



## Cluster Based Large Scale Demonstration, Popularisation and Farmers Perception of Common Bean Production Technology at Gofa and Basketo Zones of Southern Ethiopia

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### ABSTRACT

Pulses are the critical component of the many Agricultural systems and major contribution for global food security. Common beans are one of the popular pulse crops. Cluster based large scale demonstration of common bean technology was conducted at Melo-Koza and Laska Zuria district of Southern Ethiopia in 2022/23 main cropping season with the objective of to further demonstrate the common bean technology in wider scale .6 Kebeles' (2 from Melo- Koza and 4 from Laska Zuria) were selected based on potential to grow common bean. Planting was done by drilling at a seed rate of 80 Kg ha<sup>-1</sup> and 40cm by 10cm spacing between row and plant respectively. 100 Kg ha<sup>-1</sup> NPS fertilizer was applied. A total of 118 farmers were selected based on a clustering approach, covering an area of 40 ha<sup>-1</sup>. Nasir and Hawassa dume varieties were demonstrated along with their technology. To raise farmers' awareness, of the common bean production technology, training was given before beginning the activity. The result showed that the mean yield of Hawassa dume and Nasir were 2,108 and 1,960Kg/ha<sup>-1</sup> respectively. The 2 demonstrated common bean varieties exhibited better yield in their respective locations. At both districts, a field day was held with the participation of various stakeholders and experience was shared. Extension materials like banners, posters, brochures were used to popularize technology, and the field day events were promoted by face book, South Television, and Frequency Modulation radios for those who are not directly participated in the field day program. Based on the feedback, the farmers and stakeholders appreciated the varieties by grain yield, quick first branch initiation, disease-resistant, attractive seed color, and well-covered seed. Extension materials like banners, posters, brochures and leaflets were used during the field day. Therefore, to further expand the technology, the extension system of the respective districts should supply the seeds of the Hawassa dume and Nasir varieties with agronomic recommendations to the wider communities

## INTRODUCTION

In 2021, globally common bean production was more than 27 million tons on more than 34 million hectare, feeding more than 300 million people (FAO, 2023). Common bean is also recognized worldwide as an alternative means of improving soil fertility because of their ability to fix atmospheric nitrogen, enhancing soil organic matter and improving general soil structure (Maobe et al., 1998 cited in Solomon, 2021).

Common bean is a herbaceous annual crop domesticated independently in Africa, Mesoamerica and later in Europe. The crop is grown worldwide for its edible bean, popular as dry, fresh and green bean. Its production has been expanding slowly based on population growth. Its highest consumption is mainly in poor developing countries, where beans provide an alternative to meat as a source of low cost protein. It provides an excellent nutritional complement to maize, which is one of the most important grain cereals (Ferris and Kaganzi, 2008).

Ethiopia is among the top pulse growing countries in the world. Pulses take up 11% of the country's total grain production (CSA, 2014). The most dominant pulses grown in Ethiopia include Faba beans, Chickpeas, common beans, Lentils, Peas and Vetches (Frehiwot, 2010). Common bean is among the commonly cultivated pulse crop and it mostly grows well in the warm and lowland areas of the country with altitude between 1400 and 2000 meters above sea with temperatures between 18 and 24°C are optimum for its growth (Teshale et al., 2005, Cited in Mukerem, 2022). It can be grown twice a year in bimodal rainfall areas. In Ethiopia, 58% of the red color bean and 66% of white color bean were used for consumption and important dietary supplement to cereal consumption next to faba bean (Broughton, J. et al, 2003) It has high protein content and good micro-nutrient concentration. It is source of human food calories and also it has a high nutritional value with important protein contents (22%), minerals and vitamins necessary to warrant the food security of people in the developing countries (Misgana and Tadese, 2017). Ethiopia exports red and navy beans, much of which, are produced by smallholder farmers. Red bean exports to European, Middle East, African and Far East and it account for more than 10% of the country's common bean volume while navy beans accounts for 90% (Fekadu, 2017, Berhanu et al., 2018). It is also important mainly for making "wot", an Ethiopian stew, which is sometimes served as a main dish.

