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On farm diversity conservation assessment and characterization of sorghum (*Sorghum bicolor* (L)) Moench) landraces in Eastern Hararghe, Ethiopia

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Abstract
This study was aimed at providing an assessment on farm diversity conservation status and the characterization of sorghum landraces to document diversity of sorghum landrace, characterize variety and assess how farmers in the study area practices seed management system of indigenous sorghum landrace at farming community. Eighty House hold from eight kebeles in four woredas of eastern Hararghe zone were chosen and reviewed. Structured questionnaire survey of households, focused group discussions, key informant interviews and field observations were used to collect data. The main traits farmers use to prefer a given variety over the other were maturity, yield potential, animal feed, grain size, grain color, tillering capacity, market demand. With look upon distribution category, most of the recorded landraces of sorghum were endangered and rare. Farmers from different study locations have reported several landraces to be endangered. Most of the recorded landraces of sorghum were endangered and rare which is near to threatened indicating the need for conservation of the landraces. On-farm conservation can remain workable, depending on the sensitivity of landraces to different factors causes farmers varieties become extinct and their capacity to develop and adapt to these factors. It can provide options to farmers and community to adapt to factors that causes farmers varieties lost. Therefore, attention should be given to conservation of farmers' varieties in which involving farmers' participation is very important in order to use their indigenous knowledge for conservation of farmers' variety and on-farm conservation strategies for sustainable use. More agricultural research should be conducted on the characters and requirement of the crops for various regions and environments to conserve landrace variety.

Keywords: crop diversity, sorghum, landrace, on-farm diversity, characterization

1. Introduction
Ethiopia is considered the richest genetic resource centers in the world. According to Mekbib (2007) [8], huge diversity of biological resources that exist in the country is due to diverse agro-ecology. These biological resources are the enormous genetic diversity of the various crop plants grown in the country. Crop genetic resources constitute the building blocks of modern agricultural production to feed the growing of people currently we face (Mulualem, 2017) [9]. The indigenous plant species, their wild relatives and weedy species which form the basis of Ethiopia's crop genetic resources are highly prized for their potential value as sources of important variations for crop improvement programs (Mulualem and Bekeko, 2014) [10]. Keeping the landraces is absolutely essential since they are potential sources of materials for modern and stable selection breeding and for developing lines that are resistant to biotic and abiotic stresses. Maintaining on-farm genetic diversity and farmers' indigenous knowledge along with their behavioral practices of keeping landraces of ancestral crop populations are important strategy for conserving crop species. Farmers make crop protection decisions based on combinations of factors including adaptability, yield, socio-cultural values and food traditions as well as nutritional values. There are a number of studies that deal with how local farmers manage their seed, select varieties, renew tired seeds and decision making of the varieties in the family. An experiment conducted at Koga of West Gojjam Zone in Ethiopia confirmed diversity among 49 malt barley genotypes (Tilahun and Alemu, 2017) [14]. According to Hawkes (1983) [5] and Harlan (1992) [4], the conservation of crop genetic diversity has been a worldwide concern for many decades, particularly owing to the worry that much of this diversity would disappear with agricultural and economic development i.e. genetic erosion.

Efforts to conserve crop diversity by the scientific community have led to the collection and conservation of seeds in *ex situ* gene banks (Plucknett *et al*., 1987) [12]. Large diversity is still grown in developing countries by smallholder farmers, particularly in centers of crop domestication and diversity (Brush, 2004; Jarvis *et al*., 2008) [7]. Different research result showed that, on crop genetic resource management is crucial for wise use of landraces, and particularly, research on traditional sorghum crops helps to develop sustainable conservation strategies. Threat of loss of crop genetic diversity at an alarming rate has long been recognized in Ethiopia (M. Worede, 1997; M. Worede, 1991, M. Worede *et al.;* 2000). Consequently, various exploration and rescue collections have been made to conserve cereal crop landraces and wild relatives, and these are commonly maintained under *ex situ* conditions (M. Worede, 1992). Ethiopian Sorghum Improvement Program (ESIP) has been involved in documenting and collecting sorghum landraces.

