Innovative Partnership in Chickpea Seed Production and Technology Dissemination: a Decade of Lessons in Ethiopia

Mekasha Chichaybelu[1], Tesfaye Geleta[1], Nigusie Girma[1], Asnake Fikre[2], Million Eshete[1], and Chris O. Ojeiwo[3]

[1]Ethiopian Institute of Agricultural Research, Debre Zeit Agricultural Research Center, E-mail: chichemekasha@gmail.com

[2]International Crops Research Institute for the Semi-Arid Tropics (ICRISAT-Ethiopia)

[3]International Crops Research Institute for the Semi-Arid Tropics (ICRISAT-Kenya)

Abstract

Innovative partnership in chickpea seed production and technology dissemination was assessed in increasing chickpea productivity through facilitated access to quality seed. The study was designed to evaluate the benefits gained from partnership implemented for the last 10 years in chickpea technology by seed system of crop production. Farmers' participatory variety selection (FPVS)' has been implemented as epicenter of the new innovation. The varieties selected by the farmers were ultimately demonstrated and visited by large number of farmers and other stakeholders. This was complemented with the establishment and technical backstopping of farmers' seed producer associations to produce and market quality seed to fill the gap by the formal sector. Intervention with chickpea technologies were initiated right after training partners in chickpea seed and grain vale chain. From 2008 to 2015, over 350 FPVS trials were conducted concurrently with demonstrations. The farmers' seed producer associations cover the lion's share of the seed supply and became an innovative approach that enhanced the chickpea seed system. The production of certified and quality declared seed increased from 632.7t in 2008 to 3290 tons in 2014. The drastic increase in productivity and production of chickpea during the intervention period were largely attributed to the interventions made. The national chickpea productivity has doubled in a decade's time (2006-2015) and attained peak of 1.9ton ha^{-1} in 2014. Similarly production showed drastic increase during the intervention period where the production in 2015 was 124% more compared to the production in 2006. Lessons were driven from the approach that many development parties and the government policy recognized the approach as key player for enhancing the chickpea sector.

Keywords: Chickpea, demonstration, participatory variety selection, seed, technology

Introduction

Ethiopian agriculture accounts for 85 percent of employment (Dercon *et al*., 2012; Spielman *et al*., 2010). The country's population of 92 million is expected to grow to 160 million by 2050 (Josephson *et al*., 2014). As a result, farm sizes would be rapidly declining, increasing the need for agricultural intensification (Headey *et al*., 2014). Accordingly, increasing the productivity of smallholders through improved technology has become a policy priority for development agencies and the Ethiopian government (Abebaw and Haile, 2013).

Chickpea (*Cicer arietinum* L.) is an important food legume in Ethiopia. The country is considered as a secondary center of genetic diversity for chickpea and the wild relative of cultivated chickpea, *Cicer cuneatum*, which is found in Tigray region of the country (Anbesa and Bejiga, 2002; Kanouni *et al*., 2011). Chickpea is largely grown in central, northern and northwest highlands of Ethiopia. According to FAOSTAT (2014), Ethiopia (3.2%) is among the chickpea producing countries of the world next to India (69%), Australia (5.7%), and Pakistan (5.3%) and Myanmar (3.4%). In 2015/16, the total area covered by chickpea is about 0.26 million hectares, with a total production of 0.47 million ton and productivity of 1.83 tons ha^{-1} (CSA, 2016).

Increasing the productivity and production of pulse crops in general and chickpea in particular is critical to satisfy the national demand for increased food and nutrition security. The national chickpea improvement program has made significant research to increase the productivity and released 27 improved varieties since 1974 at both federal and regional levels (MoANR, 2015). The yield advantage of improved chickpea varieties is up to four folds more than farmer's local varieties (Fikre, 2014). Some of these improved varieties meet local and export market standards owing to their quality. The adoption of improved varieties and technologies found high in recent years, which led to an increase in the productivity and production (Fikre, 2014). This might be attributed to the confidence and adoption by the farmers improved chickpea technologies as a result of their participation in selecting technologies of their preference at the early stage of the popularization.

The wide scale adoption of chickpea technologies in Ethiopia created huge demand for seeds of improved varieties, as obviously we have seen significant imbalance between demand and supply annually. In the present condition, if one calculates the ideal seed demand on area basis of 258 000ha it is about 27.7 thousand tones, however, with the assumption that Ethiopia being center of secondary diversity for the crop, it appear convincing to keep some 25% of production for land races /traditional

cultivars/ to keep the diversity mainstreamed. Hence, with 75% coverage it is about 20.8 thousand tones; and if we further divide this in to four cycle of replacement, then it would be like 5 thousand tons. This being the case, on the contrary, the annual approximate chickpea seed supply does not surpass 2 to 3 thousand tons, a half below the demand. This could highly be attributed to low interest of the few formal public seed enterprises and private seed companies to produce seed of pulse crops (Atilaw and Korbu, 2016) but rather are predominantly engaged in production of seed of wheat, tef, barely and hybrid maize (IFPRI, 2010). Bishaw *et al.* (2008) reported that the formal sector supplies about 2% seed requirements of the major cool season food legumes such as chickpea.

Unlike the commercialized hybrids, the informal seed sector is the major player of the seed system in chickpea (Fikre *et al*, 2012). Cognizant of these facts, development of reliable and sustainable seed multiplication and supply system was found to be critical, particularly for crops where the private sector interest is weak. Therefore, efforts were made to tackle this bottleneck in a pluralistic approach where community based seed production was considered as alternative approach by the tropical legumes (TL) project and found to be effective in addressing the shortage of seeds of improved chickpea varieties.