In Southern Ethiopia, it is a common food as "nifro" in the dry, fresh and green stage with Maize, Sorghum and it is also consumed with Kocho (MARD, 2009). There are also traditional recipes used by many peoples such as *kurkufa* (cabbage and boiled bean mashed mixture) and *fossose* (maize flour and boiled bean mashed mixture) (Teamir et al., 2003). Thus, it is an important crop in addressing the issue of nutrition security in Southern Ethiopia where people's diet is dominated by Maize, root, and tuber crops (Akibode S et al, 2011).

In 2020–21 cropping season in Ethiopia, the total production area and production of white and red common bean was 311,583.83 ha and 5, 525, 640, 74 Kg respectively. The national productivity of common bean is 1773.41 kg/ha (CSA, 2021). It is cultivated mostly in the Oromia (43%), Amhara (25%), and 29% in Southern Nations Nationalities and Peoples regions in terms of area

coverage (CSA, 2021). The major identified problems in low yield performance is due to inaccessibility to improved common bean varieties, poor extension service, and low performance of local varieties are common to all Zones. *Because of this, the actual smallholder farmers' yield is very low (1,279 Kg/ha) as that of research center yield data of 3,500 kg/ha using improved varieties and improved management techniques.* To overcome these problems, Arba Mich Agricultural Research Center conducted an adaptation trial on station level on 15 improved common bean varieties (Hawassa Dume, Sari, Awash-1, Ibado, Omo95, Dimitu, Dinknesh, Dame, Nasir, chore, Cranscope, Argene, DRK, Awash-melka, AFR-702 and local). Among the 15 improved common bean varieties Hawassa Dume, Nasir and Sari were high yielding and adapted to the area and recommended for further pre-extension demonstration (Dembele and Ashenafi, 2018).

In line with this, pre-extension demonstration was also conducted at Gofa Zone and promising result was obtained by Hawassa dume and Nasir varieties and recommended for further production. Therefore, this activity was conducted to popularize improved common bean technology at Melo-Koza and Basketo districts *through large-scale demonstrations in farmers' fields.*

### **1. Objectives**

1. To increase awareness of farmers on common bean technology
2. To popularize common bean production practices and technology in the study areas
3. To investigate farmers perception on common bean technology

### **Significance of the study**

This study contributes by filling the knowledge gap on issues of common bean production packages, specific factors contributing to it and the farmer's perception related to the current common bean production practices and technology use of the study area. The information generated from this study may help in designing more common bean production and management interventions in the study area and in another similar environment in the country. Besides this, the study might serve as a reference source for researchers who are interested to further investigate the issue of common bean.

## **METHODS**

### **1. Descriptions of the Demonstration Areas**

The activity was implemented in Laska Zuria and Melo-koza districts of Basketo and Gofa Zone respectively among the potential common bean potential districts of Southern Ethiopia in 2022/23 cropping season.

Geographically, Melo-Koza district located in latitude of 6°30'N and longitude 36°40'E. The district has 3 agro-ecologies, Dega (21.73%) Woyna Dega (52.43%) and Kola (25.84%). The soil of the district is mainly clay-loam (50%), sand-loam (35%) and clay (15%). The district has 2 rain-seasons, 'Meher' season (from July to Oct) and 'Belg' season (from last week of Jan to April). The average annual rainfall is 950 mm. The average annual temperature of the district is 21.3 °C. The major crops grown are maize, wheat, common bean, sesame and teff.

Geographically, Laska Zuria District is also located in latitude of 6°14'60.00" N and longitude of 36°34'59.99" E. Altitude of the district ranging from 780-2200 metres above sea level; average annual rain fall is 1200 mm with average annual temperature of 21°C which is considered as suitable rainfall for common bean production . The soils of the district classified as 18% clay, 52% loam and 30% sandy in all agro-ecologies (Kiflu,2015).The type of soil on which the demonstration conducted is vertisol. The major crops grown in the area include teff, maize and common bean, sesame, mung bean and sorghum. The general features of Melokoza district and Basketo Zone map is described below in (figure 1)

