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Genetic erosion of barley in North Shewa Zone of Oromiya Region, Ethiopia

Girma Megersa

Department of Agriculture, College of Veterinary Medicine and Agriculture, Salale Campus, Addis Ababa University, Ethiopia.

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This study was conducted during the cropping season of 2010 at Degem wereda. The objectives were to assess the extent of genetic erosion of barley and justify reasons for its conservation at community and household levels. Formal and informal surveys were made aimed at assessing causes for genetic erosion and quantify the level of genetic erosion. Collected data were subjected to descriptive statistics; Chi-square test and relative regression analysis and analyzed with SPSS software version 15. Accordingly, 17 farmers' variety (FV's) were grown before 1994 and during 2010 only 5 FV's (35%) were grown. The estimated loss accounts for 65%. The major causes for genetic erosion were introduction of improved varieties, replacement of other crops, weather variability, and change in land use pattern and lack of policy support (76, 14, 14, 8, 13 and 90%, respectively). Moreover, socio-economic factors affected genetic erosion and statistically and highly significant at p<0.001 for Chi-square and at p<0.05 for regression analysis. Wealth of traditional sayings, poems and songs gave a picture of the importance of barley in society's daily life. Therefore, attention should be given to conservation of farmers' varieties. Involving farmers' participation is very important in order to use their indigenous knowledge for conservation of FVs', varieties end-use and share their socio-cultural preferences. On farm conservation strategies should be practiced for FVs' sustainable use and attain food security.

Key words: Genetic erosion, barley, conservation, varieties.

INTRODUCTION

Barley was domesticated in Southwest Asia from two-rowed wild barley, *Hordeum vulgare* ssp. *spontaneoum* (Harlan, 1976). However, recent researches attributed two origins for barley, that is, mountainous areas of Ethiopia and Southeast Asia. The earliest cultivation of barley was believed to have begun some 8,000 to 10,000 years ago in the area of the Middle East known as the Fertile Crescent (Giles and Von–Bothmer, 1985; Von-Bothmer and Jacobsen, 1985).

Barley is the predominant cereal crop in the high altitudes (>1800 m.a.s.l.) and it can be cropped twice a year. The main season, locally known as *meher*, relies on June-September rainfall, while the March-April rainfall provides moisture for a second season, known as *belg* (Lakew et al., 1997; Bekele et al., 2005; Shewayrga and Sopade, 2011).

The greatest diversity of barley in terms of morphological types, genetic races, disease-resistant lines, and endemic morphotypes exists in Ethiopia (Orlov, 1929; Huffnagel, 1961). In Ethiopia it was cultivated by the ancient Agews as early as 3000 before Christ (Gamst, 1969) and since then the crop is grown as farmers' variety (FV's) by subsistence farmers and provide a more dependable and sustainable production for the farming community than the other cereals in the highlands of Ethiopia. In parts of southern and central Ethiopia, the

E-mail: girma.megersa@yahoo.ca. Tel: +251911056829.

history of barley cultivation is reported to have coincided with the history of the plough culture (Haberland, 1963).

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 (Eticha et al., 2010). Indigenous knowledge and socio-cultural preferences of FVs' have not been assessed. Very few studies have examined the significance of traditional farming system (Hunduma, 2006).

In most cases, the conservation and maintenance of FV's as part of cultural heritage of a region or country has received too little attention (Zeven, 1998). Farmers' varieties are in many ways comparable with monuments, traditional costumes and folk songs as examples of cultural heritage.

At present, increasing crop yield through improved technology led to the loss of genetic diversity. On-farm genetic resource conservation receives less attention. Agricultural extension in the zone has focused on the improved varieties. Even though FV's has far greater importance to the livelihood of millions of farmers in developing countries, substantial information is lacking. In North Shewa, improved varieties of barley have been disseminated to the farmers as of 1990s. Some of the FV's have been replaced while others remained. However, the level of genetic erosion and conservation and the reasons are not known and quantified. In Ethiopia, native barley varieties are suffering serious genetic erosion (Mekonen et al., 2000).

Genetic erosion is defined as the loss of variability from crop populations in diversity centers, that is, areas of domestication and secondary diversification (Brush, 1999). 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. The term "genetic erosion" is sometimes used in a narrow sense, that is, the loss of genes or alleles, as well as more broadly, referring to the loss of varieties (FAO, 1998). It is a process acting both on wild and domesticated species. It is also both natural and man-made process. Naturally, it occurs when there is inbreeding between members of small population that will reveal deleterious recessive alleles. It causes a population "bottleneck" by shrinking gene pool or narrowing the genetic diversity available. This natural process could be the causes for the losses of heterozygosity that reduces the adaptive potential of every population (Caro and Laurenson, 1999). In cultivated plants, genetic erosion is the loss of variability from the population, that is, the loss of heterogeneity of alleles and genotypes with their attendant morphotypes and phenotypes. The American plant explorers are credited for first recognizing the problem of genetic erosion in crops (Harlan and Martini, 1936).