Hence to enhance the uptake of improved chickpea technologies the research and development interventions have generally aimed at (1) equipping the farmers with knowledge of improved chickpea grain and seed production technologies, (2) building farmers' confidence on improved technologies through participatory variety selection, (3) wide scale demonstration of varieties selected by farmers and (4) improving availability of improved seed through community based seed production. This study, therefore, provides highlights of the innovative approaches followed in the Ethiopian chickpea as enhancer of change for seed multiplication and dissemination of improved chickpea technologies.

Methodology

Interventions on multiplication and dissemination of improved chickpea technologies have been made in the main rainy seasons since 2007. Over 67 districts in 18 zones of the four major chickpea growing regions; namely, the Oromia, Amhara, Southern Nations Nationalities and Peoples' (SNNP) and Tigray regional states of Ethiopia were covered (Figure 1). To address chickpea farmers in these regions, interventions were made by eight regional and federal agricultural research centers in collaboration with zonal and district agricultural offices under the coordination of Debre Zeit Agricultural Research Center hosting the Tropical Legumes (TL I, II and III) project.

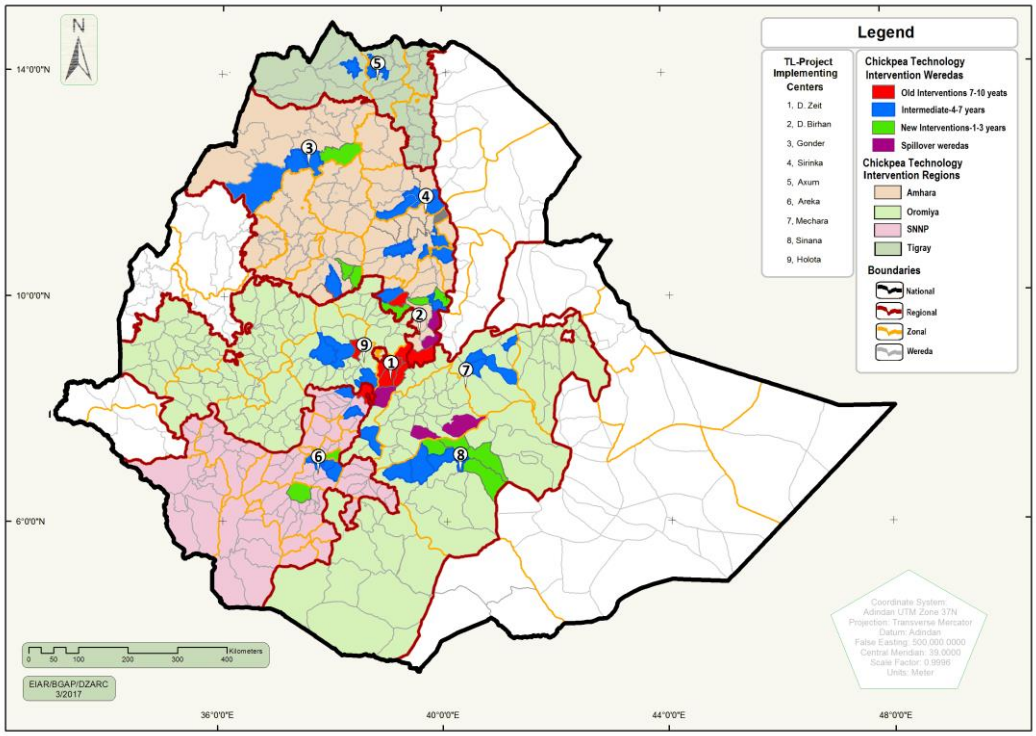

Figure 1. Chickpea technology intervention districts under the TL III project in Ethiopia

The assessment was derived from the decadal interventions experience through participatory variety selection followed by demonstration and seed business incubation. Perceptions reflected by implementing farmers and domain community have been synthesized in the discussion. The approach has segments of technology adaptation and seed incubation as feeding system of sustainable wide scope technology scaling. Hence, as approach, segments of key points, which are integral components, were elaborated.

Capacity and Partnership Building

Interventions in technology popularization and improving chickpea seed system has been started with building the right attitude of actors. This mainly was about awareness creation and technical training that subsequently subordinate to commended input. The trainings on principles and techniques of chickpea grain and seed production were given directly to farmers and seed producers as well as development agents and agricultural experts who further train other farmers.

To catalyze the uptake of improved technologies, an innovative platform of relevant stakeholders has been established. The multitasked platform provided support in identifying technology demanded, assessing product specialty options, updating market signals, evaluation of

interventions and feedbacks. The national and regional chickpea stakeholders' innovation platform met annually and share responsibilities on actions to be taken in improving technology multiplication and dissemination.

Farmers' Participation in Variety Selection

Farmers' participatory variety selection (FPVS) (Cherinet and Tazebachew, 2014) approach has been used by the Tropical Legumes project to build farmers' confidence on improved chickpea technologies (Mekasha *et al*., 2016; Mekasha *et al*., 2017). Farmers implementing FPVS trials were selected by development agents and trained on chickpea production and trial management. The trials were composed of a set of 6-8 improved varieties that could vary with locations. A local variety commonly grown in the area was included as a check. The trails are planted on 10 m x 10 m plots in three replications. The selected farmers grew and managed the trials under close supervision of researchers and development experts. The trials were then evaluated at the vegetative and maturity stage by groups of 10-15 farmers using their own criteria related to yield and yield components. Based on the ratings of the criteria, varieties of their preference were identified for further popularization.

