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Cropping System, Diversity Management and Indigenous Knowledge of Seed Handling in the Western Zone of Tigray, Ethiopia

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Abstract: This work is a field survey aims to determine cropping system and evaluate crop diversity management and associated traditional knowledge of seed storage in Tigray. The study was conducted in western Tigray, Ethiopia during 2018s. Sequential crop rotation was dominant cropping system practiced in study site. Crops growing in area were processed at least more than three forms for local consumption. Cultivated crops used for medicinal purpose to treat human and animal ailment were sorghum, tef and sesame. Crop varieties resistant and tolerant to biotic and abiotic stresses commonly found in the site were selected in addition with other associated features. Tef and finger millet can be stored for many years without losing their viability, whereas, sorghum for nearly three years if properly stored. The major challenges for no cultivation of these varieties were due to serve striga infestation, outbreak of insect pests, weather variability, low water stress and late maturity nature of varieties. It is recommended to initiate and execute additional research projects to further investigate and decide the types of crops to be included in the rotation system.

Key words: Cropping system · Diversity management · Variety selection · Seed handling · Storage method

INTRODUCTION

In the world, sub-Saharan Africa is the poorest region with GDP growth of 0.16% and the long term low average growth rate has increased level of poverty in the region [1]. Agriculture is a fundamental sector of the economy and more than half of the population is primarily relied on it and suffered markedly by low productivity with little/no use of science and technology [1]. Ethiopia is endowed with ecological diversity and have conducive environment for agricultural activity and dominantly an agrarian country. More than 80% of Ethiopians are living in rural areas and their livelihood is depending on subsistent agriculture [2] and majority of them are smallholding. The sector of agriculture is the backbone of the economy and contributes 43% of the GDP, 90% of the foreign exchange earnings and generates employment for 83% of the population [1]. Despite, The present smallholding production system in the country is intensive in practice and found under higher population pressure. Nearly 77% of the population is living in 37% of the geographical area of the country and crop production is relied on input utilization. Subsistent farmers' covered 96% of the total cultivated land with average holding of less than one hectare and more than 65% of the production is consumed by producers locally [3].

Diversity of crops grown in the country due to complex mosaic agro ecology derived from varied topography, soil type and growing conditions ranged from 600-3000 m.a.s.l. (meter above sea level) There is no hesitation on the importance of agriculture for economic development and poverty alleviation in Ethiopia. However, production system in the country is mainly based on growing seasonal field crops on marginal lands affected by soil degradation, soil erosion, low input utilization, utilized poor agronomic practices and low yielding varieties. Thus, income from such farming system is not sufficient for farming families to sustain their lives, leave alone surplus production supplying to the market.

Tigray is located in northern edge of Ethiopia and the cradle of political, economic, technological, cultural and spiritual civilization of the country. The recent archeological findings in eastern Tigray indicated that agriculture was first started in these region more than three thousands of years ago and eventually spreads to rest of the nation. In this chronological time of farming,

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farmers in the region have developed farm tools, innovative agricultural practices and found grown numerous crop species using own indigenous knowledge. In addition to anthropogenic factor, the induced diverse geo-ecological and climatic conditions in the region contributes to present diverse agro-biodiversity resources that caused evolution and formed new varieties within the species. The agricultural practice in the region is largely smallholding, marginal and self-sustaining practice, integrated and subsistent agricultural production system. Subsistent farmers of the region spread across varied ecological zones from 500 to more than 3000 m.a.s.l and found cultivate a wide range of field crops for centuries on farm. The crop species richness and abundance with indigenous knowledge of management has been significantly contributed to the food demand of the region for centuries. The current production system in Tigray is more intensive with continuous cultivation of the same piece of land year after a year. Growers who contain diverse local varieties on farm were played vital roles in sustaining crop production by adapting subsequent climate induced changes via evolution that enable to generate novel variations in the future. The conventional farming system practiced in the country enabled growers to hold diverse genetic resources needed to adapt present heterogeneous growing conditions and future climate induced changes.

Crop genetic diversity is a foundation of our food supply and provides balanced nutrition with other varied products and services. Hence, assessing the diversity management conditions in the present cropping system is required to promote on-farm conservation of diverse crop species for the present and future better use. Diversity is key strategy for adaptation and survival in harsh environmental conditions to averse risky and compromised yields. Therefore, conservation of crop varietal diversity contracts the effect of biotic and abiotic hazards, ensured family food security and increased biological and cultural diversity. Maintaining diversity widens the sources to improve food crops and is crucial precondition for assuring food security. It is required to utilize in modern breeding in addressing problems related with insects, diseases, parasitic weeds and changing physical environmental conditions [4]. Traditionally farmers were/are growing both early and late maturing varieties either same and different crops to improve the period of food availability and spreading labour required at sowing, weeding, harvesting and threshing time. Similarly, two or more component crops are growing together at the same time and same field to efficiently utilized growing resources (labour, land, water, fertilizer and radiation energy), risky aversion, maximized production and pest management.

