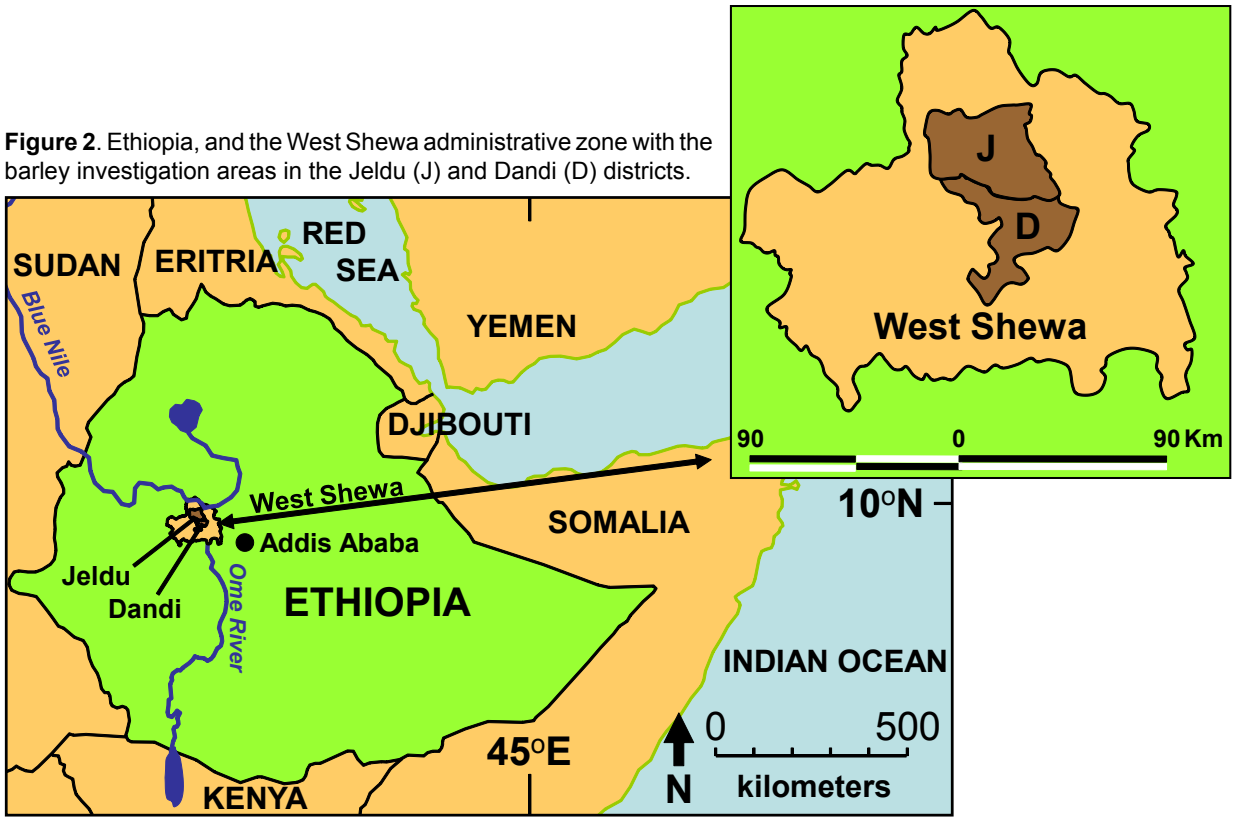

Figure 2. Ethiopia, and the West Shewa administrative zone with the barley investigation areas in the Jeldu (J) and Dandi (D) districts.

district is medium populated and has a high road density, whereas Jeldu district has a low human potential and low road density (Tefera *et al*. 2002). Three villages were selected from each community. All villages are located alongside the all-weather road from Ginchi (9°2'N, 39°9'E) to Shikute (9°23'N, 38°1'E). Generally, the study area is characterized by rugged hills, altitudes of >2000 m a.s.l. and cool climate. Focused group discussions were organized in each village with the help of development agents of the District Offices of Agriculture (DOA). All farmers of the villages were invited and 7–12 farmers per village were selected to participate in the discussions. Selection of farmers was carried out in a way that approximately half of the persons were women and elder farmers who are traditionally known as experts in farming and seeds. In total 121 respondents were interviewed, of which 25% were women, as the decision to conserve a plant variety largely depends on its usefulness to the household and community. The discussions were held in nearby barley fields to enable the farmers to demonstrate their varieties.

