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Original article

Participatory demonstration and evaluation of improved chickpea technologies in the mid altitude areas of Bale zone, Oromia National Regional State, Ethiopia

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ABSTRACT

This activity was conducted during 2017 cropping season in mid altitude areas of Bale zone, with the objectives of demonstrating and evaluating the recently released chickpea varieties (both Kabuli and Desi type) with full recommended production and management packages to the farming community, to create awareness as well as demand on improved chickpea technologies and to enable farmers to select the best performing variety/ies in Goro and Ginnir districts. Dhera, Hora and Habru (Kabuli type) and Dimtu, Teketay and Natoli (Desi type) chickpea varieties were planted at two kebeles of each district. The demonstration was undertaken on single plot design of 10m x 10m area for each variety with the spacing of 30cm between rows, the recommended seed rate (120kg/ha for Kabuli type and 80kg/ha for Desi type) and 121 kg/ha NPS fertilizer rate. Mini-field day was organized at each kebele/site on which different stakeholders were participated, participatory evaluation of the varieties was made and experiences were shared among participants. Yield data per plot was recorded and analysed using descriptive statistics. Farmers' preferences for the improved chickpea varieties were identified using focused group discussion and summarized using pair wise and simple ranking methods. For Kabuli type, the mean yield of Habru variety (standard check) was 25.5qt/ha and 26.1qt/ha at Goro and Ginnir districts, respectively. It was more yielder than the recently released varieties, Dhera and Hora. The one way ANOVA with

no blocking result showed that branches per plant, pods per plant and mean yield were significant among the kabuli type varieties. For Desi type, the mean yield of Dimtu variety was 24.7qt/ha and 25.8qt/ha and had 15.42% and 19.44% yield advantage over the check (Natoli) at Goro and Ginnir districts, respectively. Participant farmers were enhanced to set their own selection criteria and the most important were branches per plant, branches with full of pods, pods per plant, seed per plant, seed size, seed colour, well adapted to the environment, disease free and has uniformity. Thus, Habru variety (Kabuli type) and Dimtu variety (Desi type) were validated with farmers and recommended for further scaling up/out activity in all demonstration sites and similar agro-ecologies.

1. Introduction

Chickpea (Cicer arietinum L.) is among the most important grain legumes widely produced worldwide and ranks third both in area and volume of production next to faba bean and haricot bean. In 2016, 13.3 million tons was produced in the world and from this the share of Africa was 670,400 tons. From African countries, Ethiopia contributed 63%, Tanzania 15%, Malawi 9%, Algeria 5%, Morocco 4%, Sudan 2%, Tunisia 1% and Uganda 1% to chickpea production (FAOSTAT, 2016). In Ethiopia, from 1,652,844.19 hectares of land allocated for pulse in 2015/16 production season, chickpea covered 258,486.29 hectares of land from which 4,726,113.88 qt of grain was produced with the productivity of 18.28 qt/ha although its potential is more than 4 t/ha (CSA, 2016). In Bale, 728.92 ha of land were covered by chickpea in 2015/16 production season (CSA, 2016). The potential (favorable) environments for the crop represents mid to high altitude ranging from 1500 to 2400m a.s.l that receives 700 - 1200 mm annual rainfall.

Chickpea is an important food for many households in Ethiopian mid altitude and highland areas. It is the source of valuable and cheap protein and used to supplement the cereal diet and expensive animal products (meat, butter, milk, chicken, etc.). Regarding to its importance in the economy, it has become an important cash crop (income source) for our farmers and the country because of high domestic demand and export opportunities (foreign currency in export market) in the Middle East, Europe and South Asia. According to FAO (2010), chickpea alone has an average global export market of ~4% by value and volume (2000-2010), which accounts for 63.5% of the total chickpea export from Africa (ranks first in Africa). Legumes are known for their ability to fix atmospheric nitrogen. Chickpea also plays an important role in system productivity and sustainability of wheat production as a break crop through biological nitrogen fixation (can fix up to 60kg N/ha/year) (FAO and ICRISAT, 2015). This crop requires low input for production; it can be used in rotation with several cereals like teff, wheat or barley, and can maintain and restore soil fertility in cereal mono-cropping areas.