The indigenous cropping systems that has been developed based on locally accessible resources and practices for centuries using biological and cultural evolution, cultivation of diverse farmer varieties in time and space has permitted local farmers to enhance production and allowed to use the cultivated land with little environmental impact [5]. However, this type of cropping system has been affected with natural and anthropogenic factors particularly by the wider impact of climate induced changes and shrink of net cropped area per head. The activities consequently created marginal and food insecure societies. Detail thoughtful of the crop production system at district level is crucial to plan and evaluate previous interventions of agricultural policy decisions implemented at this level and what should be done next to magnify the impact of agriculture on the economy. As per the knowledge of researchers, so far, no research has been conducted related with production system, diversity management and indigenous knowledge of crop seed storage in Kafta-Humera district. Thus, conducting of this assessment was vital to generate information about the conventional production system, crop diversity management and associated indigenous knowledge on seed storage methods. Therefore, the result would provide conservationists, development agencies, researchers, scientists and policy makers to have a better understanding on the cropping system, crop diversity management, seed selection and storage methods in the site. It was also important to develop intervention mechanisms to avoid future losses and served as baseline for monitoring diversity and system changes induced by anthropogenic factors in the future.

Objectives:

- To determine the cropping system practiced in adjoining Kafta-Shiraro national park western zone of Tigray
- To illustrate crop diversity management and associated traditional knowledge of seed storage

MATERIALS AND METHODS

The study was conducted inKafta-Humera district, western zone of Tigray Ethiopia during 2018 cropping seasons. It was covered Adigoshu kebelle farming households in Kafta-Humera district of western Tigray.

Mixed farming is the livelihood of the predominant local communities in the study area. The field survey was conducted to acquire information regarding cropping system, diversity management and existing traditional knowledge of seed storage in the study area. Geographically, Kafta-Humera is located 13°45' to 14°28' north of latitude and 36°20' to 37°31'east of longitude [6]. The study area is located in border of Eritrea and characterized by valleys and extended plain lands covered with spare forest trees and bushes. The study area was situated in the low land plains at an attitude of ranging from 500-800 m.a.s.l [7]. The climate of the area is semi-arid in nature and the average annual temperature is 29°C (with mean minimum and maximum temperatures of 21 and 39°C respectively) and mean annual rainfall is 600mm [8]. The annual rainfall is primarily concentrated on four months which commences during early June and ends mid-September. The soil of the area is alluvial and non-calcareous vertisols that has predominantly water logging problems. The study area is endowed with plenty of biogenetic resources of wildlife, crop, horticulture and domestic animals, which support the stability of the ecosystem and subsistent life of the local communities for considerably long time. The semi-arid region of Kafta-Humera is covered with native *Acacia seyal* and *Balanites aegyptiaca* plant species. The study area was found adjacent to Kafta-Shiraro national park and was characterized by very sparsely human settlement. Tigray regional administration has chosen the area for resettlement program for farmers coming from populated highlands of the region and now tens of thousands were resettled in the district. The demographic changes with resettlement and seasonal migration of labour associated with semi-mechanized farming were the imminent threats of natural resources degradation.

The required data was obtained via independent interview of members of randomly selected local residents (women, youths, elders and local administrators). The data were collected from 100 respondents and among them 69 were males and 31 were females. The questionnaires were focused on type of cropping system practiced, seed selection and storage methods and crop diversity management mechanisms and other related characteristics of farming practices in the study site. Data obtained from the survey was analyzed using descriptive statistics on qualitative and quantitative variables of diversity status, cropping system and indigenous knowledge on seed storage methods using SAS, version 9.1.3, general linear model (GLM) procedures [9].

RESULTS AND DISCUSSION

Soil Characteristics: Soil is a living ecosystem inhabited with varied living organisms and known with physical qualities and chemical interactions crucial for maintaining soil health and quality. It is formed by the interaction of soil forming factors such as parent materials, climate, topography, biological activities and time. The different characteristics of soils are result of interaction process of soil forming factors. Thus, soils are described by relative abundance of their particles. The relative abundance of these particles has an impact on agricultural activities. The different size of particles has different nutrient, water and cation exchange capacity, root penetration and air circulation capacities in the root zone.

Amare, *et al*. [10] reported that the soil types predominantly found in Kafta Humera district is chromic vertisol and characterized by high contents of smectitic clay minerals. Respondents ascertained that the dominant soil types found in their locality was vertisols. Vertisols are a group of dark heavy textured soils extensively found in tropical, subtropical and warm temperate regions. The features of this soil are strongly affected by availability of moisture and swells when hydrate and shrinks upon desiccation with extensive cracking in dry season. The high clay present in vertisols enables to adsorb water and increase in volume during wetting and started to shrink with drying of the water holds and form large deep cracks. This type of soils have dark color with varied content of organic matter and problematic to farming both under too high and too low moisture. The cemented and cracking nature of vertisols during the dry season adversely affects tillage practices and farmers in the area usually started tillage following first date of effective rainfall that possibly wetting the soil. Vertisols are highly sensitive to land use changes which drastically alters soil structure.

The preparing the land for cultivation and expansion of mechanized farming in the study area were the major threats that potentially alter the soil structure in possible future. One of the soil property affected by structure alteration is soil hydraulic conductivity. Hydraulic conductivity of the soil is the main parameter that affects water and solute transport and determines water availability to plants. The semi-arid region of the study area was affected by low water availability and uneven distribution of seasonal rainfall.

