Farmers' Finger Millet [*Eleusine coracana* (L.) Gaertn] Seed Management Practices in West Gojjam Zone, Northwestern Ethiopia

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Abstract: *Finger millet is one of the major growing crops in Amhara region particularly in West Gojjam Zone in maintaining food and nutrition security. However, the quality of finger millet seeds, agronomic packages and the productivity of the crop is very low as well as maintaining of genetic diversity is not documented. The present study was carried out in Yilmana-Densa and Mecha districts of Northwestern Ethiopia to document farmers' knowledge and experiences on finger millet seed management practices. Data were collected from 120 households using a structured questionnaire and focus group discussion. The results showed that 72.5% of the respondents explained that seed selection is made by both husband and wife; and the seed was selected soon after threshing 58.3% of the respondents replied that the seeding materials are selected soon after threshing while 37.5% did during planting time. Almost all respondents used locale made materials to clean seed and 97.5% of them didn't use storage chemicals as finger millet do have a long shelf life like teff. Nowadays farmers used improved varieties of finger millet as its productivity is better than the local varieties. Therefore, the existing finger millet seed management practices has been contributing for maintaining genetic diversity, however, the system is insufficient to hold and enhance the existing function of the extension organization, farmer cooperative union, NGO and government organization to meet the seed quality thereby seed security. Hence, establishing and strengthening linkages among stakeholders to use indigenous knowledge on seed management practices, seed selection, diversity conservation and seed security for a bad time*.

Keywords: Genetic diversity, Indigenous knowledge, Seed cleaning, Seed security

1. Introduction

Agriculture is the mainstay of the Ethiopian economy and the primary source of livelihood for the majority of its population. In view of this, the supply of high-quality seed of well-adapted crops could be considered crucial among the other agricultural inputs. This is because seed is the most vital and crucial input for crop production, one of the ways to increase productivity without adding appreciably to the extent of land now under cultivation by planting quality seed (https://www.agriquest.info/quality). Even if, seed consider as a major agricultural input, its quality declined due to poor postharvest handling technics like physical damage during threshing, transportation, improper moisture content, poor storage, insect/disease attach, or prolonged shelf life and others, all these will affect the productivity of finger millet. However, it is one of the most important crops to achieve both food and feed security, especially in drought-prone areas. Millets are grown and can give reasonable yield even under harsh growing conditions with low-input agricultural situations in which major cereal crops often produce low yields in areas of Africa and Asia (Adekunle, 2012; Amadou et al., 2013; Changmei and Dorothy, 2014). However, research effort on varietal development as well as in seed multiplication and supply is very limited. As a result, finger millet producers traditionally developed a number of cultivars and have been selecting their own seed for the next season.

Finger millet seed management practice has been undertaken from the time of domestication until now. It was exercised through selecting landraces, which are adaptable to the existing environmental condition and having the most preferred traits. The seed management activities have been played their own role in seed quality, on-time availability, productivity and diversification of varieties. However, finger millets seed management practices of farmers are not studied well and well documented. Therefore, this study was initiated to assess and document farmers' knowledge and experiences on finger millet seed management practices in West Gojjam Zone, Northwestern Ethiopia.

2. Materials and Methods

2.1. Description of the study area

The study was carried out in Yilmana-Densa and Mecha Districts (*Woredas*) in West Gojam Zone of Northwestern Ethiopia. Yilmana-Densa and Mecha Districts are found between 11^o 16'19" N and 11^o 25'20" N latitudes, and 37^o 28'38" E and 37^o 10'20" E longitudes; with an altitude of 2240 and 1960 meters above sea level (m.a.s.l.). The soil type of the study area is characterized as Luvisol and Nitosol with pH setting of 5.38 to 5.48 and 5.09 to 5.3, respectively (NSRC, 2006; Berhanu, 2014). The temperature of Yilmana-Densa (Adet) varies between 10.9 (Min) and 26.9°C (Max) with a mean annual rainfall of 1164.1 mm. On the other hand, Mecha District experienced an annual temperature that ranges from 9.4 to 28.1^{O}C with an annual rainfall of 1454.5 mm (WAMSC, 2013). The farming system of these districts is mainly mixed crop-livestock production. Most farmers in the district undertake both crop and livestock production activities. Agriculture is mainly characterized by rain-fed production system. The major crops grown in the study areas include maize, finger millet, tef, wheat, barley, green peas, fava bean and vegetables.