Demonstration of Identified Technology

Based on the above premises, the varieties selected through FPVS were demonstrated on a quarter of a hectare (Kebebew *et al*, 2011). The demonstration plots were designed for wider visits to grab the attention of farmers located in proximity to roads, meeting places, administration, villages, etc. The demonstrations were handled with recommended management practices under close supervision of researchers and agricultural development experts.

The demonstration plots were visited by large number of farmers invited from adjacent villages on formally organized field days, in addition to the small group visits frequently initiated by development agents. The farmers, who implemented the demonstrations and/or earlier participated in FPVSs share their observations and experiences on the technologies. Briefings were also given by researchers on the merits of the technologies such as better yield, quality and disease resistance and major management practice to create awareness to the visiting farmers. Discussions were made on these occasions where queries raised were entertained by researchers, development experts and farmers. Finally, the interest of the farmers on the demonstrated technologies was considered for scaling up decisions.

Decentralized Seed Production and Sourcing

In order to satisfy the demand for seeds of improved varieties, the informal seed system was strengthened

through establishment and technical backstopping of farmers' seed producer associations. The seed producers often were farmers who are organized and with better technical skill to undertake seed production. Such a decentralized seed sourcing (DSS) approach was based on premises of access by geography, volume and low transaction cost and affordability.

Data Analysis

Data on FPVS trials and demonstrations were used to express interventions made and data from FAOSTAT and the Ethiopian central statistical agency (CSA) were used to assess impacts of the interventions. Non-parametric statistics was applied to elaborate progresses, differences and inferences. Simple regression equations were generated using Excel software to assess trends over years.

Results and Discussion

Building the Right Aptitude for Technology Promotion

The first step of intervention was meant to start from the basics and move to the innovative concept. Lead and elite, risk-taker farmers are assumed to be critical community groups to start with. Intervention in chickpea development started with awareness creation and inclusive training in building the technical capacity enhancing the seed system and dissemination of improved technologies. Between 2006 and 2016, technical trainings on management of improved chickpea technologies were delivered to over 3,000 agricultural experts and development agents as training of trainers, who further trained over 14,500 farmers. Actors engaged in the seed system were equipped with knowledge and skills in seed production. Table 1 summarizes the number of trained manpower from 2006 to 2016.

Table 1. Numbers of different stakeholders trained on chickpea technology

Year	Number of trainees						
	Researchers and technicians	Agricultural experts and development agents	Farmers	Farmers' Cooperative unions	Community Seed producers	Others	Total
2006	30	155	250	5	-	35	475
2007	50	210	470	10	2	63	805
2008	57	243	603	15	6	79	1,003
2009	72	399	934	28	10	153	1,596
2010	85	463	1,785	20	12	263	2,628
2011	100	563	2,175	13	13	200	3,064
2012	78	475	2,000	12	14	185	2,764
2013	81	402	3,024	13	12	215	3,747
2014	45	89	1,321	-	-	3	1,458
2015	-	135	964	-	-	-	1,099
2016	-	36	1,328	-	-	5	1,369
Total	598	3,170	14,854	116	69	1,201	20,008

Evaluating the impact of the training, overall perception changes towards improved technology was created effectively, like from nearly zero to as high as three to four folds. Because some two decades back, chickpea technology was applied by research to farmers' fields and rejection of the technology was very common; while in a decade and half down the line, farmers load technologies from research sources with big ambition. Another indicator of change is that more than 10 seed associations have been able to sale their seed with premium, showing perception towards improved technology is growing well.

Seed producer farmer practiced the knowledge they acquired and managed to produce quality seed and became major suppliers to bridge the gap. This is in agreement with the report by Atilaw and Korbu (2016) that states the informal sector remains the dominant and almost the sole supplier of improved chickpea seeds. Livelihood changes are evident with some well adapted farmers and they have been featured as story tellers.

Farmers' Confidence on Improved Technologies Hastened their Promotion

Most farmers are often reluctant of new things to test at their own risk. Hence, it has been customary to just start from simple to complex and small to big. In 2008/09, farmers' participatory variety selection (FPVS) approach was started in three districts, namely; Gimbichu, Lume and Minjar-Shenkora, by Debre Zeit Agricultural Research Center with the support of TL projects. A lot of lessons were driven to improve the approach for more effect. Since then the scope of intervention has expanded and covered over 67 districts in 18 zones of the major chickpea growing regions; namely, Oromia, Amhara, Southern Nations, Nationalities and Peoples' (SNNP) and Tigray regional states (Figure 1). This rapid progress was

made possible by progressive inclusion of eight research centers that collaborated in implementing the project in major chickpea producing areas and integrated efforts of various institutions related to the chickpea development that resulted in increased awareness of farmers' perception of improved varieties.

In this approach, farmers (male and female) from the respective locations had evaluated the varieties in the FPVS trials in groups of 10 to 15 individuals at the vegetative stages and maturity by setting their own selection criteria. The common criteria used by the farmers for selection of varieties of their preference were plant height, plant stand, branching habit, disease resistance, earliness, yield, pod number, seed size and seed color. From 2008/09 to 2016/17 over 350 FPVS were conducted where 16 improved chickpea varieties were evaluated under different agro ecologies over years (Figure 2). Among these 14 improved varieties were selected by the farmers in various localities for wider scale production and dissemination.