Vertisols have high water holding capacity and very suited for dry land crop production found in semiarid regions like in the study area. These factors of vertisols

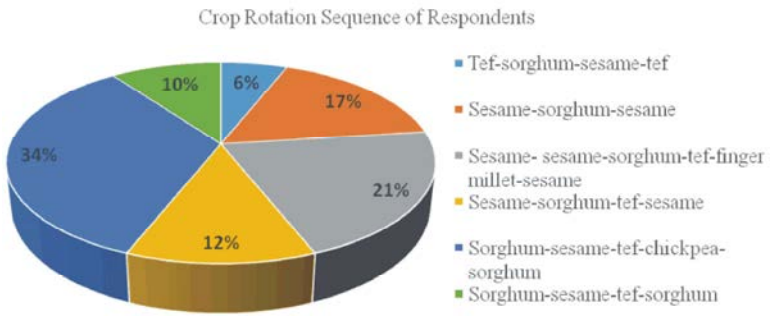

Fig. 1: Percentage of respondents on succession of crops growing in the study districts

contributed in enhancing productivity of crop in semiarid environment suffered with uncertain and variable rainfall distribution. Sometime, rainfall is too high and too little and thus, ability of the soil to hold much water for extended period of time carry crops to postpone drought during drought periods is countless importance. Nutrient availability, water holding capacity, aggregation, temperature and infiltration rate are important agronomic soil properties of vertisols.

Cropping System and Season

Cropping System: Cropping system is a systematic/pattern of crop arrangements to enhance effectively transform of environmental inputs like solar radiation energy, nutrient and water in the soil and other related inputs into economic yield in the form of food, feed, fiber and fuel.

An assessment was carried out to identify the type of cropping systems practiced in the study area and the finding indicated that continuous cropping practices were predominantly practiced by local farmers (Figure 1). It was aforementioned that the entire respondents involved in the interview were found practicing of sequential cropping as cropping system with different rotation years. The result prevailed that three to six years of rotation was found practiced in the study area. From the total respondents, majority 34% of them indicated that they had followed five years of rotation system with sequence of sorghum-sesame-tef-chickpea-sorghum. In these rotation systems, the succession crops were varied in root depth and allowed them to exploit growth resources in different depth of the soil. This avoids destruction of soil quality such as texture, structure and organic matter content. In addition, involving of legumes (chickpea) in cropping sequence enables to fix nitrogen, interrupt weed, diseases, insect pest, reduced erosion and improve soil fertility status.

Similarly, 21% of respondents were practiced six years of rotation system with sequence of sesame-sesame-sorghum-tef-finger millet-sesame, whereas, 17% of them were practiced three years rotation with sequence of sesame-sorghum-sesame. This cropping sequence involves succession of different crops with different root depth in the first years of rotation and placed cereal crops in extended succession and the system caused to exploit growth resources in alternative depth. Thus, such type of succession might bring some destructive results on yield and soil quality and hence not advisable to practice. On the other hand, 12, 10 and 6% of respondents followed sesame-sorghum-tef-sesame, sorghum-sesame-tef-sorghum and tef-sorghum-sesame-tef sequential rotation system respectively. Even though, crops in succession have different root depth and can exploit growth resources alternately, there were no synergetic effects among succession crops. Therefore, including of legumes in the succession was mandatory to enhance synergetic, interrupt life cycle of weeds, pests and improve soil quality. Generally, it was the practice of growing crops in succession in time on the same piece of land in specific time.

It was observed during the interview that farmers are growing their crops with definite succession in the field to augment benefits in the system. Succession is primarily relied on crop management, financial capacity and prevailed environmental factors in the area. Therefore, the final goal of succession is to increase profit, minimize risk, enhance organic matter, effective and alternate utilization of resources and maximized economic yield. Furthermore, respondents practiced succession to eradicate problems related with weeds, pest infestation and development, replenish soil fertility and increasing final productivity. The cropping succession in the study area was influenced by occurrence of pests, parasitic weeds, soil type, rainfall distribution, topography, socioeconomic condition and fertility status of the soil. The succession of different crops in definite time manner combination with other crop management practices are cheapest way of pest and weed management practices.

The continuous land use systems with cultivation of similar crops is an offensive system that has adverse influence on soil physical conditions, crop development and extended consequence on environmental pollution. Cultivation of the same land year after a year with same crop has caused loss of organic matter, damages soil structure and texture resulted from soil disturbance due to tillage and exploiting of resources from same depth. The conventional monoculture approach in crop production practices caused disease development, organic matter depletion, soil degradation and damages soil structure. Leaving crop residues in the field and incorporating of legume crops in the rotation system is crucial to improve the physical and biochemical property of soils by enhancing additional organic matter into the root zone. Unlike other areas of Tigray, farmers in western Tigray left crop residues in field after harvesting of the economic yield and remained residues has crucial roles in enhancing organic matter, increased activity of microorganisms, reduce erosion, increase rain water infiltration and improve soil physical and chemical conditions. Continuous growing of same crop on same intensively land significantly influenced soil health and crop growth. Therefore, selecting of successor crops based on agricultural system, finance and environmental conditions is advisable.

Cropping Season: Cropping season was identified through years of trial and errors to determine right season of growing that fully supports crop growth and development. The cropping season in the study site was usually started from late May to early of June. The cultivation time of Adigoshu was started during end of May to early of June and extends until mid of November for harvesting of few long cycle crops. Seedbed preparation was started together with the commencement of main rain from late May to early of July.

