Ethiop. J. Agric. Sci. 32(2) 99-117 (2022)

Analysis of Actors in Chickpea Seed Supply Chain; Gondar Zuria Woreda, Ethiopia

Asrat Mulat Asegie[1*], Almaz Giziew[2], and Dereje Ayalew[2]
[1] College of Agriculture, Wollo University, P.O. Box: 1145, Dessie, Ethiopia
[2] College of Agriculture and Environmental Sciences, Bahir Dar University, P.O. Box: 5501, Bahir Dar, Ethiopia; E-mail: asrat19mlt@gmail.com

Abstract

Chickpea provides numerous benefits to smallholder households in different ways. Increasing access to improved seed has the potential to improve the productivity of chickpea in Ethiopia. In the chickpea seed supply chain, understanding the seed source and actors' role is important for providing quality and improved chickpea seed to farmers through creating effective seed supply chain mechanisms. The present study was carried out at Gondar Zuria Woreda in 2018. A multi-stage sampling technique was employed for the random selection of 140 sample households for individual interviews. The data were analyzed using descriptive statistics and qualitative approaches. From the present study, it is possible to note that the only source of improved chickpea pre-basic and basic seeds in the study Woreda is Debre-Zeit Agricultural Research Center. Gondar Agricultural Research Center (GARC), Tsehay Farmers' Cooperative Union, and the University of Gondar play a dominant role in improved chickpea seed production and marketing. However, these institutions have been facing a shortage of supplying breeder and pre-basic seeds. It can be concluded that the involvement of different actors in the supply chain contributes a lot to accessing improved chickpea seeds for smallholder farmers. Therefore, the governmental and non-governmental organizations should work strongly to build the capacity of seed producer cooperatives and clustered smallholder farmers.

Keywords: Chickpea seed, mapping actors, seed supply chain, seed system

Introduction

Chickpea provides various benefits to smallholder households as a source of food (protein), cash income and means for sustaining soil fertility (Atnaf *et al.*, 2015; Mazid *et al.*, 2013). Chickpea is an important crop for human well-being throughout the world both in terms of nutritional security and food security (Burman *et al.*, 2010; Considine *et al.*, 2017; Shari *et al.*, 2018). In Ethiopia, chickpea has also a critical contribution to attaining food and nutritional security of smallholder farmers (Atnaf *et al.*, 2015; Chichaybelu *et al.*, 2018). During the 2012/2013 production season, about 1.1 million smallholder farmers have been cultivating the crop (Atnaf *et al*., 2015). In the same production season, chickpea was planted on 239,512.43 hectares of land (1.95% of the grain crop area) and 4,097,331.63 quintals (1.77% of grain production) was produced with productivity of 1.71ton ha^{-1} (CSA, 2013). In the 2017/2018 production season, contributed to 1.91% of the grain crop area (242,703.73 hectares) and 1.63% of the grain

production (4,994,255.50 quintals) with productivity of 2.06ton ha^{-1} (CSA, 2018). These figures imply that chickpea productivity has increased over time even though the share of chickpea in terms of grain crop area and grain production has decreased. The national chickpea productivity doubled during 2006- 2015 and attained a peak of 1.9ton ha^{-1} in 2014 (Chichaybelu *et al.,* 2018).

The increased productivity of chickpea may be due to the use of improved agricultural technologies. Authors such as Asfaw *et al.* (2011) argued that the adoption of improved agricultural technologies has a significant positive impact on farmers' integration into the output market as a result of increased productivity. Among improved agricultural technologies, the use of improved chickpea varieties plays a prominent role in increased productivity (Beyene *et al.*, 2014; Chichaybelu *et al.,* 2018). The attributes of quality seed can contribute up to 40% to productivity enhancement, keeping other productivity factors constant (EIAR, 2020). Efforts have been made to improve the availability of improved seed of chickpea to the farming community in Ethiopia (Alemu, 2011; Fikre *et al.*, 2012; Fikre & Eshete, 2014; Gaur et al., 2013). However, those efforts can't satisfy the demand for improved chickpea varieties due to limited awareness of farmers on existing improved chickpea varieties, less popularization of improved varieties, socioeconomic status of farmers including the limited functionality of the various seed systems in the country (Asfaw *et al.,* 2011; Chichaybelu *et al.,* 2018; Tegegne, 2017).

The seed sector development strategy of Ethiopia recognizes three types of seed systems (formal, intermediate and informal) (MoA & ATA, 2017). The formal seed system is a system that involves a chain of activities leading to the certified seed of released varieties (Louwaars 2007) as cited in Sisay et al. (2017). The formal seed sector, which is dominated by public seed enterprises and a few private seed companies, plays an important role in supplying certified seed of improved varieties (Ayana & Alemu, 2019). The major actors of the formal system are the National Agricultural Research Systems (NARS)-including National and Regional Agricultural Research Institutes, Higher Education Institutions, Ministry of Agriculture (MoA), Ethiopian Seed Enterprise (ESE) currently known as Ethiopian Agricultural Businesses Corporation (EABC) operating at the national and regional level, seed producer cooperative unions, and private seed companies (Atilaw, 2010; Chichaybelu et al., 2018). The intermediaries exist between formal and informal seed systems (Fikre et al., 2012). The intermediate seed system mainly involves farmers organized into seed producer cooperatives and it shares some features of the formal and informal systems. It plays an important role especially in ensuring access to certified seed of crop varieties for which there is limited commercial interest for seed companies (Ayana & Alemu, 2019). The informal seed system is defined as seed production and distribution practices where there is no legal seed certification (Alemu, 2011).

An informal seed system is characterized by a farmer-to-farmer seed exchange under non-law regulations (Atilaw, 2010). Farmers are the dominant seed value chain actors as the prevailing sources, multipliers, and disseminators of seeds in the informal sector (ISSD Africa, 2013). To date, the majority of chickpea producers obtain their seed for planting informally from their own saved seed or through a local exchange (Eshete et al., 2013). Atilaw and Korbu (2016) as cited in Chichaybelu et al. (2018) reported that self-saved or farmer-to-farmer seed exchange, accounts for over 95% of the chickpea seed used by smallholder farmers.

