

## Adaptability Evaluation of Kabuli Chickpea Varieties under Irrigation Production at Kobo, Ethiopia

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**Abstract:** The experiment was executed during the 2018 – 2019 irrigation cropping season to evaluate the adaptability and yield performance of kabuli type chickpea varieties with the involvement of farmers based on their preferences criteria. Ten improved varieties were laid out in RCB design with three replications for the mother trial and the baby trial, a single rep of the mother trial, which was used for farmers' preference selections. Data on days to maturity, number of pods per plant, number of seeds per pod, number of branches, plant height, biomass, hundred seed weight, and grain yield were collected and analyzed. The farmers evaluated and selected the varieties depending on their criteria from the baby trial. The criteria were grain productivity, earliness, seed size, and free from any diseases. Farmers' selection was analyzed by the PairWise and Matrix ranking method. The analysis of variance showed a significant difference ( $P < 0.05$ ) for grain yield and most traits. The result showed that variety Akuri was the best yielder with seed yield 2558kg/ha, followed by harbu (2300.5kg/ha) and Kobo (1922.5kg/ha), respectively. Grain yield was the first prioritized trait to farmers for selecting the best adaptable chickpea variety under irrigation. Akuri was the best variety based on ANOVA result and visually selected by the farmers as good for grain yield under irrigation followed by Harbu and Kobo. Therefore; based on researchers' and farmers' perception Akuri and Harbu varieties will be recommended and pre-scale up for producing areas in the district and similar agro-ecological zones under irrigation production system.

**Keywords:** *Kabuli type chickpea, irrigation, Grain yield, Farmers' preferences.*

### INTRODUCTION

Chickpea (*Cicer arietinum* L.) is the third most important pulse crop in the world, after dry common bean and field pea (Padmavathiv, *et al.*, 2013). India is the largest chickpea producing country accounting for 72 % of the global chickpea production (Ojiewo, 2016). Ethiopia is considered as one of the secondary centers of diversity for chickpea (van der Maesen, 1987). In Ethiopia, chickpea is the third-largest legume crop in area and production next to faba bean and common bean (CSA, 2019).

There are two types of chickpeas depending on seed color, shape, and size; *desi* and *kabuli*. According to Nigusie, *et al.*, (2017) the *kabuli* type has large, round, or ram head and cream-colored seeds, and is grown in temperate regions. In Ethiopia, the *kabuli* type of chickpea covered 25% of the whole area coverage (Asnake, 2014). Mostly it is produced based on a source of foreign currency or export purpose.

Chickpea is important for a protein sources and soil fertility improvement. It is also known as a risk avoidance crop. Besides being an important source of human food and animal feed, it also plays an important contributor to soil fertility as it provides nitrogen to soil due to nitrogen fixation ability with help of bacteria (Gul, *et al.*, 2011). Ecologically, chickpea is known to be an efficient  $N_2$ -fixing crop due to its capability of symbiotic nitrogen fixation. Chickpea meets 80% of its nitrogen (N) requirement from symbiotic nitrogen

fixation and can fix up to 140 kg N per ha from the atmosphere (ICRISAT, 2010).

In Ethiopia, chickpea is produced by rain-fed and irrigation production systems. Ethiopia is one of the few African countries endowed with relatively abundant water resources, favorable climate, and potentially huge irrigable land (Tilahun, *et al.*, 2008). The country has potentially suitable land and water resources for irrigation-based chickpea production that surpasses many thousand hectares (Nigusie, *et al.*, 2017). In most irrigation potential areas in the country, farmers produce triple crops per season. Based on this, Kobo is one of the potential areas which have a high irrigation potential for crop production including chickpea.

According to Kobo Girana Valley Program, in Kobo district there is more than 2100ha of land cultivated by farmers under irrigation. They produce triple crops per season, tef or maize – chickpea – onion. Not only regionally but also nationally, there is no released chickpea variety for an irrigation production system, especially *kabuli* type which can increase farmers' income more than that of *desi* type. Due to this, farmers produce local chickpea variety which is low yielder (0.7 – 1t/ha) and fetch low income. To increase the production and productivity of chickpea in this area under irrigation there is a need to recommend an improved *kabuli* type chickpea variety. Therefore; the objective of this experiment was to evaluate and recommend the best adaptable, high yielding,

and early maturing of *kabuli* type chickpea varieties with the involvement of farmers based on their preferences for producing areas under irrigation production system in the district.