Sowing is placing of a specific quantity of seeds in the soil for germination and growth. Verifying quality of the seed present at hand is important before placing in the field and requires determination of the ability of the seed to germinate and stand as normal seedling. Respondents indicated that availability of moisture was the principal factor that determined time of sowing and tillage practices. Respondents were asked to indicated whether they were tested viability of their seeds before planting or not and their response was summarized in (Table 1). Majority, 76% of them showed that they did not conducted any seed viability testing before planting, whereas, 24% them indicated that they tested viability of their seeds before planting. Those farmers who did not conduct viability test

Table 1: Practices of seed viability testing in the study sites

Variable	Adigoshu
Number of respondents conducts seed viability testing before planting frequency (%)	
Yes	76
No	24

Data sources; own survey result, 2018

indicated that the seeds used for sowing were not stored long and do not required to conducted viability testing. They took certain fraction of seeds during the main harvest and stored for around nine months before sowing and believed that the storage period did not affect viability of the seed as they witnessed from experience. Some of them also said that seed was properly germinated and grow into normal seedling when handled in required manner. Respondents those who test seed viability indicated that, viability was checked by sowing of some amount of seeds in the backyard and detect whether the seeds at hand were viable or not based on their germination capacity. In addition, detection method of viability was conducted by soaking of seeds stored for sowing in the bucket partially filled with water and those seeds immersed in the bottom are viable whereas those floated on the surface are not viable seeds.

Cultivated Crops and Their Medicinal Values: Respondents were asked to indicate into what forms they processed cultivated crops for local consumption and their responses was summarized in (Table 2). Respondents were used cultivated crops among one of the following thirteen processed forms such as *injera, bread, soup, soft porridge (genfo), kinche, Roasted grain, row grain (eshet), Boiled grain (Nefro), Roasted spike (Enkuto), Alcoholic beverage, fuel, medicinal and other* (like wot, cooking oil, animal feed).The assessment result indicated that sorghum was found prepared in thirteen processed forms as depicted above for local consumption such as *injera, bread, soup, soft porridge (genfo), kinche, Roasted grain, row grain (eshet), Boiled grain (Nefro), Roasted spike (Enkuto), Alcoholic beverage, fuel, medicinal and othe*r (animal feed). It was indicated that, six of the respondents locally consumed/used sorghum in ten processed forms and twelve, eleven, thirty five and thirty two of them used in nine, eight, seven and six forms locally respectively. The lowest processed forms of sorghum were recorded with one respondent that he used into five processed forms. The fourth largest processed crop for local consumption was tef and was found used in seven processed forms such as *injera, bread, soup, soft porridge, kinche medicine and others* (animal feed).

Table 2: Summary of respondents' on use of crops for human being

Sorghum		Sesame		Tef		Finger millet		Maize		Chickpea	
Number of Respondent	Response on use forms	Number of Respondent	Response on use forms	Number of Respondent	Response on use forms	Number of Respondent	Response on use forms	Number of Respondent	Response on use forms	Number of Respondent	Response on use forms
6	10	3	2	4	7	4	6	1	10	1	9
12	9	76	1	3	6	2	5	1	9	1	6
11	8	21	0	7	5	1	4	4	8	17	4
35	7			28	4	9	2	2	7	2	3
32	6			13	3	14	1	2	6	2	2
1	5			7	2	70	0	5	5	77	0
				5	1			2	4		
				33	0			1	3		
								82	0		

Sources; own survey data, 2018

From total respondents, four, three, seven, twenty eight and thirteen of them were used tef into seven, six, five, four and three processed forms respectively, whereas, thirty five of them were not used tef for local consumption. Tef is one of the recently introduced crop in the site and most farmers were not found engaged in its production activities.

Sesame is one of among widely cultivated crops in the area and processed into three forms for local consumptions as *food*, *fuel, medicine and others* (as livestock feed). Based on the result found, three and seventy six of the interviewed households processed sesame into two and three forms respectively, whereas, twenty six of them were not used sesame locally. On the other hand, finger millet was found processed into six forms for local consumption in the study site as *injera, bread, soup, soft porridge, alcoholic beverage and other* uses such as livestock feed. From total respondents, seven, six, four and one of them had explained that they processed finger millet into one, one, four and two forms in the site respectively. Similarly, maize was recently introduced crop into the site associated with irrigation development and found processed into eleven forms for local use in the form of *injera, bread, soup, soft porridge, kinche, roasted grain, row grain, boiled grain, alcoholic beverage, fuel and other uses (livestock feed*). From total respondents, one, one, four, two, two and five of them showed that they used into ten, nine, eight, seven, six and five forms respectively for local consumption. Chickpea is another crop found growing in the site either in mono-cropping or sequential cropping system and was used for nine processed forms locally. Among respondents, one, one, seventeen and two of them depicted that they used chickpea into nine, six, four, three and two processed forms respectively. The findings indicated that each crop growing in the area were processed at least more than three forms for local consumption. The descending order of crops in their processed form for local consumption were sorghum, maize, chickpea, tef, finger millet and sesame respectively in the study site.

Certain plant species were used and used to be in drug development synthesis whereas others considered crucial sources of nutrition and recommended for their therapeutic values. Respondents in western Tigray, Adigoshu Kebelle were asked to list crop plants being used locally as medicinal purpose to heal ailments, describe for what kind of disease was used and method of application and their response was mentioned below. The cultivated crops used for medicinal purpose to treat human and animal ailment were sorghum, tef and sesame. Tef is used to treat problems related to common cold, anaemia and chronically malnourished kids. Tef was prepared in the form of porridge and soup and allowed to consume consistently by patients affected by common cold, anaemia and chronically malnourished kids. The patients were fully recovered from their ailment after certain days of exposure to above processed food of tef. The respondents were strongly believed that the therapeutic nature of tef and their traditional believe was supported by the health extension teaching in the kebelle. According to respondents, the preferred food provides to newly delivery women was tef and they did believed that it replaces the bleeding blood during delivery.