Farmers have multiple concerns that are reflected in multiple criteria for selection and variety ranking. Thus, farmers' management of their varieties and their role in seed selection activities are crucial to agricultural production, conservation and enhancement of the genetic resources. Farmers often noted varieties that had become tired and needed replacing; they gave their tired seed to farmers in cooler and more fertile areas for multiplication (Almekinders *et al*., 1994) [1]. According to Howard (2013), varietal preference and cooking, generally maintained by women, has a major influence on selection, knowledge and use of agricultural biodiversity.

Even though, Ethiopia is one of countries regardless of being the world's rich biodiversity center and harboring a variety of distinct food crops, attempts made so far to conserve the crop is very less. Still, on-farm genetic resource conservation and research activities targeting improvement of indigenous crops received less attention in several countries. Their cultivation is declining from time to time and in recent decades, only practiced by smallholder farmers for subsistence use only. For this reason, it is important to study and document diversity of Sorghum landrace, management of seeds, renewal of tired seeds, farmers' variety selection criteria. The present study has, therefore**,** been initiated with the following objectives:

- To document diversity of sorghum farmers' varieties, characterize landrace variety and assess how farmers in the study area practices seed management system of indigenous sorghum landrace at farming community.
- To assess perception of farmers on loss of land race and threaten farmers' variety in eastern Hararghe.

2. Materials and Methods

2.1 Description of study area

This study was conducted during 2020 in Eastern Hararghe Zone, Oromia Regional State of Eastern Ethiopia. The Zone is bordered on the southwest by the Shebelle River which separates it from Bale, on the west by West Hararghe, on the north by Dire Dawa and on the north and east by the Somali Region. The Zone comprises of 18 districts, namely Babille, Bedeno, Chinaksen, Deder, Fadis, Girawa, Gola Oda, Goro Gutu, Gursum, Haramaya, Jarso, Kersa, Kombolcha, Kurfa Chele, Malka Balo, Meyumuluke, Midega Tola and Goro Muti. Accordingly, four study sites from Eastern Hararghe zones (Babile, Fadis, Kersa and Meta) will selected for investigation based on the recommendation from the Zone agricultural office experts and the researcher own observation. This Zone has a total population of 2,723,850 of whom 1,383,198 are men and 1,340,652 women; with an area of 17,935.40 square kilometers and has a population density of 151.87. A total of 580,735 households were counted in this Zone, which results in an average of 4.69 persons to a household, and 560,223 housing units. The two largest ethnic groups reported were the Oromo (96.43%) and the Amhara (2.26%); all other ethnic groups made up 1.31% of the population. Afan Oromo is spoken as a first language by 94.6%, Somali is spoken by 2.92% and Amharic by 2.06%; the remaining 0.42% speak all other primary languages reported. The majority of the inhabitants are Muslims (96.51%), while 3.12% of the populations professed Christianity (CSA, 2007).

2.2 Research design and methods of data collection

A cross-sectional research design was employed focusing on selected farmers' districts and kebeles within a district that were identified after a rapid preliminary informal survey and discussions. Both primary and secondary sources of data were gathered for information. Data were collected with farmers who cultivate farmer variety crop on farm land. Questioner, household interview, and focus group discussions (FGD) using key informants and personal observations at different farm fields were conducted. Questionnaire method was used with the intention of setting information from a wide range of sources (respondents) regarding the indigenous knowledge and practices involved in crops landraces farming, management, conservation, and utilizations in the study areas. The questionnaire was written in English and translated into local languages such as 'Afan Oromo. The household heads were purposively selected based on the preliminary survey and documents from district agricultural offices. In addition, all the required age groups and sexes including elder women household heads were intentionally involved to guarantee good coverage of the required diversity in indigenous knowledge.

