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Seed Systems of Sorghum(*Sorghum bicolor* (L.) Moench) in *Konso*, Southern Ethiopia

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Abstract:*Sorghum is the most important staple crop for the Konso people. To assess the level of sorghum diversity, three sorghum growing Kebeles, namely Arfyidie, Fasha and Gaho were selected purposively. A total of 190 randomly selected households based on the population proportion of each Kebele were interviewed using a structured questionnaire that elicited information on socioeconomic aspects of households, seed exchange systems and seed flow together with selection criteria as well as seed selection process and management.Group discussion was conducted to asses historical trends of diversity and use of sorghum, the social and cultural values of sorghum and sorghum diversity. Sorghum seed and grain production is not separated in Konso and seed system also informal. The main source of seed was own production and farmer to farmer exchange remained most important seed exchange mechanism in the form of exchange with different varieties of sorghum, other crops, gift and loan. Women play the major role on seed management, especially after seed selection. Seed marketing is almost zero. Female farmers play the major role on seed management.*

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I. Introduction

Sorghum (*Sorghum bicolor* (L) Moench) is a C4 grass closely related to sugarcane and adapted to hot and adverse environments (Harris, 2007). It is used as a source of food, feed, fiber and fuel and is one of the most important cereal crops grown in arid and semi-arid areas of the world, receiving 400 to 800 mm of rainfall annually.

In Ethiopia, it is a staple food crop widely cultivated in different agro-ecological zones of the country, predominantly in dry areas where other crops can survive least and food insecurity is widespread. These areas cover nearly 66% of the country (Adugna, 2007). Sorghum is one of the staple crop of *Konso* Special *Woreda* and is said to be ancient in the area and due to its drought-tolerance characteristic (Förch, 2003).

Farmers in Konso use a wide variety of sorghum, and select particular species depending on specific site conditions and the production objectives. This approach also results in the potential opportunity/benefit of growing sorghum with different qualities, and subsequently reaping the benefits from the different types. For example, one type may be good for animal feed, with another being good for drought weed and disease resistance (Tadesse, 2010).

The majority of small-scale and subsistence oriented farmers do rely on informal seed system operating in low potential areas where complex environmental stresses challenge agricultural production. In developing countries, it is estimated that 80% of all seeds planted are provided by informal seed system (Duttfield, 2007). In countries like Ethiopia where the formal seed supply is inefficient, the informal system is extremely important for seed security of the nation. The majority of Ethiopian smallholder farmers are largely dependent on this system mainly through farm-saved seed exchange (Alemu, 2015).

Informal seed system usually draw on a relatively high number of landraces which are better adapted locally and more resilient, but usually low yielding. This poses a major challenge for farmers in informal seed system: saving a certain amount of seeds from a low quantity of seeds harvested is especially tough when livelihoods are weak (IAASTD, 2009). The exchange and distribution of seeds are dependent upon geographical boundaries, cultural systems and social networks (de Schuetter, 2009).

Farmers based sorghum seed system is performed for a lengthy period of time in Ethiopia. But, there is only a little information about farmers' sorghum seed system. In *Konso* context, there is a lack of empirical studies to design strategies for seed system. Even though the seed system is known as informal, How the farmers get the seed, how they manage and exchange their seed is not well known. Therefore, this study is initiated to identify sorghum seed system.

II. Material And Methods

Description of the Study Area

Konso*Woreda* (KW) is located at latitude 5°15'N and longitude 37°29'E in Southern Nations, Nationalities and People's Regional State (SNNPR) of Ethiopia and 595 km south of Addis Ababa. The KW has a total population of 235,087, of whom 113,412 are men and 121,675 are women. With an area of 2,273.km^2, the *Woreda* has a population density of 103.39 with only 4% of the population residing in urban settlements(Central Statistical Agency of Ethiopia, CSA, 2007).

The elevation of KW ranges from 550 - 2100 masl. The *Woreda* receives a total average annual rainfall of 750 millimeters with highly variable distribution pattern. The temperature varies from 25-30°C with annual average temperature of 27°C. The soil type chiefly found in KSW is a black and red (KonsoWoreda Bureau of Agriculture, 2016).

The people of *Konso* are known for their internationally recognized stone-walled terraces registered by UNESCO as world heritage cultural landscapes (UNESCO, 2011). The *Konso* are also known for their indigenous intensive agricultural landscape with unique mixed crop-livestock agriculture and agro forestry systems that have been maintained for hundreds of years despite the social changes (Tadesse, 2010).