Farmers were exposed to open questions following a questionnaire modified after Hunduma (2006) to get as much information as possible on the cultivation, and maintenance of the landraces and values linked to socio-cultural settings of the society. Consolidated opinions and agreements on the discussed topics were noted. Moreover, key informants like agricultural extension experts were asked to give their knowledge concerning barley. Secondary information was also collected from the DOA to support primary data.

On-farm loss was calculated following Hammer *et al*. (1996) as the ratio of the number of currently to formerly cultivated landraces. The current loss was calculated considering the number of landraces matching with accessions stored *ex-situ* in the gene bank of the Institute of Biodiversity Conservation (IBC), Addis Ababa, and which were originally collected in Dandi and Jeldu. Vernacular names of landraces were used as a proxy indicator for diversity considering that barley is a self-pollinating species and, therefore, its genetic integrity is maintained over relatively long periods of time. The members of the studied peasant communities all belong to the same ethnic group, have similar socio-economic and cultural environments, and perform similar farming systems and cropping patterns. Hence, information concerning crop species and vernacular names has co-evolved with the cultivated crops and, most likely, remains consistent (Tsegaye & Berg 2007).

Results

Staple crops

In the study area barley is exclusively grown in meher season and it is the dominant crop. It is more important than wheat (*Triticum* L.) or tef (*Eragrostis tef* (Zucc.) Trot-

ter) for both home consumption and market. Farmers reported that barley adapts better to lower soil fertility than wheat. However, barley landraces also vary in their nutrient demand, and it was reported that many landraces which demand good soil properties are presently out of production. According to the interviewed farmers, only four types of barley landraces are grown at present, two of them – **balame** and **garbuguracha** – are grown on a larger acreage. Recently, the production of potato (*Solanum tuberosum* L.) has increased around homesteads where it competes with barley for space. Farmers use potato as a major food crop providing food security as well as cash. Particularly elite farmers are specialized in seed potato production for sale to other farmers/organizations from different parts of the country. The expansion of potato at the expense of barley is a result of research intervention by the introduction of improved, high yielding and disease resistant varieties along with agronomic practices, i.e., one or two fungicide sprays.

Systems and trends in barley production

Depending on the type of available farmland and landraces, it is common that the farmers systematically divide their farms to different varieties every season. If a farmer does not have a field available which is suitable for planting a particular landrace he would be forced to give up its cultivation if in another year no seeds of that landrace are available within the informal seed system. Sometimes also more than two landraces are grown in mixtures; the harvest of such mixtures is called **asharo** and indicates mixed barley grains of low quality. **Asharo** is usually sold at the market at low prices to make home-made drinks. The farmland is allocated to each landrace based on soil fertility and nutrient demand of the variety. The applied cropping practice, locally called **wartaba**, should reclaim soil fertility and/or improve soil texture by fallowing the farmland every second season. Farmers indicated that planting barley after barley or any other cereal results in very low if any yield. Crop rotations with grain legumes failed since the latter ones did not adapt to the prevailing environmental conditions. Recently, research and extension promoted improved linseed (*Linum usitatissimum* L.) varieties as a strategy to maximize land use for crop production in the face of growing human population and declining farm size. Linseed is suitable to the growing conditions of the study area and it is now expanding as a rotation crop to barley instead of the usual barley-fallow system.

In the area of Edensa Gelan, barley production has passed through intricate processes. Farmers reported that there was a brief period when barley was replaced by wheat in the late 1980s. Improved wheat varieties which were introduced into the system pushed to wider areas and wheat became the main cereal crop at that period. Later on, wheat cultivation declined to its prior acreage due to declining soil fertility, frost damage and diseases. In return, barley production rose to its previous status. The transitional period implicated losses in the diversity of barley landraces. Since then the acreage of barley fields steadily increased while the number of cultivated landraces and the yield per unit area decreased. A few farmers reported that they once also received modern varieties of barley, the names of which they could not remember. These varieties were given up since they could not adapt, however, some had influence on the replacement of landraces during their cultivation.

