

Pre-scaling Up of Improved Haricot Bean Varieties in Lowlands and Mid-Highlands of Borana Zone, Oromia National Regional State, Ethiopia

Feyissa Desiso^{*}, Ahmed Mohammed Abdulla, Yonas Asefa

Department of Agricultural Extension, Yabello Pastoral and Dryland Agriculture Research Center, Yabello, Ethiopia

Email address:

feysa2013@gmail.com (Feyissa Desiso)

^{*}Corresponding author

To cite this article:

Feyissa Desiso, Ahmed Mohammed Abdulla, Yonas Asefa. Pre-scaling up of Improved Haricot Bean Varieties in Lowlands and Mid-Highlands of Borana Zone, Oromia National Regional State, Ethiopia. *Science, Technology & Public Policy*.

Vol. 10, No. 5, 2022, pp. 177-182. doi: 10.11648/j.jps.20221005.12

Received: September 20, 2022; **Accepted:** October 24, 2022; **Published:** October 29, 2022

Abstract: This research was undertaken in the Yabello and Abaya districts of Borana and West Guji zone, Southern Oromia with the objective of disseminating the already tested and selected varieties of haricot bean, Hawassa-Dume and Batu to the farming community. The districts were chosen purposively based on the potentiality for Haricot bean production and accessibility to road; and one potential peasant association (PA's) from each district was selected. A total of 24 experimental farmers, twelve (12) from each PA's were chosen. Then, 86 participant farmers and other stakeholders were given training by multi-disciplinary team of agronomist, pathologists and agricultural extensionst researchers on importance of technology and its agronomic practices. Two haricot bean varieties, Hawassa-Dume and Batu were sown on 0.25 ha of trial farmers' fields. A seed rate of 80kg/ha and 100 DAP kg/ha were used with a line spacing of 35 cm between rows. Consequently, a total of 24 farmers were reached, 480kg seed was distributed and an area of 6ha was covered. A mini field day was prepared and a total of 86 participants were attended. The overall grain yield performances of two improved varieties were 12.8 and 5.7 quintals per hectare for Hawassa-Dume and Batu respectively. The research intervention had improved the production and productivity, knowledge and skill of participated farmers. At completion of the research project, an exit strategy was designed to ensure its sustainability. Therefore, all concerned bodies should scale up/out those varieties within the study districts and similar agro ecology to improve the production and productivity of haricot bean in the region.

Keywords: Borana, Pre-scaling up, Hawassa-Dume, Batu, Multi-disciplinary

1. Introduction

In Ethiopia, agriculture remains the mainstay and key sector that contributes to nearly 34% of the country's Gross Domestic Product (GDP) and 71% of employment. From this, the share of crop production is about 72% percent of the total agricultural GDP, of which cereals production covered 79.9 %, pulses 13.2 % and oil seeds 6.9 % [4]. Haricot beans (*Pharsalus vulgaris*) are an important pulse crops in areas where rainfall is marginal. Common beans are among the most economically important pulse crop produced in Ethiopia and are the main cash crop and sources of protein for many lowlands and mid-altitude zones of the country. Moreover, a haricot bean is an important source of income;

its straw is serves as feed for livestock, and also improves soil fertility through its nitrogen fixation in the cropping season. It is known as an export crop, drought tolerant and emergency crop for poor farmers especially in areas receiving low amount of rainfall [7, 12]. Despite its contribution, the production of haricot beans is generally low due to lack of high yielding variety, drought, poor soil fertility, poor linkage of input-output markets, and loss due to pests and diseases [8].

Haricot beans are largely grown in the rift valley of southern eastern, as well as the western parts of the country and its production is mainly confined to small farmer, where inputs such as improved and fertilizers are rarely used. For instance, in Ethiopia, in 2017 cropping season, 78,910.13

hectares of land was covered by white Haricot bean with an estimated production of 1.26 tons per hectare [2]. However, the average national productivity of haricot bean is far less than the average research demonstrated productivity potential (3.4 tons per hectare) in the country due to drought, diseases and pest, lack of improved seed, high price of improved seed, low adoption of improved production technologies and poor cultural agronomic practices [2, 3, 10, 14, 15].

A haricot bean is the dominant pulse crop grown in pastoral and agro-pastoral areas of Borana and West Guji zone. Yet, the productivity of the haricot bean is low due lack of improved variety, diseases and pests, drought, and poor agronomic management practices. Having recognized this fact, the Yabello Pastoral and Dryland Agriculture Research Center (YPDARC) has undertaken demonstration of already tested haricot bean varieties (Hawassa-Dume and Batu) on the selected trial farmers field for two consecutive cropping season (2013 and 2014) based on the result of adaption. The results of demonstration have shown that Hawassa-Dume and Batu were selected by farmers and high yielder variety compared to local standard check. Accordingly Hawassa-Dume was recommended for Abaya and Batu for Yabello districts. Therefore, the present study was initiated to further promote and pre-scale up of these two varieties in the selected peasant association (PA's) of Yabello and Abaya districts.

