

Assessment of the Current State of Genetic Erosion of Field Cro Species in Tigray, Ethiopis: A Survey Report

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Abstract: This study was conducted to understand why farmers conserve and maintain agro-biodiversity, the extent of Agro-ecological richness, the estimated loss of traditional varieties and the threats of the loss of on-farm agro-biodiversity. A baseline survey for crop biodiversity assessment was conducted in seven selected districts. The sites were purposively chosen to represent the different agro-ecological zones from where the data for this study was collected. All the information was compiled from 240 respondents among them 189 were males and 51 were females. The surveyed districts were enriched by the known diversity of major staple crops of wheat, barley, maize, tef, millet and sorghum in terms of varietal diversity and the crops are still dominantly cultivated in the areas. This study illustrated that complexity of genetic diversities were maintained for these most important crops in past decades in the areas. Grounded on this survey result 146 crop varieties have been recognized and growing in areas for many years, but currently only 113 of them are found under cultivation. The number of local varieties estimated to be lost in the district are 133 (91.10%) of crop varieties used to be grown before. The diversity and richness of the local varieties are now under serious threat due to the changing nature of farming conditions. Entirely total varieties currently under cultivation are 113 in number, but out of these crop varieties 98 (86.73%) of them are under serious threat of extinction. The probability of extinction of these varieties in the near future is imminent unless drastic measures are taken to conserve on farm and prevent from complete loss. The remained 12 (10.62%) varieties are categorized into conservation dependent that could remain conserved on farm for a certain period of time.

Key words: Genetic erosion • Agricultural diversity • Small-scale agriculture • Conservation

INTRODUCTION

Crop and varietal diversity conservation is a key element of rural households' livelihood strategy that provides adaptation and survival in harsh environmental conditions. Maintaining of crop and varietal diversity contracts the effect of biotic and abiotic hazards ensured family food security and conserve biological and cultural diversity [1]. Crop genetic resources meet vital ecosystem functions related to soil structure, nutrient cycling, hydrological flows, agro-ecosystem stability, defense against insect pests and diseases [2, 3]. The diversity is essential to improve food crops through breeding and is a crucial precondition for assuring food security [4]. It is required to utilize in modern breeding in addressing problems related to insects, diseases, parasitic weeds and changing physical environmental conditions [5]. Traditionally, farmers were/are growing both early and late

maturing varieties either same or of different crops to improve the period of food availability and spreading labor required at sowing, weeding, harvesting and threshing time.

Plant genetic resources are a component of biodiversity that encompasses farmer varieties (Landrace), cultivated varieties (in use), newly developed varieties, wild and weedy species, including current elite and breed lines used in agriculture [6]. These landraces are the foundation for sustainable agriculture in the world now and in the future that may used in traditional farming system, conventional breeding or in new technologies. Local crops are adapted to local growing conditions which selected, named and maintained by local farmers for centuries to meet the ultimate demand of social, economic, cultural and ecological needs [7]. From the start of agricultural field crops have been a staple food production throughout the globe, but their use started to

drastically decline in the second half of the 20th century due to replacement by improving varieties, replaced by other crops, land use change, weather variability and soil marginality for supporting landraces. Farmer varieties are threatened component of agro-biodiversity in most part of the world and facing genetic erosion and extinction. These varieties have tremendous potentials in the development of new varieties adapted to changing biotic and abiotic factors that may play crucial role in supporting sustainable agricultural production to alleviate poverty and ensure food security.

Tigray is enriched with diverse Geo-ecological conditions which enable to contain varying agro-biodiversity resources that may develop *via* domestication, selection, exchange and introduction [8]. Farmers in Tigray are largely small holders, marginal and practice a self-sustaining, integrated and subsistence agricultural production system. Subsistence farmers of the region spread across varied ecological zones and maintain a wide range of field crops for centuries growing on their farm. The diversity of crops growing has been started to decline since the late of the 20th century and hence currently few numbers of farmers' varieties grow in limited areas with few numbers of elite varieties in larger swathe of areas [9]. Even though, inter and intra species genetic loss is not yet documented, improvement in access of new varieties, government policy and pressure, climate change and attitudinal changes of farmers significantly affects genetic diversity of cultivated crops in Tigray. The research is mainly related to 2020 strategic plan of the Ethiopian biodiversity institute on reduction of threats to biodiversity in the country.

The importance of understanding and mitigating the effects of erosion of crop genetic resources has been re-emphasized by the Ethiopian Biodiversity Institution. Although it is widely accepted that genetic erosion takes place, its extent has not been technically documented. Replacement of a diversity of landraces with few unified modern varieties as part of a wider agricultural modernization is considered to be the main cause of genetic erosion. Accordingly, this paper provides background information on status of loss and threatened cultivated crop species once and still growing in Tigray. The information will assist policy makers, researchers, conservationists and related stakeholders act accordingly in devising strategies of avoiding complete loss of threatening farmer varieties and replacement of lost.