The causes and effects of the genetic erosion of plant genetic resources are poorly understood. Agricultural modernization is the major cause of the erosion of plant genetic resources. At present, increasing crop yield through improved technology led to the loss of genetic diversity. On-farm genetic resource conservation receives less attention. Agricultural extension in the zone has focused on the improved varieties. In Ethiopia, traditional barley and durum wheat varieties are suffering serious genetic erosion due to displacement by introduced varieties (Friis-Hansen, 1999). For many years government agricultural policy did not adequately address the role and contribution that farmers' varieties could play. This is partly due to lack of information regarding the traditional ways of life using farmers' varieties and partly because of the ambition to fill gaps in food security. On the other hand, information on traditional farming system is scanty. Genetic erosion of crops and their wild relatives is accelerating at a high rate because of human activities in Ethiopia (Mekonen, 1997). The recurrent drought in the past decades has eroded considerable amount of biodiversity in the country. Furthermore, less is known about the causes and the degree of genetic erosion on local varieties of crop plant species or list of varieties/species lost in various parts of the country. Knowing the causes of genetic erosion is equally important for devising conservation measures. Likewise, identifying local crop varieties and associated wild relatives that are lost or are on the verge of extinction, play crucial role in designing and implementation of conservation policies.

Research on crop genetic resource management is indispensable for wise use of crop varieties by research and seed producers for further improvement and conservation in particular, research on traditional management of crop genetic resource in a marginal areas help to develop sustainable on-farm conservation strategy.

Therefore, the objective of this study was: to assess the extent of genetic erosion and justify reasons for its conservation at community and household levels.

MATERIALS AND METHODS

North Shewa Zone, Oromiya (Figure 1) was selected for the following reasons: (I) barley was the dominant crop in the area, (II) improved varieties have been disseminated for over fifteen years that influence on-farm diversity of the barley FV's, (III) it had less government attention with regard to conservation of FV's of barley and (IV) there was no known similar study of any kind that was done before in the study area that could be used as a baseline reference. This assumption emanates from the fact that the prevailling networks in the farmers' seed system had been highly influenced by the formal seed system. In order to assess farm GE, survey research was undertaken. These were, formal and informal survey to explore the level of on-farm genetic erosion in depth by interviewing carefully selected group, homogenous in social composition with 105 farmers; key informant interviews (interviews with special barley knowledge holders in farming community) with 3 to 5 farmers (farmers seconded by the farming community for their rich indigenous technical knowledge on barley production, management