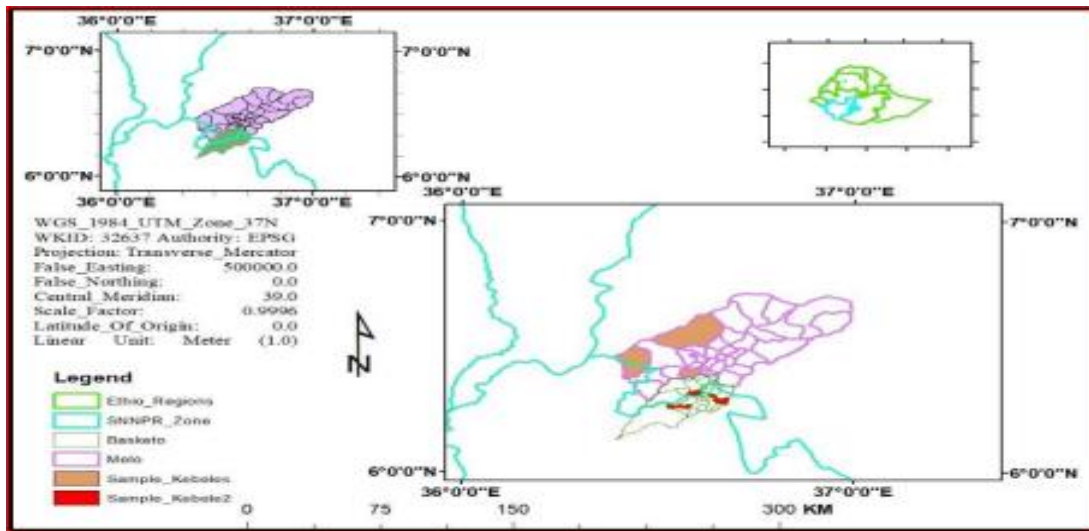


Figure 1. Descriptions of the Demonstration Areas

## 2. Description of the Varieties Demonstrated

Hawassa dume and Nasir are among the high yielding common bean varieties in pre-extension demonstration trials at Gofa Zone, Southern Ethiopia

Table 1. Descriptions of the Hawassa Dume and Nasir Varieties

Name of the Variety	Year of release	Seed color	Grain Yield (Kgha-1)		Released Research Center
			Farmers field	Research Center	
Hawassa Dume	2001	Small red	2,400	3,000	Hawassa
Nasir	2003	white	1,820	2,500	Melkasa/EIAR

Source Fitsum and Tasew, 2022

## 3. Site and Farmers Selection

Melo-Koza district from Gofa Zone and Laska Zuria district from Basketo Zone were purposively selected based on common bean production potential. 4 representative Kebeles (Banka, Bokire, Gergeda and Leha) from Melo-Koza Distric, and 2 Kebeles ( Angila-1and Angila-3) from Laska Zuria, with total of 6 Kebeles were selected purposively for the demonstration. 41and 77 farmers were selected from Melo-Kaza (for the Nasir) and Laska Zuria

district (for the Hawassa dume) respectively based on cluster approach by considering each farmer as a replication table 2.

Table 2. Participant Farmers for Large Scale Demonstration of Common Bean at 2 Districts

Zone	District	No of Kebele	No of farmers		Varieties demonstrated	No of clusters	Area(ha)
			Male	Female			
Gofa	Melo-Koza	2	31	10	Nasir	2	10
	Laska Zuria	4	69	8	Hawassa dume	8	30
Total		6	100	18		10	40

#### 4. Implementation Procedure for the Demonstration

##### 1. Farmer's Research and Extension Groups Establishment

The cluster based large-scale demonstrations are implemented on a relatively medium-scale after technologies proven their performance under pre-extension demonstration after adaptation trial (Derese, 2020).