The chickpea seed multiplication and delivery systems comprise variety development and release, and seed production and distribution (Fikre et al., 2012). An innovative partnership of different actors in the chickpea seed system facilitates access to certified seeds of improved chickpea varieties (Chichaybelu et al., 2018). According to Chichaybelu et al. (2018), the actors involved in chickpea seed systems in Ethiopia are; national improvement programs, research centers, public seed enterprises, cooperative unions, farmers' seed producer associations, private seed producers and farmers. In the case of chickpeas in Ethiopia, the Debre Zeit Agricultural Research Center (DZARC) coordinates chickpea research at the national level with a number of collaborating and supporting centers, mainly with the Consultative Group on International Agricultural Research (CGIAR) centers such as International Center for Agricultural Research in Dry Areas (ICARDA) and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) (Fikre et al., 2016).

Ethiopia has an emerging sector of private seed producers. Farmers' seed producers associations are the dominant supplier of improved chickpea seeds in Ethiopia (Chichaybelu et al., 2018) implying informal seed systems are the main seed source for smallholder farmers. Private sector involvement in self-pollinated legumes including chickpea is low with several factors including lack of incentives (Gaur et al., 2013).

Analyzing and understanding chickpea seed systems is critical to supporting the increment of farmers' access to improved chickpea seeds. The performance of a particular seed system determines the adoption rate, yield gaps and diversity of actors involved, where for some crops, the formal seed system plays a crucial role while for others the informal seed system dominates (Alemu & Bishaw, 2019). The supply and use of certified seed in the country generally vary considerably with the type of crop and the development of the seed system for a particular crop (Ayana & Alemu, 2019). Accordingly, analyzing the seed system assists to know the major source of seed for local farmers and the corresponding actors involved in the chickpea seed value chain to understand the role of actors in supplying

improved chickpea seeds. As the actors involved in chickpea seed systems vary in locations depending on the specific physical and social contexts, it requires generating area-specific evidence that enables the designing of local-level intervention strategies. Such an argument is supported by Audet-Bélanger et al. (2013) who reported that seed system analysis requires specific analysis and intervention of sub-sectors and therefore it cannot be generalized for seed in the entire sector. In addition, Warner et al. (2015) argued that a detailed understanding of farm production at the Woreda level is essential to plan and evaluate interventions because many agricultural policy decisions are implemented at this level.

Therefore, this study was intended to identify and map different actors involved in the chickpea seed supply chain in Gondar Zuria Woreda of the Amhara region, Ethiopia. The study highlighted the roles and major challenges faced by each actor. This study will enable development practitioners and decision makers to take measures on weak sections among actors in chickpea seed the supply chain.

Materials and Methods

Sampling Techniques

This study was conducted in Gondar Zuria woreda, which is one of the potential chickpea production areas in the Amhara region. The location map of the study area is presented in figure 1. According to Gondar Zuria Woreda Office of Agriculture's basic information, the Woreda has a total area of 114983ha (GZWoA, 2012, unpublished). In the study area, chickpea is the second most important crop next to Teff.

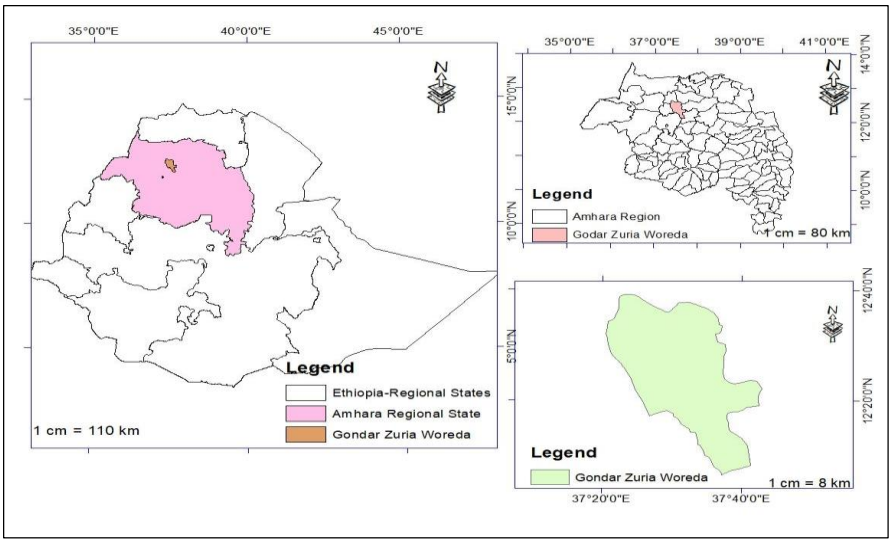

Figure 1: Map of the study area
Source: GIS Sketch, 2018

For this study, a multi-stage sampling technique was employed. First, the Gondar Zuria woreda was selected purposively. Second, Chinchaye and Tach Tseda kebeles were selected purposively based on their potential for chickpea production. Thirdly, a total of 140 respondents were selected randomly using a simple random sampling technique. Following a procedure proposed by Yamane, (1967), the sample size was determined using a sampling formula, $n = \frac{N}{1+N(e)^2}$, where, 'n' is the sample size, 'N' is the total population in the sampling frame (1314), and 'e' is an error of margins (0.08). Finally, the sample size for each kebele was taken proportionately. Accordingly, 46% from Chinchaye and 54% from Tach Tseda kebeles were taken.