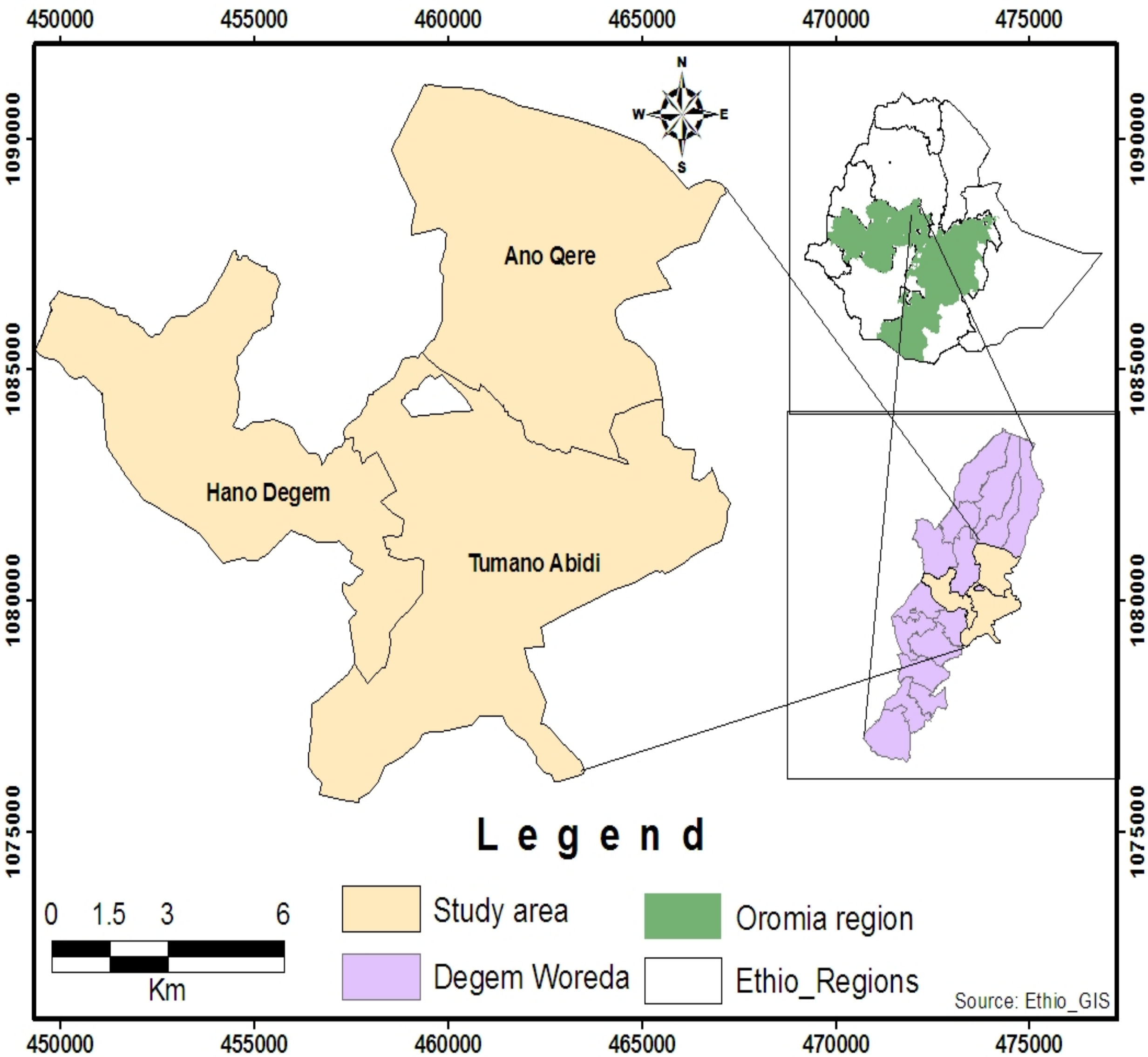

Figure 1. Map of Ethiopia, Oromiya and Degem wereda showing the study area.

and utilization) and *kebeles*, cooperative leaders, development agent (DA), Wereda agriculture and rural development office experts, working in activity related to barley genetic erosion and semi-structured interviews (a survey done with a structured questionnaire with individual farmers for quantifying and comparing data on on-farm barley genetic erosion) with 90 farmers.

Selection of respondents

During the survey, leaders of the peasant, associations and development agents working in each peasant association assisted in providing the list of farmers in each PA. From the list, informant was selected randomly, and this random sampling permitted all class, sex and age categories to be represented. Ninety randomly selected households, that is, 70 males and 20 females were involved in a household questionnaire survey from the three peasant associations.

Ninety smallholder farmers, 3-5 rich and poor (farmers in each group), and 3-5 women were selected and interviewed. The key informants were selected in order to conduct in-depth interview and discussion. They were selected from household heads of both sexes and different age groups based on their availability, willingness and practical knowledge on barley genetic resources of the area. The local administrators and DAs helped in identifying the names of the focus group.

The households were interviewed using a semi-structured questionnaire (Appendix 10). The questionnaire covered different topics such as information about the study area, landholdings, FV's of barley commonly grown, introduced improved varieties and specific information on the use and management of barley. The detailed information focused on cultural practices, the effect of new varieties on local genetic erosion, seed quality of FV's, and types of food prepared, and traditional values of barley. The respondents were also asked about their perception of the production of FV's of barley and the possible advantages of growing the crop as compared to other cereal crops known in the area.

Focus group discussions and key informant interviews

In addition to personal interviews, focus group discussions and key informant interviews were carried out to complement the information obtained from individual farmers. For focus group discussion, three to five farmers from each PA were identified to conduct in-depth interview and follow-up on interesting issues that had surfaced during individual interviews.

Two approaches were used to quantify the loss of FV's. The first approach was a comparison of the number of FV's or botanical varieties found in an area during collection missions at two different times. A second approach was interviewing farmers about FV's formerly grown in the area. In both methods, evidence for genetic erosion was reflected in a decrease in the number of FV's or botanical varieties. Using the calculation scheme: gene erosion = 100% - genetic integrity, that is, the still extant FV's, a genetic erosion was calculated for Degem wereda. A digital camera was used to document the landscape and the different FV's of barley interaction with improved varieties of barley that had been identified by farmers.

Participatory varietal evaluation (on-farm exhibition, description and characterization of barley diversity on spike length, number of spikelet's per spike, plant height, days to heading and maturity or seed color), agronomic and socio-cultural preferences (seed rate, low input requirement, medicinal value, socio cultural value, for malt and yield) were used. Local cultivars that were once cultivated by farmers were also recorded during the study. Furthermore, key informants and focus groups were asked about the meaning of local names in cases there were special attributes were associated with the names. This evaluation was one of the methods employed for assessing and inventorying on farm GE. This was done around physiological maturity of the crop. An average of 33 farmers participated in each peasant association. Both women and men discussed the prevalence, distribution, medicinal and socio-cultural importance of each variety. Furthermore, wealth of traditional sayings, poems and songs were interviewed to obtain a picture of the importance of barley in society's daily life and expressions linked with barley production.