Interview questions were used to authenticate the information generated through the questionnaires. In this regard, semi structured questions that address matters regarding the sorghum landraces currently or used to be cultivated, extents of their production challenges, and major utilizations were presented. The 10 key informants from each kebele were carefully selected during the harvesting cropping season in 2020 from the household heads of both sexes. Different age groups were involved based on their willingness and rich practical knowledge on crop species production, conservation and utilization in the areas. Focal group discussions were carried out with selected sorghum landrace variety growing elders and experts to complement the information obtained from individual farmers and to minimize missing data. The key informants involved were well recognized elder farmers aged 50 or more and spent their entire lives in the localities and were engaged in sorghum farming and seed selection. Open group discussions regarding the reasons why sorghum landraces are left marginalized, main factors for the current decline in production of the landraces, and their general views regarding the benefits of the landraces were presented. Finally, after thorough discussion, consolidate ideas were noted.

2.3 Data Analysis
The collected qualitative and quantitative data were mostly analyzed and summarized by table. The data on level of land race threat and local name was analyzed by descriptive statics such as, Table, graph and percentage by using excel Microsoft.

3. Result and Discussion
3.1 Sociodemographic characteristics of the study population
In the present study, the marital status from total of 80 respondents were interviewed from the seven districts (20 from each) of which the majority were male respondents 68 (85%) and the rest 12 (15%) were female respondents (Figure 1). Males are more involved in agricultural practices as compared to females in all the study districts and their respective kebeles. Active participation of women are dominant in other activities like selling and buying chat because income generated from crop production is too low as compared to chat.

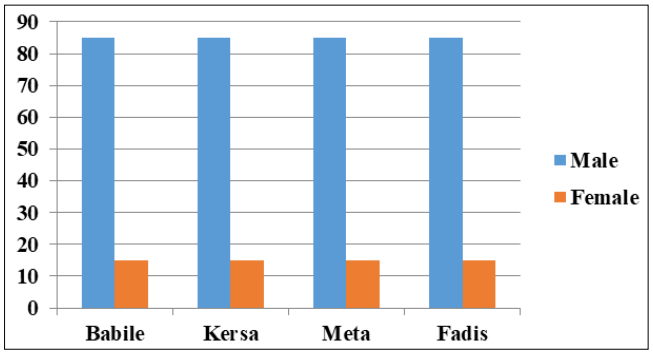

Fig 1: Marital status of respondent in the study area

Regarding to educational status larger number of the respondents 51 (51.25%) were uneducated who can't write and read and 22 (27.5%) respondents were primary school education (figure 2). 13'n respondents (16.25%) and remaining respondents of respondents 4 (5%) were secondary educated and above 12 grade respectively. Even though large numbers of respondent in all study area were illiterate they didn't challenge to conserve landrace crops and characterize the crops based on their indigenous knowledge. This study also showed that lack of education didn't any effect on crop production.

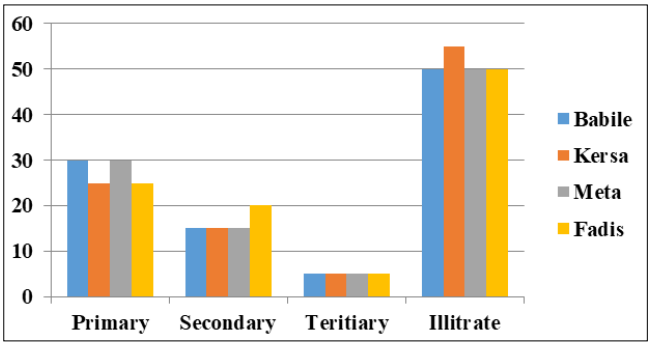

Fig 2: Educational status of respondents in the study area

From the recruited 80 respondents, large number of respondents age group were between 16-36 (30 %) followed by 36–50 and 0-15 (27.5%) (Figure 3). Age groups above 50 were 20%.