2.2. Sampling procedures and participants selection

The study population comprised of a researcher in a public agricultural research organization, extension personnel in extension offices and bureaus of agriculture and rural development, seed supplier organizations and farmers who produce finger millet. The survey was undertaken with a multi-stage sampling technique having three stages that involve the selection of (1) sample zone and districts, (2) Peasant associations and (3) smallholder farmers. In the first stage, West Gojam Zone and two Districts, namely Yilmana-Densa and Mecha were selected purposively from all the finger millet growing zones and districts based on larger area coverage and production potential. In the second stage, the study included four total finger millet growing Peasant associations; two PA from each district based on their area coverage and production potential of finger millet. In the third stage, 120 farm households were randomly selected from lists of names of household head in the peasant association. The sample size was determined proportionally to the population size of farmers.

2.3. Data collection and analysis

The information was collected on farmers' seed management practices: perception of seed cleaning, seed sorting, seed storage, varietal obsolete and seed security. Both qualitative and quantitative primary data were collected from extension staffs, researchers, farmers and key informant. Respondents were interviewed independently with a structured questionnaire. Further, additional information was collected using Focus Group Discussions (FGDs) and individual interviews on socioeconomic and demographic characteristics of sample farmers, seed selection, seed cleaning, seed storage and seed security. In addition, an open-ended questionnaire was used to capture information during the focus group discussion from key informants, who have knowledge and experience about the management practice of finger millet.

Descriptive statistics was employed to analyze the seed management practice of finger millet. The qualitative data generated using FGDs and key informants were analyzed thematically. The quantitative data analysis was performed using SPSS (Version 21) computer package (IBM, 2012); and results are presented in the form of frequency distribution and percentage**.**

3. Results and Discussion

3.1. Socioeconomic and demographic characteristics of sample farmers

Of the 120 sample households about 113 were male-headed and seven were female-headed. Mecha and Yilmana-Densa had 54 and 59 male-headed households, respectively. Of the seven female-headed households, five were in Mecha and two were in Yilmana-Densa. The mean number of male and female family members above 15 years was 1.75 and 1.54, respectively. This group of people is economically active workforce, which helps farmers during crop production. On the other hand, the mean number of male and female family member less than 15 years old was 1.34 and 1.12, respectively, which are participated mainly in cattle herding (Table 1).

Table 1: Mean family size and number of family members in sample households

Item	Yilmana-Densa District		Mecha District	
	Mean	Std.	Mean	Std.
Family size	5.75	1.73	6.58	1.66
Male family member (>15 years)	1.75	1.07	1.76	1.07
Male family member (<15 years)	1.34	1.05	1.48	1.18
Female family member (>15 years)	1.54	0.87	1.78	0.74
Female family member (<15 years)	1.12	0.82	1.56	1.12

Std. = Standard deviation

Table 2: Age of farmer and level of education in sample household (n= 120)

Item	Yilmana-Densa district		Mecha District	
	Mean	Std.	Mean	Std.
Age MHH	43.9	10.5	45.04	8.6
Age FHH	37.5	3.5	46.4	4.2
Level of education	Number of farmer	Percent of farmer	Number of farmer	Percent of farmer
Illiterate	22	36.1	31	52.5
Read and write	3	5	2	3.4
Adult education	24	39.3	14	23.7
Grade (1-4)	10	16.4	10	17.0
Grade (5-8)	1	1.6	1	1.7
Above	1	1.6	1	1.7

Std. = Standard deviation; MHH = Male household head; FHH = Female household head

About 52.5% the sample respondents in Mecha and 36.1% in Yilmana-Densa district were illiterate. About 63.9% of the respondents in Yilmana-Densa district were literate where 19.6% had got a formal education. In Mecha District, about 47.5% were literate where 20.4% had exposure to formal education. These results showed that more than 50% of the respondent were literate with different level of education, that bring good opportunity for agriculture extension service, which allows farmers to make better decision and choice for improvement of seed management practice. These findings agree with that of Reimers and Klasen (2012) and Oduro-Ofori *et al*. (2014) who also discovered that the technology adoption of farmers increases in relation to the level of education to obtain maximum output.