On-farm participatory variety selection was conducted with farmers on field experiment to compare the overall performance of the enhanced FV's using farmer's own evaluation criteria (plant height, spike length, kernel color, days to maturity, straw character, for food quality, low input requirement, medicinal value, socio cultural value, for malt and yield). Local cultivars that were once cultivated by farmers were also recorded during the study. Furthermore, key informants and focuses groups were asked about the meaning of local names in cases there were special attributes associated with the names.

Finally, they were asked about their opinion on the production status of barley. A gender-specific question within individual households was raised to see whether there were differences in the participation of the household in management and household (preference) use of barley and if a particular management functions, such as seed selection, as related to gender.

Quantification of genetic erosion: Genetic integrity and erosion were calculated as indicated by Hammer et al. (1996). Genetic integrity (GI) = ratio of the number of collected accessions per crop per area where farmer varieties (FVs) were presented in 1960s and 2010, that is, C2010/C1960s x 100. Information about the 1960s collections was obtained from the Ethiopian Institute for Biodiversity and Conservation. Then, GE was calculated as GE = 100% - GI. Using the indicated formula, number of collection made in the 1960s was compared with that of the collection made in this study, in the year 2010. Comparison of collection was made both in number and in name because of the similarity in the area of collection. Besides comparison of collections, survey methods such as on farm monitoring, semi-structured interview and focused grouped discussion were also used in assessing farm GE.

Collected data were subjected to descriptive statistics; Chi-square test and relative regression analysis and analyzed with SPSS software version 15.

RESULTS AND DISCUSSION

Distribution of farmers' varieties

In all study sites, barley has been growing in monoculture. The number of FV's that are traditionally used by farmers were considerably higher. All households involved in the survey had grown FV's of barley before 1990s. Interviewed farmers reported that previously they were growing a wider diversity of FV's for various reasons. Survey result in the study area indicated that 65.6% of barley grown before a decade was dominantly FV's. As seen from key informant and focus group discussion, at least seventeen FV's of barley (*Mugaa, Magee, Barsaddad, Buttujji, Abiso, Abichu, Karfee, Hadhoo, G/gurracha, Tolasee, Damoy adii, Damoy sayintee, Kasalee, Carree, Luqa'a* (*sanf kolo), Samareta, Qaxxee* and *G/adii)* had been grown. Yirga et al. (1998) reported that among the crops grown in the study area, barley showed the highest diversity (15 barley cultivars). Similarly, Shewayrga and Sopade (2011) reported that fifteen FV's were grown in north eastern Ethiopian highlands, which varied in maturity, yield potential, stress tolerance, end-use qualities and other agronomic traits. As of 1994, farmers had specialized on a few varieties that would meet their needs best (Table 1).

However, recently six FV's *G/gurracha, Tolasee, D. adii, D. sayintee, Qaxxee, Hahdoo* and *G/adii* have been grown in different proportion of plots in the study area (Table 2).

Among the lists, the four FV's, namely *D. adii, D. sayintee*, *Qaxxee*, and *G/gurracha* were found to be common in all the study sites and distributed on small plots. The dominance of the four major FV's found to be associated with the specific qualities were attached to each variety (Table 2).

Other local cultivars such as *G/adii*, *Tolasee* and *Hadhoo* were reported to be specific to only certain sites. Despite the initial wide genetic base, key informants and individual farmers confirmed that considerable numbers of local cultivars had been lost. There was clear evidence of ongoing genetic erosion, which had resulted in the complete loss of most of the FV's. According to the key informant farmers, eight FV's namely *Mugaa, Abichu, Barsaddad, Abiso, Samareta, Buttujji, Kasalee and Luqa'a (senef kolo)* were lost for several reasons (Table 2).

Genetic erosion of barley farmers' varieties

The estimated loss accounted for 65% (Genetic Erosion = 100%-Genetic Integrity). The current level of Genetic Integrity (GI) is 35% (the ratio of the number of currently available FV's to the number of FV's mentioned before from Degem expressed as a percentage).

Table 1. Trends on barley production at Degem wereda before and since ten years.

Proportion of farmers' and improved varieties between 1990-1994	N=90	%
FV's	59	65.6
Improved varieties	10	11.1
Both	21	23.3
Dominant barley varieties grown after 1994		
Qaxxee, Damoy, G/gurracha, Filatama	6	6.7
G/adii, Damoy, Qaxxee, Tolasee	7	7.8
Filatama,Qaxxee, Damoy, G/gurracha, Tolasee	11	12.0
Filatama, Tolasee, G/adii, G/gurracha, Damoy, Qaxxee	6	6.7
Filatama, Tolasee, Qaxxee, Damoy	13	14.0
Filatama (Hb42, HB1307, *Shagee)*	47	52.82

Source: own survey result 2010.

Table 2. Trends in barley production at Degem.