Hence, conducting a survey to estimate loss of traditional varieties and threats to loss of on farm agro-biodiversity is crucial for development of conservation measures, extent of agro- ecological

richness, control methods and sort out of research thematic areas. Thereby, this study attempted to understand why farmers conserve and maintain agro-biodiversity, the extent of Agro-ecological richness, the estimated loss of traditional varieties and the threats of the loss of on-farm agro-biodiversity with the following specific objectives;

- To determine the extent of genetic erosion and its causes in different agro-ecological zones of Tigray
- To distinguish and determine various factors responsible for genetic erosion
- To offer counseling for a future germplasm survey and collection to be more efficient.

Data Collection and Methodology: Field assessment was conducted in 2016 to determine what exists, where and what is lost to plan how to conserve crop genetic resources and use it effectively in the future. The aim of this research was to take a baseline survey for crop biodiversity assessment and future monitoring in Tigray in selected districts of Raya Alamata, Endamokhoni, Enderta, Atsbi Wenberta, Degua Temben, Laelay Mice and Tahitay Quraro. In order to conduct this survey, a team comprising of crop biodiversity officers, researchers and including a center director was formed. These teams draft a comprehensive survey questionnaire to measure the extent and trends of staple crop diversity and farmers understanding and perceptions of the likely impact of staple crop diversity on their food security and support. Following finalization of the questionnaire, the sites were purposively selected to represent the different agro-ecological zones from where the data for this study was collected. The target staple field crops in this study were cereals, leguminous plants and oil crops that stand for the predominant field crops cultivated by farmers. All the information was compiled from 240 respondents among them 189 were males and 51 were females (Table 1).

Observation and Assessment Result: Established on the projected design, field assessment was taken for thirty (30) consecutive days from 22 October 2016 to 21 November 2016 in five zones of Tigray comprised of southern, south-eastern, eastern, central and north-western. Information on the number of varieties cultivated by local farmers for important staple crops were collected from eight districts spread across three different Agro-ecological zones to understand farmers' perception of losing on-farm crop diversity, estimate agro-ecological richness, species richness and the overall loss of traditional varieties, to know the farmers' level of

Table 1: Detail of the study sites and respondents

Agroecological zone	District	Number of informants			Average age of respondents	Average land holding size in Ha
		Male	Female	Total		
Low land	Raya Alamata	28	2	30	46.4	0.82
High land	Engamokhoni	15	15	30	44.2	0.49
Mid high land	Enderta	21	9	30	46.87	1.02
High land	Atsibi wenberta	22	8	30	46.43	0.39
High land	Degua Temben	25	5	30	52.10	0.5
Low land	Qolla Temben	25	5	30	48.50	0.85
Low land	Tahitay Kuraro	25	5	30	50.87	1.04
Mid high land	Tahitay Maichew	28	2	30	48.57	0.86
Total		189	51	240	G. Means = 48	G. Means = 0.75

Sources: survey result of 2016

awareness of genetic erosion and the different threats to crop diversity. During the interview, data were collected entirely based on the information recalled by farmers. Name of crop varieties reported by respondents was made up of those cultivated now or used to be cultivated before as heard from village elders and established on their remembrance. The exclusive information on crop varieties is based on mentioned by respondent farmers. Basic information was gathered to both traditional and improved forms. Improved varieties are formerly released by research institutes of the country either in the form of introduction from different sources outside and or development *via* hybridization with local varieties.

The survey enabled us to identify lost and threatened on farm conserved crop genetic resources which have unspeakable economic values. The survey mainly targets elders to get comprehensive and better perspective on the status and trends of staple crop varieties growing now and used to be growing before. The average age of respondents recorded during the survey was indicated 48 years and farmers in this age group are believed to be well acquainted with local varieties used to be growing in their areas. We determined the current status of on-farm agro-biodiversity for individual crops by listing the number of varieties that surveyed farmers are currently cultivating in their farms. In estimating the number of varieties grown for each crop, we simply used type and number of crop varieties grown by respondents. In determining level of diversity, individual variety named by the respondents for each crop was used as the basic diversity unit. The average landholding size across all districts is estimated 0.75 ha per household (Table 1). This indicated that the optimum land is there for cultivation of varied crops, but current size cultivable land is contracted due to sharing of children without land. Land was first distributed to households once during 1990 but since then no land was

officially distributed to landless adults and youngsters. The gradual shrinkage of available tillable lands to needy ones affects maintenance of a diversity of crops.

Information collected in all districts to understand farmers reasons for maintaining of on farm crop diversity indicated that farmers are still struggling to maintain local varieties which have strong cultural and economic ties with them. A significant portion of interviewing farmers showed consumption and growing preference for local varieties due to assured/guaranteed harvest even under unpredictable weather, better yields with limited use of inorganic fertilizers and other inputs (low input tolerance) and Better grain toast (Table 2). The importance of traditional varieties is unreservedly described by different literatures and households interviewed during this survey also underpin this view. The result of this study indicated that the majority of respondents manage and use of traditional varieties for household food security and livelihood due to these varieties have crucial principal characteristics.