One of the major human diseases in the area was malaria and there were rich indigenous knowledge in the locality to treat menace using traditional knowledge using cultivated crops. The sorghum variety *dagnew* was used to treat peoples suffered by chronic malaria. This variety was preferred for traditional medicine for its bitter taste.

It was prepared by boiling for certain period of time and then the water is disposed and again another water is added and allowed to boiled for certain period of time. Finally, it has been consumed by a person with chronic malaria and abdominal swelling caused by malaria together with table oil, onion and honey as ingredients. The patient gets relief from their ailments after consistent exposure with this food. Sesame was the other crop used as therapeutic of diseases related to abdominal problems. It was prepared by pounded the grain using mortar and pestle to extract oil and nearly one liter oil was remain usually in the bottom of the mortar after required oil was extracted. This remained oil in the mortar was used to treat a person having abdominal problems and allowed to drink it for few days. Muhammad and Amusa, [11] indicated some plant species like oats and sesame showed healing actions against diseases of central nervous and autonomic nervous systems.

Households Seed Preference, Access and Storage Methods

Seed Preference and Access Mechanisms: Seeds of agricultural crops are means of survival in addition to sustaining and protecting of life. Seeds are continued to be major sources of food worldwide and vehicle to spread of new life from place to place. Seed access is one of the determinant factors to start agricultural activities, ensured food security and is key to development. Respondents were asked to show how could they obtained and access seeds of different crops in case of seed shortage and exchange mechanisms they followed was described as of below. Households used different seed sources and one of them was purchased from the local market when farmers in the area were supplied to market during sowing time. The other depicted seed sources was shared from close relatives and paid later in kind after harvesting of the growing crop. Exchange of seeds with neighboring farmers was the other option of seed access not present at hand. This could be facilitated by providing one of the variety present at hand required by other farmers and receiving in exchange the variety required by him. It may also performed in the form of providing grains that has comparable market values for consumption and receiving required variety in need of by another farmer in exchange. On the other hand, farmers with financial constraints to purchase and limitation of another crop seeds to exchange were borrowed seeds from rich locals. They borrowed required quantity of seeds during sowing time and payback during harvest time in kind. The other form of borrowing was taking seeds from local cooperatives with reasonable interest rate. Same times, seeds also supplied to detriment ones from office of agriculture as a starter. It was indicated that there were varied mechanisms of seeds access during seed shortage and in need of growing other varieties not found at hand in the study site.

Seed selection is very important to establish a health crop and farmers in the area were deciding type of seed to be selected. Respondents were asked type of criteria's used to identify quality seeds for sowing and their response was summarized as follows. Households set their own criteria in selecting of own seeds required to be sown in the next cropping season. Even though, yield is the major factor consider for variety or seed selection, there are also other important characteristics consider for selection. One of them was pest and drought resistance, communities selected seeds/varieties resistant and tolerant to biotic and abiotic problems commonly found in the site. Plant height was another factor consider for selection of variety to be grown and households prefers shorter crop that is not susceptible to lodging. This is because lodging could affect both quality and quantity of produce. Maturity time (early matured variety) was preferred criteria for seed selection and respondents indicated that they prefer early maturing variety that used growth resources effectively particularly moisture. The sowing time was shifted in the study area because of lateness in onset of rainfall and early matured varieties that avoids yield and quality reduction and tolerant to late moisture stress have got attention now a days greatly. The following factors were considered during seed selection by local residents as summarized in the below (Table 3).

Seed Storage Methods: Seeds can be stored safely for many years under controlled temperature and relative humidity but which is not feasible to most seed lots.

Respondents were asked to indicate storage longevity of their seeds and their response was summarized in (Table 4). From total respondents, 44% of them indicated that Tef/millet-sorghum-maize-chickpea-sesame were positioned based on descending storage longevity order of cultivated crops growing in the area, whereas, 42% of them indicated that tef-sorghum and sesame were stored long in descending order. On the other hand, 11% of them depicted that tef-finger millet-sorghum and sesame were descending orders of longevity during storage. Generally, it was indicated that seeds were stored locally from harvest time till next sowing season but very rarely can stored up to two years in the study site. Local communities commonly used

Table 3: Seed selection criteria of local communities in the study area

Seed Selection Criteria's of Local Farmers		
• Larger Head/panicle size	• Well filled grain/not shrink	• Pod size
• Plant with compacted head	• Free from head smut	• Heads with attractive color
• Longer panicle length	• More pods in sesame	• Plant height
• Hairy panicle for sorghum	• Unaffected with pests and diseases	• Good performance
• Resistance to bird feeding	• Adaptability	Grain/pod weight
• Heads with more tiller (finger millet)	• Who growth the seed	• Drought tolerant
• Early maturing	• Seed size	• Pest and weed resistance
• Seed colour (white seed)	• Crops with larger stalk size	• High productive
		• Well matured

Sources; own survey result, 2018.