Varieties in production	Varieties rarely in production	Varieties lost	Reasons for loss of the varieties
Magee	*Karfee*	*Mugaa*	Climate change
G/adii	*Hadhoo*	*Barsaddad*	Degradation in soil fertility
G/gurracha		*Abichu*	Introduction of improved varieties
Damoy adii		*Abiso*	Replacements'by other crops
Damoy sayintee		*Kasalee*	Extension system focused on improved varieties
Filatama		*Buttujji*	
Tolasee		*Luqa'a*	
Qaxxee		*Samareta*	

Source: own survey result 2010.

Only 35% of FV's were cultivated in Degem during 2010 cropping season. These included, *Tolasee, G/adii, G/gurracha, D. adii, D. sayintee*, and *Qaxxee.* Similar results in many other crops reported that FV's are rarely seen in the fields (Mekonen, 1997; Tesemma, 1991; Mekonen and Mekbib, 1993) as cited in Tsegaye and

Berg (2007). On the contrary, Mekbib (2007) reported that there was no genetic erosion based on the number of FVs in sorghum.

Factors that contributed to genetic erosion of barley farmers' varieties

No single factor was solely responsible for FV's genetic erosion in Degem wereda. Introduction of improved varieties, replacement by other crops, recurrent drought, government policy, change in land size and cropping pattern were factor reported for barley genetic erosion at Degem wereda. Similarly, Tsegaye and Berg (2007) reported that the causes of genetic erosion are multifaceted, emanating from responses to changing natural, socio-economic and policy environments. The relative contribution of each factor varies across space and time. The main factors that contributed to the loss in the study area discussed below.

Introduction and expansion of improved barley, wheat and potato varieties

Improved food barley varieties and wheat along with improved production packages were promoted through the formal agricultural extension system since the early 1990s. In addition, access to agricultural inputs (improved seeds, inorganic fertilizers, herbicides), and information on improved production practices were made available along with the new varieties. Many farmers adopted the new varieties; as a result, the FV's were gradually left out of production. As 84.4% (76) of the respondent indicated, the main reason for genetic erosion was introduction of improved varieties, followed by replacement by other crops 15.6% (14) (Table 3). Similarly, Balcha and Tanto (2008) reported that agricultural development in developed and developing countries alike has been accompanied by the replacement of local populations of crops with a handful of modern varieties threatening genetic diversity. This finding was in contrast to Engels et al. (1991); Teklu and Hammer (2006) who reported that the main reason for the reduction or abandonment of cultivation of FV's was displacement of FV's by other crops and followed by introduction of improved varieties.

Van de Wouw et al. (2009) also reported that replacement of FV's with modern cultivars is a gradual process,

Table 3. Annual and seasonal rainfall (mm), 1997- 2007 at Degem Wereda.

Year	Annual mean	*Kirmet* mean	*Belg* mean	*Bega* mean
1997	238.19	854.8	117.2	127.9
1998	241.32	965.5	121.9	51.9
1999	246.72	1062.4	15.9	130
2000	242.31	1014.4	112.3	23.5
2001	233.07	873.8	132.5	22.8
2002	235.53	778.7	197.7	83.5
2003	244.58	919.1	214.5	43
2004	239.25	896.8	190.6	18.8
2005	229.82	776.5	143	64.1
2006	258.02	1060.5	182.5	105.5
2007	241.16	920	142.14	66.4

Source: EMA 2007. *Kirmet* (main rainy season, June-September), *Belg* (February-April), *Bega* (October-January).

and the length of the transition period will vary much between crops and regions. In developing countries, the replacement of FV's is currently in progress, while in North America, many European countries for many crops, FV's have become absent, and farmers grow only modern cultivars. The first cultivar introduced in an area will not immediately displace FV's, and therefore it is likely that the total diversity will initially show an increase. In the early stages, the contribution of the cultivars to the total diversity will be minor, while in the latter stages the FV's contribution will become small. For studying trends in diversity during the process of replacement of FV's with cultivars, the total diversity at a certain time should be taken into account. A possible modernization bottleneck due to the replacement of FV's by cultivars would be reflected in a higher diversity of the FV's before the introduction of cultivars as compared to the diversity of the cultivars after the replacement with the FV's is completed (van de Wouw et al., 2009).

Change in land use and change in land size are problems that limit local barley production and leads to genetic erosion. However, individual farmers allocated farm size to each FV's based on soil fertility and nutrient demand of the varieties (Figure 2). Rich households had relatively large land holdings (average 2.36 ha) as compared to the poor households (average 0.5 ha). Better-off farmers maintained more FVs varieties than poor did. Although it is just natural, farmer with limited plots of farmland would be forced to give up cultivation of FVs in favor of improved varieties. Hence, in another year no seeds of that FV's will be available within the informal seed system. This study is in agreement with Tsegaye and Berg (2007), the larger the size of total land holding, the larger is the wheat area of a household.