Traditional varieties are mainly replaced with improved ones and few early matured local varieties. Respondents during this survey describes their rationale why prefers growing of improved varieties against of traditional ones. According to farmers, improved varieties are preferred to put into production because of the following desired principal characteristics as depicted in Table 2.

Status of Lost and Threat of Field Crop Varieties in Study Districts: Data generated from respondents during the study indicated that a number of local varieties have been lost and decreased significantly in the farming system since topple of the Derg regime. The results summarized in Table 3 truly based on information received during a study to collect information on crops, varieties grown, lost, threatened, conservation dependent, not in

Table 2: Characterization of Local and Improve Varieties Based on Respondents Perception

Local varieties	Improve varieties
high productivity, adaptability	high productivity
maintains stability in yield at marginal conditions	early matured
high quality straw yield	adapted to technological inputs
drought tolerant,	responsive to chemical fertilizer
frost tolerant	have equal grain size
water logging tolerant	reach physiological maturity at same time
pest tolerant	escape drought
adapted to local conditions	pest tolerance
minimizes input cost,	Marketability
Bereket at home	
suited for local food and local drink preparation	
quality taste	
contains balanced nutrients	
preferred for consumption	
longer in height and large in calm size	
important for conservation of cultural and traditional values	

Source: Survey Result of 2016

Table 3: Status of crop varieties growing now and traditional varieties used to be growing before in the study sites

No. of varieties cultivated in the past	246
No. of varieties currently cultivated	113
No. of varieties lost	133
% of varieties lost	91.10
Number of varieties currently under threat	98
% of varieties under threat	86.73
Number of varieties conservation dependent	12
% varieties conservation dependent	10.62
Number of varieties not in risky of lost	3
% of varieties not in risky of lost	2.65

Sources: Survey Result 2016

risky and farmers' perception on crop biodiversity. Current status of on farm agro-biodiversity of individual crops was determined by listing of interviews farmers currently cultivated on their farm. Basic diversity unit for each crop were taken from named of individual varieties by respondents. In this study, we also used farmer's knowledge and description as the basis to distinguish whether a variable was similar or different when varieties with different names were reported from the same location. Name of crop varieties reported by farmers was considered for analysis and classification of these varieties into endanger, conservation dependent and not risky range. Varieties which are not being cultivated now and used to be cultivated before of interviews households were considered extinct on farm (Table 3). The summarized information represents the status and trends of both traditional and modern varieties cultivated now and used to be cultivated before in survey sites are coordinated.

The surveyed districts were enriched by the known diversity of major staple crops of wheat, barley, maize, teff, millet and sorghum in terms of varietal diversity and

the crops are still dominantly cultivated in the areas. This work illustrated that complexity of genetic diversities were maintained for these most important crops in past decades in the fields. Grounded on this survey results of 146 crop varieties have been recognized and growing in areas for many years, but currently only 113 of them are found under cultivation. The number of local varieties estimated to be lost in the district are 133 (91.10%) of crop varieties used to be grown before (Table 3). Erosion in genetic resources of crops was more drastic for major staple crops in these districts. The diversity and richness of the local varieties are now under serious threat due to the changing nature of farming conditions. Entirely total varieties currently under cultivation are 113 in number, but out of these crop varieties 98 (86.73%) of them are under grave threat of loss (Table 3). The probability of red ink of these varieties in the near future is imminent unless drastic steps are claimed to economize on the farm and prevent from complete loss. The remained 12 (10.62%) varieties are categorized into conservation dependent that could remain conserved on farm for a certain period of time.

Market oriented productions also gain momentum on farmers' perception and influenced farmers to become less selective for crop characteristics preferred for local custom and culture. Technological changes like the use of chemical fertilizer and irrigation declines the demand of local varieties adapted to marginal growing conditions. Advancements in plant breeding have been possible with the usage of a broad scope of genetic resources provided by local varieties. The past and present successful plant breeding gradually threaten the genetic diversity basis on which future progress depends together with less rewarding of farmers to keep genetic diversity descendent from ancestors. Hence, erosion in crop genetic resources is most rapid and beyond our imagination. Thereby, it will involve strategies to slow rapid loss and to conserve sustainable for fully exploiting their incredible potential in the future in supplying of required raw materials for crop improvement.

Extensive loss and threatened of crop genetic resources were aggravated and enormous, especially in the last ten years with the promotion and expansion of modern input usage. The degree of erosion is rapid and alarming for taking precaution measures to save threatened and reverse lost crop varieties. Especially with the predicting scenario of keeping changing in climate will present grave problems in conserving of later matured local varies under current farming conditions. The major derived factors in reduction and loss of local varieties were low productivity, introduction of new varieties, pest susceptibility, late maturity, small land holding size, weather variability, lodging problem, less responsive to improve technologies, bird susceptibility, soil fertility degradation, replacement by other crops, uniformity problems in attaining physiological maturity at the same time, labor intensive, requires larger quantity of farm yard manure and compost to cultivate and limited time of moisture availability in soil are major ones. The most imminent threat to management and on farm conservation of agro-biodiversity is weather variability, introduction of improved varieties, low productivity and small land holding size.