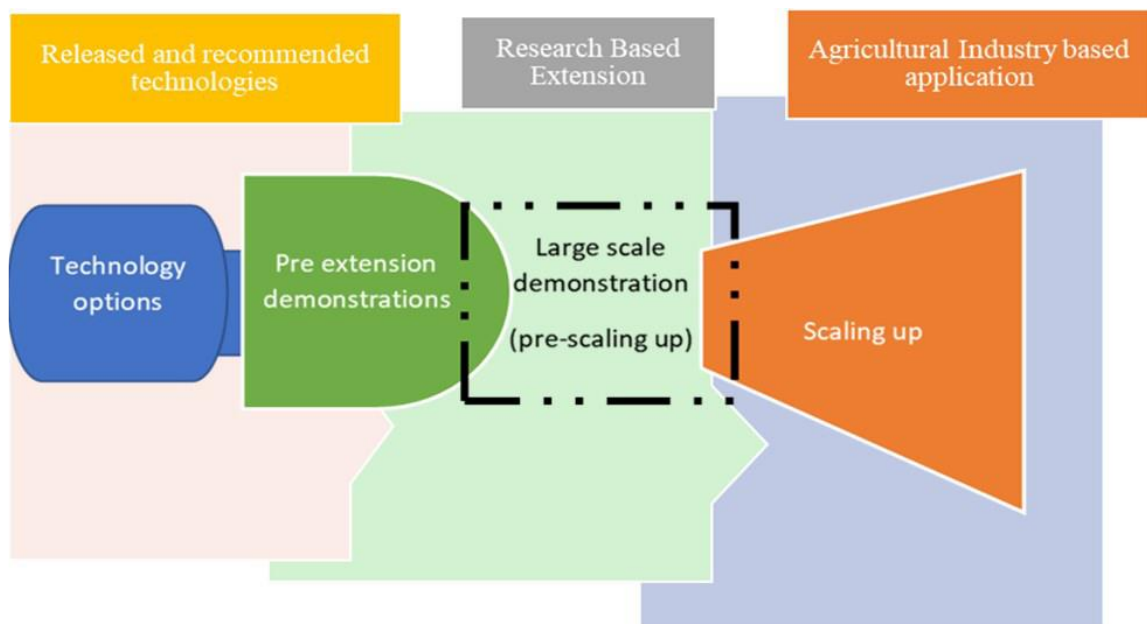


Figure 2. The Large-Scale Technology Demonstration  
Source: Adopted from Derese (2020)

Farmers Research Extension Group (FREG) was organized to integrate passive farmers with active (model) farmers and the FREG members were selected based on their willingness to become member, accessibility for monitoring the activity and openness in sharing experiences with other farmers. As a result, each Kebele developed a FREG with 10-12 members consisted of men, women, and young farmers from resource rich, medium-income, and poor categories of farming (JICA, 2015; Chimdo, 2008). FREG was organized to build farmers knowledge and skill through technical and theoretical trainings

and experience sharing (Joshi,1996). For the demonstration, 118 farmers were grouped in eight cluster and all clusters cover a 40 hectares of land (Table: 2).

One of the extension method used in technology transfer is training. Training and field day can enhance farmers knowledge and skill (Kebede et al,2023). Training was given for selected farmers as well as Development Agents in the Kebeles about common bean production technology packages. Then after all necessary inputs were delivered to the farmers. A total of 202 farmers including follow farmers, 18 development agents and 16 other experts from different sectors are participated in the training (Table 3).

Table 3. Training on Common bean Agronomic Practices and Concept of Cluster Approach

District	Farmers			Development Agents			Others		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Melo-Koza	60	5	65	2	1	3	2	-	2
Laska Zuria	122	15	157	15	-	15	12	-	12
Total	182	20	202	17	1	18	14	-	16

### 5. Agronomic Recommendations and Inputs Used

The demonstration was conducted under clustered farm plots in Melo-Koza and Basketo Special districts in 2022/23 main cropping seasons. Nasir was demonstrated at Melo-Koza district and Hawassa Dume at Laska Zuria district. A total of 800 and 2,400 Kg of Nasir and Hawassa- dume seeds respectively were supplied to the participant farmers in the 2 districts (Table 4).