Seed selection and maintenance

Farmers are not aware of seed production per se. Seeds for next season's sowing and grains for consumption are not stored separately. However, information was provided that plumpness, size and weight of grain are of major interest for seed. Sometimes, but not very often conditioning of seeds is done by winnowing. Thereby, light, small sized grains and weed seeds, and chaff are removed from the seeds. Selections within and between landraces are seldom carried out and if it is rather a mass selection considering specific traits such as height, lodging, earliness, head type and shape, etc., than an individual plant selection. Concerning end-use quality, women are responsible for the decision of planting a particular landrace.

Usually farmers sow their own seed, less often seed exchange and loans are practiced within the community. The household leader controls the outgoing and incoming of grain, however, the control is weak when the seeds are stored in **gotera**, traditional containers made from wood, mud and cow dung. Recently, plastic sacks were becoming popular mainly for easy control of grain in the household. Grain is also sold in open markets or by retailers.

Landraces and their main characters

A total of 14 barley landraces were documented. Farmers are familiar with the nature of the landraces they grow, able to describe their agronomic characteristics and end-uses. They use specific names for all the landraces and generic names for groups of landraces. Generic names were given based on characters like head type, e.g., **netela** for two-rowed and **diribi** for six-rowed barleys, and seed color. Most of the landraces have distinct and non-overlapping characters of their own. The descriptions were all given by farmers and supported by own field observations for those landraces which are still cultivated. In Table 1, the main characteristics of the landraces are reported. In the following the presently cultivated landraces are described more comprehensively.

Garbuguracha which means 'black barley' is a six-rowed, black grained barley with oval-shaped seeds of heavy weight. Its grain is soft and breaks easily. Currently it is the dominant barley landrace in the study area. Farmers rank **garbuguracha** first concerning tillering capacity. It is

Table 1. Description of barley (*Hordeum vulgare* L.) landraces cultivated in Dandi and Jeldu districts, West Shewa zone, Ethiopia.

Vernacular name	Seed color	Head / Caryopsis type	Maturity (months)	Preferred end-use	Agronomic remarks
Ababadhas	white	6-row, hulled	5	**kinche**, **chiko**, **injera**	long spikes, drought tolerant, lodging, light & chaffy seeds
Abashewaye	white, purple	6-row, hulled		**injera**, beverage	tall plant height
Balame **Balame-adi** **Balame-shamarigura-cha**	white, black	2-row, hulled	5-5½	**injera**, roasted, **kinche**, **chiko**, **beso**, porridge, beverage	tolerant to low soil fertility and drought, good flour quality
Butuji **Butuji-adi** **Butuji-guracha**	white, black	6-row, hulled	early	malt (**bikil**), home-made beer, liquor	short plant height, lodging tolerant, requires fertile soils, large grain size, requires soil fertility, high
Garbuguracha	black	6-row, hulled	6	malt, beverage	needs fertile soils, high yields, tall plant height, tendency to lodging
Hadho (**Garbuhadho-adi**)	white	6-row, hulled	6	**injera**, **kinche**, **chuko**	large seeds, good flour quality, tall plant height, lodging tendency, susceptible to drought and cold, straw for livestock feeding
Kate	white, black	2-row, hull-less	3-3½	malt (**bikil**), beverage, roasting (grains burst like popcorn)	short plant height, lodging tolerant, seed shape similar to wheat grains,
Kitankite	white	6-row, partially hulled	4	roasted (**kolo**), beverage	small seed size, short plant height, loses easily the hulls after heating, needs fertile soils
Luka'a (**Senefgebs**)	white, black	2-row, partially hulled	4-5	roasted, **kinche**, **beso**	prefers fertile soils, low yield
Muga	purple	6-row, hulled	7	**injera**, beverage, liquor, porridge, roasted	large seeds, house construction, needs long rainy seasons and fertile soils, high grain yields, good flour yield, straw for thatched roofs
Samareta **Samareta-adi** **Samareta-dima** (**Dimicho**)	white, purple	2-row, hulled	4-5	**beso**, **injera**, **shameta**, roasted (**kolo**)	large seed size, requires fertile soil, tall plant height, lodging tendency, high 'vitamin' content[1]
Shamari	black	2-row, hulled	6	beverage, liquor, roasted	
Sidamo	white, purple, black	6-row			probably named after the Sidamo region, located in the southern parts of Ethiopia
Warkina	white	6-row, hulled	3-3½	**beso**, porridge, beverage	short plant height, tolerant to lodging, prefers fertile soils, residual moisture production system

tall and has heavy spikes, therefore, a low seed rate and late planting are practiced to reduce lodging, especially under fertile soil conditions. Farmers reported that black barley is most preferred for making **bikil** (malt) used for preparing the home-made spirit/liquor known as **areke** or a home-made beer of high market demand. Consumed as roasted whole grain snack, known as **aka'i** or **kolo**, black barley causes discomfort in the stomach. Although the stem is thick, the straw is weak in strength, decays easily, and is not preferred for thatching roofs or feeding livestock.