Table 1: Sample distribution of key informants

Respondent category	Number
Amhara Seed Enterprise	1
Amhara Regional Agricultural Research Institute	1
Gondar Agricultural Research Center	2
Amhara bureau of Agriculture	1
University of Gondar	1
Farmers' multipurpose cooperatives	2
Amhara Seed Enterprise	1
Gondar Zuria woreda office of Agriculture	1
Gondar Zuria woreda office of cooperatives	1
Kebele development agents	3
Central Gondar Zone Seed and other Agricultural Inputs Regulatory branch office	1
Total	15

In addition to sampled households, 15 key informants from different institutions were included purposively based on their involvement in the chickpea seed system in the study area to triangulate the data with sample households (Table 1).

Data Collection and Analysis

The study used qualitative and quantitative data from both primary and secondary data sources. Primary data were collected directly from smallholder chickpea growers and key informants, while secondary data were collected from available resources including journal articles and annual reports. For collecting data semi-structured interview guidelines were prepared. The semi-structured interview helps to get a deep understanding of the issue raised by letting interviewees add other points not mentioned in the guideline. Separate interview guidelines were prepared for sample respondents and key informants. The interview guideline is made in a way that answers the objective of the study. The pre-test was conducted on randomly selected 10 households (not included in the analysis), and some technical corrections were made to the final interview guideline.

Before data collection, consultation with kebele agricultural development agent on how to approach sample households was made. Kebele agricultural development agents facilitated the identification of randomly selected households in respective convenient clustered locations to contact interviewers. Accordingly, four clusters in each kebele were arranged to conduct interviews. Then the schedule was prepared for those clusters to undertake data collection, and Kebele agricultural development agent together with local leaders assisted to bring selected respondents to the site. When selected respondents are not available during the scheduled date, the enumerators interview those households at their homes. For this survey, five enumerators were involved to collect data after one-day of training on the details of the interview schedule. The training is also given on the techniques to approach farmers and ethical principles adhered to during the interview. The data were collected through face-to-face interviews with selected respondents and key informants. As a result the data on household characteristics, chickpea seed sources, area planted by chickpea varieties, amount of chickpea produced, allocation of products to different purposes, and marketing of chickpea seeds. In addition, qualitative data such as major activities done in the chickpea seed sector as actors, the challenges they faced, and best practices were collected from key informants.

These data were analyzed using both qualitative and quantitative methods. Qualitative data were analyzed by categorizing information into different themes and sub-themes. Then the data were further interpreted through narration, explanation, and interpretation of the issue. On the other hand, quantitative data

such as household characteristics were analyzed using simple descriptive statistical tools such as percentages and mean.

Results and Discussion

Demographic Characteristics of Respondents

As depicted in Table 2 below, 55.7% of respondents used improved chickpea varieties, whereas the remaining 44.3% used local varieties. The potential landholding size of smallholder farmers for chickpea production ranges from 0 to 2.25ha with a mean holding of 0.8 ha. During the 2016/2017 production season, on average, smallholder farmers allocated 0.26ha of land for chickpea production, which is smaller than the potential land for chickpea production. The land allocated for chickpea production ranges from 0ha to 2ha in the study area.

Table 2: Demographic characteristics of households

Variables	Responses	Frequency	Percentage
Sex	Female	14	10
	Male	126	90
Improved chickpea utilization status	Users	78	55.7
	Non-users	62	44.3
	Minimum	Maximum	Mean
Age (years)	25	79	47
Educational level (grade)	0	12	1.7
Family size	1	11	5
Potential Land size (ha)	0	2.25	0.8
Land covered by chickpea (ha)	0	2	0.26

Source: Own survey (2018)

Actors in the Chickpea Variety Development and Acquisition

The key informants' interview shows that the chickpea seed system encompasses different actors from germplasm acquisition to seed distribution and marketing. These actors have different roles, including germplasm acquisition, variety development and registration, variety release, adaptation, promotion, seed production, seed processing, and seed marketing. The acquisitions of chickpea germplasm and variety development are done by DZARC and other national, regional, and international agricultural research organizations. The registration and release of chickpea varieties are done by the Ministry of Agriculture via the National Variety Release Committee (NVRC). As summarized from discussion with key informants, most of the chickpea parental materials/germplasms are developed by two CGIAR centers namely ICRISAT and ICARDA. With the established agreement, DZARC has been receiving chickpea germplasms from these CGIAR centers for further varietal development for the specific agro-ecological conditions. The germplasms imported through these organizations were inspected by the Plant Health and Quality Control Directorate under MoA.

Following germplasm acquisition and quarantine, DZARC tests varieties of chickpea in different locations and releases them with full agronomic packages. Key informants from GARC noted that the only source of improved chickpea varieties for pre-basic and basic seed in the study area is DZARC. GARC is responsible for the adaptation and testing of chickpea varieties in the northwest part of the country where Gondar Zuria Woreda is located. In the study area, actors are engaging and working from the stage of chickpea variety adaptation which is one of the chickpea seed value chain nodes. Key informants from Tach Tseda kebele responded that the GARC promoted the Arerti variety of chickpea on 32 hectares of land in the area during the 2016/2017 production season.

Table 3: Varieties adaptable in the study area

Varieties	Number of producers	Percentage
Arerti	56	40
Shasho	71	50.7
Naatolii	96	68.6

Source: Own survey (2018)

The major chickpea varieties grown by farmers in the study area are Naatolii, Shaho, and Arerti (Table 3). Arerti and Shasho are Kabuli-type chickpea varieties whereas Naatolii is Desi-type chickpea. Kabuli-type chickpea is the most important commercial crop in Ethiopia and worldwide (Belete et al., 2017). In the study area, most smallholder farmers (68.6%) grow local Naatolii varieties. Desi type Naatolii local variety is easily accessible at the local market and their homes. The respondents replied that even though the Naatolii variety is less productive, it is widely adapted to the local environment and the seed is easily accessible.