## MATERIALS AND METHOD

### Description of Experimental Site

The experiment was executed under an irrigation production system at Kobo, which is located at 11°08'21", 39 18'21" and 1450masl latitude, longitude, and altitude; respectively. The annual rainfall of the site is 637mm with a 15.8°C minimum and 29.1°C maximum temperature. According to Sirinka Agricultural Research Center soil classification (unpublished), it is classified as *Eutric fluvisol*.

### Experimental materials and methods

About 10 *kabuli* type improved chickpea varieties were evaluated for their adaptation and yield performance under irrigation during 2018 and 2019 at Kobo district. These varieties were improved and released by Sirinka and Debre Zeyt Agricultural Research Centers under rain-fed conditions. The experiment was done by Mother and Baby Trial form. The Mother trial was done by Random Complete Block Design with three replications. Each variety was sown in six rows at 40 cm, 10 cm and 1m spacing between, rows, plants, and plots, respectively; with 4m row length. The Baby trial, a single replication of the Mother Trial, was done on three different farmers' fields to participate farmers to select the best varieties based on their preferences. Totally 27 farmers who produce chickpea under irrigation participated in a variety of selection processes. All agronomic practices were done uniformly for all varieties as required without fertilizer application. For controlling the pod borer, the insecticide *Karate* at the rate of 200ml/300 lit of water per hectare was applied at the branching stage (two times within 15 days intervals). The irrigation frequency was applied before sowing, at seedling, at branching, and at pod setting stage similar to Fitsume, *et al.*, (2015).

### Data Collection and Data Analyses

Agronomic data were collected from the mother trial, which has three replications. The data of the number of pods per plant, number of seeds per pod, hundred seed weight, plant height, biomass

yield, and grain yield were collected from the harvestable plot area of the mother trial. And biological data like biomass yield (kg/ha) and seed yield (kg/ha) were collected from the harvestable plot area of the mother trial. In addition to these disease data also scored. Farmers participated in the best variety selection process during 2020. Twenty-seven farmers who produce chickpea under irrigation participated in a variety of selection processes. Farmers' criteria to select the best variety were grain productivity, earliness, seed size, and free from any diseases. The ranking procedure was explained for participant farmers and each selection criteria was ranked from 1 to 5 (1= very good, 2= good, 3= average, 4= poor, and 5= very poor). Then farmers were given the chance to rank each variety based on the attributes listed by them. The agronomic data were subjected to the analysis of variance (Gomez and Gomez, 1984) using Gen stat software eighteenth editions from the mother trial. According to Ceccarelli (2012), two methods by which farmers can evaluate varieties in the PVS trials are the Pairwise ranking and the Matrix ranking method. The selection data were analyzed by the Pair-Wise ranking method.

## RESULTS

According to the analysis of variance (ANOVA), the variability between varieties showed significant difference ( $P < 0.05$ ) for the number of pods per plant, hundred seed weight in gm., grain yield, and biomass in kg per hectare in the results of the two years (Table 2 and 3). The analysis showed variety Akuri was the best yielder in both years with grain yield 2558kg/ha, followed by variety Harbu (2300.5kg/ha) (Table 3). The least grain yield scored by Dhera variety (840.5kg/ha). The influence of disease is minimal under irrigation production systems (Nigusie, *et al.*, 2017). The same result also occurred in this study, there was no disease occurrence in both years trial (Table 2 and 3). In general, the grain yield of chickpea under irrigation production is highly increased than the rain-fed production system. Similar to this study, an increase in grain yield of chickpea under irrigation has been reported by many authors (Anwar, *et al.*, 2003; Pacucci, *et al.*, 2006; Kang, *et al.*, 2008; Vinayak, *et al.*, 2012 and Mansur, *et al.*, (2010).