Balame is a two-rowed barley with both white and black seeds. According to farmers, **balame** forms irregular numbers of rows under good soil fertility conditions. On soils with low fertility and under drought stress **balame** outyields the other landraces. **Balame**-**adi**, the white seeded form, is mainly used for food and it is widely grown. The flour is used to prepare **injera** of good taste and quality. Bread made from **balame**-**adi** is regarded by the farmers as good as that made from wheat. The grains are preferred for making roasted whole grain snacks and other forms of barley products such as **kinche**, **beso**, **chiko**, home-made beverage and porridge. **Balame**-**shamariguracha**, the black-seeded form, has a better adaptation to cooler temperatures. It is mainly used for the preparation of home-made beer and liquor, and less frequently for food. Generally **balame** is regarded by farmers as an exceptional cultivar due to its multiple uses. Moreover, **balame** is exchanged by the farmers for tef which is not the case for any other landrace. The straw is used for thatching roofs of houses and feeding livestock.

Shamari is a two-rowed black barley with a long maturity period of about six months. **Shamari** outyields **balame** but requires fertile soils for its growth. It has similar plant stands as **balame**. It tolerates drought and frost, tillers well and does not have lodging problems. Some farmers confuse this landrace with **balame**-**shamariguracha**. Only experienced farmers can discern the difference between the two landraces.

Luka'a (syn. **senefgebs**) is a partially hull-less, black or white grained and large seeded two-rowed barley. In Oromo language, **luka'a** means a form that loses the husk while **senefgebs** means 'the lazy person's barley' in Amharic language (Asfaw 2000). Both words describe that the husks of this landrace can be easily removed by slightly pounding with a pestle in a mortar or using any other mechanical means after light roasting. Most farmers of the survey area reported that **luka'a** can mature in five months, except farmers of Edensa Gelan who reported that this landrace needs only about four months until maturity, presumably because of lower altitude, warmer temperature and faster development in Edensa Gelan. Fertile land is required for better yield; despite its tall plant height, lodging is not a problem. **Luka'a** is highly preferred for making roasted whole grain snack (**kolo**) that is commonly sold in supermarkets and on roadsides at bus stops. Many cottage industries, primarily residing in Addis Ababa, are widely engaged in selling roasted whole grain barley as the main source of income in their businesses. To a lesser extent, **luka'a** is used for **beso**, **kinche**, home-made drinks and for making **injera**. It can also be used for low quality malt. Its production is currently challenged by declining soil fertility although farmers are encouraged to grow it because of its high market demand: the price for **luka'a** in January 2007 was about double the average market price of normal barley grains, i.e., >420 ETB (Ethiopian Birr) compared to 230 ETB for other forms of barley per 100 kg grain. Hence, it can be considered as a cash crop of barley growers.

Loss of barley landraces in Dandi and Jeldu

Farmers who participated in the present study have listed many natural and social factors that have contributed to the loss or maintenance of barley landraces. The major factors were the decline in soil fertility, changes in climate, e.g., the more frequent occurrence of cold temperatures, diseases and changes in market prices. All these factors led to changes in farm ecology. Currently **balame** and **garbuguracha** are the dominant and widely cultivated landraces, **shamari** and **luka'a** are cultivated to a lesser extent, while the cultivation of other landraces including **ababadhas**, **abashewaye**, **butuji**, **dimicho**, **hadho**, **kate**, **kitankite**, **muga**, **sidamo** and **warkina** was given up in recent times. Therefore, on-farm loss (genetic erosion, GE) of barley diversity in the survey area was calculated to be 71.4%, i.e., GE = ((14-4)/14)x100). From the 'lost' landraces, **butuji**, **muga**, **samareta**, **sidamo** and **warkina** collected at Jeldu and/or Dandi are available in the IBC collection. For three landrace accessions, vernacular names with similar spelling and/or collection site are present at the IBC: **Hadho** is stored as **hado** collected from Selale, **kate** as **ketyie** or **ketye** from Jeldu/Dandi, and **kitankite** as **kitan kit** from Woliso or **ketankert** from Arsi. For **ababadhas** and **abashewaye** no similar accession is found in the IBC collection, however, many other entries from Jeldu/Dandi for which local names were not given are included. Therefore, the diversity loss of 71.4% can be partitioned into a current loss of 35.7% (i.e., (5/14)x100) for which a back-up exists at the IBC, a loss of 21.4% (i.e., (3/14x100) which is unsure, and a definite loss of 14.3% (i.e., (2/14)x100).