According to discussion with key informants from GARC, Tsehay farmers' multipurpose cooperative union and Gondar Zuria woreda office of Agriculture, currently research center, seed producer cooperatives, and agriculture office work on the promotion of improved Arerti and Shasho varieties of chickpea seed. As it is presented in Table 3, 50.7% and 40% of respondents were grown Shasho and Arerti varieties, respectively. During the interview, key informants and respondents indicated that Arerti varieties are better productive and disease tolerant compared to Shasho. The finding of Verkaart et al. (2019) is consistent with this finding that reported farmers prefer the Arerti variety because of its tolerance to fungal diseases. These figures in Table 3 include both local and improved seeds for both varieties. All of these varieties were released by DZARC (Belete et al., 2017; Mulugeta et al., 2021). This is why DZARC is the only source of a breeder and pre-basic seed of chickpea varieties in the study area.

Chickpea Seed Multiplication and Processing

Seed multiplication passes a series of seed classes such as breeder seed, pre-basic seed, basic seed, and certified seeds in its seed class. Certified seeds also have C1,

C2, C3, and C4 seed classes (adopted from Organization for Economic Cooperation and Development (OECD)). The success of seed multiplication largely relies on the availability of breeder seed of the highest possible genetic purity and the efficient management of subsequent generations (EIAR, 2020). According to key informants from GARC, the center can't access the required amount of breeder and pre-basic seeds of chickpea, even for adaptation and demonstration work at the required time. The reason reflected during the discussion for this issue is that there is a shortage of supply by DZARC to provide sufficient amounts of a breeder and pre-basic seeds. This implies that the demand and supply of breeder, pre-basic and basic seed of chickpea is not well understood. This may be due either to the limited capacity of the breeding institution to produce them in large quantities or the absence of information on the required demand of the seed. The presence of a short supply of seeds affected the adaptation and promotion activities done by GARC. For better keeping the quality of seeds to be supplied for research institutions and seed producers, access to a breeder and pre-basic seeds is imperative. Fikre et al. (2012) reported that the quality of seeds decreases as one goes along the paths of breeder seed, pre-basic seed, basic seed, and certified seeds.

Besides early generating seed shortage, a lack of experienced professional chickpea breeders at GARC due to a high turnover of skilled professionals is another constraint. Consequently, the center has no experience in releasing chickpea varieties. According to the response of researchers from the center, if the varieties are released at the center, not only the shortage of pre-basic and basic seed is solved but also better adaptable and productive varieties will be released.

Even if the quality of seed produced deteriorates due to a lack of the continuous availability of both pre-basic and basic seeds, farmer-based contractual seed multiplication in the study area is one means of accessing improved seeds. This result is consistent with the findings of Gaur *et al*. (2013), who explained farmers' cooperative unions involved in chickpea seed production and marketing in Ethiopia. Similarly, Alemu (2011) reported that a farmer-based seed multiplication strategy is one of the driving forces to access quality seeds of improved varieties.

In the study area, particularly from the Tach Tseda kebele, Tana farmers' seed multiplying cooperative is actively involved in the multiplication of seeds on improved teff, maize, and chickpea varieties. As key informants explained, this cooperative is organized by technical support from the Tsehay multipurpose cooperative union and the University of Gondar. In the 2016/2017 production season, chickpea seed multiplication activity was undertaken by Tana farmers' seed multiplying cooperative on 50ha of land by 98 households. The seed source

was Tsehay multipurpose farmers' cooperatives union, by which the union has provided 50kg seed (Arerti- C_2) for each of the selected farmers on a cluster basis. Tsehay multipurpose farmers' cooperatives union accessed certified seed from DZARC and multiplies contractually with farmers and seed multiplying cooperatives. The union faced the challenge to access early generating seed of chickpea varieties from DZARC due to its short supply. The farmers and union made an agreement to keep seed quality, return to 50kg of seed sowed, and supply the remaining seed produced at a 15% premium price. During that production season, 836 quintals of Arerti-C_3 chickpea seeds were produced. When the C_2 seed class is sowed, the product becomes C_3 and the union continues to multiply them up to the C_4 seed class.

Seed producers and regulatory organizations pass a series of seed processing activities to maintain its quality. Seed processing involves cleaning a threshing floor, cleaning threshed seed, and grading activities to maintain the physical purity of the seed. In addition, lab analysis, germination test, and moisture content analysis could be done before packing and storing the seed to ensure the fulfillment of minimum requirements (WCDI, 2020). According to key informants, seed producer farmers are aware of keeping all quality parameters starting from field selection to final storage. Kebele Agricultural Development Agents, Woreda Office of agriculture experts, University of Gondar, and Tsehay Union played a prominent role in creating awareness, training farmers, and monitoring and inspecting activities. In this regard, seed producer farmers are responsible to keep the physical purity of seed that meets quality requirements to be further checked by Tsehay farmers' multipurpose cooperative union internal quality control procedure. The union checks the quality of seed in terms of physical purity, germination, and moisture content through its internal quality control procedure. Finally, the external quality control authority (in this case Amhara seed quality regulatory author, Gondar branch office) assures its quality and finally certifies the quality of the seed.

Chickpea Seed Sources in the Study Area

Seed marketing deals with the transaction of chickpea seeds from the source to the final users. The major source of seed for farmers is the local saved seed, which accounts for about 47.14% of respondents using local saved seed. The second major source of seeds is purchasing from local farmers (Table 4). Nearly 33.6% of the respondents access seeds by purchasing from the local market. In the study area, farmers use Makesegnit and Tseda markets to undertake marketing activities. Farmers purchase non-certified improved varieties from farmers at the local market. As it is presented in Table 4, nearly 18% of respondents access improved chickpea varieties from the local market. Once the demonstrated varieties are distributed to farmers, they have been recycling the seedfor other farmers. As the

degree of demonstration and scaling up of improved chickpea varieties is high, access to improved varieties for local farmers may increase. However, the qualities of improved varieties accessed at the market may not fulfill the required quality parameters. This implies that the informal seed system is the dominant seed source in the study area.