**Table 1:** Mean performance of *kabuli* type chickpea varieties under irrigation at Kobo, 2018

Varieties	DM	PH	NPP	NSP	NB	BMKH	HSW	AGYKH
Kobo	98bcd	46.2	35.3a	1c	14.1	6859a	38.5a	1736cd
Akuri	94d	40	26.5b	1.1c	10.1	4899bc	35.3ab	2653a
Kassech	101abc	42.2	26.7b	1.14bc	12.1	4681bc	30.6bcd	1651cde
Yelbie	101abc	42.2	26.7b	1.14bc	12.1	4681bc	30.6bcd	1651cde
Teji	101abc	46.5	33.3a	1.1c	15.4	4595c	35.5ab	1988bc
Ejeri	102abc	42.8	34.1a	1.13	11.3	5341b	33.2abc	2234ab
Harbu	96cd	39.5	26.6b	1.13	7.7	5030bc	33.8abc	2462a
Chefe	101abc	39.5	17.8c	1.13	9.8	3785d	27.4cd	1026fg
Hora	106a	42.4	25.7b	1c	13.3	4757bc	27.9cd	1368def
Dhera	104ab	46.6	20.5c	1c	11.3	3630d	25.7e	722g
GM	101	42.2	26.8	1.14	12.1	4680.8	30.6	1650.5
DMRT 5%	*	ns	**	**	ns	**	**	**
CV%	5.3	8.0	9.0	8.4	10.7	17.8	11.6	15.9

Notes: DM= Days to maturity; PH= Plant height; NPP= Number of pods per plant; NSP= Number of seeds per pod; NB= Number of branches; BMKH=

Biomass Kilogram per hectare; HSW= Hundred seed weight; AGYKH= Adjusted grain yield kilogram per hectare.

**Figure 1:** Mother trial on picture

There was also a substantial difference between the varieties for hundred seed weight. The hundred seed weights of the varieties varied in both year's

trials with a range between 38.5gm for Kobo and 25.7gm for Dhera variety (Table 1 and 2).

**Table 2:** Mean performance of *kabuli* type chickpea varieties under irrigation at Kobo, 2019

Varieties	DM	PH	NPP	NSP	NB	BMKH	HSW	AGYKH
Kobo	85	51.1bc	43.2a	1.4	15ab	5620b	33.3a	2109b
Akuri	86	51.3bc	45.4a	1.6	13.5abc	6313a	29.2bc	2463a
Kassech	88	46.6bc	23.2bc	1.6	12.9bcd	3633e	30.7ab	1444cd
Yelbie	86	63.6a	43.2b	1.6	15.7a	4030d	27cd	1707c
Teji	90	47bc	24bc	1.6	8f	4400d	29.4bc	1524cd
Ejeri	90	51.1bc	18.6d	1.2	9.1ef	4968c	27.9cd	1348d
Harbu	88	54.6b	46a	1.4	14.8ab	5611b	26.5d	2139b
Chefe	88	44c	45.4a	1.2	11.5cde	4257d	27.1cd	1671c
Hora	92	45c	24bc	1.2	7.3f	3513e	26.4d	836e
Dhera	93	49.9bc	20.4cd	1	10.6de	3073f	29.4bc	959e
GM	88	50.3	31.5	1.4	11.8	4542	28.8	1619
DMRT 5%	Ns	*	**	Ns	**	**	*	**
CV	7.3	9.8	17.8	13	12.3	15.4	7.6	10.2

Notes: DF= Days to flowering; DM= Days to maturity; PH= Plant height; NPP= Number of pods per plant; NSP= Number of seeds per pod; NB= Number of branches; BMKH= Biomass Kilogram per hectare; HSW= Hundred seed weight; AGYKH= Adjusted grain yield kilogram per hectare

The maximum hundred seed weight for Kobo was 38.5gm followed by Teji (35.5gm) and Akuri (35.3gm) (Table 1). The days to maturity of the varieties were range 88 - 106 days, this indicates all varieties were early maturing.