2. Objectives of the Study

The general objective of the study was to increase production and productivity of drought tolerant haricot bean varieties in the study districts.

Specific Objectives:

The specific objectives of the study were:

- 1) To increase the production and productivity of participated farmers and agro-pastoralists in the study area.
- 2) To improve farmers and agro-pastoralists' knowledge and skill of application of the improved Haricot bean technologies.
- 3) To develop local capacity for future scaling up of Haricot bean technology.
- 4) To strengthen stakeholders linkage and collaboration.

3. Methodology

3.1. Description of the Study Areas

3.1.1. Yabello

Yabello is located at a distance of 570km south of the capital city of Ethiopia, Addis Ababa. Astronomically the Yabello district is located between 3° 8' 46"-10° 09' 04" North latitude and 3° 18' 03"-43° 04' 24" East longitude. The altitude of the district ranges from 1000 to 1700 meter above sea level. It is bounded by Regional State of Southern Ethiopia in northwest, Teltele district on the west, Arero district at the east, Dugda Dawa district in the north and the Dire district in the south. Generally the district has a total

area of 5550 km². The average annual temperature of the district ranges from 19°C to 24°C while the average annual rainfall of the district ranges from 500-998mm. The two major types of soils found in the district are luvisols found in central southern, southeastern and northern parts and acidic Orthic aerosols that occurred mainly on sloping terrain of northeastern parts of the district. The livelihood of the pastoralists in area mainly depends on livestock and crop production in the study area [13].

3.1.2. Abaya

The capital center of the Abaya district is Guangua and is found at 365 Km from Addis Ababa to the south and 7 km from Dilla town to the South direction. Abaya is situated at 6° 14' North latitude and 30° 10' East longitude. The altitude of the district ranges from 1200-2060masl. It has an estimated average annual rainfall of about 1223mm and the average annual temperature ranges from 16°C – 28°C. It is bordered by regional state of Nations, Nationalities and people of southern Ethiopia in the North and East, Lake Abaya to the West and Gelana district in the South. The only two types of agro-climatic condition of the district are the mid highland and lowlands. About 30% of the total area of the district falls under mid highland. The remaining 70% falls under lowlands agro-climatic condition. According to the soil map of Borena Zone, the soil unit of Abaya Woreda are calcaric and euri-cluvi sols, euri-citols and chiomic and orthicluvis sols. Of these, the first two are the types of soils covering the largest part of the Woreda. According to the information obtained from Agricultural office of Abaya district, the major crops produced were maize, barley, 'teff', sorghum, haricot bean, wheat, field pea and faba bean [1].

3.2. Site and Farmers Selection

The research was conducted at Yabello and Abaya district of Borana and west Guji zone respectively. Potential Haricot-bean producing peasant association (PA's) one (1) PA from each district and 12 farmers/agro-pastoralists per PA were selected in collaboration with the respective district of Agriculture and natural resources bureau. Two early maturing and high yielder varieties of Hawassa-dume and Batu were used for these activities. An area of 2500 m² (0.25 ha) land size was used for these research studies at each selected farmers' field. The training was given for the selected farmers and DAs concerning this research activity overview production system of the varieties. The Supervision and monitoring were closely undertaken through joint action of stakeholders.

3.3. Memorandum of Understanding

Before the beginning of the research activity, memorandum of understanding (MoU) was signed among Yabello Pastoral and Dryland Agriculture Research Center (YPDARC), and Yabello Pastoral Rural Development, and Abaya district Agricultural and Natural Resource office on their accountability to guarantee sustainable dissemination of the technology for a wider community.

4. Approaches Used and Procedures Followed for Enhancing Technology Dissemination

4.1. Research Design

Two haricot bean varieties; Hawassa-Dume and Batu were sown on a plot size of 0.25ha (50m × 50 m) of farmers' fields at each PA's. A seed rate of 80kg/ha and 100kg DAP/ha were used with a line spacing of 35cm between rows. Consequently, a total of 24 farmers were reached, 480kg seed was distributed and an area of 6ha was covered with the varieties.

4.2. Data Types and Methods of Collection

Quantitative data like yield data, change in level of knowledge and skill of farmers and/or agro pastoralists, total number of farmers participated on extension events such as training, field visits and field days, total number of farmers copying the technology/innovation and stakeholder's participation were collected. Appropriate data collection methods (Simple survey, check lists, questionnaires, personal observation, field days, five point Likert scale) were used to collect both qualitative and quantitative data.