Tana farmers' seed multiplication cooperatives, Tsehay multipurpose farmer's cooperative union, and the University of Gondar play a significant role in the demonstration and marketing of improved chickpea seeds. Cooperatives actively engage in providing improved seed to farmers as represented by 25% of the respondent's access to improved seed from Tsehay multipurpose farmers' cooperative union. In relation to producer organizations, the Tsehay multipurpose farmer's cooperative union is the only supplier of improved chickpea variety to farmers via Tseda multipurpose cooperative. The other sources of seed also constituted seed exchange with farmers and research centers. The result implies that actors in the intermediary seed system are the main source of improved chickpea varieties in the study area. This finding is consistent with the reports of EIAR, (2020), which highlighted seed producer cooperatives/ local seed businesses (LSBs) are playing active roles in the intermediate seed system.

Table 4: Major sources of seeds

Seed Source	Seed Category				Total Percentage
	Local		Improved		
	Household No.	Percentage	Household No.	Percentage	
Seed exchange with farmers	6	4.29	18	12.86	17.15
Cooperatives	0	0	35	25	25
Research centers	0	0	1	0.71	0.71
Local saved seed	66	47.14	0	0	47.14
Market	22	15.71	25	17.86	33.57

Source: own survey (2018)

Note: Total percentage is the sum of percentages of households who accessed local and improved varieties. One respondent may access seed from different sources.

The farmers in the study district allocate their own chickpea produce to different uses (their own seed consumption, selling to other farmers in the form of seeds, and exchanging it for seeds either by chickpea grain or other commodities based on the local situation) (Figure 2). During the 2016/2017 production season, out of 817.2 quintals produced by respondents, about 25.4 % of chickpea products are allocated for seed purposes.

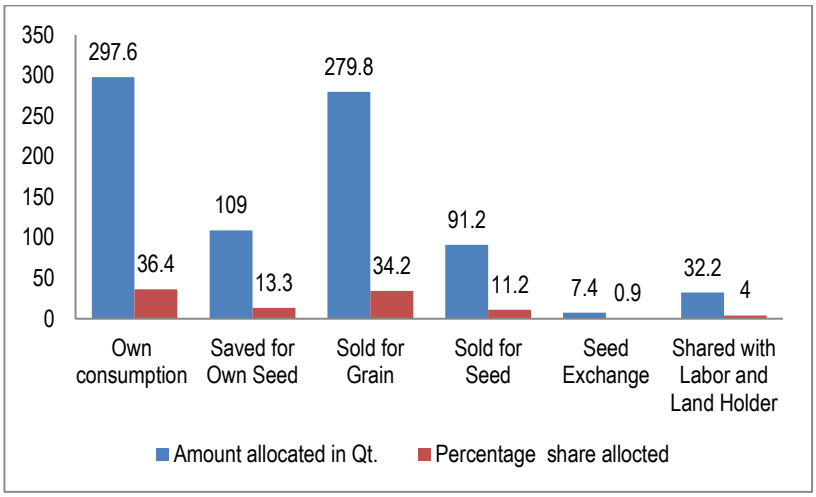

Figure 2: Chickpea production by smallholder farmers
Source: own survey (2018)

Figure 2 reveals that most of the products of chickpeas (45.4%) have been used for generating cash by selling the chickpea product in the form of seed and grain for the required period of time. According to respondents, improved varieties of chickpea are preferable to local varieties at the market to sell because they have a better price compared to local varieties. Most farmers sell the product to pay back credit from Amhara Credit and Saving Institution (ACSI), to cover fertilizer costs, and to meet other immediate household cash requirements. Some farmers also sell the crop after storing it until the peak price season and after they are confident enough for their household consumption requirements. Such farmers reported that they sold chickpea produce at the market after they are leftover from household consumption during the season.

Households allocated 297.6 quintals (34.2%) of the chickpea produce for household consumption. Respondents and key informants reported that there is also a trend that some farmers save and store it for the time of the sowing season to sell for seed purposes. During this time, as they reported, the price rises and enables them to get a better income. Out of the total produce, 13.3% is allocated for own seed (saved seed) to grow in the next growing season. This amount of seed includes both local seed and improved (not certified) seed of chickpea. In addition, a small portion of their produce is allocated for seed exchange (0.9%) and shared with labor and landholders (4%).

Table 5: Major market places for marketing chickpea seed and grain

Major Marketing places	Marketing Activities		
	Buying chickpea seed	Selling chickpea seed	Selling chickpea grain
Local market	47(33.6)	28(20)	112(80)
Cooperatives	35(25)	25(17.9)	50(35.7)
Local farmers	24(17.1)	0	0

Source: own survey (2018)

Note: The figures in the parenthesis represent the percentage of respondents in respective category calculated from (n=140)). One respondent may use more than one market.

In the study area, the major market outlets are local markets, multipurpose farmers' cooperatives, and local farmers (Table 5). The result reveals that about 33.6% of respondents buy chickpea seed from the local markets at Tseda and Maksegnit markets. Farmers buy both local and improved varieties (non-certified) from the local farmer. During such kinds of transactions trust among farmers is required to verify the quality of seed regarding germination and other aspects. Cooperatives are also involved in supplying seeds to farmers. As a result, 25% of respondents bought chickpea seeds from cooperatives. Tseda multipurpose farmers' cooperative supplies chickpea seed (certified and non-certified) to local farmers. In addition, around 17% of respondents buy chickpea seed from the neighboring farmers without going to the marketplace. Respondents explained that buying from local farmers enables them to develop trust in the purity of seed based on their long-stayed social relations.