**Table 3:** Mean performance of *kabuli* type chickpea under irrigation in 2019 - 2020

Varieties	Mean Grain yield		
	2018	2019	Mean
Kobo	1736	2109	1922.5
Akuri	2653	2463	2558
Kassech	1651	1444	1547.5
Yelbie	1651	1707	1679
Teji	1988	1524	1756
Ejeri	2234	1348	1791
Harbu	2462	2139	2300.5
Chefe	1026	1671	1348.5
Hora	1368	836	1102
Dhera	722	959	840.5
GM	1650.5	1619	1634.75

Participatory variety selection (PVS) was also done as an option to increasing productivity and production in terms of users' preferences under irrigation. A very important advantage of PVS is that the adoption of new cultivars is much faster than under the formal system, in which farmers are confronted with only a very restricted range of new cultivars (Mohammed A., et al., 2016). During the 2019 trial season, Farmers participate to select the best variety based on their criteria. Totally 27 farmers who produce chickpea under

irrigation participated in a variety of selection processes. For chickpea variety selection farmers focused on the traits of grain productivity, earliness, seed size, and free from any diseases (Table 4). All the criteria were set by farmers without contributing the researcher. According to Ceccarelli (2012), two methods by which farmers can evaluate varieties in the PVS trials are the Pairwise ranking method and the Matrix ranking method.



**Figure 2:** Participant farmers and researcher

**Table 4:** Pair-wise ranking of the criteria for *kabuli* type chickpea variety by farmers

Criteria	Prod	DR	ER	SS	Total	Rank
Productivity (Prod)	X	Prod	Prod	Prod	3	1 <sup>st</sup>
Diseases Resistant (DR)		X	ER	SS	0	4 <sup>th</sup>
Earliness (ER)			X	ER	2	2 <sup>nd</sup>
Seed size (SS)				X	1	3 <sup>rd</sup>

**Notes:** Prod= Productivity; DR= Disease Resistance; ER= Earliness; SS= Seed size.

The ranking procedure was explained for participant farmers and each selection criteria was ranked from 1 to 5 (1= very good, 2= good, 3= average, 4= poor, and 5= very poor). Before the selection process, farmers had given weight to their criteria. Based on this, grain yield productivity was the most prioritized farmers' criteria to select the best variety followed by seed color, earliness, seed size, and disease-free which had given 1, 2, 3, 4, and 5 weights; respectively (Table 4). Abebe, *et al.*, 2005 reported that farmers

have their own selection criteria for new varieties which largely depend on the importance of the crop in the farming system and uses. Matrix ranking was used to assess farmers' opinions and perceptions of the varieties. According to Amhara Agricultural Research Institution's unpublished Guideline for Participatory Varietal Selection, (2018), the variety which has the least rank index, the most desirable variety. The ranking of *kabuli* type chickpea varieties based on the perception of the farmers is presented in Table 5.

**Table 5:** the selected *kabuli* type varieties' rank index based on farmers preferences /traits

Varieties	Traits with their weights				Total	Rank
	Prod (1)	DR (4)	ER (2)	SC (3)		
Kobo	7	31	8	19	65	3 <sup>rd</sup>
Akuri	15	7	14	11	47	1 <sup>st</sup>
Kassech	17	32	10	21	80	4 <sup>th</sup>
Yelbie	32	29	19	14	94	7 <sup>th</sup>
Teji	28	13	23	24	88	5 <sup>th</sup>
Ejeri	35	26	28	22	111	6 <sup>rd</sup>
Habru	9	10	7	30	56	2 <sup>nd</sup>
Chefe	31	8	30	32	101	8 <sup>th</sup>
Hora	22	18	34	17	91	10 <sup>th</sup>
Dhera	23	21	32	26	102	9 <sup>th</sup>

**Notes:** Prod= Productivity; DR= Disease Resistance; ER= Earliness; SS= Seed size.

As per the selection criteria set farmers ranked the overall preference ranking of varieties based on four criteria was in the order Akuri, Harbu, Kobo, Kassech, Teji, Ejeri, Yelbie, Chefe, Dhera, and Hora; respectively. Farmers prefer varieties that meet multiple objectives; on chickpea (Yasin G and Mathios A, 2016), on sorghum (Tulole, *et al.*, 2010); on groundnut (Tulole, *et al.*, 2008). That means that in this study Akuri (2558kg/ha), Harbu (2300.5kg/ha), and Kobo (1922.5kg/ha) best varieties under irrigation could be introduced and in the farming systems based on various subjective preference criteria. Farmers preferred the variety Kobo thirdly as it produced attractive seed size and grain yield.