4.3. Method of Data Analysis

Farmer's preference was analysed qualitatively through narration and description and Economic & agronomic data was analysed by descriptive statistics using SPSS version 20.

4.4. Method of Analysis of Change in Level of Farmers'/Agro Pastoralists' Knowledge and Skill

The investigation of the immediate application of new knowledge is crucial to assess whether the knowledge of a particular farmers/ agro pastoralists was improved after engaging in it or not. For example, Seba *et al.* (2012) [11] and Lin and Lee [9] (2004) developed a questionnaire based survey to measure level of knowledge, skill and perception using five point Likert attitude scale. Based on their studies, about 8 (eight) statements/items which were used as proxy indicators of knowledge such as: change in level of knowledge and skill on application of appropriate seed rate, distance between rows and plants, sowing, weeding and other management practices, seed preference, importance of technology and changes in knowledge and skill made by the participated farmers and agro pastoralists pre and postharvest management were developed. The knowledge level and skill of the respondents was scored before and after participating in pre-scaling up of improved Hawassa-Dume and Batu. The score was calculated by giving values to all responses used as a proxy indicator of the level of knowledge and skill following five point Likert type attitude scale (5= Strongly agree, 4= Agree, 3= undecided 2= Disagree, 1= Strongly disagree). Then, the total knowledge and skills score test for the participant becomes a total score which is suitable for analysis of paired sample t-test to test/check whether

knowledge of farmers has improved or not following the procedure used by Desiso *et al.* [6]

5. Results and Discussions

5.1. Yield Performance of Pre-scaled up Varieties

The average grain yield performances of Hawassa-Dume was 9 and 7.5qt/ha at Yabello and 18 and 16.8qt/ha at Abaya while that of Batu was 6 and 5.4 qt/ha in 2015/16 and 2016/17 cropping season respectively as shown in (Figure 1). Generally, the pooled average grain yield performances of two improved varieties were 12.8 and 5.7 quintals per hectare for Hawassa-Dume and Batu respectively. The yield obtained in 2016/17 was lesser compared to that of 2015/16 cropping season because of rainfall interruption. Despite this, all the trial farmers were very interested with the Hawassa-Dume for its high yielder and Batu for its early maturity compared to the local varieties. Consequently, the production and productivity of the participated small scale farmers and agro-pastoralists has increased compared to local haricot beans varieties they were using so far. However, the overall mean yield of pre-scaled up of haricot bean varieties were below the average national productivity of demonstrated local varieties which was reported to be 14.8 quintal per hectare [5]. This could be explained by the fact that drought, infestation and improper management practices related with the pre-scaled up varieties.

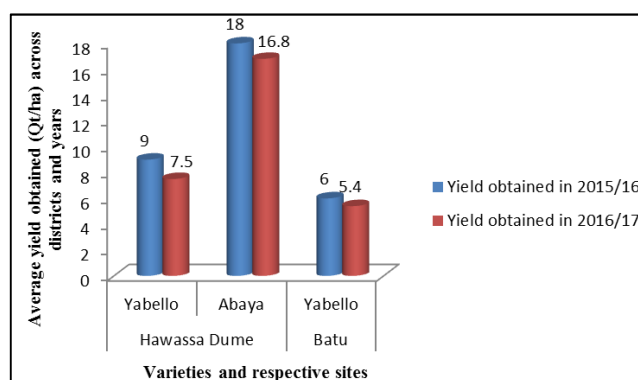


Figure 1. Average yield performance of Hawassa-Dume and Batu across site and the years.

5.2. Capacity Building of Participated Stakeholders

Training is very important for the transfer of new technologies. Both practical and theoretical training were given to the farmers and other stakeholders by multidisciplinary team of Yabello Pastoral and Dryland Agriculture Center researchers consisting of Breeder, Agronomist, Economist and extensionist in the selected districts of Yabello and Abaya. Accordingly, a total of 86 participants: out of which 72 farmers and 14 experts including DA's and SMS were participated in training (Table 1). The topics of the training were built-in the agronomic practices, major diseases and their control measures, rate of fertilizer application, appropriate amount of seed rate,

recommended distance between rows and plants and creating strong linkage among relevant stakeholders through multi-

stakeholders approach to alleviate the problems in joint action taking immediate, short and long term actions.

Table 1. Training given for farmers and other stakeholders on haricot bean production.

Year	Participants (N=86)						Grand Total
	Experts (Development Agent SMS)			Farmers/agro pastoralists			
	Male	Female	Total	Male	Female	Total	
2015/16	5	3	8	39	9	48	56
2016/17	4	2	6	20	4	24	30
Total	9	5	14	59	13	72	86

Note: SMS= Implies Subject Matter Specialists.