Apart from buying, smallholder farmers sell their seed and grain to cooperatives and at the local market. In the study area, 20% of respondents sold their seed at the local market and 17.9% of respondents sold their seed to cooperatives. To sell the chickpea produce in the form of seed, farmers undertake certain seed processing activities such as maintaining physical purity cleaning and grading. By keeping those required quality parameters, farmers fetch attractive prices by selling their chickpea produce in the form of seed. Particularly, seed producer farmers who are members of Tana seed multiplying cooperative produce improved seeds and sell the portion of the produce to the cooperative as per their agreement. As explained by EIAR (2020), the seed producer cooperatives/LSB have also seed quality control committee, which oversees whether the standard isolation distance kept, the land is clustered, rouging off-types is done timely, and overall field management and post-harvest handling are done as per recommended procedures. The remaining chickpea seed produce is sold at the local market. According to key informants from Tsehay multipurpose farmers' cooperative union and kebele office of agriculture explained that seed producers are not willing to return back to the cooperative the amount of seed sowed at the 15% premium market price. This is because farmers can sell the seed at local markets at a better price than the premium price of cooperatives during sowing time. Moreover, 80% of respondents sold their grain at the local market and 35.7% of respondents sold their grain to cooperatives. In the study area, farmers from Chinchaye kebele use Chihra

Manterno multipurpose farmers' cooperative and farmers from Tach Tseda kebele use Tseda multipurpose farmers' cooperative to sell chickpea grain.

Map of Actors in Chickpea Seed System

The chickpea seed supply chain involves different stakeholders with their respective roles. The details of the actors involved and their roles are presented in Table 6 and the chickpea seed supply chain map is drawn in Fig. 3. The seed value chain has its own stages, which makes it unique to the grain value chain. The supply chain map includes supply chain functions, major actors, and an enabling environment. These functions include the supply of inputs, seed production, seed distribution, and chickpea marketing. In the chickpea seed system, the dominant actors are those service providers; hence, the formal seed system in Ethiopia is dominated by the public sector. Consistent with the results of this finding, Gaur *et al*. (2013) reported that the involvement of the private sector in self-pollinated legumes such as chickpea lacks incentives.

In the study area, informal and intermediary seed systems are operating in the chickpea seed supply chain. The majority of farmers use local saved seeds and only small portion of the respondents use the improved varieties of chickpea from cooperatives (intermediaries).

Table 6: Summary of actors and their function

Stages	Actors	Functions
Germplasm Acquisition and Quarantine	EBI	Collects and conserves genetic resources of chickpea.
	EIAR	Identifies and selects productive traits of chickpea.
	MoA	Organize & facilitate overall activities of stakeholder.
	Ethiopian Standards	Controls and assures the quality of germplasm from any bad traits
	ICARDA & ICRISAT	Supplies the required type of germplasm
Variety Development, Release and promotion	DZARC	Develop, Release and Promote to different varieties
	ICARDA & ICRISAT	Provide technical and financial support
	GARC	Adapt released varieties to different agro-ecologies, arrange and provide training for farmers and DAs, promote adaptable varieties in different mandate areas.
	Kebele Development Agents	Facilitate selection of areas and farmers, supervise activities, and coordinate field days.
	Woreda office of Agriculture	Facilitate selection of areas and farmers for promotion, coordinate field days.
	Farmers	Providing land; successfully implement the recommendations of researchers.
Seed multiplication and processing	GARC	Providing training for farmers and DAs, selecting appropriate sites, supplying seed and other required inputs, monitoring and inspecting the status of the field.
	Tsehay multipurpose farmers' cooperatives union	Providing training for farmers and DAs, selecting appropriate sites, supplying seed and other required inputs, monitoring and inspecting the status of the field.
	University of Gondar	Providing training for farmers and DAs.
	Farmers	Preparing fields properly and producing seeds.
	Development Agents	Facilitating the selection of farmers and fields, monitoring and inspecting the field.
	Tana seed multiplying cooperative	Keeping the cooperative members functional, supervising and coordinating seed production activities of members.
Seed quality control & certification	Tsehay union	Control the quality of seed by using internal quality control methods, certifying the seed by.
	Quality control Authority	Controlling the quality of seed by field inspection and through laboratory.
	Development Agents	Supervising the field continuously.
Seed marketing	Tsehay union	Buying the seed from farmers, distributing the seed collected for others
	Farmers	Selling the seed produced for cooperatives and individual farmers.
Seed utilization	Farmers	Utilizes the seed to produce chickpea
	Other organizations	Utilizes seed for demonstration and promotion of improved chickpea varieties.