Table 4: Respondents' perception on storage period of crops in the study site

Storage period	Percentage respondents perception
Tef –sorghum-sesame	42
Tef-finger millet-sorghum-sesame	11
Finger millet-tef-sorghum-sesame	3
Tef/millet-sorghum-maize-chickpea-sesame	44

Sources; Own Survey Result of 2018

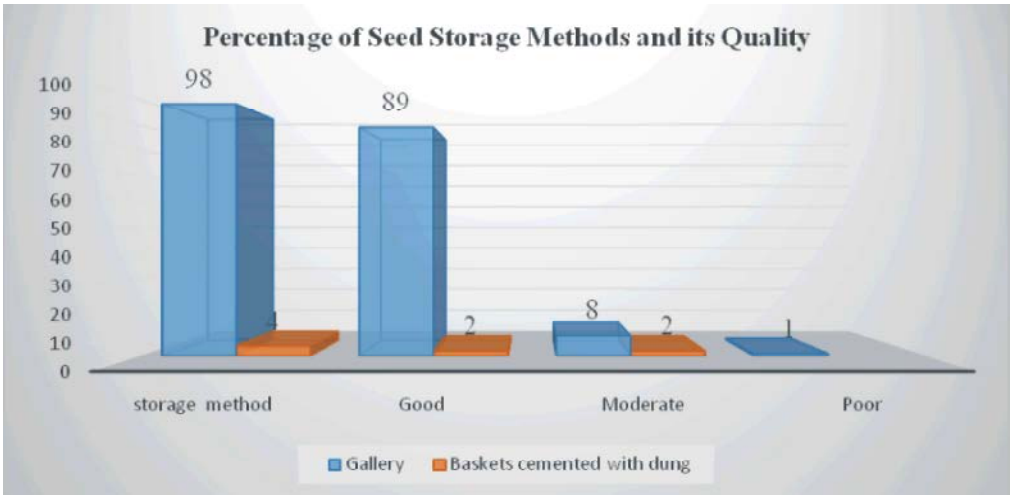

Fig. 2: Storage method of seeds and associated qualities in the study site

seeds of harvested in each season and renewed annually. However, respondents perceived that Tef and finger millet can be stored for many years without losing their viability and germination capacity under proper storage, whereas, sorghum can stored for up to three years if properly managed and stored it. It was also showed sesame stored only for one year under serious management of sieving in each four months interval.

Following harvesting, threshing, cleaning packing of field crops, it was stored in the house or outside. Outside storing was not practiced in the study area but commonly stored in the house. The seeds are harvested after fully matured and dried in the field at time of harvesting and threshing. The moisture content of the seed were allowed to dry in the field by lied the mowed piled in the open air ground for few days before threshing. Respondents were asked to indicate the storage methods used and its level of quality and their response was summarized in (Fig. 2). From total respondents, 98% of them used gallery storage method whereas 4% of them were used baskets cemented with dung. On the other hand, 89% of them used gallery method said the level of quality of their storage was good, whereas, 8% and 1% of them said moderate and poor respectively. Similarly, 4% of basket cement with dung storage used said their storage method was good whereas, 2% of them said it was moderate. The materials used for construction of local storage were wood, mud, animal dung (to cement the floor), stone, sand, metal sheet, straw (from tef or finger millet) and sometimes polyethylene sheet were employed.

Table 5: Local varieties used to be growing but no longer cultivated now in the study site

Crop type	Variety name		
Sorghum	•Taber	•Wareja	•Wedigebru
	•Koden	•Gumbin	•Beyan
	•Wanzie	•Tewzalye	•Merewey
	•Beyan	•Cabir	•Moror
	•Gaymseber	•Wedisbuh	•Wanzie
	•Tejile	•Tselimgurdi	•Tetiron
	•Jemrok	•Delenice	•Tekemiche
	•Ganseber		•Meruey
Sesame	•Gomoro	•Kunamaselit	
	•Abatselit	•Tegl	

Sources; Own Survey Result of 2018.

Table 6: Listedof local and improved varieties found growing in the area and meaning of local variety name

Family Name	Crop name	Local name of the crop	Local Variety Name	Meaning of the local Variety name	Date of Registration	Folk Taxonomy	Soil Type
Sorghum bicolor	Sorghum	Meshela	• Wediakir	Wediakir:- the last crop	Not known	No perception	Vertisols
			• Shilkuit	Shilkuit:- to indicate whitish long panicle			
			• Dagnew	Dagnew:- strong panicle with figure head			
			• Chimerey	Chimerey; white seed			
			• Wedi 40	Wedi 40; the day taken to maturity			
			• Korokora	Korekora; used to make injera immediately			
			• Birhan	Merewey; red color			
			• Deber	Birhan; high productive			
			• Masho	Wanzie; no idea			
				Deber; no idea			
				Masho; no idea			
				Tewzale; no idea			
Sesamumindicum	Sesame	Selit	• Hirhir	Hirhir:- early matured	Not known	No perception	Vertisols
			• Gojamazene	Gojamazene:- late matured and high water demand			
			• Zenabit	Zenabit:- sowing at the onset of rain and never lodging			
			• Bawnji	Bawnji; high yielder and late matured			
			• Setit 1	Gomoro; medium maturity time			
			• Setit 2	Setit 1:- early matured			
			• Humera 1	Setit 2:- early matured			
Eragrostis tef	Tef	Taf	• Red	Red and white; Based on color of the grain	Not known	No perception	Vertisols
			• White	Sergen; mixture of red and white			
			• Sergen	Quncho; no idea			
			• Quncho				
Eleusinecoracana	Finger millet	Dagusha	• Black	Color of the grain	Not known	No perception	Sandy soil
			• White				
			• Sergen				
			• Red				
Cicerarietinum	Chickpea	Ater	Red	Color of the seed	Not known	No perception	Vertisols
Zea mays	Maize	Efun	• Red	Red; color of the seed	Not known	No perception	Vertisols
			• White	White; color of the seed			
			• America	America; no idea			

Sources; Own Survey Result, 2018

Crop Management Practices: Respondents indicated the dominant post plant activities were weeding, inter-cultivation (sorghum and finger millet), fertilization, thinning, pest management (using both cultural and chemical method) and harvesting of the standing crops in the field. Similarly, the postharvest activities undertake were threshing, winnowing/ cleaning, drying and collected in to sack, packing, transport, stored in the wide gallery and used chemicals to protect from weevil outbreak during storage.