Traditions linked to barley

Ethnobotanical conditions have contributed much for the continued cultivation of barley landraces. The diversity of foods and drinks prepared from particular landraces has motivated farmers to cultivate some landraces despite low yields realized under unfavorable edaphic and climatic factors. It was observed that farmers' beliefs, social and cultural situations have strong linkages with foods and drinks made from barley. The wealth of traditional sayings,

poems and songs gives a picture of the importance of barley in society's daily life (Table 2).

Discussion

The replacement of landraces began about 150 years ago in central and north-western Europe, when individual plants with specific traits were selected by farmers to build up 'improved' seed stocks. In the centers of agricultural activity, the original landraces disappeared during the early decades of the 20th century (Fischbeck 2003). In more remote, often marginal and mountainous regions, like in the highlands of Ethiopia, traditional farming systems and with it the cultivation of landraces survived until the second half of the 20th century or even today. Nevertheless, it can be assumed that also in these regions the diversity

Table 2. Traditional songs, phrases and sayings linked to barley (*Hordeum vulgare* L.) landraces cultivated in Dandi and Jeldu districts, West Shewa zone, Ethiopia.

Traditional saying	Meaning
Ya abalu garbuu nuu ta'i (Please be barley for us /… kind to us)	Expression to another person to be as kind as barley. Refers to the tolerance of barley
Abalu garbu dha (He/she is (tolerant as) barley)	Description of a person who bears any kind of burden, stress or unforeseen risk. Refers to the wide adaptation of barley
Manyaan rakasee, **garbuun kiiloo kore** (Barley became more expensive than tef, but in normal cases it is vice versa)	Refers to increasing price and, hence, increasing importance of barley for highland farmers
Dadhiin bishanuma, **itti buusi farso gaariin midhaanuma** (Drink **farso** since well prepared **farso** is more a food than **dadhi**)	Refers to end-use quality. **Farso** (local barley beer) is believed to be more nutritious than **dadhi** (local drink made from honey)
Akkana sanyiin mootii, **Balame dhuma xajjii gooti** (The woman deserves respect since she makes **tej** from **balame** barley)	Refers to the excellent brewing quality of **balame** landrace
Itti hammaari garbuu, **itti hammaaran malee fardi daarii hin darbu**, **dhiirris roorroo hin sarmu** (Feed the horse with barley. Otherwise it cannot cross the border (to an enemy) and be used for fighting)	Refers to the food and feed quality. Horses fed with barley will become strong and powerful
Mangaagaa raasaa bulee, **garaan hagabuu bule** (I was eating all through the night, but still I feel hungry)	Refers to the food quality. Used for comparison with other cereals, e.g., sorghum
Garbicha garbuu nyaatu, **goftaa qamadii nyaatu** (The servants consume barley, the lords eat wheat)	Refers to the food quality. Barley is believed to be more nutritious than wheat. Therefore, hard working people should eat barley to become strong and persistent
Garbuu jedhi garbichi, **adagaa danada'a** (Barley and servants tolerate hardship)	Refers to the tolerance of barley to stress
Lolii qoti farsoon kooticha, **buddeen furdicha** (Now you can plough strongly since you drank **farso** and ate food made from barley grown on black soil)	Refers to the nutritional quality of barley foods and beverages
Eeyyee yaa jibaati biyya koo, yaa midhaan dhirsa koo, **daddagaagii margi balaan si hin argiin** (Jibat my living place and barley my husband grow and flourish well, I wish you the best season)	Wish of a local farmer. Refers to the specific (geographic) adaptation of barley and its importance to local prosperity
Baallammi haammannee, **Edsii balleessina waliin mar'anne** (Let us be busy by producing more **balame**, and being busy will help protect ourselves from AIDS)	Being busy in the production of **balame** provides not only food but also prevents idleness and infidelity and, therefore, death by AIDS
Ballammii yaa asheeta garbuu, **gurba hin agartuu Qeerransa qaxxaamuree darbuu** (**Balame** at milk stage, guy don't you see the leopard passing by)	Refers to the popularity and food quality of **balame** landrace. **Balame** food gives strength to the grower so that there is no reason to fear the leopard
Aannan bassotti dhangala'e (The milk added into **beso**)	Praise of a food which is as tasty as **beso** (barley food) with milk. Refers to the food quality of barley
Garbu hangafa midhani (Barley 'elder' of crops)	Refers to the long history of barley cultivation