The *Konso* animal husbandry involves rearing of major livestock such as cattle, goats, sheep and sometimes chickens and donkeys. Crop production is dominated by great variety of cereals, while other crops such as pulses, root and tuber crops are also known and cultivated in the area (Förch, 2003). Sorghum is arguably the most important crop which has been under cultivation for several years as main staple in the Konso diet **(**Tadesse, 2010; Förch, 2003).

Research Design and Sampling Methods

Three *KebelesFasha, Gaho* and *Arfayide* purposively base on their sorghum production potential. 190 (159 male and 31 female) HHs considered in the study. Population proportion method was employed to determine the sample size that proportionally represents the total populationas well as gender of HHs in each of the three *Kebeles*.Eventually, the respondent households were identified from the resident HH record book using systematic random sampling techniques to give equal chances for all the households.

Data CollectionandAnalysisMethods

Both qualitative and quantitative data related to sorghum seed system was collected from sampled households. The data were collected by combination of tools and methodologies including focus group discussion (FGD), pre-tested survey questioners and farm observation.

Descriptive statistics such as frequencies, percentage, mean, standard deviation and charts were used to analyze sorghum seed system. Data on variety characteristics, seed exchange system and seed flow, selection criteria's and seed selection and management were analyzed descriptive statistics.

Statistical Package for Social Science SPSS 20.0 application software was used for analysis. The descriptive analysis was used (frequencies, percentage, mean and standard deviation) to analyze the socio-economic characteristics, types of crops, cropping systems and type of sorghum varieties. The statistical significance of the variables was tested through chi-square and t-test for dummy and continuous variables, respectively.

III. Results And Discussion

General Characteristics of the Respondents and Study Area

Demographic characteristics such as age, farming experience, education and family size showed wide range variation among the interviewed sorghum farming HHs. The HHs were on average 40.9 (SD = 10.7) years old with the youngest and oldest HH being 21 and 70 years old. The HHs had experience of farming their holdings for a minimum of one years and maximum of 50 years with average of 21.8 (SD = 10.5) years. Most (54.7%) of the farmers had never been to school where as (45.3%) had education with total average schooling year of 5.4 (SD=3.85).

The family size of households ranged from one to 17 persons with average number of 7.8 (SD = 3.2) members per HH. The age structure of sorghum farming HH members indicated that majority (70.3%) of the members were in economically active age group whereas about a quarter (26.7 %) were children of less than 14 years and the remaining very few (3%) were aged group of people above 64 years.

The average farmland area was 0.84 (SD = 0.69) hectares (ha) across interviewed HHs with the minimum and maximum farmland area of 0.63 and 4 ha, respectively. On average the farmers allotted 0.37 ha of farmland for sorghum; some of the farmers allotting as minimum as 0.06 ha and as maximum as two ha of land for sorghum for the cropping season during the survey *Meher* 2016. Most of the sorghum was cultivated in steep farm land. Other than sorghum the interviewed farmers cultivated various crop species mostly cereals like maize (*Zea mays* L.), *teff* (*Eragrostistef*(Zucc.) Trotter) and barley (*Hordeumvulgare L.*) and Pulses like haricot bean

(*Phaseoulesvulgaris* L) and soya bean (*Glycine max(L.) Merr.*). Number of crops other than sorghum produced by the farmer ranges from zero to seven with an average 2.61 (SD=1.09).

In addition to crop production, the interviewed *Konso*HHs maintained livestock in their landholdings. Livestock like cattle, goat, sheep, chicken and donkey were common in the area. About 71.1% of sorghum farming HHs own oxen range one to six with an average 1.61 (SD=1.11) while 56.8% of farmers own minimum one and maximum seven cows with an average 1,42 (SD=0.82). Goat and sheep were common in the area which owned by 88.4% of the HHs with an average 6.20 (SD=4.68) while poultry owned by 72,6% of HHs with an average 5.44 (SD=4.12). This livestock holdings changed Tropical Livestock Unit (TLU). The average TLU were to be found 2.67 (SD=2.53). The majority of the total sampled households (67.9%) own below the average.

On-farm income is common source of income for all HHs but some farmers (31.6%) involved in off-farm income sources. Total income ranges from 600 to 57000birr per year. The average total income to be found 11602.5 birr (SD=10396).

The minimum and maximum market distance was found to be 0.15 and 12 km, respectively (Table 8). The average market distance was about 2.9km (SD= 2.5). The survey data indicated that 123 (64.7%) respondents were situated close to the market centers (less than 3 km).