The net barley area has reduced from 1.72 ha in 2006 to 0.35 ha in 2010 for the period of 5 years. The mean area for each crop in the 2006, 2007, 2008, 2009, and 2010 are indicated in Appndix 4.

Introduction of other crop seeds were also factors for the loss of FV's. It was indicated that mean area allocated for wheat production relatively increased from 0.24 in 2006 to 0.56 ha in 2010 and mean plot area allocated for potato increased from 0.003 in 2006 to 0.114 ha in 2010. Likewise, mean plot area allocated for faba bean increased from 0.074 in 2006 to 0.153 ha in 2010. This showed that trends of plot allocation for FV's of barley were decreased (Annex 4). (Mekonen et al., 2000) reported similar result that the overall barley production area in Ethiopia has been gradually diminishing due presumably to the expansion of wheat and rye cultivation in some regions. Leur and Gebre (2003) also reported that the cultivated area of a number of traditional barley varieties is declining rapidly. On the other hand, plot allocation for improved barley, wheat, potato and faba bean gradually increased.

Lack of policy support for farmers' varieties

Policy makers and some local expertise have expected FV's as low yielding ones. All of the respondents reported that training and other awareness had been given on production of improved varieties of crop to increase production and to attain food self-sufficiency. Socio-cultural values for FV's, indigenous knowledge of the local people and local crop genetic resources have been given little or no attention by policy makers and development agents. However, this scenario was not always true. Study conducted indicated performance evaluation of FV's and improved varieties that there were high yielder FV's in yield and yield related parameters (Table 3). Tsegaye and Berg (2007) reported that in tetraploid wheat FV's have not been part of the agricultural extension package in Ethiopia. Inadequate attention has been given to improvement of FV's, as they have often been regarded as low yielding. The policy makers were interested in increasing grain yield and total food production in the short run.

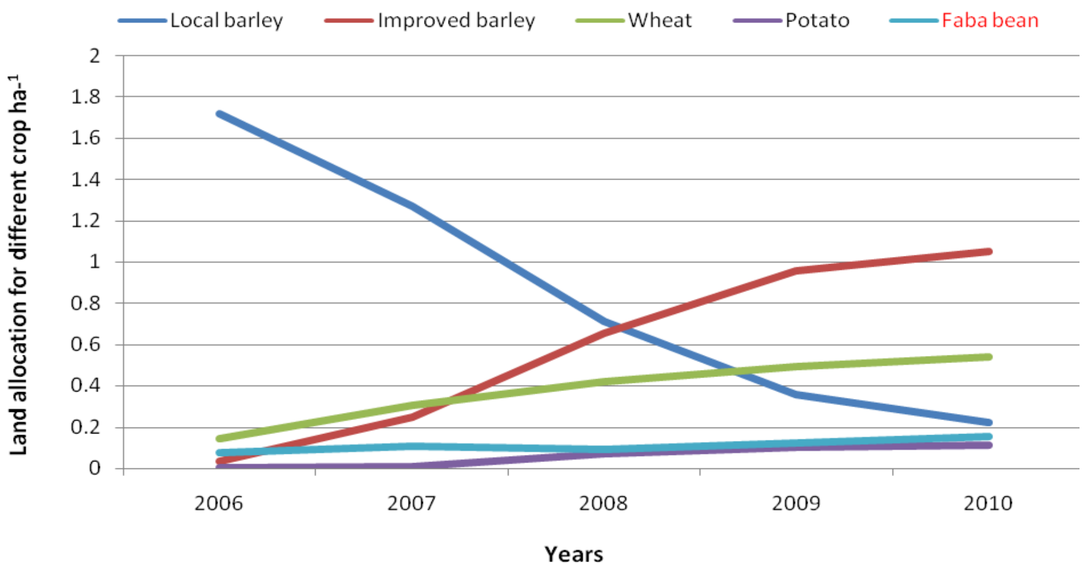

Figure 2. Trends in diversity of crop during the replacement of farmers varieties by improved varieties.

Table 4. Factor affecting on farm genetic erosion in barley.

Factor	N=90	Percentage (%)
Introduction of improved varieties	76	84.4
Replacement by other crops	14	15.6
Weather variability	14	15.6
Change in land use pattern	8	8.9
Change in land size	13	14.4
Policy	90	100

Source: own survey result 2010; Sum greater than 100 is due to double counting.