Table 4. Agronomic Recommendations Used for Common Bean Production in Two Districts

No	Practices	Recommendations used for the 2 demonstrated varieties	
		Nasir	Hawassa Dume
1	Location	Melo-Koza	Laska Zuria
2	Number of farmers participated	41 from 2 Kbeles	77 from 4 Kebeles
3	Land size (ha-1)	10	30
4	Seed rate (Kg/ha-1)	80	80
5	Sowing depth(cm)	5-7	5-7
6	Spacing(cm)	40 b/n rows and 10 b/n plants (250,000 plants ha <sup>-1</sup> )	40 b/n rows and 10 b/n plants (250,000 plants ha <sup>-1</sup> )
7	NPS fertilizer rate (Kg/ha-1)	100	100
8	Weed Management	4 times hand weeding	4 times hand weeding

## 6. Stakeholders Responsibility in the Demonstration

The stake holders involved and their responsibility in the demonstration was shown here under (Figure 3).

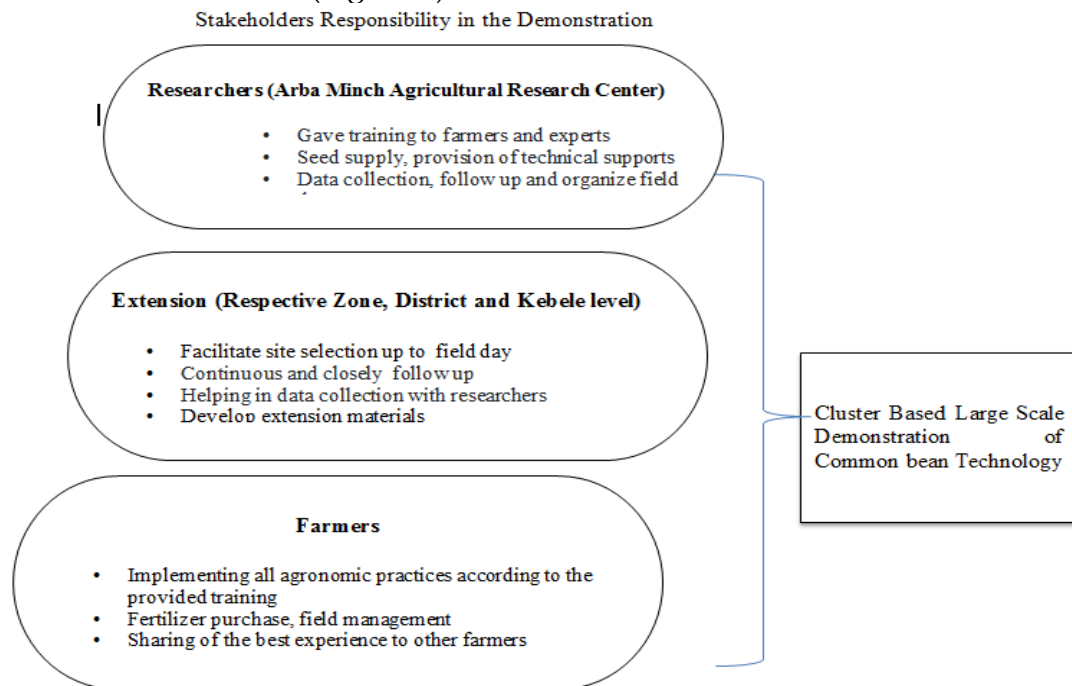


Figure 3. List of Stake Holders Responsibility Shared During the Demonstration

## 7. Monitoring, Evaluation and Field Day

Field day increase technology adoption by 12.2% (Emerick and Dar,2020). At different crop stages, evaluation of the technology was done by farmers and different stakeholders and experience sharing sessions were undertaken. At the maturity stages of the crop, farmers' field day organization was taken place with inclusion of multi-stakeholders. A total of 154 participants (105 farmers, 15 Development Agents, 5 subject matter specialists and 20 others invited guests from Basketo and 68 farmers, 6 Development Agents, 4 subject matter specialists and 6 others were attended the field events and the field day events were shared to medias the mass by Face book, South Radio and Television (Table:5)