Extension service is provided by extension workers and to some extent by non-governmental organizations. Two to three development agents were assigned at each *Kebele* to give frequent and continuous technical support and advice. Most of sample households of the survey (84.2%) had extension services from agriculture office, credit providers and non-governmental organizations (Table 5). The services were training, credit access, seed supply and motivational award for successful farmers.

The use of improved sorghum seed was found to be low in the study area. Only 21.1% farm HHs were used improved sorghum seed (Table 5). Some improved sorghum varieties (Gubye, Abshir, Brihan, Teshale and Gambella) were introduced for striga*(Strigahermonthica, S.)* management purpose. The use of chemical fertilizer was also limited because of financial shortage and erratic rainfall distribution. However, during group discussion, it was realized that the inputs are mainly supplied by Bureau of Agriculture but not in time and the cost is also high.

Almost all the respondents get extension service from agriculture office with a variation of number of visit and advice from development agents. The number of visit by development agent ranges between 0 and six times per household. The average number of development agent visit is 1.6 (SD=1.3) .

About 46.8% of HHs reported that they have access to credit. The remaining 53.2% of the total sampled household reported that they have no access to credit. Concerning cooperative involvement or contact, it was found that only 8.4% of HHs reported that they have involvement and contact with cooperatives. The remaining 91.6% reported that they have no involvement and contact with cooperatives. From the respondents who have involvement and contact with cooperatives 62.5% of them involved in farmers' union and the remaining 37.5% involved in seed supplier organization. Farmers who involved in cooperatives got training, improved seed, quality seed of local varieties and market facilitation support.

Importance and Use of Sorghum

Sorghum is multipurpose crop that takes special position in the *Konso* food culture and ethno-medicine. Food recipes such as *Kurkufa* and porridge as well as beverages like *Cheka* and *Areki* are most commonly prepared dishes and drinks respectively, in the studied *KonsoKebeles*. To supplement sorghum derived dishes, farmers in *Konso* maintain other cereals such as maize (*Zea mays* L.), teff (*Eragrostistef*(Zucc.) Trotter), and barley (*Hordeumvulgare L.*), legumes like haricot bean (*Phaseoules vulgaris* L) and soya bean (*Glycine max(L.) Merr.*) as well as leafy vegetables such as cabbage (*Brassica oleracea* L.) and moringa (*Moringastenopetala* (Bak.) Cuf.Farmers grew between one and eight different crops. On average, 3.61 (SD=1.09) crops were grown in a season. In Ghana, as many as 14 crops were cultivated by sorghum growing farmers in Bawku East district (Kudadjie, 2006)

The major purposes of producing food crop and cash crop by the sampled households were for consumption and sale respectively. Thus, sorghum and maize were mainly produced for consumption in the study area. As indicated in the table, teff is important sources of income for farmers producing this crops.

Table 1: Purpose of crop production

	Purpose of crop production			
	Consumption	Sale	Consumption& sale	Total
Type of crop	N(%)	N(%)	N(%)	N(%)
Sorghum	174(91.6)		16(8.4)	190(100)
Maize	152(89.4		18(10.6)	170(100)
Bean	195(87.6)		15(12.4)	121(100)
Teff		7(10.9)	57(89.1)	64(100)
Soya bean	7(63.6)		4(36.4)	11(100)

Sorghum Seed Management and Seed System

Many more farmers tended to use their own seed (98.9%) or sourced seeds from other farmers (20.53%), than from the Agriculture office (1.05%), or the market (0.53%) (Figure 1). Seeds obtained from other farmers were either in the form of gifts, or through exchange for seed, grain or labor. In this study the market appears to be the least important source of sorghum seed. This result found in agreement with group discussion that selling seed is not culturally accepted in *Konso*but at the time of seed shortage farmers may buy grain from market and use for seed.McGuire (2002) also found preferred sources for sorghum seed were, neighbors/other farmers, government, market next to own sourced seed Western Harerghe.