of landraces was reduced over the centuries, mainly by natural and human mass selection. The causes of diversity loss in the study area are manifold. In the last three decades, agricultural research and extension services favored improved varieties. In the barley growing highlands of Dandi and Jeldu, no modern cultivar was produced at the time of this study. Improved varieties once introduced during the last three decades failed due to low adaptation to the prevailing conditions, however, several landraces might have been lost in the short transitional period when farmers tried improved varieties and displaced landraces. The same scenario was reported by Hunduma (2006) for the neighboring district Gindeberet. Tarekegne *et al*. (1997) showed that improved varieties often yield significantly lower grain and straw yield, and grain weight compared to local landraces when no fertilizer is applied. It may appear that improved barley varieties failed because they were not adapted to the management system of the subsistence highland farmers with no fertilizer input, no application of fungicide and manual weed control. Sinebo (2005) demonstrated that the landrace **balame** is one of the most stable varieties in the present farming system. In the investigated area other cereals such as wheat and tef do not perform well. Therefore, the introduction of improved varieties and/or the substitution by other cereals does not substantially contribute to the ongoing loss of landraces. This situation is contrary to that described by Tsegaye & Berg (2007) for tetraploid wheat (*Triticum turgidum* L.) in two districts of East Shewa, where the expansion of tef and of improved varieties of common wheat (*T. aestivum* L.) contributed significantly to the genetic erosion of tetraploid wheat landraces. However, we note that as a result of research intervention, a high yielding improved barley variety (HB 1307) is currently expanding and could accelerate the loss of barley varietal diversity within the nearest future.

Changes in natural environments such as the degradation of soil fertility and the more frequently occurring low temperatures are the most important causes for the loss of landrace diversity. Landraces which demand fertile soils, called 'fertility lovers' by the farmers, were either recently lost or are presently becoming out of production. Farmers reported that the application of mineral fertilizers did not improve the grain yield. This is presumably due to the textural changes in soil properties and loss of soil organic matter as a result of land degradation which occurred through time due to the ever-increasing human population and livestock, deforestation, long time intensive cultivation, cereal mono-cropping, soil erosion, etc. (Erkossa *et al*. 2006, Tadege 2007). It may also be conjectured that the amount of mineral fertilizer farmers apply is often too small to trigger perceivable yield increases or that the landraces farmers refer to are adapted to low input conditions and, therefore, are barely responsive to fertilizer application. Although barley has a good ecological plasticity, differences in temperature at various altitudes contribute significantly to specific adaptation of landraces. In the study area, the shift in landraces with increasing altitudes and/or changes in temperature can be demonstrated by **balame** and **shamari**, the latter one replacing the first one at higher altitudes with very cool temperatures. Although climate change generally increases the average temperature in Ethiopia (Bryan *et al*. 2009, Tadege 2007) the massive deforestation of the highlands might change the micro climate in a way that also negative temperature extremes occur more often. The recent changes in land use or cropping patterns e.g., the intensified cultivation of potatoes exerts pressure on barley growing in home gardens and fields around homesteads. Barley landraces usually grown in those fields need special treatments e.g., fertilization with cow dung, and more intensive supervision. With the expansion of potato production around homesteads – the West Shewa potato area increased from 805 ha in 2004 to 3374 ha in 2006 (CSA 2005, 2007) – thus barley diversity could be lost within the nearest future.