Enderta district is known with growing diversity of crop varieties which were crucial for survival of subsistence farmers and their livestock. The dominant staple crops growing in Enderta are wheat barley, sorghum, tef and legumes respectively. This survey result indicated that 60 crop varieties were used to be grown in the district but currently only 18 of them were found on farm under cultivation and out of these 16 (88.89%) were seriously threatened to lost. Greater loss of crop varieties

were also occurring to Enderta district with losing of 42(70.00%) of the 60 varieties used to be grown compared to other districts in the study sites. Second highest loss was recorded to Endamokhoni and Degua Temben districts with loss of each 31(58.11%) and 30 (58.33%) varieties respectively and closely followed Tahitay Quraro district with loss of 24 (57.89%) of the varieties used to growing in the district (Table 4). Lower in genetic erosion of 26 (40.63%) was obtained at Laelay Maichew district relatively compared to other districts in this survey. Generally obtained information during survey indicated that lager number of crop varieties were lost and crop genetic erosion is occurred with vital dominant staple crops used to be growing the area.

From historically 48 varieties used to be growing in Atsbi Wenberta district, only 22 of them were found to be on farm and out of 18 crop varieties being growing now 21 (95.45%) of the varieties are found under serious threat of loss (Table 4). The larger percent of varieties threatened to loss were recorded under this district compared to relative districts included in the survey and closely followed by Degua Temben district with 28 (93.33%) of varieties were found on farm seriously threatened to lost. The relative lowest threat to loss of genetic materials were observed in Qolla Temben districts with 18 (78.26%) of varieties currently under cultivation were under threat to future loss. The result further indicated that there is no insurance for conserving of threatened crop varieties with doing nothing and left everything to farming households to choose and hold what they want to grow on farm. Hence, complete loss of crop genetic resources which may have unspeakable roles to coming generation in supplying of food, feed, medicine and gene pool for breeding are about to happen.

It is required immediate action to save threatened varieties from complete loss and conserve for future exploitation. Respondents said that major factors responsible for decrement and loss of valuable genetic material in the districts were introduction of improved varieties, introduction of improved agronomic packages, late maturity, weather variability, pest susceptibility, lodging problem, government pressure, seed access, extension biasedness, low responsiveness of chemical fertilizer and soil degradation and low moisture holding capacity are among major ones. Hence, erosion in crop genetic resources is most rapid and beyond our imagination. Thereby, it requires strategies to slow rapid loss and to conserve sustainably for fully exploitation their incredible potential in the future in supplying of required raw materials for crop improvement.

Table 4: Survey summary of status of crop varieties in study districts

District	Varieties cultivated	Varieties currently	Varieties lost	Varieties currently under threat	% of varieties lost	% of varieties under threat
	in the past	cultivated				
Raya Alamata	34	17	17	14	50.00	82.35
Endamokhoni	74	31	43	28	58.11	90.32
Enderta	60	18	42	16	70.00	88.89
Atsbi Wenberta	48	22	26	21	54.17	95.45
Degua Temben	72	30	42	28	58.33	93.33
Qolla Temben	41	23	18	18	43.90	78.26
Laelay Maichew	64	38	26	35	40.63	92.11
Tahitay Quraro	57	24	33	21	57.89	87.50

Source: Survey Result of 2016.

Table 5: Summary of Perception of Respondents on Local Varieties in study sites.

Variables	Respondents Frequency percentage
Number Of Local Varieties On Your Farm	
Increased	2 (0.83%)
Decreased	167 (69.58%)
Stay the same	71 (29.58%)
Age of Lost Varieties 30-50 Years Old	
Yes	152 (63.33%)
No	31 (12.92%)
Don't know	57 (23.75%)
Length Of Year The Variety Disappeared	
Over last 5 years	14 (5.83%)
Over 5-10 years	49 (20.42%)
More than 10 years	124 (51.67%)
I don't know	53 (22.08%)
Status Of Loss Of Local Varieties	
Sudden	7 (2.92%)
Gradual	157 (65.42%)
I don't know	76 (31.67%)
Popularity Of The Varieties	
Very popular	90 (37.50%)
Popular	79 (32.92%)
Not so popular	5 (2.08%)
I don't know	66 (27.50%)
Seed Sources	
Informal	131 (54.58%)
Purchase	1 (0.42%)
Both	105 (43.75%)
I don't know	3 (1.25%)
Number of respondents Matter with loss of Local Varieties in their Village	
Yes	152 (63.33%)
No	88 (36.67%)
Possibility of finding Lost Varieties In Your Village	
Yes, very likely	80 (33.33%)
No, very likely	142 (59.17%)
Don't know	18 (7.50%)
Do You Believe That Local Varieties Are Replaced by Improved Varieties	
Yes	221 (92.08%)
No	17 (7.08%)
Don't know	2 (0.83%)
Number of respondents Los of Local Varieties Influencing their Livelihood	
Yes	62 (25.83%)
No	178 (74.17%)