Source: Summary of key informant interview, 2018

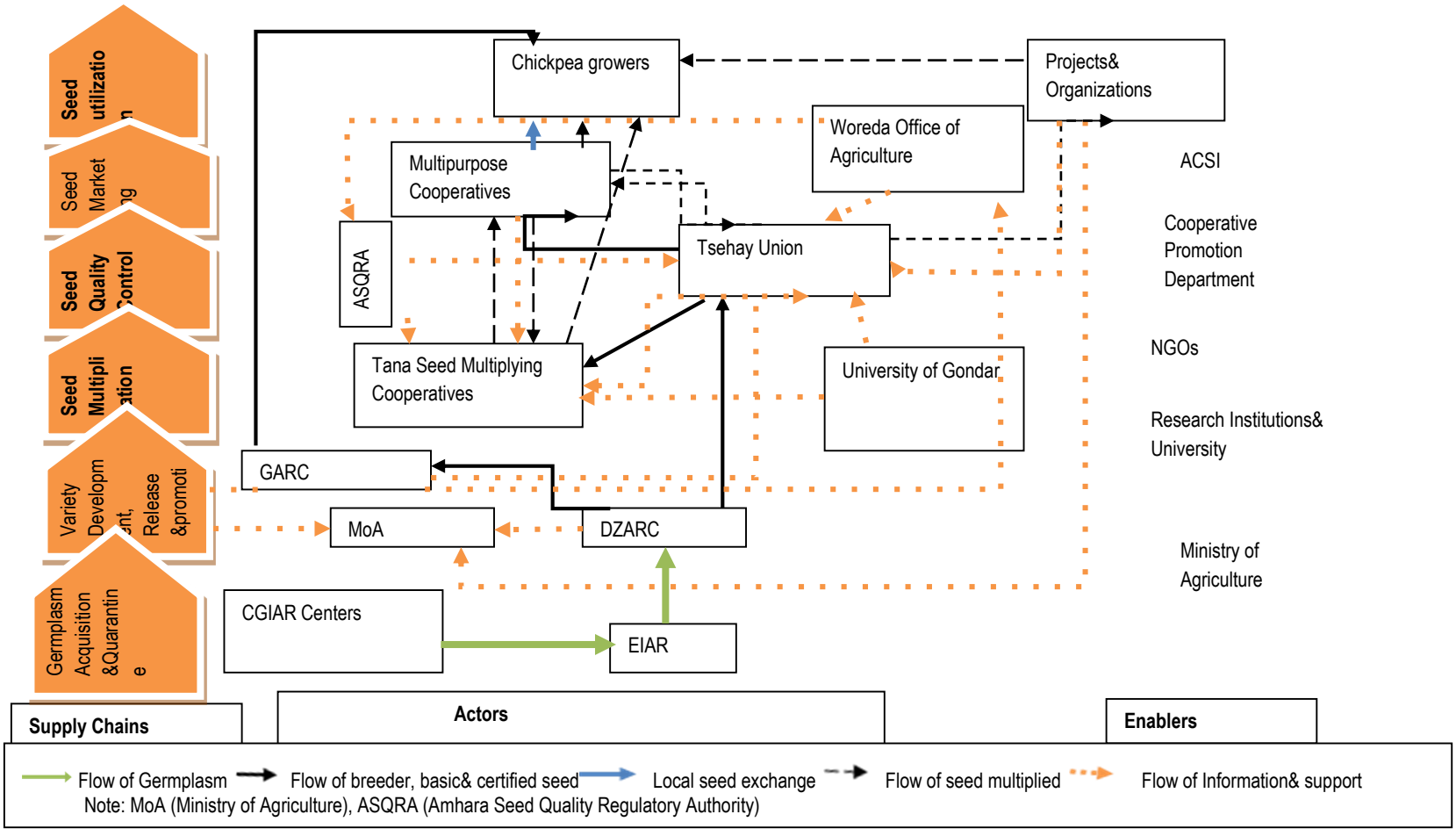

Figure 1: Supply chain map of chickpea seed system

Conclusion

Improved seeds play a significant role in increasing crop productivity. For this purpose, different stakeholders are involved in the chickpea seed system in the study area. Among others, the informal seed system is the dominant seed source for improved chickpea seeds in the study area. For access to improved seeds, the intermediary seed system has a significant role. However, accessing the breeder and pre-basic seeds is a bottleneck for adaptation and seed multiplication works for seed multiplying cooperatives and GARC. It can be concluded that the involvement of different public organizations contributes a lot to the access of improved seeds of chickpea for smallholder farmers. Therefore, governmental and non-governmental organizations should work strongly to build the capacity of seed producer cooperatives and clustered smallholder farmers. In addition, the government has to improve the supply mechanism of the breeder and pre-basic seeds to agricultural research centers and seed producer cooperatives. In line with this, the government should build the capacity of existing breeders at GARC to release locally adaptable improved chickpea varieties.

Acknowledgements

We would like to thank Wollo University and ISSD (Integrated Seed Sector Development) Ethiopia for funding the necessary budget for data collection. Our gratitude also goes to the Gondar Zuria Woreda Office of Agriculture for giving us necessary information about the study area and for their unlimited support by providing informed consent. We also thank data collectors for their unreserved efforts for the successful completion of collection activities. We are also indebted to Dr. Amogne Asfaw for his professional contribution in sketching the updated map of the study area. Moreover, the authors would like to acknowledge all other concerned bodies that have shared their support for the successful development and completion of this study.

Reference

Dawit Alemu. 2011. *Farmer-based seed multiplication in the Ethiopian seed system: Approaches, Priorities and performance*.

Dawit Alemu and Zewdie Bishaw. 2019. Yield gaps, adoption and seed commercial behavior: Implications for chickpea seed system in Ethiopia. *African Journal of Agricultural Research*, *14*(33), 1778–1784. https://doi.org/10.5897/ajar2019.14307

Asfaw S, Shiferaw B, Simtowe F, and Hagos M. 2011. Agricultural technology adoption , seed access constraints and commercialization in Ethiopia. *Journal of Development and Agricultural Economics*, *3*(9), 436–447.

Abebe Atilaw. 2010. *Baseline survey on the Ethiopian seed sector: submitted to the African Trade Association*.

Mulugeta Atnaf, Tesfaye K, and Dagne K. 2015. The Importance of Legumes in the Ethiopian Farming System and Overall Economy: An Overview. *American Journal of Experimental*

Agriculture, *7*(6), 347–358. https://doi.org/10.9734/AJEA/2015/11253

Audet-Bélanger G, De Boef W, Gildemacher P, Heemskerk W, Subedi A, and Thijssen MH. 2013. *Seed Value Chain Analysis: Integrated Seed Sector Development (ISSD) Technical Notes Issue no 3; Center for Development Innovation Wageningen UR, Wageningen & Royal Tropical Institute* (No. 3).

Ayana A and Dawit Alemu . 2019. Rice Seed System in Ethiopia. In T. Tadesse, M. Atnaf, D. Alemu, T. Tadesse & K. Shiratori (Eds.), *Advances in Rice Research and Development in Ethiopia*. Ethiopian Institute of Agricultural Research.

Belete T, Mekbib F and Eshete M. 2017. Assessment of Genetic Improvement in Grain Yield Potential and Related Traits of Kabuli Type Chickpea (Cicer arietinum L .) Varieties in Ethiopia. *Advances in Crop Science and Technology*, *5*(3). https://doi.org/10.4172/2329-8863.1000284

Beyene S, Worku Z, Abate B, Lirie E, Bahiru T, and Taran B. 2014. *Promoting Adoption of Chickpea production Technologies; Final Technical Report* (Issue 107540/001).