The average age was 43.9 (Std. = 10.5) and 37.5 (Std =3.5) for male and female sample farmers in Yilmana-Densa. The average age in Mecha was 45.04 (Std. = 8.6) and 46.4 (Std. = 4.2) for male-female sample farmers, respectively (Table 2).

3.2. Farm and household resources

The results of the survey indicate that the average farmlands owned by the farmers were 1.24 ha in Mecha and 1.2 ha in Yilmana-Densa districts. From interviewed farmers, 25.5% of Mecha and 31.1% for Yilmana-Densa farmers' have owned less than 1 ha of land. On the other hand, 8.5% of Mecha and 6.4% of Yilmana-Densa farmers' own more than 2 ha of land (Table 3).

During the assessment of oxen, the result depicted that 18.7%, 54.2%, 18.6% and 8.5% of Mecha, owned more than two oxen, two oxen, single ox and have no ox; similarly, 16.4%, 59%, 23% and 1.6% of Yilmana-Densa owned more than two oxen, two oxen, single ox and have no ox, respectively (Table 3). Farmers gave comparatively large area coverage for finger millet production from available cultivation of land. Finger millet is among the highest labor demanding crops, farmers said that it was the crop that most required mechanization, particularly for threshing. Hence, farmers have two and above two oxen, which enables them to thresh timely by sharing their oxen with relatives and neighbors (which is known as *wonfel*) before deteriorating the seed quality through high rainfall and sun damages.

Table 3: Farm and household resources of sample households (n=120)

Farm and household resource	Yilmana-Densa district		Mecha district	
	Mean	Std.	Mean	Std.
Number of oxen	1.9	0.7	1.93	1.03
Number of cattle	9.0	4.6	7.6	7.1
2012 amount of land cultivated (ha)	1.77	0.63	1.73	0.72
2012 rent farm size (ha)	0.57	0.54	0.49	0.5
2012 own land (ha)	1.2	0.57	1.24	0.62
Maize (ha)	0.32	0.13	0.51	0.27
Finger millet (ha)	0.26	0.098	0.54	0.25
Tef (ha)	0.62	0.25	0.13	0.24
Wheat (ha)	0.098	0.12	0.004	0.033
Barley (ha)	0.2	0.16	0.04	0.11
Green peas	0.08	0.24	0.0	0.0
Bean	0.08	0.19	0.17	0.06
Noug	0.0	0.0	0.04	0.14
Eucalyptus farm land (ha)	0.11	0.09	0.3	0.21

Std. = Standard deviation

3.3. Seed selection

Farmers are exercising several seed management activities. One of them was seed sorting. About 72.5% of the respondents reported that both husband and wife are responsible for seed sorting while about 20.0% reported that women/wives alone are responsible for seed sorting (Table 4). About 58.3% of the respondents sorted their seeds on the threshing ground after threshing while 37.5% of the respondents sorted the seeds during planting. Only 4.2% of the respondents sorted the seeds before harvesting (Table 4). Characteristics of seeds such as size and weight are important selection criteria.

The results of the present study showed generally most farmers sort the seeds after threshing on the threshing ground and in the store. These practices help to maintain genetic diversity within the cultivar and to contribute to the conservation of finger millet genetic resources. However, during the interview period, the respondents said that, as compared to other cereal crops like teff, finger millet seed and/or variety selection at harvesting stage is low; which is because farmers did not give more care to the crop due to its low productivity and market demand. This kind of activity ascribed how the crop gets low emphasis even by farmers. In contrary to th**ese** result**s**, Baniya *et al*. (2005) reported that many farmers followed seed selection during the harvesting of finger millet, while some did this activity before harvest. The farmers either select the better ears from the whole field or first select a better area and select the better ears from the fixed area only.