Bale zone is characterized by integrated (mixed) farming systems in which most of the crop areas were under cereal production. The current cereal-based cropping systems put sustainable crop production system of the area at risk. Thus, crop diversification using improved chickpea technologies can be a means to stay in sustainable crop production in the study areas. However, lack of access to improved chickpea varieties in mid altitude areas of Bale zone is the main problem that hampers production of this crop. The usage of seeds of improved varieties is one of the most efficient ways of raising crop production, but in Ethiopia less than 10% of farmers use seeds of improved chickpea varieties with full packages (FAO, 2010). To date, the majority of chickpea producers obtain their seed for planting informally from own saved seed or through local diffusion mechanisms/traditional means such as exchange with others as gifts, bartering, cash transactions or social obligations (FAO, 2015).

In line with this, the research system (both national and regional) has made a lot of efforts to address the bottleneck of farming communities, and developed and released more than twenty (20) chickpea varieties with their full recommended production packages over the last three decades. Among these, Dhera and Hora (Kabuli type), and Dimtu and Teketay (Desi type) were recently released varieties with recommended practices. Thus, participatory on-farm demonstration, evaluation and validation of the varieties with the participation of farmers

and other stakeholders were undertaken in 2017 cropping season with the financial support of ICARDA project. The study objectives:

   ✓   To demonstrate and evaluate improved chickpea technologies in Bale zone and recommend the preferred one

   ✓   To create awareness on the importance of and demand on improved chickpea technologies

   ✓   To collect feedback on the performance of the technology/ies

2. Materials and methods

2.1. Description of the study area

2.1.1. Bale zone

Bale zone has eighteen (18) rural and two (2) town districts, out of which nine (9) rural districts are found in the highlands and suitable for crop production. The other nine (9) rural districts are found in the mid and low lands, and agro-pastoralists and pastoralists. Robe town is the capital town and the administrative center of the zone and located at 430km from Finfinne/Addis Ababa. The total area of Bale zone is about 63,555km^2 (6,355,500 hectars), which is 16.22% of Oromia region. About 95% of the population is engaged in agriculture. The altitude ranges from 300m to 4377m a.s.l. The agro-ecological zones of the zone are extreme highland (cold) 0.04%, highland (14.93%), midland (21.5%) and lowland (63.53%). The mean annual temperature of the zone is found between 3.5 °C and 32 °C, respectively. The minimum and maximum rainfall is 400mm and 2500mm, respectively. Bale zone has bimodal rainfall patterns and two distinct seasons, namely, Belg (in Afan Oromo called 'Ganna' by referring to the harvesting time) extends from March to July and Meher (in Afan Oromo called 'Bona' by referring to the harvesting time) extends from August to January. The zone is bounded by West Arsi and Arsi zones to the North, Guji zone to the South, by West Hararghe zone and Somali National Regional State to the East and West Arsi zone to the West (BZANRO, 2017).

The research was carried out in Goro and Ginnir districts of Bale zone. The altitude of Goro district is 1272m - 3275m a.s.l, receives 796.99 - 1138.48mm annual rainfall, the minimum and maximum temperature is 12.93 °C and 22.59 °C, respectively. The dominant soil type is Chromic Cambisols and Vertisols (65% clay, 20% Vertisol and 15% Sandy Soil). Whereas, the altitude of Ginnir district is 907m - 2524m a.s.l, receives 612.16 - 1214.73mm annual rainfall, the minimum and maximum temperature is 11.31 °C and 24.72 °C, respectively (Adamu, 2018). The dominant soil type is Pellic Vertisols and Distric Nitosols (26% Clay, 48% Vertisol and 18% Sandy Soil).
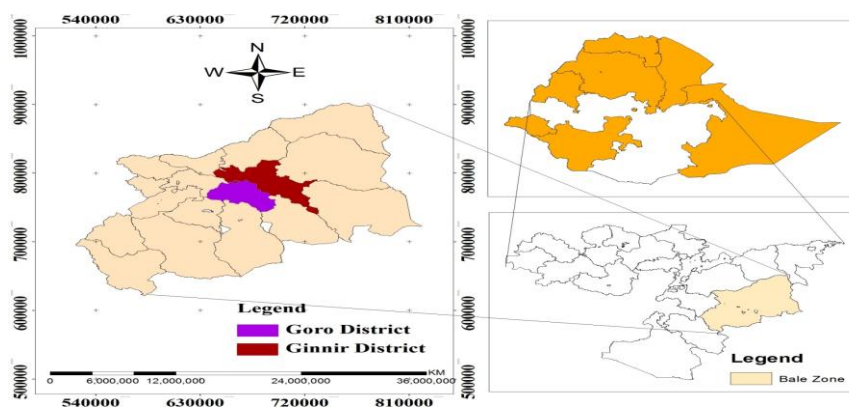
Source: Own sketch