Asfaw (2000) demonstrated that landraces kept *ex-situ* in gene banks around the globe which were collected in the beginning of the 20th century are not cultivated any more at their original collection site. Hammer *et al*. (1996) have reported a loss of 80% for barley, 100% for durum wheat (*T. turgidum* subsp. *durum* (Desf.) Yan ex. P.C. Kuo), Poulard wheat (*T. turgidum* subsp. *turgidum*) and einkorn wheat (*T. monococcum* L.), and 87.5% for common wheat in Albania. Similar values, i.e., 85.7%, 88.9%, 100% and 77.8-100% for durum, common, Poulard and emmer (*T. turgidum* subsp. *dicoccum* (Schrank ex Schübler) Thell.) wheat, respectively, were reported by Teklu & Hammer (2006) for Chiro district and Harar area, Ethiopia. Five of the described 14 landraces were collected in Dandi and Jeldu in former times and are nowadays maintained in the barley collection of the IBC. These landraces and probably three others with similar spelling of their vernacular name are not completely lost. They can be restored from the gene bank samples. However, it has to be considered that landraces represent evolutionary bulks which can be modified by natural or human selection, or genetic introgression and recombination through outcrossing or mixtures (Anderson 1961, Parzies *et al*. 2000, Tsegaye 1996). The change of the genetic make-up of landraces may take place both spatio-temporal and spatio-geographical. For landraces maintained in gene banks, an evolutionary process may take place only sporadically, i.e., at the cycles of multiplication for seed renewal. Alemayehu & Parlevliet (1997) have shown that the variation within Ethiopian barley landraces is to a large extent overlapping between landraces. Due to this overlap the authors suggest that the collection and maintenance of genetic variation within a region should be carried out at the crop level rather than at the individual landrace level. In the present study, however, the farmers ascribed particular traits to the specific landraces. The rapidly ongoing decline in the number of cultivated barley landraces makes the collection and maintenance in gene banks essential so that this germ-

plasm will be available in the future either for the creation of improved landraces/multiline varieties (Ceccarelli & Grando 2000, Tesemma & Bechere 1998) or as sources of valuable genes in crossing programs.

Some landraces are popular and known to most farmers while others are not. This fact implicates wider adaptability of some landraces across a range of environments as well as their inherent values for consumption by households, socio-cultural needs and market demand. Household preferences for different types of landraces that meet the criteria for processing foods or drinks were indicated above in the description of the available landraces. It should be noted that in Ethiopia women are the sole members of the households who are fully responsible for the processing of food and drinks. In rural societies women do also the bulk of farm labor. Women's contribution in agriculture and their decisions about the utilization of biological resources to satisfy the needs of rural households are often ignored (Eyzaguirre 2006). In this study women were better able to describe the landraces in regard to their grain texture, grain hardness, flour, cooking, malting, food and beverage-making quality, while men had better knowledge about agronomic traits such as lodging, plant height, maturity, disease tolerance, threshability, yield performance and straw quality. Opposite to women, men's interest was on the typology and suitability of their farms for different landraces. In addition to household preferences external factors such as market demand and/or the expected prices play a key role in the choice of landraces by farmers. Black or purple barleys are preferred for malting in the processing of alcoholic beverages, while white colored types are used in preparing different dishes. A detailed description on end-use of barley landraces of Dandi and Jeldu is given by Eticha *et al*. (2009). The traditional sayings demonstrate a meaningful folk-plant relationship and/or interaction and the different attributes that barley can give to the household. These all are used to appreciate the crop for its dependability, wide stability under changing environments, and popularity over other crops and qualities of specific landraces.

In conclusion, the high on-farm loss of 71% of barley landraces in the study area is comparable to similar studies. Climatic changes, the degradation of soil fertility, the destruction of ecosystems and habitats, and changes in the farming system induced by research and extension interventions are the major causes for the loss of genetic diversity in barley landraces. The reclamation of soil fertility alongside with the re-introduction of lost landraces, most probably as improved multiline varieties, is suggested to be considered for the maintenance of barley landraces in Dandi and Jeldu districts. Moreover, the target oriented and rural-based breeding of higher yielding barley varieties, i.e., varieties which are adapted to the low input farming systems of highland farmers and meet the quality requirements for both home use and market need to be pushed forward in order to feed the increasing human population.

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