Challenges of Local Variety Conservation: Conserving of diversity of varied local crop species and their varieties is important to generate high yielding, stress tolerant, early maturing and pest resistant and high quality crops to ensure food security for the alarmingly booming world population. However, these local varieties are subjected to anthropogenic and natural factors that affect their diversity and conservation for present and future use. The major challenges of local variety conservation are small landholding size, low productivity, seasonal rain variability, poor seed access, seasonal shifting and late maturing problems, occurrence of pests, occurrence of drought, introduction of improved seeds, improvement of seed access and credit to improved seeds, extension service biasness and promotion to improved seeds, farmers attitude, government pressure and attention to improved seeds are the crucial ones [12].

The diversity status of crop genetic resources was decided based on respondents listing of crops and their varieties growing now in the site. On the other hand, the diversity of each crop species was determined by local names of individual varieties listed by respondents. It was also used respondents indigenous knowledge and description to understand the meaning of local nomenclature of varieties. The summarized information presents status and trends of crop diversity both improved and local varieties in the study site (Table 5, 6). The study indicated that larger diversity was recorded with sorghum and sesame respectively. Similarly, tef and finger millet were recorded comparable amount of varieties, but the least was chickpea. From total 56 crop varieties identified, only 29 of them were found growing in the study site. The higher, twenty three variety loss were recorded with sorghum, whereas, lower four variety loss were recorded with sesame. The result showed that numbers of local varieties grown in the site were found declining with time and required measures to conserve them on farm before completely distinct. Naming of crop varieties is assigned by both breeders and farmers based on some exhibiting features of the variety. The meaning of some of the listed crop varieties were described in the below table but for most varieties respondents don't have idea about the meaning of the variety name.

Respondents were also asked to identify the improved varieties distributed in the area and their response was summarized in (Table 7). The larger numbers of six improved varieties were recorded with sesame and only three with sorghum.

Table 7: Improved varieties distributed in the study site

Improved crop varieties	
Sesame	Sorghum
•Setit 1	•Brhan
•Gobiye	•Tewzale
•Setit 2	•Masho
•Mesho	
•Hirhir	
•Humera 1	

Sources, Own Survey Result, 2018

Table 8: Households' variety preference, replacement status and challenges of local varieties cultivation in the study site

Variable	Adigoshu
Replacement of improved varieties to local varieties frequency (%)	
Yes	36
No	64
Variety preference of local community frequency (%)	
Local varieties	57
Improved varieties	37
Both local and improved	6
Difference between local and improved varieties frequency (%)	
Yes	43
No	57

Sources; Own Survey Result, 2018

Respondents were asked to mention the replacement status of local varieties by recently released improved ones and their response was summarized in (Table 8). From total respondents, 64% of them agreed that local varieties were not replaced by improved varieties, whereas, 36% of them stated local varieties were replaced by improved varieties. High yielding potential of improved varieties, its maturity at the same time, capacity to escape drought, early maturity nature, high market demand and heavy grain weight characters of improved varieties were made the variety to be preferred by local communities and found replaced local varieties. The sesame improved variety setit 1 was found replacing the late matured gojam-azenein most areas and the sorghum variety berhan was on the way to replace local sorghum *shilkuit.*

Local communities were also asked to indicate their variety preference for growing and their response was summarized in (Table 8). Among the respondents, 57% of them mentioned that they preferred to grow local varieties, whereas, 37 and 6% of them preferred improved and both improved and local varieties respectively in the study site. Majority of respondents preferred to grow local variety because of traditional food preference, do not have much exposure with improved varieties, poor improved seed access, low awareness about improved seeds and Straw palatability. Familiarity local communities with characteristics of crops particularly to sowing, harvesting and threshing activities were the other factors responsible for choosing of local varieties.

Table 9: Observed differences between improved and local varieties list by respondents in the study site

Observed difference between improved and local varieties	
Local varieties	Improved varieties
Late matured	Early matured
Lighter seed weight	Higher yielder
Susceptible to striga	Heavy seed weight
Low demand in market low resistance to pest	Resistant to striga
Adapt in water logging areas (gojamazene)	High market value
Susceptible to drought	Resistance to pest
Provides higher yield under sandy soils	Resistance to moisture stress
Early sowing	Adapted well to vertisols
Low productivity	Late sowing
Less responsive to fertilizer	High productivity
	Responsive to fertilizer

Sources; Own Survey Result, 2018s

On the other hand, those preferred improved varieties were mentioned that they preferred for the following features of improved varieties. The preferred attributes of improved varieties mentioned by respondents were comprised of early matured and used efficiently existing moisture effectively, highly resistant to striga (ex. Brhanis better withstand striga compared to shilkuit), seed color and market value (mainly in sesame), high yielder, responsiveness to fertilizer applied, escaping drought and heavy grain weight. The other respondents mentioned that they have cultivated lands preferred for improved varieties and local varieties specifically. The local and improved varieties were grown in their specific areas assigned without replacement each other. They grow improved varieties under vertisols, whereas, local varieties under infertile sandy soils. Respondents were asked to mention the difference between local and improved varieties to understand their perception and their response were summarized (Table 8). Among respondents, 57% of them mentioned that there were no difference between local and improved varieties, whereas, 43% of them said they could observe differences between improved and local varieties. Interviewed households were asked to mention observed differences between local and improved varieties and their response was summarized in (Table 9).