2.2. Site and trial farmers' selection

The activity was conducted at ICARDA project intervention districts on a total of four sites (Two sites at Goro and two sites at Ginnir for both Kabuli and Desi type). Two kebeles were selected from each district based on their accessibility and production potential of the crop. Kebeles were considered as replication, i.e. the demonstration activity was replicated on two kebeles per district.

Selection of trial farmers were based on good history of compatibility with groups and genuineness, having suitable and sufficient land to accommodate the trials, accessibility for supervision of activities (vicinity), initiatives

to implement the activity in high-quality, good in field management, willingness and transparency to share innovations to others. Besides, resource rich, medium and poor category of farmers, including men, women and youth farmers was considered during trial farmers' selection.

2.3. Implementation design

2.3.1. Materials used and field design

Recently released chickpea varieties, namely, Dhera, Hora and Habru as a check (Kabuli type) and Dimtu, Teketay and Natoli as a check (Desi type) were planted at two kebeles of each district on selected farmers' land with simple plot design (10m x 10m) in 2017 main cropping season. Sinana Agricultural Research Center was the source of all agricultural inputs (seed of improved varieties and fertilizer-NPS). The varieties were treated with full recommended chickpea production and management packages. Row planting method and other crop management practices were employed during the research work. The spacing of 30cm between rows and the recommended seed rate (120kg/ha for Kabuli type and 80kg/ha for Desi type) were used during planting by drilling in the prepared rows. Shallow planting of 5cm depth was used in the presence of sufficient soil moisture. The recommended inorganic fertilizer rate 121 kg/ha NPS was applied during planting time.

Depending on weed infestation, two effective weeding were done; the first at one month after sowing with cultivation and the second at two months after sowing of improved chickpea varieties. Farm operations (land preparation-ploughing two to three times using oxen plough) were carried out by trial/hosting farmers, whereas activities such as land leveling, planting, first and second weeding, cultivation, harvesting, threshing, cleaning and other laboratory works were handled by SARC researchers and technical assistants.

2.4. Technology demonstration and evaluation techniques

Yet, in evolution of different extension approaches, four important phases have passed in National Agricultural Research System (NARS) based on the experiences learned, with contributions and limitations. The paradigm shifts has been started with Transfer of Technology (TOT) in the 1960s and have reached at Client Oriented Research Approach (PRA) in the end of 1990s. A participatory research and extension (the fourth phase) is a typology of research that enables clients to involve at all stages of the research process. It provokes collaborative form of farmers' genuine participation in research process through combining indigenous knowledge with scientific knowledge. In the process of participation, farmers having different socio-economic characteristics can obtain information on the available technologies; they make technological choices on their own and their wants, needs, problems and also the possible consequences are identified. It develops farmers' analytical skills (increase motivation, brain storming); enables farmers to develop a sense of ownership of the technologies (sustainable) and enhances wider technology adoption since farmers were in the research process. Besides, participatory research and extension approach provides researchers with valuable information about farmers' preferences and the problems they face; useful for evaluating the biophysical performance, profitability and acceptability or adoption of a potential technology/ies under a wider range of conditions.

However, farming community is not exposed to the required level to evaluate improved agricultural technologies under their environment and existing system of production. As a result, dissemination and adoption rates of many improved agricultural technologies popularized so far was not impressive. Furthermore, technologies from research station failed to fulfill farmers' technology selection criteria; hence adoption rate become low (Abera, 2004). Whereas, the target beneficiaries of improved agricultural technologies are strongly inclined to their preferences. Thus, consulting the intended end users to assess which quality/ies of a particular variety they desire (to be considered in plant breeding program) is highly important. Because, it will not only be resource saving in terms of preferred variety promotion/dissemination, but also time saving and fast adoption (Dan, 2012). Therefore, participatory research and extension approach whereby stakeholders, mainly farming community actively participate in decision making and implementation from stage of problem identification through experimentation to utilization and dissemination of research results is by far crucial in addressing those problems. The two way feedback between farmers and researchers is indeed vital component of stable, high yielder, disease and pest resistant varietal development (Getachew et al., 2008).