Source: Survey Result of 2016

Perception of Farmers on Lost Varieties: Crop diversity has used full social values and able to improve livelihood of farmers and assist them to lead satisfactory life. Tigray is abundant with crop plant genetic resources which are highly tolerant to shock of extreme temperature, drought, insect pest and diseases resistance. Preservation of these resources is very vital in developing of climate resilient crops, high water efficient crops, early maturing species, generate high yielding and improved market access potential in the future. Arresting of human interaction with varied ecosystem and life form to manage crop biodiversity so as to maximize benefits provide today and preserve their potential for meeting the coming generation aspiration is inevitable. Diversity is insurance for low input traditional farming system of poor households to maintain production stability under climate, disease and insect pest risky prone areas tend to be less production.

Majority 167 (69.58%) of respondents said local varieties used to be growing both on their farm and in their village were found notably decreased whereas 71 (29.58%) said number of long-established varieties on their farm is stayed the same (Table 5). This is because as per of 221 (92.08%) of farmers during the interview local varieties have been replaced by dominantly with early matured, high yielding improve varieties and with few preferable early matured local varieties. Respondents indicated that vital problems in cultivation of local varieties were weather variability, drought and seed access of local varieties particularly when subsequent drought was occurred. At time of hardship, communities are also consumed their seed stored for survival and hence adversely affects availability of planting materials in good rainfall time. It indicated that there is urgent need of proper seed storage by collecting during harvesting and supply to growers during good time of the year which suited for late matured and high yielding local varieties cultivation. Introduction and promotion of improved varieties and pressured farmers to grow them in cluster were negatively affects sustainable conservation and cultivation of local varieties. Generally the number of local varieties gets ceased gradually with time in the near future if required drastic measures to save local varieties are not taken by concerned individuals, organization and government bodies.

According to 152 (63.33%) of respondents, most of lost crop varieties were old varieties that have been known and grown in the districts for many years as sources of livelihood to subsistence farmers, but 57 (23.75%) of respondents don't have recognition on age status of lost varieties (Table 5). Most of respondents 124

(51.67%) out of 240 said that it is more than ten (10) years since the varieties disappeared and no more growing in their locality. Whereas about 53 (22.08%) of respondents said don't have idea on time of local varieties were vanished on farm (Table 5). This indicated that the lost happened to long been crop genetic resources which were with farming households adapted their farming conditions and ecology. Hence, missing such type of old varieties with no notice from both farmers and decision makers would adversely affect demand and aspiration of future generation. It seems that the present generation is living at the cost of future generation and nothing is done still to save and conserve such valuable genetic resources for future use.

Raising awareness and building the capacity of all actors in agriculture on the role of crop biodiversity and associated traditional knowledge on agricultural development is vital for enhancing quantity and quality of sustainable food production, agro-ecosystem health and for cascading economical and ecological sustainable development. Feeding the ever increasing population requires increasing staple food production in sustainable manner so as to curb degradation of farm ecosystem, ecosystem functions, lose of natural resources and biodiversity. Hence, providing awareness rising to all concerned actors together with stake holders underpins to improve knowledge about crop diversity in the future. Therefore, raising the awareness of all actors at all level is vital for preservation of local landraces by farming households and providing support to farmers is also advisable for maintenance of diversity and benefit sharing.

The obtained result in survey indicated that the rate of loss of local varieties were not instant and 157 (65.42%) of respondents ascertained that the process to loss was gradual and eventually complete erosion was happened (Table 5). The other portion 76 (31.67%) of households don't have memory on how speed of crop genetic resources lost was occurred and simply sense that an old varieties used to be growing were not on farm today. With frequent occurrence of drought, soil degradation and pressure of extension agents with frequent visit to change attitude of farmers gradually affects conservation of local varieties long been with farming households.

Most of respondents 90 (37.50%) believed that extinct varieties were very popular in terms of productivity, quality straw yield, drought tolerance, healthiest for eating, preferable for local consumption and traditional food and drink preparation whereas 79 (32.92%) of respondents said that extinct varieties were popular in

their respective localities (Table 5). The third momentous 66 (27.50%) portion of respondents don't sense about conditions of lost varieties in their locality but recognized that varieties long been with them have been lost regardless of their popularity. Growers in survey districts have found seeds from different sources and this survey indicated that 131 (54.58%) of respondents utilized informal system to exchange seeds among themselves whereas 105 (43.75%) of interviewed farmers said their seed sources were both informal and purchase on local markets and from neighboring farmers (Table 5). Respondents were asked about the possibility finding lost local varieties and 142 (59.17%) of respondents said possibility of finding local varieties in their surrounding is not likely and 80 (33.33%) where said it is likely possible to find lost varieties elsewhere out of their village (Table 5). This indicated that loss in crop genetic resources seems permanent and difficult to retrieve on farm again for cultivation and conservation.