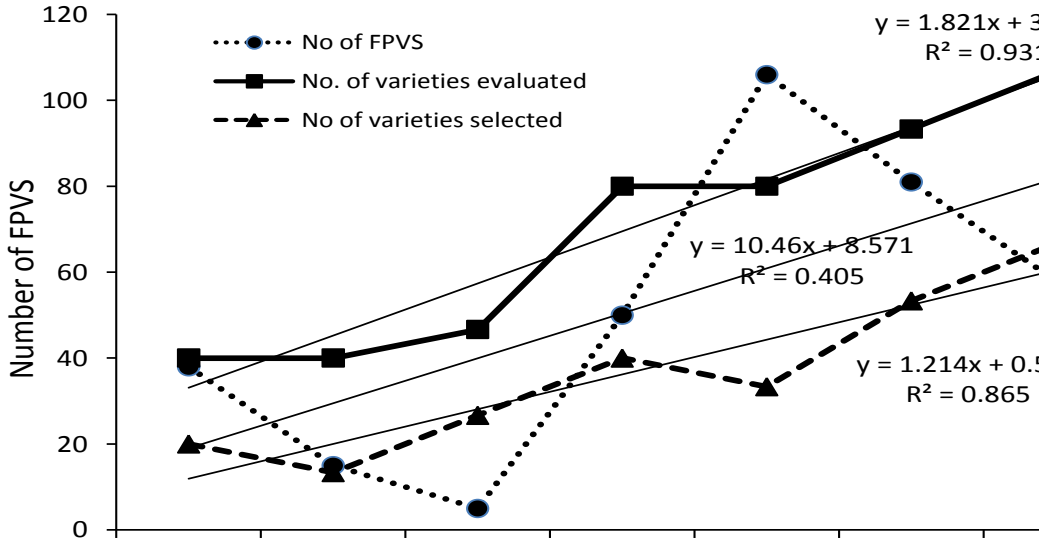

Figure 2. Chickpea varieties evaluated and selected by farmers' participatory variety selection (FPVS) in Ethiopia

Technology development for boosting agricultural productivity is worth investments, if and only if, it reaches the farmers and changes their livelihoods. A collaborative arrangement that brings together several organizations working towards technical and social change or organizations that are involved in generating, diffusing and adapting new knowledge in agriculture is a way out to improve and build the capacity of the conventional extension system (Aliy, 2016). Different platforms were used at different times to enhance research-

extension-farmer linkages. Earlier efforts made to popularize improved chickpea technologies through demonstration helped in promote the technologies to the farmers with some limitations in acceptance and adoption. Aliy (2016) suggested that a paradigm shift is needed to employ farmers' participatory research approach, that relies on farmers' experimentation and farmers' interaction with important market opinion and backstopping. The briefings made on group and field day visits by the farmers involved in FPVS and demonstration built confidence of the large group of farmers on the technologies. It is natural that farmers can easily learn from their fellow farmers other than any one else. Therefore, such participatory technology popularization approach was used as smooth awareness creation and learning ground that created significant demand by the farmers. Knowledge empowerment of farmers through electronic and print media, organizing field days, farmers' fairs, and conducting training programs, demonstrations, and farmer-participatory varietal selection trials (FPVS) will help strengthen the local seed systems and enhance the adaption of new improved cultivars (Laxmipathi *et al*, 2016). As a result of this approach recent interventions enhanced technology dissemination and fastened their uptake, as the varieties demonstrated are those selected by the farmers' participation.