Thus, farmers in the project area were encouraged to participate on participatory selection of demonstrated varieties during the activity. A total of 124 participants from two districts (104 farmers, 14 DAs and supervisors and 6 experts) and 3 researchers were participated on the selection of the varieties at maturity stage of the crop. First,

the evaluators were grouped in to small manageable group (one group had 10 members including one group leader and one secretary). At each demonstration kebele, brief orientation was given to the evaluators on how to integrate researchers' criteria to their own criteria to select the demonstrated varieties in order of their importance, how to carefully assess each variety by considering each criteria and using rating scale, how to organize collected data, how to make group discussion and reach on consensus, and finally report through their group leader at the end.

2.5. Data type and method of data collection

Both qualitative and quantitative data were collected using appropriate data collection methods such as direct field observation/measurements and focused group discussion (FGD). Agronomic data such as flowering date, disease score, maturity date, stand, branches per plant, pods per plant, seeds per plant and yield data per plot in all locations were recorded. Farmers' preferences (likes and dislikes, which is the base for plant breeding process) to the demonstrated technologies were identified.

2.6. Data analysis

SPSS was used as statistical package (descriptive statistical technique such as percentage was used to analyze the data). Pair wise ranking matrix was used to rank the varieties in order of their importance. Pair Wise Ranking was used as a tool to summarize farmers' preference towards important variety traits (Boef and Thijssen, 2007). The agronomic data were analyzed using GENSTAT computer software.

3. Results and discussion

3.1. Yield performance and farmers' preference of the demonstrated varieties

For Kabuli type, the mean yield of Habru variety (standard check) was 25.5qt/ha and 26.1qt/ha at Goro and Ginnir districts, respectively. It was more yielder than the recently released varieties, Dhera and Hora. Moreover, the result is presented in table as shown below.

$$\text{Yield advantage \%} = \frac{\text{Yield of new variety (qt/ha) - Yield of commercial variety (qt/ha)}}{\text{Yield of commercial variety (qt/ha)}} \times 100$$

Table 1
Comparison of yield advantage of demonstrated improved chickpea varieties (Kabuli type).

District	Mean yield of standard check (qt/ha)	Mean yield of improved chickpea varieties (qt/ha) and yield advantage over the local check			
	Habru	Dhera	%	Hora	%
Goro	25.5	21.5	-15.7	20.8	-18.4
Ginnir	26.1	21.8	-16.5	19.5	-25.3

As it is shown in Table 1, both recently released chickpea varieties (Dhera and Hora) were low yielder than Habru. This is because the variety that has been used as standard check during variety verification trial and release was Ejere and it might have been low yielder than Habru.

Table 2
Rank of the demonstrated chickpea varieties (Kabuli type) based on farmers' selection criteria.

P #	Varieties	Rank	Reasons (all sites)
1	Habru	1st	Average branches per plant 16, pods per plant 184 (good branches and full of pod), attractive seed colour, well adapted, high yielder, has uniformity, no disease
2	Dhera	2nd	Average branches per plant 14, pod per plant 114 (long but not full of pod), well adapted, good for mechanization for its plant height
3	Hora	3rd	Average branches per plant 10, pod per plant 110, small seeded, well adapted, disease

The FGD result showed that the participant farmers ranked the demonstrated chickpea varieties (Kabuli type) based on their preferences and degree of satisfaction after they made detail discussions and debates on the important variety traits. Thus, the farmers' preference summary result shows (Table 2) that Habru variety was preferred by the farmers followed by Dhera at both districts.

Table 3
Statistical analysis result of the demonstrated chickpea varieties (Kabuli type).