Table 4: Finger millet seed selection responsibility and seed selection stages

Seed selection practice	Number of respondents	Percentage
Responsible for selection		
Both husband & wife	87	72.5
Women only	24	20.0
Men only	7	5.8
All family members	2	1.7
Total	120	100
Time of selection		
On the field before harvesting	5	4.2
On threshing ground after threshing	70	58.3
On the store before planting	45	37.5
Total	**120**	**100**

3.4. Seed cleaning

One of the practice exercised by farmers on finger millet seed management is seed cleaning. All respondent farmers used to clean seed during threshing by winnowing using locally made wooden material called "*mankia/lamieda"*. Moreover, farmers also cleaned sorted and cleaned seeds at planting using weight and size based separating materials called "*sefed"*. The seeds are cleaned usually two times using locally made materials. Its main purpose is to improve the physical quality of the seed by removing inert matter, weeds and other crop seeds, and broken or diseased/insect damaged seeds. These locally made seed cleaning materials are also used by farmers in different parts of the country and for different crop species (Bishaw, 2004; Brikti *et al.,* 2011; Birhanu *et al*. 2016).

However, these cleaning methods that were used by the respondent households in this study are inadequate to ensure seed quality. Mechanical devices, called separators, should have to get emphasis for future to be established by farmers' cooperative union and /or projects work on seed sector. Cleaning separate unwanted seeds from wanted ones and thus reduces the bulk to be handled and stored, reduces potential vectors for pathogens and pests, removes moist material to maintain viability (Guzzomi *et al*., 2016).

3.5. Seed storage practice

According to the respondents, finger millet seed does not have a storage problem. Accordingly, 97.5% of the respondents did not apply fungicide or insecticide in the storage to prevent finger millet seed from diseases and insect pest damages. Only 2.5% of respondents use zinc phosphide chemical to control rodents. They did not use specialized or airtight seed storage structures. About 14.2% and 85.8% of the respondents use sack and "*Gushgusha /Gota"*, respectively to store finger millet seeds (Table 5).

The grain storage structure "*Gushgusha or Gota"* is locally made from a mixture of mud and teff or barley straw. Both are kept in house and did not have a mechanism to regulate the relative humidity and the temperature. Hence, the existing finger millet seed storage structures cannot ensure seed quality and cause shorten seed longevity. Therefore, farmers use fresh seeds the production of finger millet. Regular replacement of seed may contribute to maintain genetic diversity through gene recombination as well as to improve the existing landraces through natural selection. Farmers in various countries use various storage materials or structures for storage of finger millet seed including small earthen pots, wooden vessel, bamboo container, tin vessel and small plastic bags (Baniya *et al*., 2005).

Farmers appreciate the long storability of finger millet seed. It is not susceptible to major insect pests such as weevil. This quality of finger millet guaranteed farmers to save seed for bad times that cause total crop failure due to unfavorable weather condition such as drought. This peculiar feature of finger millet makes it a priority crop in most drought-prone areas of Africa and Asia. A similar feature has been reported on another neglected crop teff, which has an absence of serious storage pests (Melkam and Mekbib, 2013).

Table 5: Farmers' finger millet seed storage structures/materials

Storage structure and	Seed		Grain		Mix		Yilmana Densa	Mecha	Total	
Measurement taken	N	%	N	%	N	%			N	%
Sacks	14	11.667	-	-	3	2.5			-	-
Gota/Gushgusha	50	41.67	62	51.67	62	51.67			-	-
No chemical use	-	-	-	-	-	-	61	56	117	97.5
Chemical use	-	-	-	-	-	-	0	3	3	2.5

N = Number of farmers

3.6. Varietal status

Results showed that some farmers have terminated growing different finger millet cultivars, which were widely grown before in the districts (Table 6). From 2002-2007 cropping season, 41.7% of the respondents in Yilmana-Densa District stopped growing a finger millet cultivar called *Angedie*. Similarly, about 58.1% of the respondents from Mecha District terminated *Abate tikur* from the production system. During the period of 2008 to 2013, farmers in Yilmana-Densa District continued with the termination of *Angedie variety* and started withdraw *Abate tikur* from the system. Similarly, in Mecha District farmers continued with the termination of *Abate tikur*, *Angedie* and *Abate necho* from the system (Table 6). These obsoleting of finger millet landraces might be due to small landholdings and availability of high yielding improved variety like *Necho*, *Mecha* and *Degu* which may reduce the competitiveness of land races.

Interviewed farmers were illustrated that norms of self-reliance and social value by the community forced the farmers to keep their own seed in priority from other problems and these make reluctant to admit receiving freely gifted seeds. The finding on side location seed or other side sources, such as exchange and purchasing seed of local variety is considered as second seed source when their own seed is not selected for sowing. This is because of an absence of improved variety and quality seed in the market.