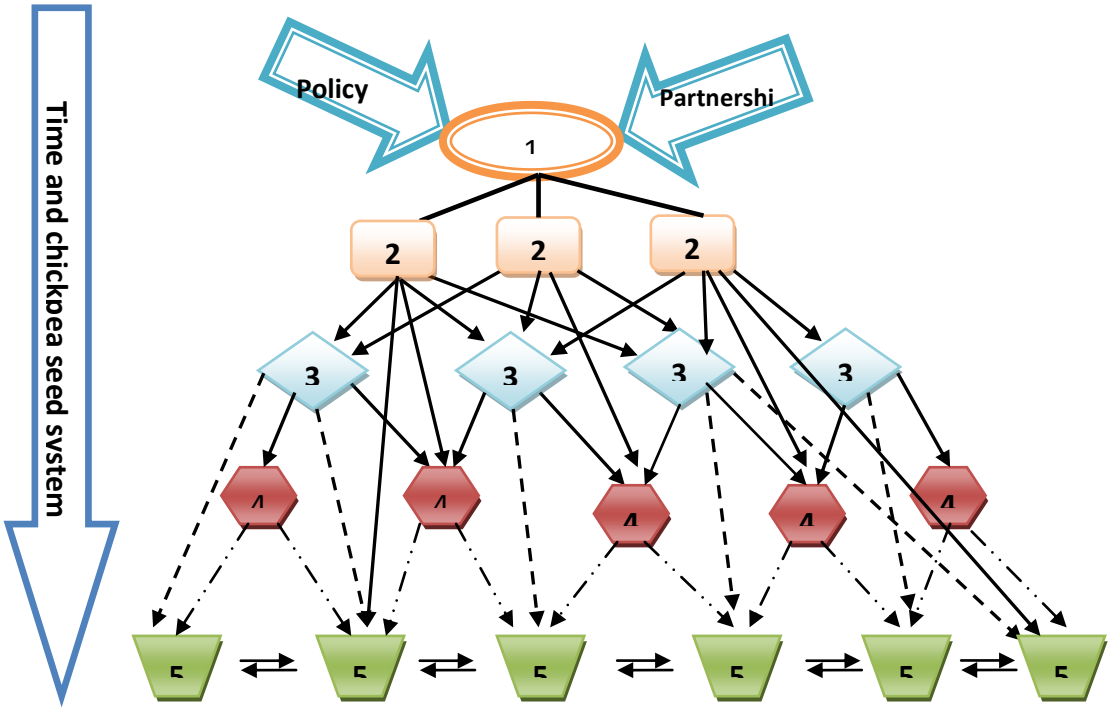

Figure 3. Schematic representation of the current chickpea seed system in Ethiopia

1 = National improvement program, 2 = Research Centers, 3 = Public seed enterprises, 4 = CBOs (Unions, Farmers' seed producer associations), 5 = Private seed producers, 6 = Farmers

→ = EGS, - - → = Certified, —·· → = QDs, ⇄ = Farmer to farmer seed exchange

Chickpea Seed System Developmental Scheme in the Innovation

Describing the developments of the complex in the seed system, one can find out a narrative scheme as indicated in Figure 3. It is interesting that as in the technology adaptation there are interactivity in the seed system. This could mainly be due to its stage of development, from whole farmers based (own saved) to the community segments (intermediary) and heading to the destiny of private system.

Farmer to farmer seed exchange, either in kind or sales is believed to cover significant scale of the seed transaction. Atilaw and Korbu (2016) reported that self-saved or farmer to farmer seed exchange, accounting for over 95% of the seed used by smallholder farmers, is playing indispensable role in the supply and expansion of chickpea technologies.

The intermediate sector obtains basic seed either from the research system or the public seed enterprises and sells the quality seed produced to farmers for grain production. Due to technical support from the research and agricultural development system their capacity of the intermediate sector has been progressively built. As a result, seed laboratories under the Ministry of Agriculture have recently started evaluating the status of community seed producers and provide them with competency certificate in recognition of their capacity to produce certified seed, taking their infrastructural, financial and technical capacity into consideration. We can witness among the 18 seed organizations established during the decade, some 75 have got evaluation and pass through certificate of competence for their produce. There are also few seed organizations who try to promote to private limited. There are partner institutions and projects who were parts of the success in the due course

The formal seed sector in general is not a major supplier, as far as pulse crops are concerned. They devote much effort in the production of cereals primarily hybrid maize and wheat and less on legume seed (Bishaw et al., 2008; Aliy, 2016; Emmanuel *et al.,* 2016). According to Bishaw *et al.* (2008) the formal sector supplies about 2% seed requirements of the major cool season food legumes such as chickpea taking into account the area under production and the seed supply from the public or private sector. Emmanuel *et al.* (2016) reported TL-II baseline studies in Ethiopia, Malawi and Tanzania indicated that there was very limited awareness about improved legume varieties, and that neither public- nor private-sector interventions to produce and market legume seeds had a successful track record in these countries.

Even though the contribution of the formal sector is not significant, the public seed enterprises (Figure 3)

obtain early generation seed from the research and produce pre basic, basic and certified seed of chickpea. They sell basic seed to private seed companies and community based organizations such as farmer seed producer association and unions to produce certified seed which is marketed to chickpea farmers.

The birth of Intermediate Seed Sectors and its Impact

The participatory popularization efforts resulted in a growing demand for improved technologies as discussed above. This demand, however, could not be satisfied because the formal legume seed system in general and chickpea is weak. This led to the birth of innovative seed system, called community based seed production (CBSP) synonym with farmers seed producer association, in filling the critical gaps.

The chickpea improvement program, with the support of the TL projects, worked on development of CBSP system by encouraging active farmers to engage in seed production. These farmers were rendered with special support by building their knowledge on basic techniques of seed production, providing technical supports and early generation starter seed. This resulted in gradual establishment of 20 legal farmers' seed producer associations to date (Table 2). The associations became strong covering the major share of chickpea seed supply and became effective chickpea seed corridors of the country.

Table 2. Farmers' seed producer associations working on chickpea seed production

No	Name of Seed Producer Association (SPA)	Number of members		Location	
		Male	Female	Region/State	District
1	Hundaf Hate'u	74	6	Oromia	Ada'a
2	Megertu Denkaka	56	6	Oromia	Ada'a
3	Giche-garebabu Kolbe	66	8	Oromia	Ada'a
4	Ude	67	7	Oromia	Ada'a
5	Biftu	121	27	Oromia	Lume
6	Guchi	59	9	Oromia	Ada'a
7	Memihir Ager	53	3	Amhara	Minjar
8	Diquana	?	?	Amhara	West Belesa
9	Kalay	110	13	Amhara	West Belesa
10	Geta Amba	197	6	Amhara	Siyadebirna Wayu
11	Timret	167	6	Amhara	Siyadebirna Wayu
12	Tesefa	150	15	Amhara	Ensaro
13	Weyra Amba	46	3	Amhara	Moretina Jiru
14	Hawi Boru	137	23	Oromia	Chefe Donsa
15	Lemlem Chefe	113	13	Oromia	Chefe Donsa
16	Chala	55	2	Oromia	Lume
17	Utuba Jiregna	?	?	Oromia	Adaa
18	Gudina	100	8	Oromia	Lume
19	Burka	?	?	Oromia	Lume
20	Birbirsa	19	7	Oromia	Lume