Varieties	Branches per plant (count)	Pods per plant (count)	Mean yield (Quintal/ha)
Habru	16^a	181^a	25.8^a
Dhera	13^b	114^b	21.65^b
Hora	10.5^b	110^b	20.15^b
LSD$_{0.05}$	3.9	8.6	1.9
CV (%)	9.3	2	2.7

As shown in Table 3, the one way ANOVA with no blocking result showed that branches per plant, pods per plant and mean yield were significant among the demonstrated chickpea varieties (Kabuli type).

Table 4
Comparison of yield advantage of demonstrated improved chickpea varieties (Desi type).

District	Mean yield of standard check (qt/ha)	Mean yield of improved chickpea varieties (qt/ha) and yield advantage over the local check			
	Natoli	Dimtu	%	Teketay	%
Goro	21.4	24.7	15.42	21.8	1.87
Ginnir	21.6	25.8	19.44	23.1	6.94

As it is shown in Table 4, the mean yield of Dimtu variety was 24.7qt/ha and 25.8qt/ha, and had 15.42% and 19.44% yield advantage over the check (Natoli) at Goro and Ginnir districts respectively.

Table 5
Rank of the demonstrated chickpea varieties (Desi type) based on farmers' selection criteria.

P #	Varieties	Rank	Reasons (all sites)
1	Dimtu	1st	Average branches per plant 11, pods per plant 162 (good branches and full of pods), well adapted, high yielder, has uniformity, no disease
2	Teketay	2nd	Average branches per plant 9, pod per plant 148, well adapted, good yield, big seed size
3	Natoli	3rd	Average branches per plant 7, pod per plant 111, small seeded, late maturing, disease

The FGD result showed that the participant farmers ranked the demonstrated chickpea varieties (Desi type) based on their preferences and degree of satisfaction after they made detail discussions and debates on the variety traits. Thus, the farmers' preference summary result shows (Table 5) that Dimtu variety was preferred by the farmers followed by Teketay at both districts.

Table 6
Statistical analysis result of the demonstrated chickpea varieties (Desi type).

Varieties	Branches per plant (count)	Pods per plant (count)	Mean yield (Quintal/ha)
Dimtu	11^a	162^a	25.25^a
Teketay	8.5^b	148^b	22.8^{ab}
Natoli	6.5^b	111^c	21.5^b
LSD$_{0.05}$	3.2	4.5	3
CV (%)	11.5	3	6.6

As indicated in Table 6, the one way ANOVA with no blocking result showed that branches per plant, pods per plant and mean yield were significant among the demonstrated chickpea varieties (Desi type).

4. Conclusion

In participatory demonstration and evaluation of improved chickpea varieties (both Kabuli and Desi type), the best performing variety/ies for the target areas were identified, validated and ranked based on participant farmers assessment and grain yield data.

For Kabuli type, the analysis result indicated that the highest mean yield was obtained from Habru, 25.5qt/ha and 26.1qt/ha at Goro and Ginnir districts, respectively. The second highest mean yield was obtained from Dhera, 21.5 and 21.8qt/ha at Ginnir and Goro districts, respectively. The yield increment of Dhera and Hora varieties over Habru were -ve. This means both recently released chickpea varieties (Dhera and Hora) were low yielder than Habru. The Habru variety performed well than both varieties in all parameters.

For Desi type, the analysis result indicated that the highest mean yield was obtained from Dimtu, 24.7qt/ha and 25.3qt/ha, and had 15.42qt/ha and 19.44qt/ha yield increment over check (Natoli) at Goro and Ginnir districts, respectively. The second highest mean yield was obtained from Teketay, 21.8qt/ha and 23.1qt/ha, and had 1.87qt/ha and 6.94qt/ha yield increment at Goro and Ginnir districts, respectively.

For Kabuli type, Habru is still the leading variety at both districts and recommended for wider scaling up/out activity. Dhera is recommended for wider scaling up/out activity in both districts for its mechanization merit. While Dhera and Hora will be maintained by Breeders for the merits to be used for breeding purpose. For Desi type, Dimtu and Teketay are recommended for wider scaling up/out activity in the study districts and other similar agro-ecologies. Natoli will be maintained by Breeders for its merits to be used for breeding purpose.

The most important selection criteria set by the farmers were branches per plant, branches with full of pods, pods per plant, seed per plant, seed size, seed colour, well adapted to the environment, disease free and has uniformity.

Acknowledgments

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