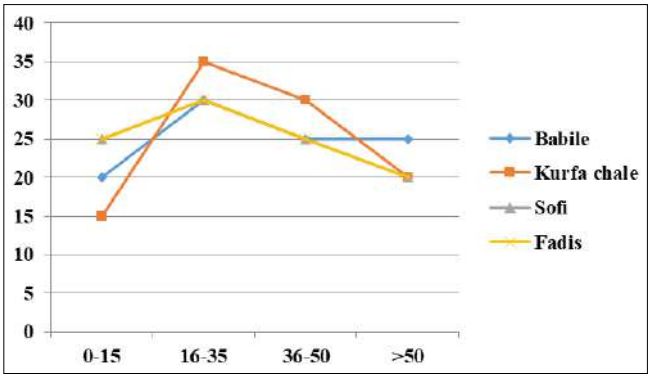

Fig 3: Age of respondents of study area

3.2 Status of on farm diversity conservation of sorghum landrace in the study area
According to this study greater numbers of respondents were agreed that farmers are able to keep landraces adapted to their growing conditions and socio-cultural preferences through farming practices (time of planting, thinning, and seed selection). Most of household in the study area conserved and maintain crop evolution in their own farming fields. In line with present result, Bellon (2009) [2] reported that to maintain evolutionary processes in crops is 'to generate new potentially useful genetic variation, which in turn contributes to maintain the capacity of agricultural production and food systems to adapt.

In the same way, all number of respondents raised ideas that keep their landrace crops as it is not to become extinct by adopting different approaches to get seed for cultivation of next season. For instance, they use the seeds produced by themselves. If they do not have sufficient quantity of seed then they get it from neighbors. Seed may be acquired through exchange, barter, free of cost or for cash or kind which finding of (Rana, R.B, (1998) [13] confirmed this current survey research result. Farmers in the study area also conserve their seed by mechanics of seeds exchanging between villages far apart from each other through family ties and friendship. Seeds also make their way to different households in the form of gift. So, in order to preserve seed their source or place of found should be known and collection activities takes place (Table 1).

Table 1: Identified farmers varieties of sorghum, local name, accession and collected place in study area

Crops specie	Local name	Accession	Collected place
Sorghum	Afareee	01	Kurfa chalee
	Muyraa adii	02	Kurfa chalee
	Muyraa diima	03	Kurfa chalee
	Come	04	Kurfa chalee
	Shako	05	Sofi woreda
	Diima	06	Sofi,babile
	Badu qanyii	07	Sofi,babile
	faddish	08	Fadis
	Dangaa	09	Sofi,babile
	Dukkun	010	Sofi
	Wagaree	011	Fadis
	Tarigaa	012	Fadis
	Carcaroo	013	Fadis

Additionally all house hold interviewed said that government and non-government should be doing on landrace in order to keep and continue the life span of local seed crops. In line with this case studied by Faith *et al.*

(2010) proved that economists call option values, which are to do with the idea that maintaining diversity keeps our options open to benefit from unanticipated future uses of biodiversity. Similar to this study Pautasso *et al*. (2012) [11], confirmed that a crucial aspect of on-farm conservation of seed systems are associated with the maintenance and management of landraces in centers of crop diversity.