The respondents were also asked to mention major constraints in cultivation of local varieties and measures need to be taken to overcome the problem and their response was described below. The major constraints mention in production of local farmer varieties were occurrence of early and late drought, outbreak of pests (insects like webworm in sesame), infestation of striga, moisture deficit, access of improved seeds, lack of awareness about improved seeds, low productivity, low soil fertility status of the farm, shortage of capital in order to adopt chemical fertilizer, outbreak of blight in sesame, water logging, late maturity, shortage and uneven distribution of rainfall. Respondents also provide measures need to be taken to alleviate the problem. These includes government supply of right chemicals that deter the problem of pests, use of green manure, compost utilization, proper application of chemical fertilizer, problems access to loan during time of sowing, use early matured varieties and development of irrigation schemes.

CONCLUSION

This study was identified crops with particular social, cultural and economic significance in the study site. It was assisted to identify the varieties growing for better production, consumption, market and varieties preference for growing. The result was analysis and illicit available use forms such as dish prepared, beverage made, cultural value of beverage and purpose of use like religious, medicinal and reason of preference for use. It was also analysis the parameters administered for variety selection, method of seed selection, sources of seed for sowing and storage methods. The output assisted to generate new practices for strengthening capacity of producers to overcome shortcoming related with conservation, production and income generation from available local varieties. The result will utilize for capacity building and awareness raising of concerned parties on systems of cultivation, use form, seed sources, production preference and seed storage methods and its mechanisms to address further expansion of unauthorized land and mining in the future. The livelihood of communities will increase and infrastructure development will enhance by blocking unauthorized use of natural resources and enabling conservation of biogenetic resources. It will raise the awareness and provide decision making support information about opportunities at farm and local community level to enhance the income of small-scale farmers. It will provide directions to focus on a farm and nonfarm enterprises that integrated into small farms to increase income and enhance livelihood.

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Conflict of Interest: The authors declare that there is no conflict of interest regarding publication of this paper. The authors alone are responsible for the content and writing of this article.

Ethical Approval: The research was conducted with full respect of the Ethiopia national research ethics review guideline of 2014s [13]. Respondents were informed about the objective of intended study and were allowed to decide about their participation before the interview was administered. The oral informed consent of respondents was received and proceeds with the interview. An ethics approval was not required for this research as per the Mekelle Biodiversity Center's guidelines and Ethiopian regulations.

REFERENCES

1. Nicolas, D.C., M. Francis and P. Guido, 2012. Food Production and Consumption Trends in Sub-Saharan Africa: Prospects for the Transformation of the Agricultural Sector.
2. Dorosh, P. and S. Rashid, 2013. Food and Agriculture in Ethiopia: Progress and Policy Challenge. IFPRI Issue Brief 74. Washington, DC: International Food Policy Research Institute.
4. Andersen, P., 2006. Agricultural research and policy to achieve nutrition goals. Poverty, Inequality andDevelopment, 1: 353-370.
5. Altieri, MA., 2000. Agroecology: Principles and Strategies for Designing Sustainable Farming Systems. Hayworth Press, New York.
6. ENUPI, 2002. Report on development plan of Humera Town, Tigray. Ethiopian National Urban Planning Institute (ENUPI) (Unpublished).
7. Muez, B., A. Berhanu, T. Geremew and W. Melaku, 2008. Sesame Harvest Loss Caused By Sesame Seed Bug, Elasmolomus Sordidus F. At Kafta-Humera Sesame Fields. Ethiop. J. Sci., 31(2): 147-150.
8. Shabtaia, I.A., M. Shenker, W.L. Edeto, A. Warburg and M. Ben-Hur, 2014. Effects of land use on structure and hydraulic properties of Vertisols containing a sodic horizon in northern Ethiopia. Soil and Tillage Research, 136: 19-27.
9. SAS, 2002. SAS/STAT User's Guide, Version 9.1.3. SAS institute Inc., Cary, NC.
10. Amare, M., G. Woldewahid and J. Sharma, 2009. Sesame crops versus weeds: when is the critical period of weed control? Afr. Crop Sci. Conf. Proc., 9: 591-593.
11. Muhammad, S. and N.A. Amusa, 2005. The Important Food Crops and Medicinal Plants of North-western Nigeria. Research Journal of Agriculture and Biological Sciences, 1(3): 254-260.
12. Abraha, R. and M. Mebrahtom, 2018. Current Status of farm Conserved Varieties and Possible Threats inSustainable Utilization at Hawzen and GantaAfeshum Districts of Tigray. Middle-East Journal of Scientific Research, 26(1): 141-154.
13. Federal ministry of science and technology, 2014. National Research Ethics Review Guideline.Fifth edition, Addis Ababa, Ethiopia.