Seed security is vital for food and nutrition security. Reliability and availability of seeds at the right time and in the right price, as well as easy access, are crucial for poor smallholder farmers, but such hallmarks might not be universal in all systems. Farmers' seed systems are often considered good traditional practices for seed security and therefore, for ensuring food sovereignty. The present findings showed that 100% of seed was obtained from the farmer seed system. Similarly, Louwaars (2007) reported that over 60 to 85% of the seed was found from farmer seed system depending upon the crops and countries. Sthapit and Padulosi (2011) also reported that close to 99% seeds of neglected and underutilized crop species sourced from farmer's seed system. According to Wekundah (2012), the informal seed supply system also provides about 80-100% of the seed used in the African states.

The farmers' practice indicated that formal seed multiplication, certification and supply systems do not exist for finger millet and are not sufficiently available for other crops in the study areas. But, it ensured the survival of landraces to obtain the seed they need and enables them to produce for their own consumption, sale and for their social relations within the villages. However, the presence of seed for sowing cannot assure the existence of sufficient food to eat. This trend continues till now because of the absence of improved seed supply in the market.

Table 6: Status of finger millet varieties in the study area

Finger millet withdraw from production system	Yilmana-Densa district (n=12) N	%	Mecha district (n=31) N	%
Between 2002— 2007				
Abate necho	2	16.7	7	22.6
Angedie	5	41.7	7	22.6
Abate tikur	_	_	18	58.1
Total*	7	58.4	32	103.3
Between 2008— 2013				
Abate necho	1	8.3	11	35.5
Angedie	4	33.3	13	41.9
Abate tikur	7	58.3	17	54.8
Nech dekie	_	_	1	3.2
Total	12	100	42	135.4

N = Number of farmers, *the same farmer practiced repeated response

3.7. Household seed security and relation to wealth category

All the respondents in Yilmana-Densa District and 98.3% of the respondents in Mecha District save their own finger millet seed for their next cropping season (Table 7). The wealth category of the respondents was identified on the basis of the following characteristics, which includes hectare of farmland, plantation, livestock and constructed houses. The result showed that, about 21.3% rich farmers; 47.5% medium farmers; 29.5% poor farmers and 1.6% very poor farmers in Yilmana-Densa. In correspondence to the above figures, 28.8%, 54.2%, 17% and 0% of the respondents found to be in Mecha District, respectively (Table 7). Differences in wealth category have been documented in this study. Wealthier households were produce higher production and more self-sufficient in food than poor households. But, seed self-sufficiency have priority in all wealth groups rather than eating or selling a large portion of their harvest. The community norms and social values attributed to retain and store their own seed for the next season or for unfavorable weather condition; and surprisingly the poor farmers can assure their own seed through side location seed sources by off-farm incomes and selling sheep and goats.

Table 7: Farmers' perception for reasons of seed security in the study area

Seed security	Yilmana-Densa District (n = 61)		Mecha District (n = 59)	
	N	%	N	%
Secured farmer	61	100	59	100
In secured farmer	0	0	0	0
Own seed	61	100	58	98.3
Purchase seed	29	47.5	17	28.8
Exchange seed	29	47.5	25	42.4
Wealth category for seed security				
Secured farmer	61	100	59	100
Rich	13	21.3	17	28.8
Medium	29	47.6	32	54.2
Poor	18	29.5	10	17
Very poor	1	1.6	0	0

N = Number of farmers, same farmers practiced more than one criterion

4. Conclusions and Recommendations

Finger millet is a multipurpose staple crop in the study areas. Farmers save and use seeds of local cultivars, due to the unavailability of improved varieties. Quality of the farmer saved seeds is relatively poor since it is not produced and processed as per certified seed production and processing procedures. The existing farmers' seed management practices found to be useful in maintaining genetic diversity and seed security in the study areas. However, high yielding crops threaten diversity of finger millet varieties and farmers started withdrawing the production of some landraces. Therefore, it is critical to collect, conserve and improve the existing finger millet landraces. Establishing and strengthening linkages between stakeholders such as cooperative union, NGOs and government organizations for indigenous knowledge management practices in seed selection, conservation and seed security is necessary.

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