This is in agreement with the report by Aliy (2016) that state that the huge gap as well as uneven access to scarcely available improved chickpea seed has created the development of an alternative and innovative seed production and delivery systems that responds to the immediate demand of the resource poor farmers. The author indicated that community-based seed production, which operates neither purely as commercial seed business nor as farmer managed ones, has been playing an important role in seed production and supply. Bishaw and Sushil (2016) also emphasized on the importance of mobilizing and engaging farmers in seed production and marketing and promoting farmer based smallscale enterprises due to the inefficiency of the formal sector in pulse crops seed production. For sustaining seed production, informal seed systems, community based as well as individual farmer based are instrumental to meet seed requirements and to disseminate new varieties (Laxmipathi *et al*, 2016).

Due to the innovative technology multiplication and dissemination approaches, chickpea seed production of various classes have increased considerably (Figure 4). Breeder seed production showed an increase of 113% over the 6 years (Figure 4a). It increased from 3.8 tons at the start of the project (2008) to 8.1 ton in 2014, which means an annual increment of 0.72 tons. On the other hand pre-basic and basic seed production showed 246% increment over the years with an average annual increment of 16.1 tons (Figure 4b). There has also been 420% increment in the production of certified and QDS seed in 2014 compared to that of 2008 (Figure 4c). The production of certified and QDS seed in 2014 (3290 t) was more than five- fold over that was produced at the start of the project (632.7t) in 2008.

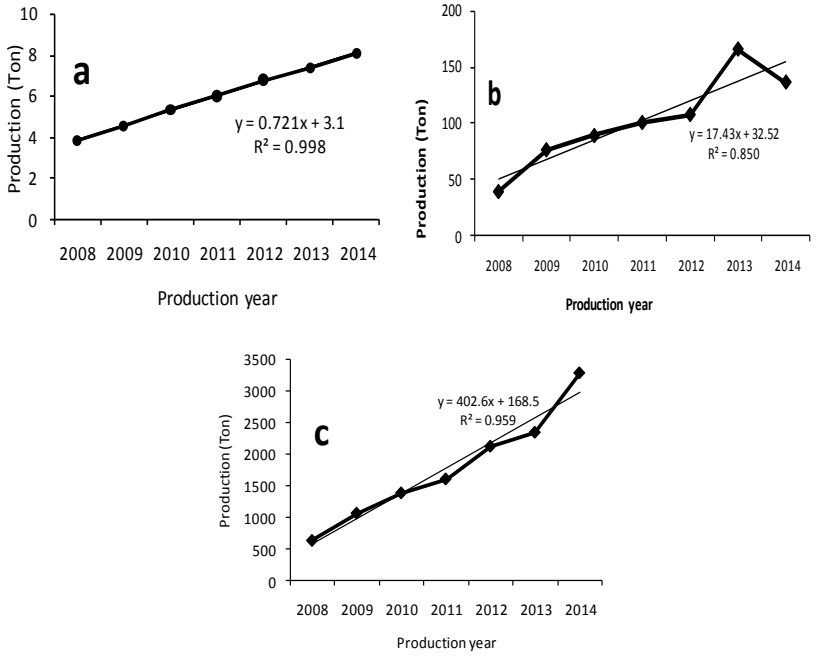

Figure 4. Chickpea seed production in Ethiopia (2008-15); (a) breeder seed, (b) pre-basic and basic seed and (c) certified/QDS seed.

Considering the area under chickpea, however, the amount of seed produced is far below the demand. For instance, the area under chickpea production in 2015/16 was 258,486.29 ha. To cover 75% of this area with improved varieties (leaving the 25% for landrace maintenance) 23,264 tons of seed is required at an average seeding rate of 0.12t/ha. Hence the highest amount of certified and QDS seed produced in 2014 (3290 t) was only 14% of the required amount. Much effort is, therefore, needed to strengthen the seed system to satisfy the demand for the development of the chickpea sector.

Impact of Research and Development Intervention

The national chickpea productivity and production data of the central statistical authority of Ethiopia shows low tonnage of chickpea production in the early years (Figure 5). Stimulated by the innovative interventions chickpea production increased drastically during the decade and attained 124% increase in 2015 over that of the production in 2006. The 96.5% yearly increment in chickpea production (R^2=0.965) in the period could be largely attributed to the significant improvement in the productivity (90.5% yearly) of the crop, without undermining the increment in the production area that had 78% annual increment. The national productivity of the crop was one ton per hectare in 2006. It nearly doubled in decade's time and attained

peak of 1.9 ton ha^{-1} in 2014, which is among the highest record globally. This significant improvement in the national productivity and production of chickpea was the result of the innovative intervention in the multiplication and dissemination of improved technologies. Asfaw *et al*. (2012) and Simone *et al* (2016) also reported that dramatic increase in improved chickpea adoption had a strong positive effect on household welfare.