Weather variability

The erratic and unstable rainfall coupled with the longer growing period of FV's forced farmers to adopt early maturing and improved varieties or other crops that either escape or tolerate droughts. Before two-decade common planting time of barley was at the beginning of April and ended at the mid of May. The respondents reported that since fifteen years barley planting time has been changed due to lack and shift of rainfall. As a result, barley planting time at Degem changed from April 1st to May 10. Currently, planting for late maturing varieties was in the mid of May (Table 4). Inter-annual and seasonal variability of rainfall is a major cause of fluctuations in production of cereals in the central highlands of *Shewa*. Over the 1997-2007 decade, for which crop production data showed the patterns of inter-annual variability in productions of major cereals cultivated in the area, there are similar patterns of inter-annual variability in the seasonal or annual rainfall amounts (Table 3). Woldeamlak (2009) reported that sorghum exhibits the largest year-to-year variability in terms of area cultivated, total production and yield as compared to the other cereals. This high inter-annual variability is caused mainly by inter-annual variability in rainfall.

As Hammer and Teklu (2008) reported, there have been several catastrophic droughts in the country that caused complete crop failures and subsequently severe genetic erosion has taken place in the FV's that had been maintained through many generations. Farmers have been forced to consume the seeds normally kept for planting. The famine of the mid-1980s seriously threatened Ethiopia's biological resources. Generally, among the factors affecting farm genetic erosion of barley, improved varieties played a significant role (84.4%) (Table 4) followed by weather variability and replacement by other crops.

This finding is also in agreement with Friis-Hansen (2000) who noted that new varieties have had a dramatic impact on genetic erosion of local crops. Tsegaye and Berg (2007) reported for tetraploid wheat (*Triticum turgidum* L.) in two districts of East Shewa, where the expansion of *tef* and improved varieties of common wheat (*Triticum aestivum* L.) contributed significantly to the genetic erosion of tetraploid wheat FV's. Eticha et al. (2010) indicated that, a high yielding improved barley variety (HB-1307) is currently expanding and accelerating the loss of barley varietal diversity. On the contrary, Mekbib (2007) reported that improved varieties of sorghum were not the reasons for genetic erosion of FV's in the context of eastern Ethiopia and they contributed to the genetic enrichment of the existing on farm genetic diversity.

Socio-economic factors affecting genetic erosion

The three categorized independent variables: sex, level

Table 5. Number of barley varieties related to gender, education and class.

Independent		Number of varieties grown			S.E	X^2	Sign.
Variable		Increasing(N)	Decreasing(N)	Percent			
Gender	Male	5	65	78.8	0.0440	27.778***	0.000
	Female	1	19	22.2			
Level of education	Literate	1	18	21.1	0.0432	30.044***	0.000
	Illiterate	5	66	78.9			
Wealth	Rich	2	24	28.9	0.0480	16.044***	0.000
	Poor	4	60	71.1			

Source: own survey result 2010.

Table 6. Regression analysis for factors affecting genetic erosion.

Constant	Beta	S.D	t	Sig.
		0.455	**4.272*** **	**0**
Total farmland owned by the household	-0.23	0.906	-2.09*	0.04
Farmers age on genetic erosion	0.3	12.83	2.69***	0.009
Adoption of improved varieties	0.23	0.251	2.29*	0.024

Source: own survey result 2010.

of education and class had positive association with trend on FV's of barley genetic erosion. They were statistically and highly significant at $P < 0.001$ levels (Table 5). The reason for this could be that male farmers were socially powerful on the discussion of farming activities, had access to adopt new technologies than female farmers. Level of education also influenced access to extension on adoption of new technologies. Moreover, rich farmers owned more plots of farmland and maintained FV's than poor farmers. However, in order to obtain better yield and sustain their families' poor farmers used improved varieties, most of the time through seed exchange from their neighbor, which on the other hand positively correlated to genetic erosion.

From the regression analysis, significant result was observed that land holding and adoption of new varieties at $P< 0.05$. While age of the respondent was significant at $P<0.01$, land size showed negative association for genetic erosion, that is, with decrease in one hectare of farmland there was increase genetic erosion by -0.23. On the other hand, age of the respondent showed positive association with FV's conservation. An increase in one year of the respondent's age contributed to maintain FV's by 0.30. However, with one-year decrease in the age of the respondents, there was an increase in genetic erosion by 0.23. Likewise, adoption of improved varieties had positive association with the loss of FV's. From this study, one percent increment in adoption of improved varieties resulted in increased genetic erosion by 0.23 (Table 6).

Traditional songs and sayings related to barley

The diversity of foods and drinks prepared from particular FV's has motivated farmers to cultivate some FV's 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 and growers show their feelings and expressions linked with barley production (Table 7).

Conclusions and recommendations

This study was conducted to assess the extent of genetic erosion and reasons for its conservation at community and household levels. Genetic erosion in cultivated crop species is a complex process. In this study, the most important factor possibly leading to genetic erosion is the replacement of FV's by modern cultivars followed by weather variability. The numbers of FV's before a decade at Degem wereda were reported to be 17. However, currently only five FV's are being grown on small plots of land in marginal environments (G/*adii*, *G/gurracha*, *Tolasee*, *Qaxxee* and *Damoy*). *Karfee* and *Hadhoo* were replaced, *Mugaa, Buttujji, Barsaddad, Abiso, Luqa'a, Abichu, Semareta* and *Kasalee* were lost. The estimated loss accounts for 65% (Genetic Erosion = 100% - Genetic Integrity). The current level of genetic integrity (GI) is 35%.