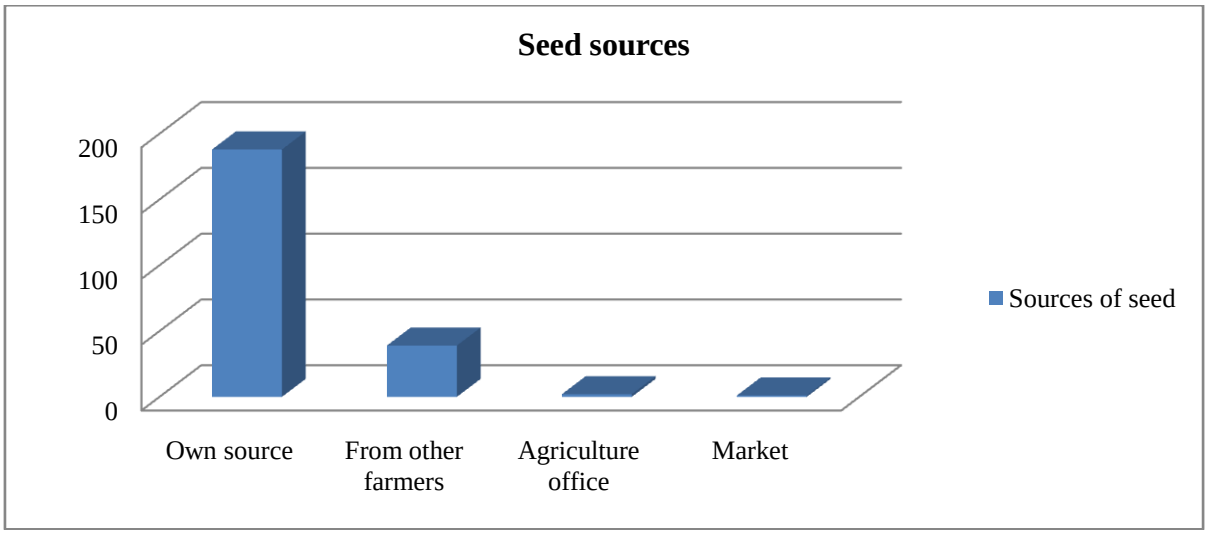

Figure 1: Farmers' Sorghum Seed Sources in *Konso*

No separate plot was allocated for sorghum seed production; it is normally produced with the grain. Seed selection take place immediately before harvesting. Farmers based their selection on both panicle and grain characteristics. Principally, these were grain size, grain health, maturity and panicle size (Table 2). Panicles must be large and have large grains, mature and free from disease and free from insect attack. The most common seed selection criteria used were panicle size (94.74%) and grain purity (90%) (Table 2). In Ghana, Kudadjie (2006) found the same seed selection criteria.

Table 2: Farmers' Sorghum Seed Selection Criteria in *Konso*

	HHs	Percent[1](N=190)
Big panicle	180	94.74
Pure seed	171	90
Mature	62	32.63

[1]*= Figures do not add up to 100 as farmers may use different selection criteria.*

The most common form of storage was storing threshed (90.4%) seed and the other was keep the seed in the unthreshed state (9.6%). Farmers in the study area stored their threshed seed in calabash (*kill*), sack and pot. Aloe vera ash, moringa ash and chemicals used for seed quality maintenance. More than 73% of farmers use calabash as seed storage material whereas 20% of farmers use suck (Table 3). On the other hand farmers store unthreshed seed hanging over smoke area, hanging on tree and stay over the roof. Kudadjie (2006) also reported that sorghum growing farmers in Ghana stored their seed threshed or unthreshed form and they also used wood ash and chemicals for seed treatment

Table 3: Farmers' Seed Storage and Treatment practice in *Konso*

Storage and treatments or seed quality maintenance	HHs	Percent
Calabash (kill) by adding ash	139	73.2
Suck by adding ash	20	10.5
Hung over smoke area	12	6.3
Pot by adding ash	11	5.8
Hung over tree	4	2.1
Put over the roof	2	1.1
Calabash & pot by adding ash	1	.5
Calabash & pot by adding chemical and ash	1	.5
Total	190	100.0

From the focus group discussion with men and women farmers and survey result, it was noted that women farmers play the leading role in seed management. Threshing, storing and exchange of seed is almost completely the responsibility of female in the study area (Figure 2). The result of this study is consistent with the result of Yemane*et al*. (2009) in Tigray, Ethiopia which was noted that women farmers play the leading role in selecting and cleaning seeds from the storage.