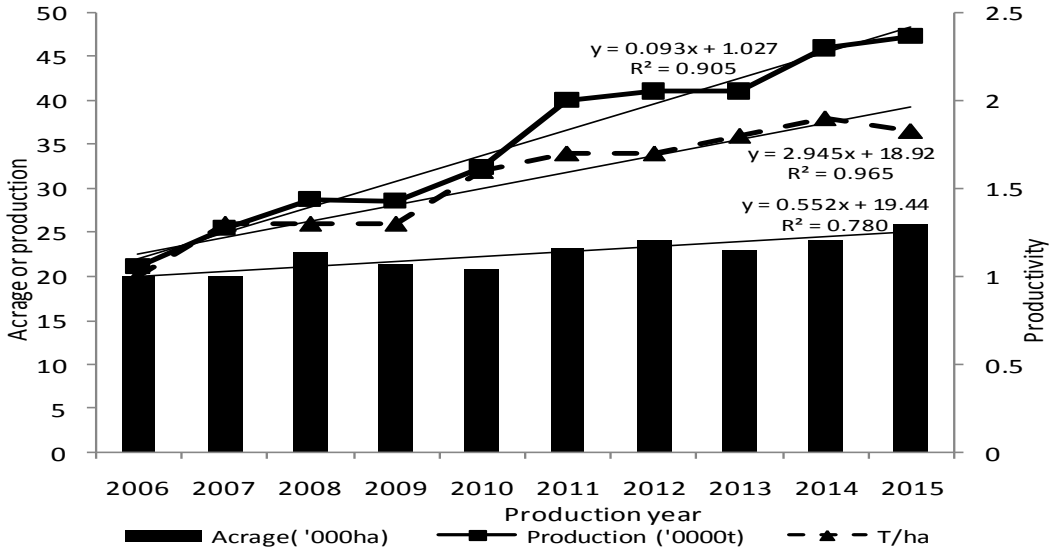

Figure 5. National area coverage, production and productivity of chickpea in Ethiopia (2006-2015). Source: Compiled from CSA (2006-2015).

By the end of the Growth and Transformation Plan of the country for chickpea productivity was set 3.9 tons per ha by 2012, hence there is too high to go looking the ambitious plan. The two pulling factors farmers would be encouraged with are: 1) productivity gain per unit area, which is comparable to some high input cereals, 2) market for seed and grain for chickpea which is among the highest. Chickpea production using improved varieties is profitable, as reported by Fikre (2014), that it fetches about USD 2,000 per hectare. The low production cost of the crop is among the contributing factors. This time around, in layman's estimate, chickpea grain price hit USD 3,600 per hectare (3,000 ETB/ha x 1.2 USD/kg). This could even be complimented to 15% seed premium values. The growing demand in both the domestic and export markets that provides a source of cash for smallholder producers as reported by Abera (2010) and Shiferaw and Teklewold (2007) would make chickpea production an important business.

Conclusions and Recommendation

Intervention in the development of chickpea sector started with awareness creation and training of relevant actors, as building their capacity helps in enhancing the seed system and dissemination of improved technologies. An innovative approach of farmers' participatory variety selection (FPVS) built confidence of farmers on new varieties and enhanced uptake of technologies in addition to the efforts on popularizations.

The legume seed system in general and of chickpea in particular has limited involvement of the formal seed sector. To overcome the chickpea seed shortage the Tropical Legumes project took an innovative approach of bringing CBSP or FSPA into picture. The program worked on development of CBSP system by encouraging active farmers to engage in seed production through building their technical capacity in seed production, providing advisory supports and starter seed that resulted in the establishment of 'seed producer associations' in the country. The associations got the strength of covering the lion's share of the chickpea seed supply and became an effective national seed corridor. Due to the innovative technology popularization and seed multiplication approaches chickpea seed production of various classes have increased considerably over years in response to the increasing demand. Currently few of the associations are engaged in certified seed production as a result of the recognition they got due to their improved infrastructural, financial and technical capacity. The increased availability of seed in turn resulted in the drastic increment in the national chickpea productivity and production and thereby income of the farmers.

In spite of the improvements made in increasing the availability of seed, the amount of certified and QDS seed being produced is still too low to satisfy the demand. Hence, much effort is needed to strengthen the seed system for the development of the chickpea sector. It is, therefore, critical to strengthen the informal seed system. To this effect, establishing more farmers' seed producer associations in other chickpea growing regions is necessary to avail seed in the vicinity of the farmers. More over the capacity of such association need to be built so that they would be able to produce quality seed that could be certified under the proper regulation system. Efforts should also be made in popularizing improved technologies to unaddressed potential chickpea production areas to boost the national production.

Acknowledgement

The authors are grateful to the Bill and Melinda Gate Foundation for supporting the chickpea improvement program through Tropical Legumes projects that made significant contribution to the R&D success.

References

Abebaw D., and Haile M.G. 2013. The impact of cooperatives on agricultural technology adoption: empirical evidence from Ethiopia. Food Policy 38: 82–91.

Abera H. 2010. Chickpea Production, Supply, Demand and Marketing Issues in Ethiopia. Ethiopia Commodity Exchange Authority, Addis Ababa.

Aliy S. 2016. Community-based seed system in chickpea: prospects and challenges. *In*: Lijalem K, Tebkew D, Asnake F (eds). Harnessing Chickpea Value Chain for Nutrition Security and Commercialization of Smallholder. 30th January – 1st February 2014. Debre Zeit, Ethiopia.

Anbesa Y and Bejiga B. 2002. Evaluation of Ethiopian chickpea landraces for tolerance to drought. Genetic Resources and Crop Evolution 49:557-564.

Assefa K, Fikre A, Alemu D and Teklewold A (eds). 2011. Mitigating crop technologies and seed gaps. EIAR, Addis Ababa, Ethiopia.

ATA (Agricultural Transformation Agency) (undated) Seed System Development Strategy, vision, systemic challenges, and prioritized interventions. Working strategy document. http://tasai.org.