Significant portion 152 (63.33%) of households interviewed during this survey said complete loss of local varieties and no longer growing in the village matters to them (Table 5). This is because loss of local varieties causes, loss of quality and nutritious food, loss of quality straw yield, loss of culture and tradition, loss of varieties suited to local food and drink preparation, loss of preferred health food, loss of bereket at home during consumption. Local varieties can grow and provide optimum yield under marginal condition without investing on seeds and chemical fertilizer to enhance production and hence majority of respondents did not want to see complete loss of local varieties both on their farm and village. Respondents' claims loss of local varieties destabilizes their way of living and brought them into debt trap. Skyrocketing cost of inputs with time adversely affects food security and the final product obtained is invested on payment of input loans. For this reason, households sensed that missing of local varieties on farm causes loss of quality and nutritious food, loss of quality straw yield, loss of culture and tradition, loss of varieties suited to local food and drink preparation, loss of preferred health food, loss of bereket at home during consumption. Generally local varieties provided quality injera which remains soft for several days and greater satisfaction while eating.

Another portion of households 88 (36.67%) did not matter about loss of local varieties that have been grown on their farm for centuries with them and disregards conserving of them for sustainable utilization (Table 5). These type of respondents heavenly reliant on high yield

improve varieties which provided by government agencies and promote to use to brought significant changes in final production and market values. Early maturity nature and highly demanded in market also positively influences and changes farmers altitude. Basic information collected on the reason why respondents ignore production of local varieties were includes;

- Late maturity and exposed to late drought occurrence
- Not suitable to grow with current weather variability
- Susceptible to disease and insect pest
- Seed access and yield improvement is obtained with improved seeds
- Are not suited with improved agricultural technologies
- Were susceptible to birds
- Improve in access of technologies by government to change their livelihood.

Respondents were asked whether lost varieties have poses influence on their livelihood or not and 178 (74.17%) of respondents said no more growing of local varieties on their farm did not drown impact on them and their livelihood (Table 5). This is due to improvement in access of high yielding, early matured and market demand improve varieties with government. Hence, respondents believed that local varieties were discarded from production by government because of lack of essence in their values to farming households and following of government attention in our production system, we left local varieties and divert to improve ones. Whereas remaining 62 (25.83%) of households said loss of local varieties on their farm and village affects their livelihood. The major assertion they rose was growing of improved varieties significantly affect straw quality demand for their livestock. Thus, loss of local varieties causes miss of animal feed, family food security, local drink preparation and cultural erosion, nutritional demand and bereket at household consumption.

Varieties Preference for Growing: Respondents were asked to list the type of crop varieties needed to be growing on farm and an overwhelming number of respondents showed interest in growing of improved varieties but significant portion of households also show interest to grow local varieties. Thereby, types of crop varieties need to be sown in respective districts were summarized here below (Table 6). Most respondents preferred to grow local varieties where aged farmers who have a strong association with cultural foods and hesitate

Table 6: Local varieties preferred to be grown by respondents and reasons of preference in study districts

Woreda	Crop type	Preferred varieties to grow by respondents	Why
Alamata	Sorghum	Degalit	<ul style="list-style-type: none"> • Productivity • Bereket • Local food preparation • local drink preparation • preferred for consumption • early maturity • high market demand • required for construction and fire wood • Market value
		Jagrite	
		Komatie	
	Maize	Gededom	
		Bar	
		White improve	
		White local	
	Tef	Red	
		Magna tef	
		Bunign	
Red tef			
Jegerie			
Endamokhoni	Mungbean	Mungbean	
	Wheat	Local wheat	
		Dekotsa	
		Gune	
	Barley	Lilay	
		White wheat	
		Improve	
		Kinchibe	
	Sorghum	Saesea	
		Zinba	
Abiy ekili			
White barley			
Saesea			
Enderta	Field pea	Shewa	
	Wheat	Bar sorghum	
		Desalegn wheat	
	Barley	Milhug wheat	
		Adimoy	
Aykurtem			
Tef	Shehan		
	Black wheat		
	Improve		
Atsbi Wenberta	Wheat	Burguda barley	
		Black saesea	
	Barley	Red tef	
		Bunign	
		Magna	
	Tef	Tef hagay	
		Improve	
		Gerey	
		Adimoy	
	Barley	Desalegn	
Muruts			
Burguda			
Tselamo			
Karkaeta			
Tef	Demhay		
	Kintsibe		
		Tef hagay	

Table 6: Continued

Degua Temben	Wheat	Improved wheat
		Ashmolmole
		Sielu
		Shehan
		Gojo
		Meleelay
	Barley	Wejerat
		Keyho
		Saesea
		Black
		Genber beeray
		Atsa
Tef	White	
	Gonfel	
	Red	
Kola Temben	Tef	Improve
		White
		Sergen
	Mazie	Anjo
		Red
		White
Dagusha	Arkibi	
	Abat	
Tahtay maichew	Tef	Improve
		Sergen
	Dagusha	Red
		Keyeho
	Maize	Black
		Toga
Laelay Maichew	Wheat	Kinkina
	Noug	Local
	Tef	Improve
		Zezew
Gerima		
Fenkil		
Red		
Maize	Shewa	
	Kobo white	
	Changer	
Chickpea	Anjo	
	local	