#### **Pre-scale up of recommended Akuri and Habru Varieties at Kobo**

We used Akuri and Habru which were the selected varieties by farmers through participatory variety selection trial. These activities were done; on 5ha of land covered by Akuri variety and 18 ha of land covered by Habru variety. Ninety-Two farmers directly participated. We gave 32.2 tons of seed for covering 23ha of land. Farmers took agreement to give seed after harvesting and threshing to other five farmers to popularize the technology. Training was given for districts' participant farmers, development agents and office of Agricultural professionals.

#### **General Feedback given by participant farmers**

Chickpea production under irrigation not usual farmers practice before this but now we took lessen about important of chickpea production under irrigation because its cost of production very small amount compare to other crops which needs frequent irrigation and weed management. And also it has good market demand especially in green pod stage. So it should be more popularized for farmers who produce different crops under irrigation.

#### **CONCLUSION AND RECOMMENDATION**

Ten improved *kabuli* type chickpea varieties were evaluated for yield and adaptation under irrigation at Kobo for two years. Differences among varieties were significant for grain yield and some of the traits. Grain yield was the first prioritized trait for farmers for selecting the best adaptable *kabuli* type chickpea variety under irrigation. Akuri was the best variety based on ANOVA result and visually selected by the farmers as good for grain yield under irrigation followed by Harbu and Kobo. This study also indicated that proper selection of varieties with improved management can increase farmers' income under irrigation. Therefore; based on researchers' and farmers' perception Akuri and Harbu varieties will be recommended and pre-scale up for producing areas in the district and similar agro-ecological zones under irrigation production system.