Plot allocation for improved barley, wheat and potato has gradually increased. On the other hand, farmland allocated to FV's of barley gradually reduced. Introduction of other crop seeds was also factor for the loss of FV's. It was indicated that mean area allocated for wheat

Table 7. Traditional songs and sayings related to barley.

Traditional sayingS	Meaning
Abalu garbuu dha	Description of a person who bears any kind of burden, stress or unforeseen risk.
Manyaan rakase garbuun kilo kore	Refers to increasing price and, hence, increasing importance of barley for highland farmers.
Dadhin bishaanumaa, itti buusi farsoo gaarin midhaanuma	Refers to end-use quality. *Farsoo* (local barley beer) is believed to be more nutritious than *Dadhi* (local drink made from honey).
Akkana sanyiin mootii, sila midhaanuma xajjii gooti.	The woman deserves respect since she makes *tej* from barley and indicates to the excellent brewing quality of barley.
Biroolee roobee daalen gasheen soore qabaa hin sarmu mee itt hammaari garbuu	Refers to the food and feed quality of barley. Horses fed with barley will become strong and powerful and more preferred for bridegroom during wedding.
Birrolee roobee xaafin badda hin- margu nyaadhu buddeen garbbuu	To indicate agroecological areas where barley is growing and most preferred for *injera* to *tef* for wedding in the high land.
Garbuu fi garbich hadagaa dada'a	Signifies to the tolerance of barley to stress.
Garbicha garbuu nyaatu gooftaa qamadii nyaatu	Barley is believed to be more nutritious than wheat. Therefore, hard working people should eat barley to become strong and persistent.
Annan bassootti dhagala'e	*Beso* (barley food) is as tasty as milk. Refers to the food quality of barley (to indicate well being of something).
Garbu hangafa midhani	Describe the long history of barley cultivation.
Biyya ormaa yaa gaaddisa mukaa aduun nama gubaa ,biyya ofii yaa gaaddisa garbuu aduun nama hin arguu	Signifies the importance of barley for household food security.
Biyya ormaa yaa gaaddisa mukaa aduun nama gubaa ,biyya ofii yaa gaaddisa garbuu aduun nama hin arguu	Signifies the importance of barley for household food security.
Carree nyataa harka nyanyaata	*Carree* type cultivar is very nutritious and gives strength to the workers.
Illaamu maraxame akka garbuu	*Illamu is* powerful tribe in Oromo local leader; barley is superior to cereals in highland areas.
Yaa garbuu kan sidhabe ijaan lafa hin argu	Anyone who does not have barley is vulnerable to food insecurity.
Biile daraaran garbuu anuu beekaa daarii dinbara hin darbu	As barley awns at its appropriate time, it is imperative for everyone to obey the law.

production relatively increased from 0.24 in 2006 to 0.56 ha in 2010 and mean plot area allocated for potato increased from 0.003 in 2006 to 0.114 ha in 2010. Likewise, mean plot area allocated to faba bean increased from 0.074 in 2006 to 0.153 ha in 2010. This showed that trends of plot allocation for FV's of barley were decreased (Annex 4). This indicates serious genetic erosion and vulnerability of genetic diversity of FV's of barley at Degem wereda. Losses of varieties from the study sites do not totally mean the extinction of varieties. Those varieties may survive and can be grown somewhere in the region or boundaries.

The erratic and unstable rainfall coupled with the longer growing period of FV's forced farmers to adopt early maturing and improved varieties or other crops that either escape or tolerate droughts. There are social, economic and political reasons that limit the use of FV's of barley production. Some of those are farmers' age, level of education, legislation coming into force and the lack of incentives for FV's. Old farmers mostly grow FV's; few of the young people, who are often not able to appreciate their biological and cultural importance, stay in the field of agricultural production. This makes it difficult to continue their cultivation if not to increase it, which is important for plant genetic resources conservation. Varieties that cannot meet changing demands by farmers and consumers become neglected and farmers abandon such varieties in favor of more promising varieties.

Barley, as a food and feed grain, is important to the livelihood of farmers in Degem wereda. 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 local barley in society's daily life and growers show their filling and expressions linked with barley production.

Therefore, farmers' participation in barley improvement is very important in order to use their indigenous knowledge for varieties end-use and share their socio-cultural preferences. Attention should be given to on farm conservation and enhancement of farmers' varieties.

In conclusion, the use of genetic resources will remain the best way of meeting future food needs and driving the economic and social benefits for the world's rapidly growing human population. Thus, policy makers and researchers should give attention to conservation of FV's and indigenous knowledge of farmers for better use of genetic resources.

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