Sources: survey result of 2016

to change their farming into improved varieties. The other reasons for growing of local varieties were bereket in home consumption and higher productivity during good season of the year. It is also because farmers' varieties provide quality straw yield for livestock feed suited for preparation of local drink and food, tolerant to drought, provides good flavor and taste are major ones. Thus, depicted features of local varieties above were derived factors for their preference to be growing in the coming growing season by farming households. All listed local crops/varieties preferred to be growing may not be

available either at household or community level and hence requires collection, multiplication and distribution of these seeds to needy ones. It requires all actors involves in conservation and sustainable utilization of local varieties to be part of it and support the process of replacement of preferred local varieties disappeared in the districts. 6. Challenges of Local Crop Varieties Production under Tigray Conditions: The cropping system started to be commercialized and resulted in reduction in crop and varietal diversity. The dominant improved varieties distributed in the districts were wheat in highlands,

chickpea and tef in mid and low lands. It is witnessed that in all districts prioritized for this survey, farmers were adopting improved varieties of few major crops and growing them in a cluster regardless of previous habit in maintaining range of crops for cultivation to ensure food security and risk aversion. It was also observed during the visit that most fields were seen sown with improved wheat in wheat cluster of Endamokhoni, Atsibi Wenberta and Degua Temben; improve tef, in tef cluster of Alamata, kola Temben, laelay Maichew and Tahitay Kuraro. The other factors (out of the introduction of improved seeds) which affect diversity maintenance of local crop varieties growing in respective districts were weather variability and land holding size. Late matured varieties which usually sown in April, May and June were out of on farm conservation, because of cessation of occurrence of short (Belg) rain season and late onset of the main seasons (kiremt). With dramatic increase in population size in the region, available land for cultivation is reduced and number of varieties used to be cultivated on farm also down with land holding. Conservation of local varieties on farm in farmers' field is unthinkable with current socioeconomic conditions of Tigray, low productivity of soils because of land degradation and small land holding size. Breaking the firm stand of decision makers on the current approach of production and policy of agriculture into a conservation based production system is very challenging. The regional strategy to enhance productivity is planned to exploit every available improve technologies that could change production and productivity fragmented plot of lands at farmers holding. The policy target planned to achieve in record production is through effective utilizations of all actors from researchers who emanates technologies to agricultural experts those disseminates it with full participation of all government sectors in respective district and kebelles.

The other stated problem related to traditional crops was failing to perform under marginal conditions and less responsive to chemical fertilizers. Respondents are worried about skyrocketed the cost of chemical fertilizers and improved seeds in one side and less adaptive nature of local varieties to chemical fertilizer adaptive areas on the other side. Farmers claims chemical fertilizer contaminated areas are not suited for growing less responsive local varieties under marginal conditions. This view of respondents adversely affects local varieties cultivation and conservation for sustainable utilization. They also claim that water holding capacity of farm lands has gotten significantly reduced since the start of utilization of chemical fertilizers and these exposes to late mature local crops to occurrence of late drought.

The limited number of domestic animals at home to get farm yard manure (FYM) and inadequate availability of compost raw materials in their areas also negatively affects farm fertility replenishment. All these factors are causes of agro-biodiversity erosion that may provide raw materials for adaptation, evolution and survival of species and individuals under change environment and social conditions. Thereby, community is penalized not only with production failure, but also with straw yield that supports livestock feed mostly during long dry seasons. The survey also indicated that the economic value of the straw is comparable with grain. The marginal nature of grazing lands in the districts causes communities to directly depend upon final straw yield and always considered straw yield, quality while selecting of crops to be grown in the field. Generally, local crop types and varieties have been with local communities for centuries. Crops and or varieties developed adaptive genetic and phenotypic capability for existing ecological conditions that acquired *via* evolution in time. Local crop provides better economic benefits to households in terms of risk absorption, stability production, quality straw provision, preferred health food, strongly tied to culture and required to make traditional foods and drinks. While losing of many farmers' varieties, still conserving of few local crop types on farm are due to their unbreakable relation with traditional, cultural and economies of communities. Based on current observation during the interview, households believed to maintain local crop types until all the societal value will be degraded.

The assessment ascertained depletion of most valuable genetic resources that ensures survival of humans goes with no notices from the public and little attention from both political leaders and scientists. It is believed that the indigenous local crop genetic diversity in all districts is eroded dramatically and hence significant measures are needed to conserve threatened local crop types. Farmer varieties have already abandoned production today might have a variety of agronomic, genetic, economic, social and cultural roles tomorrow. Replacement of lost local crops/varieties from the gene bank stored by previous collection and or collecting through funding in another part of the region if they are under cultivation still is advisable. The replacement would also be aligned with promotion and further conservation of local farmer varieties to ensure food security and access in the foreseeable future.