3.3 Farmers' choice of sorghum landrace and probable cause for threatened and replacement by other crops

Farmers in the study area use to prefer a given variety over the other by considering different criteria like maturity, yield potential, suitability for animal feed, grain size, grain color, tillering capacity, market demand, condition of the soil and product volume. Similar to current result, Eticha *et al*. (2008) [3], the selection criteria for landraces of barley reflect adaptations to changing farming conditions, and responses to the socio-economic and cultural factors that shape farmers priorities. With regard to distribution status, most of identified farmers' varieties of sorghum in the study area are rare and endangered. Farmers in the study area use sorghum landrace for different purpose. For instance, as injera, kolo, kitta, porridge, tella and so on. In the same way a case study made on enset was similar to present results which showed that the biggest uses of landraces are for *kocho*, *bulla*, *amicho*, fiber and medicine (Zerihun *et al*., 2016) [15]. A study made on wheat indicated a wide range of variations among landraces for the traits studied which help farmers with an opportunity to make a choice of genotypes that fit their purpose (Zewdie *et al*., 2014) [16]. The goodness of a variety or a seed has to be first looked from the farmers' perspective. The farmers' perspectives were determined by the factors related to both the biophysical (biotic and abiotic circumstance) and socioeconomic circumstances (resource ownership, markets, institutions) that are inherent in the production system the farmers are engaged with. The circumstances determined whether the variety is good in terms of tolerance to abiotic and biotic stresses, food quality, high yield and other variety attributes like color and size. A good seed is then the seed of the good variety that fulfills the requirements of seed true to type, required purity and required germination rate.

Present surveyed result showed that, farmers from different study locations have reported several sorghum landraces were endangered and lost. However, it is essential to understand the reasons and the value of PGR before they become extinct from the ecosystem. Those germplasms may have potential value either as donor parent or a commercial variety. Therefore, their actual value needs to be assessed. According to (Rana, R.B, 1998) [13], direct observation on-farm and participatory evaluation of such landraces would provide a basis for rejuvenation, commercialization and source for future breeding.

This survey study also proved that replacement of modern variety was the most farmer variety loss (45%) in study area. Expansion of chat was the second loss of farmer variety in eastern Hararghe area (40%). Another possible factor that leads to loss of landrace variety in the study area were repeated drought and weed disease followed by less production of land race variety in study area were 3rd and 4th the loss of farmer variety respectively. Most of farmers in the study area said that it is become harder to find traditional varieties of crops due to their replacement by the new ones as the traditional varieties are becoming less productive, no longer tolerant to drought, susceptible to diseases and incompatible with the type of soil farmers are dealing with. In line with current result, farmers understood the general pattern of yield deterioration in their own varieties (Heisey and Brennan, 1991) and make a replacement decision accordingly.

Data recorded from survey result showed that four crop species in study area were threatened due to different factor (Table 2). Badu qanyi (Local name) is one accession of sorghum now it was lost in study area due high bird interest, lack of fodder, affected by striga and easily susceptible to drought. Dangaa is also other farmers' variety of sorghum now it was less cultivated in study area due to no good test of food and high bird interest. Shako and dukkun were also sorghum landrace now less cultivated in study area due to take long maturity and no good test and low market value respectively.

Table 2: Threatened landrace sorghum and reason for accession lost

No.	Crop species	Threatened accession	Reason of loss
1	Sorghum	Badu qanyi/butanne	Birds interest, lack of fodder, weed and drought
		Dangaa	No good test food and high bird interest
		Shako	It take long maturity
		Dukkun	No good test and low value market

4. Conclusion and Recommendation

This study was aimed at providing an assessment on farm diversity conservation status and the characterization of sorghum landraces to document diversity of sorghum landrace, characterize variety and assess how farmers in the study area practices seed management system of indigenous sorghum landrace at farming community. The main traits farmers use to prefer a given variety over the other were maturity, yield potential, animal feed, grain size, grain color, tillering capacity, market demand. With look upon distribution category, most of the recorded landraces of sorghum were endangered and rare. Most of the recorded landraces of sorghum were endangered and rare which is near to threatened indicating the need for conservation of the landraces. On-farm conservation can remain workable, depending on the sensitivity of landraces to different factors causes farmers varieties become extinct and their capacity to develop and adapt to these factors. Therefore, attention should be given to conservation of farmers' varieties in which involving farmers' participation is very important in order to use their indigenous knowledge for conservation of farmers' variety and on-farm conservation strategies for sustainable use. More agricultural research should be conducted on the characters and requirement of the crops for various regions and environments to conserve landrace variety.

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