Table 5. Number of Participants for the Field Day Events

S No	Participants	Melo-Koza			Laska Zuria		
		Male	Female	Total	Male	Female	Total
1	Farmer	63	5	68	83	22	105
2	Development agents (DAS)	6	-	6	11	3	15
3	Subject Mater specialists	4	-	4	5	-	5
4	Other invited gusts	8	-	8	20	-	20
<b>Total</b>		<b>81</b>	<b>5</b>	<b>86</b>	<b>129</b>	<b>25</b>	<b>154</b>

## 8. Method of Data Collection

The grain yield data was collected from an area of 2m x 2m in the form of quadrat estimation method (from the highest, medium and lowest performed crops per field) diagonally and sun-dried, threshed and measurements were undertaken from fields of 20 randomly selected farmers from the 2 districts. The grain yield was adjusted to 10% moisture content. Sample field harvests were weighed and summed and converted into grain yield on hectare basis. Farmers' perception data toward the technology from the 2 districts was collected from Focus Group Discussion participants using check lists. The lessons learned by farmers in common bean production was also recorded.

## 9. Method of Data Analysis

The grain yield data was analyzed using mean, minimum, maximum, percentage and standard deviation. Farmers' perception was analyzed using Likert scales using perception mean score. Farmer's feedback was analyzed and interpreted qualitatively.

## RESULTS AND DISCUSION

### 1. Adjusted Grain Yield Performance of Each Common Bean Varieties at Farmers field

The mean grain yield of Nasir in Melo-Koza district was 1,960 and Hawassa-Dume at Basket Special district was 2,108 Kg/ha-1 (Table:6 and Fig.4). Both varieties gave better yields compared to Ethiopian national average yield of common bean of 1,762Kg/ha-1 (CSA 2021). The result is consistent with Murut et al, 2014 in Tigray, Northern Ethiopia, Mukerem Eliyas, 2022, Worabe Ethiopia and Abebe et al,2022 at Central Rift Valley of Ethiopia. This is an indication that realized yields at farmers' farms still have huge potential for further improvement. The result was consistent with that of (Teame et al., 2017; Yitayal and Lema (2019).

Table 6. Summary of Adjusted Mean Yield of Common Bean Varieties at 2 Districts in Kg/ha-1 in 2022/23 (N=40)

Variety	District	Minimum	Maximum	Mean	Stand. Dev.
Hawassa dume	Basketo	1,900	2,350	2,108	244
Nasir	Melokoza	2,000	2,175	1,960	292



Nasir performance at flowering stage

Hawassa Dume performance at flowering stage

Figure 4. Performance of the Two Varieties at the 2 Districts

## 2. Farmers Perceptions

Likert scale values were created for eight positive and three negative questions. A score was requested from the farmers: - \* The values for positive perception were do not know = 0, disagree = -1, and agree = 1.

\*\*The parameters for negative perception were do not know = 0, disagree = 1, and agree = -1.

In terms of farmer attitudes, most farmers concur that the Nasir variety in the Melo-Koza district has good germination performance, high yielding ability, large seed size, and a quick maturity time. On the other hand, most farmers in the Basket district agree that Hawassa dume has good germination performance, high yielding, a short maturity period, and intercropping adaptability (Table 7).

Table 7. Farmers Perception on Common Bean Technologies at Melo-Koza and Laska Zuria Districts in Cluster Approach (n=50)

No.	Perception	Nasir at Melo-Koza			Hawassa- dume at Laska Zuria		
		Farmers level of perception			Farmers level of perception		
		Agree	Disagree	Do not know	Agree	Disagree	Do not know
<b>Positive perception*</b>							
1	Good germination performance	1			1		
2	Large seed size	1			1		
3	High yielding potential	1			1		
4	Good grain color		-1			-1	
5	Takes short time to mature	1			1		
5	Sweetness/ good taste	1					0
6	Threshability		-1				0
7	High Market demand		-1				
8	Suitability to intercropping	1			1		
<b>Negative perception**</b>							
1	Sensitive to water loading			0		-1	
2	Poor pod set		-1			-1	
3	Easily attacked by pests		-1				0

### 3. Awareness Creation

The suggested rates for fertilizer and seeding were communicated to all participating farmers at the conclusion of the activity. Remarkably, following the implementation demonstration in the study region, 100%, 88.98%, 66.94%, and 56.5% of participating farmers knew how to apply fertilizer, seed rate, spacing, and agrochemicals, respectively (Table 8).