Conservation Implication: With the preliminary result of this study, crop genetic erosion across all districts is dramatically higher and alarming. The higher number of

diversity in crop varieties was obtained at high land and midlands and similarly the greater the genetic erosion was also recorded in these Agro-ecological zones. Per district, the highest erosion was recorded at Endamokhoni with losing of 47 varieties and closely followed by Enderta and Degua Temben by losing of 42 varieties each. It indicated that nearly 50% or above of local varieties used to be grown were lost and remained with few local varieties growing in small areas and 1 or 2 improved varieties grown in swathe of areas in respective agro-ecological zones where this survey is comprised. More than 95% of local crop varieties found under cultivation conserved on farm were seriously threatened with loss. Once the complete loss of these genetic resources, it gets difficult to restore unless found stored in gene bank during previous collection of EBI. Introduction of improved seeds is considered as major threats that lead to loss of genetic variability in a given farming system & popularity and largely presence of improved varieties in farming system is an evidence of genetic erosion. Farmers demand in growing of modern varieties is increasing due to productivity, marketability and earliness in maturity results significant in farm genetic erosion.

Providing of poor attention to the concept and value of crop genetic diversity at all levels in Tigray affects conservation measures and hence crop genetic erosion is rapid. Conducting awareness raising campaigns to the public in general and policy makers in particular on the scope and seriousness of genetic erosion is important for further deterring losers. It requires urgent recognition of growing diversity loss of field crops that have imminent negative effects on the livelihood of the resources poor farmers and future agricultural development. Preparation of urgent plan of action for conservation and wise use of crop genetic resources should be placed into practice. Selection of proper crop varietal conservation strategies requires clear decisions about farming households, commercial and volunteer contributors to varietal development and seed distribution. Currently, commercial and government seed enterprises are found replacing local seeds (public sectors) and contribute much on plant breeding and varietal development. Seed companies respond most effectively to farmers' needs compared to public sectors. Major bottlenecks on commercial seed companies is neglecting of minor crops which adapts marginal growing conditions and important resource for poor farmers and not plays crucial roles in conservation activities. Providing of legal rights and protection to farming households for conservation and sustainable utilization of local varieties is required.

Solution for Conservation of Local Varieties Proposed by Respondents: Respondents were asked questions in regard with on how to conserve of valuable local varieties which have been with them for many years to come across with their own solution for sustainable and effective utilization in future. Respondents were also provides what they think is the best solution for the conservation of local varieties on farm in the future as summarized here bellow. The first proposed for conservation of local varieties were seed collection finding everywhere the seeds could be available for replacement of lost varieties on farm and multiplication to distribute to beneficiaries for on farm conservation. Irrigation areas should be utilized for the cultivation of threatened and lost varieties as insurance of loss control with undesirable environmental conditions which occurred during the growing season.

The other bottlenecks in production of local varieties were lack of seed access for production during good season of the year and hence improvement in seed access to farming households is crucial. Once the replacement of lost varieties was conducted, improve in access of market conditions; improve in awareness of households on role of crop genetic diversity in their farm and livelihood for proper management and sustainable conservation is also important. The other important solution proposed by respondents was providing of equal emphasis to both local and improve varieties is required for conservation and prevent from complete loss. Preparation of agronomic production packages to improve productivity of local varieties is required in the future. This is because if local varieties are properly managed and recommended agronomic packages are applied in the crop production system yield of local varieties is not significantly less compared to improve varieties. The only problem in production of local varieties doesn't yield rather it is moisture deficit.

CONCLUSIONS

Our assessments showed us the fact that landraces are undoubtedly the most threatened element of biodiversity in the study areas. The overwhelming portion of local varieties has been extinct on farms in all studied districts. Preservation and utilization of local crop genetic resources that have a pivotal role of marginal, a diverse biotic agricultural environment where improved varieties had less successful are essential. The major challenges of conservation of crop genetic resources are the dilemma between balancing development and conservation. Technological advancement contributes in lessening of modern varieties development, both in time and efficiency.

This weakens crop diversity basis by replacing local varieties and thus threatens further progress in breeding. Poor attention in research and extension services in such areas forced farmers to become more dependent on non-farm income which may bring a reduction in growing and maintaining of crop genetic resources. The occurrence of undeniable evidence of genetic erosion and innovative responses to calm were/are limited by knowledge gaps to decide on available alternatives. The main gap associated with these is our level of technical understanding about crop biodiversity and socio-economic correlates. The ordinary solution to conserve genetic materials is either through growing on farm subsequently or properly stored on gene bank. Finding of lost varieties on every corner of the region if it is available stored or growing by some aged farmers to collect for replacement and conservation should be started immediately.

Therefore, such an assessment and further research on on-farm conservation of landraces was timely and there is a need to conserve threatened local varieties before complete loss in the farming system. Restoration action is mandatory for local varieties extinct on farm to be conserved for future generations, to ensure wealth creation and crop sustainability in times of ecological uncertainty and to conduct successful advance breeding in enhancing production.

Conflict of Interest: The authors declare that there is no conflict of interest regarding the publication of this paper.

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