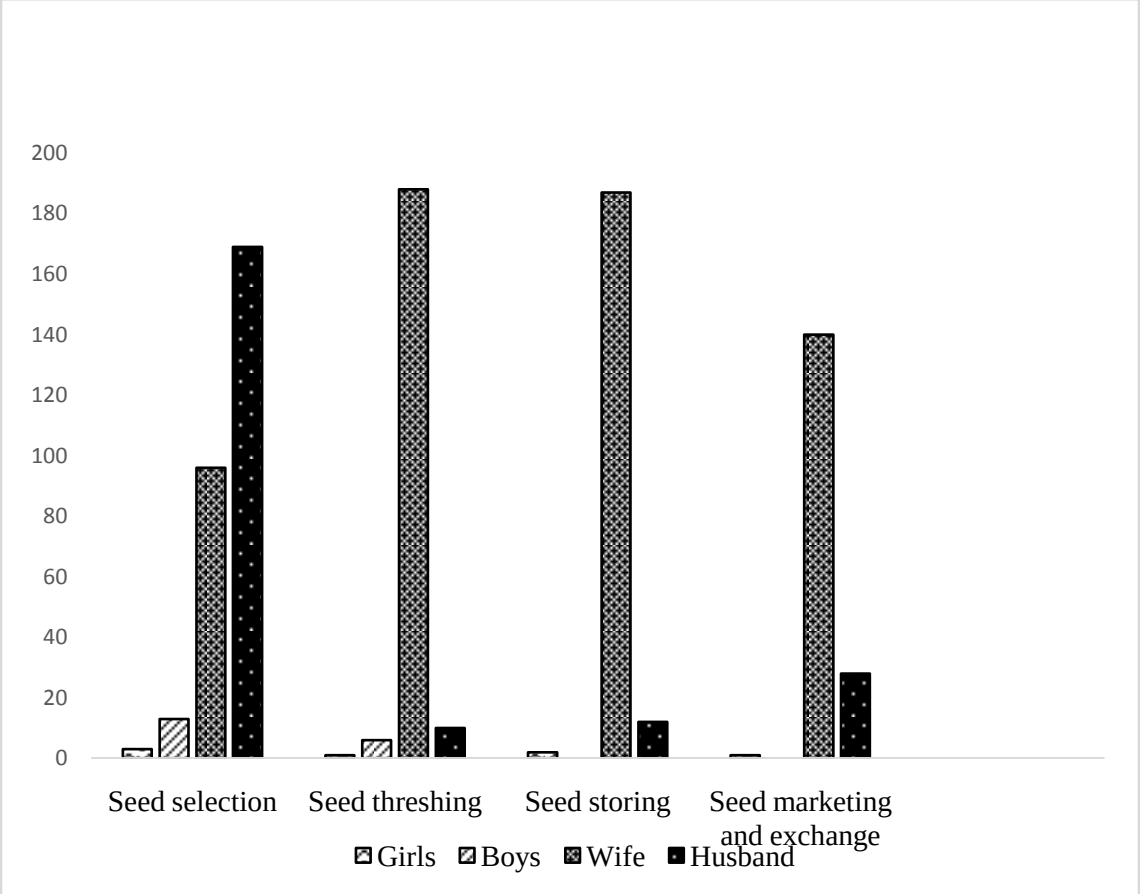

Figure 2: Farmers' Labor Division of Sorghum Seed Management Practices in *Konso*

Most farmers (83.2%) exchange seed and the remaining 16.8% don't exchange sorghum seed. They exchange their seed with neighbor, relatives and from market by barter and selling & buying (Table 4).

Table 4: Farmers' Methods of Sorghum Seed Exchange in *KonsoKebeles*

Seed exchange	HHs	[1]Percent
Exchange with neighbor	118	62.11
Exchange with relatives	106	55.79
From market	39	20.53
No Exchange	32	16.8

[1]*= Figures do not add up to 100 as farmers may practice different exchange methods.*

Most of farmers who exchange seed (91.8%) exchange their seed within their village where as 2.5 % exchange outside their village. The remaining 5.7% exchange their seed either within or outside their village. Exchange sorghum seed with other crop and with other variety of sorghum were most frequent sorghum seed exchange methods within the *Kebele*while loan is most frequent for seed exchange outside the *Kebele*. Abay*et al*. (2011) also found that seed flow of barley seed within the village was much more dominant in Tigray, Ethiopia.

Conclusion

Even though sorghum is most important ancient crop in *Konso,* the production system and seed management is the same as their parents. Seed and grain production is not separated. The main source of seed was own production followed by exchange with other farmers and women play the major role on seed management especially after seed selection. Seed marketing is almost zero. This implies that sorghum seed production and marketing need attention on awareness creation in the study area. Female empowerment is needed to improve and maintain sorghum diversity since they are the major actor of seed management.

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