Table 8. Farmers Aware of the Recommended Practices of Improved Common Bean (N= 118)

No	Recommended Technology	Number of farmers aware			
		Male	Female	Total	Percent
1	Spacing	100	18	118	100
2	Seed rate	87	18	105	88.98
3	Fertilizer rate	31	12	43	36.45
4	Fertilizer application	63	16	79	66.94
5	Agro-Chemical application	36	13	49	56.5

#### **4. Feedback Given**

Farmers appreciated the technology, its agronomic practices and approaches compared to their former cultivars and agronomic practices. Especially sole common bean sowing is not dominant in these demonstration sites and now a time, they gain good result from sole cropping. Good results of the common bean varieties in terms of grain yield, grain color, number of pods per crop, and well-coverage of pod tips were noted by farmers as reasons for their appreciation. Agricultural extension staff of Melo-Koza district reported that cluster-based approach opened the door for farmers to implement full-package applications to boost common bean technology.

#### **5. Lessons learned from the Demonstration and Approach Used**

- Farmers confirmed that a demonstration of new technology using appropriate extension methods such as training and field days are among the best approaches in technology transfer.
- The use of fertilizer for the common bean, especially NPS rate was uncommon in the study areas and this demonstration has tried to demonstrate the yield difference using the recommended NPS fertilizer rate
- Cluster-based technology dissemination and transfer approach played a significant role to easily diffuse knowledge and practice from one cluster to the other and created awareness on disseminated technologies.
- Cluster approach is also the best way to evaluate strengths and weaknesses of the member farmers in the cluster management practices and is the best approach to easily reach the majority
- Multi-stakeholders' participation and share responsibility in cluster based approach reduces the time of adoption of the technology in the community because of the multiple interactions of stakeholders through direct and indirect meetings
- A farmer-Extension-Researcher linkage creates opportunity for jointly participation in problem identification, planning, implementation and finding solution to the farmers.

#### **CONCLUSION AND RECOMMENDATIONS**

Large-scale cluster-based Common bean technology was demonstrated on 40 hectares of land across 118 farmer's fields in the districts of Melokoza and Basketo Zuria. Farmers, Development Agents, and office-level Subject Matter Specialists received consulting training on common bean agronomic procedures in order to get an understanding of enhanced common bean production practices. Farmers, Development Agents, heads of the District and Zone offices of Agriculture, researchers throughout the crop's maturity stage, and other stakeholders attended the field day. The result of the adjusted mean yield of 2,108 and 1,960 Kg/ha-1 was obtained from Hawassa dume and Nasir varieties respectively which is relatively good compared to national common bean productivity. The 2 demonstrated common bean varieties exhibited better yield in their respective locations. Target farmers have decided to grow the 2 improved common bean varieties and agreed to share their available seed to other follower farmers who eagerly follow the demonstration activities. Therefore, the respective districts and Zonal office of Agriculture each Zone

should expand and address the technology with its full packages to wide areas of the community through different means of extension system for further production.

#### **Disclaimer (Artificial Intelligence)**

Authors hereby declare that NO generative AI technologies such as large language models(Chat GPT,COPILOT,etc) and image to text generators have been used during writings and editing manuscripts.

#### **Consent and Ethical Approval**

Before work, a support letter from Arba Minch Agricultural Research Center was given to the Gofa and Basketo Zone office of Agriculture for their permission and support. After getting permission, the study design was explained to the administrative bodies of the office of Agriculture of the respective Zones. Furthermore, the study kebele' selection was purposively undertaken. Then, a supporting letter from the district office of Agriculture head was also presented to the sample kebele administrators and Development Agents by informing the purpose of the research for being there. All the respondents have been informed of the objective of the study in general and the purpose of the demonstration in particular. Respondents were also informed about the data obtained from them will be kept confidential and all respondents who participated in the demonstration were fully acknowledged.

#### **Competing Interests**

All authors have declared that there is no competing of interests

#### **ACKNOWLEDGMENTS**

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