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## REFERENCES

1. Abebe, G., Assefa, T., Harrun, H., Mesfin, T. & Al-tawaha, A. M. "Participatory selection of drought-tolerant maize varieties using mother and baby methodology: a case study in the semi-arid zones of the central rift valley of Ethiopia." *World Journal of Agricultural Sciences*, 1.1 (2005): 22-27.
2. Asnake, F. "Overview of chickpea improvement research program in Ethiopia." *The Journal of the International Legume Society*, 3 (2014).
3. Anwar, M. R., McKenzie, B. A. & Hill, G. D. "Water-use efficiency and the effect of water deficits on crop growth and yield of Kabuli chickpea in a cool-temperate sub-humid climate." *Journal of Agricultural Science*, 141 (2003): 285-301.
4. Central Statistical Agency (CSA). "Agricultural sample survey (2018)." report on area and production for major crops (private peasant holdings, main season), Addis Ababa, Ethiopia (2019).
5. Ceccarelli, S. "Plant breeding with farmers – a technical manual." PO Box 5466, Aleppo, Syria. (2012): xi + 126.
6. Desta, F., Bissa, M. and Korbu, L. "Crop water requirement determination of chickpea in the central vertisol areas of Ethiopia using FAO CROPWAT model." *African Journal of Agricultural Research* 10.7 (2015): 685-689.
7. Gomez, K. A. & Gomez, A. A. "Statistical procedures for agricultural research." 2nd ed. John Wiley and Sons, New York (1984).
8. Gul, R., Khan, H., Sattar, S., Farhatullah, Munsif, F., Shadman, Khan, B. S. A., Khattak, S. H., Arif, M. & Ali, A. "Comparison among nodulated and non-nodulated chickpea genotypes." *Sarhad Journal of Agriculture*, 27.4 (2011): 577-581.
9. International Crop Research Institute for Semi-Arid Tropics (ICRISAT). "Chickpea Seed Production Manual." Pooran M. Gaur, Shailesh Tripathi, C. L. Laxmipathi Gowda, G. V. Ranga Rao, H. C. Sharma, Suresh Pande, and Mamta Sharma (2010).
10. Kang, S., McKenzie, B. A. & Hill, G. D. "Effect of irrigation on growth and yield of Kabuli chickpea (*Cicer arietinum* L.) and narrow-leafed lupin (*Lupinus angustifolius* L.)." *Agronomy New Zealand*, 38 (2008). Agricultural Science Department, Faculty of Agriculture and Life Sciences, Lincoln University, Lincoln, New Zealand.
11. Mansur, C. P., Palled, Y. B., Salimath, P. M. & Halikatti, S. I. "An analysis of dry matter production, growth, and yield in Kabuli chickpea as influenced by dates of sowing and irrigation levels." *Karnataka Journal of Agricultural Science*, 23(3 (2010): 457-460.
12. Maqbool, M.A., Aslam, M. and Ali, H. "Breeding for Improved Drought Tolerance in Chickpea (*Cicer arietinum* L.)." *Plant Breed.* 136 (2017):300–18.
13. Mohammed, A., Asefie, S., Dagnachew, W. and Seyum, N. "Participatory evaluations of field pea (*Pisum sativum* L.) varieties in Wollo, Ethiopia." *Excellent Word J Agricultural Science* 1.2 (2016): 1-6.
14. Girma, N., Fikre, A. and Ojiewo, C.O. "The Genotypic and Phenotypic Basis of Chickpea (*Cicer arietinum* L.) Cultivars for Irrigation-Based Production in Ethiopia." *Journal of Agricultural Sciencem*, Published by Canadian Center of Science and Education 9. 8 (2017): 229-236.
15. Chris, O. "Presentation of Chickpea Production, Technology Adoption, and Market Linkages in Ethiopia." Presented at the Pan-African Grain Legume and World Cowpea Conference, Livingstone, Zambia, (2016).
16. Pacucci, G., Troccoli, C. and Leoni, B. "Effect of supplementary irrigation on yield of chickpea. "Supplementary Irrigation on Yield of Chickpea Genotypes in a Mediterranean Climate." *Agricultural Engineering International: The CIGR Ejournal* VIII.1 (2006): Manuscript LW 04005.
17. Hordofa, T., Menkir, M., Awulachew, S.B. and Erkossa, T. "Irrigation and Rain-fed Crop Production System in Ethiopia." *International Water Management Institute (IWMI) Sub-*

- regional Office for the Nile Basin and East Africa, Addis Ababa, Ethiopia (2008).
18. Bucheyeki, T.L., Shenkalwa, E.M., Mapunda, T.X. and Matata, L.W. "On-Farm Evaluation of Promising Groundnut Varieties for Adaptation and Adoption in Tanzania." *African Journal of Agricultural Research*, University of Kwazulu-Natal, South Africa. *Academic Journals* 3.8 (2008): 531-536.
  19. Bucheyeki, T.L., Shenkalwa, E.M., Mapunda, T.X. and Matata, L.W. "Yield Performance and Adaptation of Four Sorghum Cultivars in Igunga and Nzega Districts of Tanzania." *International Journal of the Faculty of Agriculture and Biology*, Warsaw University of Life Sciences, Poland. *Communication in Biometry and Crop Science* 5. 1 (2010): 4-40.
  20. Vinayak, N., Pujari, B.T., Halepyati, A.S. and Koppalkar, B.G. "Growth and Yield of Late-Sown Chickpea as Influenced by Irrigation Methods, Genotypes, and Planting Densities." *Karnataka J. Agric. Sci.* 25. 2 (2012): 267-269.
  21. Goa, Y. and Ashamo, M. "Yield performance and adaptation of desi chick pea varieties in selected districts of Wolayta and Hadiya zones of South Ethiopia." *International Journal of Research–Granthaalayah* 4.3 (2016): 33-41.
  22. Van der Maesen, L.J.G. "Origin, History, and Taxonomy of Chickpea." In: *Saxena MC, Singh KB (eds). The Chickpea. Wallingford: C.A.B International*, (1987): 11-34.

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