Burman RR, Singh SK, and Singh AK. 2010. Gap in Adoption of improved Pulse Production Technologies in Uttar Pradesh. *Indian Res. J. Ext. Edu.*, *10*(1), 99–104.

Chichaybelu M, Geleta T, Girma, N, Fikre A, Eshete M and Ojeiwo CO. 2018. Innovative Partnership in Chickpea Seed Production and Technology Dissemination: a Decade of Lessons in Ethiopia. *Ethiopian Journal of Crop Science*, *6*(2), 1–18.

Considine MJ, Siddique KHM, and Foyer CH. 2017. Nature ' s pulse power : legumes , food security and climate change. *Journal of Experimental Botany*, *68*(8), 1815–1818. https://doi.org/10.1093/jxb/erx099

CSA. 2013. *The Federal Democratic Republic of Ethiopia; Report on Area and Production of Major Crops, Agricultural Sample Survey (Private peasant housholdings, Meher Season) in 2012/2013, Central Statistical Agency (CSA): Vol. I*.

CSA. 2018. *The Federal Democratic Republic of Ethiopia; Report on Area and Production of Major Crops, Agricultural Sample Survey (Private peasant housholdings, Meher Season) in 2017/2018, Central Statistical Agency (CSA): Vol. I*.

EIAR. 2020. *Status of Seed Quality Control and Assurance in Ethiopia: Required Measures for Improved Performance*. Ethiopian Institute of Agricultural Research (EIAR). https://doi.org/10.13140/RG.2.2.34415.87202

Eshete M, Aliye S, Fikre A, and Ojiewo CO. 2013. Community Seed Production of Chickpea (Cicer arietinum L.) and Lentil (Lens culinaris Medic) in Ethiopia. *Community Seed Production. Workshop Proceedings, 9-11 December 2013. FAO, Rome & ICRISAT, Addis Ababa.*, 80–87.

Fikre A, Bekele Dagnachew, Tilahun G, Korbu L, Chichaymelu M, Eshete M, Morryo E, and Rao N. 2016. *Success of chickpea production in North Gonder zone of Ethiopia*.

Fikre A and Eshete M. 2014. *Guide for chickpea (Cicar arietinum L.) production in Southern Nations, Nationalities and Peoples' region of Ethiopia*.

Fikre A, Keneni G, and Eshete M. 2016. Reflection on high land pulses improvement research in Ethiopia: past achievements and future directions. In G. Alemaw & G. Asefa (Eds.), *EIAR anniversary, "50 years of service for Ethiopian institute of agricultural research*. Ethiopian Journal of Agricultural Sciences.

Fikre A, Korbu L, Eshete M, and Aliye S. 2012. *Integrated systems in chickpea and lentil seed multiplication, delivery and impact*.

Gaur PM, CLL G, Morryo ES, Rao N, Silim SN, and Simtowe F. 2013. *Enhancing Chickpea Productivity and Production in Eastern and Southern Africa*.

GZWoA. 2012. *Basic Information of the Woreda (Unpublished); Gondar Zuria Woreda Office of Agriculture*.

ISSD Africa. 2013. *Ethiopian seed entrepreneurship assessment: ISSD Briefing note; Center for Development Innovation of Wageningen University and Research center*.

Mazid A, Shideed K, El-Abdullah M, Zyadeh G and Moustafa J. 2013. Impact of Crop Improvement Research on Farmers' Livelihoods: The case of Winter-Sown Chickpea in Syria. *Expl Agric.*, *49*(3), 336–351. https://doi.org/10.1017/S0014479712001342

MoA and ATA. 2017. *Seed System Development Strategy for Ethiopia: Vision, systemic challenges and prioritized interventions, working strategy document, Addis Ababa Ethiopia*.

Mulugeta W, Nigussie DN, Molla A, Bishaw Z, and Biradar C. 2021. Suitability Analysis for Scaling Chickpea Improved Varieties in Ethiopia. *Research Square*. https://doi.org/10.21203/rs.3.rs-494305/v1

Shari P, Astereki H, and Pouresmael M. 2018. Evaluation of variations in chickpea (Cicer arietinum L .) yield and yield components by multivariate technique. *Annals of Agrarian Science Journal*, *16*, 136–142. https://doi.org/10.1016/j.aasci.2018.02.003

Sisay DT, Verhees FJHM, and van Trijp HCM. 2017. Seed producer cooperatives in the Ethiopian seed sector and their role in seed supply improvement: A review. *Journal of Crop Improvement*, *31*(3), 323–355. https://doi.org/10.1080/15427528.2017.1303800

Tegegne Y.2017. *Factors Affecting Adoption of Legume Technologies and its Impact on Income of Farmers: The Case of Sinana and Ginir Woredas of Bale Zone* (Issue November). Haramaya University.

Verkaart S, Mausch K, Claessens L, and Giller KE. 2019. A recipe for success? Learning from the rapid adoption of improved chickpea varieties in Ethiopia. *International Journal of Agricultural Sustainability*, *17*(1), 34–48. https://doi.org/10.1080/14735903.2018.1559007

Warner J, Stehulak T, and Kas L. 2015. *Woreda -Level Crop Production Rankings in Ethiopia : A Pooled Data Approach*.

WCDI. 2020. *Local seed business management: Training manual on Seed Producer Cooperatives (SPCs), Module: Seed quality control and assurance; Commissioned by the programme on Integrated Seed Sector Development in Ethiopia (ISSD Ethiopia). Wageningen Center for Develo*. https://doi.org/10.18174/536875.

Yamane T. 1967. Statistics; an Introductory Analysis. In A Harper International Edition (Ed.), *Journal of the American Statistical Association* (2nd ed., Vol. 60, Issue 310). Harper & Row, and John Weatherhill. https://doi.org/10.2307/2282703.