Atilaw A and Korbu L. 2016. The chickpea seed system and marketing in Ethiopia: challenges and opportunities. *In*: Lijalem K. Tebkew D. Asnake F. (eds). Harnessing Chickpea Value Chain for Nutrition Security and Commercialization of Smallholder. 30th January – 1st February 2014. Debre Zeit, Ethiopia.

Bejiga G and. Yadeta A. 1996. Breeding chickpea for resistance to drought. *International symposium on pulse research*, April 2-6. New Delhi, India, pp. 145-146.

Bishaw Z., Sahlu Y and Semane B. 2008. The Status of Ethiopian Seed Industry. *In:* Thijssen MH, Bishaw Z., Beshir A and de Boef WS (eds.) Farmers, seeds and varieties: supporting informal seed supply in Ethiopia. Wageningen International, Wageningen, the Netherlands, pp.23-32.

Bishaw Z and Sushil P. 2016. Whither the Chickpea Seed System? *In*: Lijalem K. Tebkew D. Asnake F. (eds). Harnessing Chickpea Value Chain for Nutrition Security and Commercialization of Smallholder. 30th January 1 February 2014. Debre Zeit, Ethiopia.

Chichaybelu M., Eshete M., Korbu L., Mohammed R., Girma N., Bekele D., Fikre A., Ganga R., Chris O., Emmanuel M., Moses S., Pooran G. and Rajeev V.

2016. Overview of Tropical Legumes Projects (TL I, TL II, TL III) - the Chickpea Scenario in Ethiopia. Poster presented on the Pan African Grain Legume and World Cowpea conference. 28 February-4 March 2016. Livingston, Zambia.

Chichaybelu M., Eshete M., Korbu L., Mohammed R., Girma N., Bekele D., Geleta T., A., Ganga R., Chris O., Emmanuel M., Pooran G. and Rajeev V. 2017. Advances in Chickpea Crop Improvement for Improved Productivity and Resilient Cropping Systems in Ethiopia. Poster presented on the InterDrought V conference on 21-25 February, 2017. Hydrabad International Convention Center (HICC), Hydrabad, India.

CSA (Central Statistical Agency), 2006-2015. Agricultural sample survey, Report on area and production of crops, Private peasant holdings, Meher season.

MoANR, 2015. Crop variety registration book. Addis Ababa, Ethiopia.

Dercon S, Hoddinott J and Woldehanna T. 2012. Growth and chronic poverty: evidence from rural communities in Ethiopia. Journal of Development Studies 48: 238–253.

Emmanuel S. Monyo, NVPR Ganga Rao, C Ojiewo, F Simtowe, JC Rubyogo, RK Varshney and CLL Gowda. 2016. The Seed Constraint: New approaches for smallholder agriculture in eastern and southern Africa. *In*: Lijalem K. Tebkew D. Asnake F. (eds). Harnessing Chickpea Value Chain for Nutrition Security and Commercialization of Smallholder. 30th January – 1st February 2014. Debre Zeit, Ethiopia.

FAOSTAT. 1995-2015. Food and Agricultural data. http://www.fao.org/faostat/en/#data/CC.

Fikre A., Wakjira A., Mekbib F., Gebeyehu S. 2012. The Informal Seed System in Ethiopia: Practices and Development. In Adefris T/Wold, Asnake F, Dawit A, Lemma D, Abebe K (eds), A moment in Ethiopian seed system. (2012). PP 237-252.

Fikre A. 2014. An overview of chickpea improvement research program in Ethiopia. The Journal of the International Legume Society. Issue 3.

Headey D, Dereje M, Taffesse A. 2014. Land constraints and agricultural intensification in Ethiopia: a village-level analysis of high-potential areas. Food Policy 48: 129–141.

IFPRI (International Food Policy Research Institute). 2010. Seed system potential in Ethiopia: Constraints and opportunities for enhancing the seed sector.

Josephson A. L, Ricker-Gilbert J, Florax R.J.G.M. 2014. How

does population density influence agricultural intensification and productivity? Evidence from Ethiopia. Food Policy 48: 142–152.

Kanouni H, Taleei A. and Okhovat M. 2011. Aschchyta blight (*Ascochyta rabiei* (Pass.) Lab.) of Chickpea (*Cicer arietinum* L.): Breeding strategies for resistance. International Journal of Plant Breeding and Genetics 5:1-22.

Laxmipathi G, PM Gaur and S Samineni. 2016. Chickpea Research and Development: Current Status and Future Perspectives in the Semi-arid Tropics. *In*: Lijalem K. Tebkew D. Asnake F. (eds). Harnessing Chickpea Value Chain for Nutrition Security and Commercialization of Smallholder. 30th January – 1st February 2014. Debre Zeit, Ethiopia.

Shiferaw B and Teklewold H. 2007. Structure and Functioning of Chickpea Markets in Ethiopia: Evidence Based on Analyses of Value Chains Linking Smallholders and Markets. ILRI, Nairobi.

Simone V, Bernard G. M, Kai M, Jeffrey D. M. 2016. Welfare impacts of improved chickpea adoption: A pathway for rural development in Ethiopia. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) www.elsevier.com/locate/foodpol.

Spielman D. J, Byerlee D, Alemu D, Kelemework D. 2010. Policies to promote cereal intensification in Ethiopia: the search for appropriate public and private roles. Food Policy 35: 185–194.