5.3. Field Days

At physiological maturity and threshing stage of the crop varieties (Hawassa-Dume and Batu) a mini field day was jointly organized with Peasant Association (PA's) leader, development agents' and target farmers/agro pastoralists in the representative PA's to create awareness about the importance of introduced crop varieties and its agronomic practices and further dissemination of the varieties through farmers to farmers approach. Generally, a total of 86 participants (61 farmers from trial and non-trial), 5 researchers, and 8 DA's and 12 stakeholders including government and NGOs were participated in the event). On

the field day, all the participants shared their best experience and discussed the condition of improved Hawassa-dume and Batu haricot bean varieties and were very much interested with both varieties for their high yielder and early maturity. Therefore, the varieties were recommended for further scaling up to increase production and productivity of small scale farmers in both study districts and zone. However, they indicated that the varieties have ensured our food security at household level but Hawassa-Dume was not demanded by market and therefore new varieties which are highly demanded by market should be generated and adapted by the concerned bodies to fill this research gap.

Table 2. Exchange visit organized on Haricot bean varieties at Abaya/Bunnata.

Year	Technology visited during field day	Location/district	Number of Participants						
			Farmers/Pastoralists			Stakeholders			
			Male	Female	Total	Researchers	DAs	(GOs and NGOs)	Total
2015/16	Hawassa-Dume	Abaya/Bunnata	50	11	61	5	8	12	86

Note: DA= Development Agent, SMS implies Subject Matter Specialist, GOs = implies Government Organizations, NGOs = Non-government Organizations

5.4. Change in Level of Knowledge and Skill

Farmers' knowledge and skills are expected to be improved after engaging in a research activity because of practical and theoretical training given for participated farmers on all aspects of production in relation to sowing, weeding, pest control, importance of technology (Desiso *et al.*, 2018). The highest attitude score for knowledge and skills improvement before and after participating in pre-scaling of improved Hawassa-Dume and Batu variety was 25 and 30 respectively; while the lowest attitude score for knowledge and skills improvement was 11 and 14 respectively (Table 3). The mean attitude score of knowledge and skill for before and after participating in pre-

scaling up of improved Hawassa-Dume and Batu variety was 18.3 and 23 respectively out of an obtainable potential score of 40. The result of paired sample t-test showed that there was positive and a statistically significant mean difference between knowledge and skills prior to and after engaging in pre-scaling up activities at less than 1% level of significance ($p= 0.001$). The implication is that farmers' knowledge and skills have improved after engaging in pre-scaling up of improved Hawassa-Dume and Batu variety as a result of actively participation of farmers in a research activity from the land preparation to harvesting. This finding is in line with the study conducted by Desiso *et al.* [6] who found the same result.

Table 3. Change in level of knowledge and skill of Farmers' on application of improved haricot bean varieties before and after intervention.

Variables	Farmers' Knowledge and Skill Improvement (N=24)		
	Before Scaling up	After Scaling up	t-value
Mean	18.3	23	3.862***
Std. Deviation	4.7	4.3	
Minimum	11	14	
Maximum	25	30	

N= Number of participants, *** indicates 1% level of significance.

5.5. Memorandum of Understanding

Before the start of the research activity, memorandum of understanding (MoU) was signed among the Yabello Pastoral and Dryland Agriculture Research Center (YPDARC), Yabello Pastoral Rural Development and Abaya district Agricultural and Natural Resource bureau on their accountability to guarantee sustainable distribution of the technology for a larger community. Accordingly, a tough linkage was enhanced among relevant stakeholders through working collaboratively; jointly monitoring and evaluation, attending extension events such training, organizing, field visit and field days and sharing and agreeing their responsibility to further scale out the technology for a wide range of farmers in the zone. As a result, the local capacity to produce seed for future scaling up of haricot bean technology was developed.

5.6. Exit Strategy

The obligation of Yabello Pastoral and Dryland Agriculture Research centre (YPDARC) is starting from technology generation, adaptation, demonstration and up to pre-scaling up stage of appropriate technologies needed for sustainable development of pastoral and agro-pastoral areas of the zone in particular and Ethiopia in general. As a result, it vital to seek an alternative options in which a large number of farmers could engage in the technology promotion through a farmer to farmer mechanisms. Therefore, the main collaborators of YPDARC were bureaus of Yabello and Abaya Agricultural and Natural Resource of their respective districts. As a result, the wider scope of further scaling up of the newly introduced technologies should be supposed to have remained to be implemented by respective offices of Agricultural and Natural Resource district in both study districts. These could enhance strong extension system linkages among relevant stakeholders to guarantee the sustainability of diffusion of the technologies for a wider coverage until better technologies with regard to those haricot bean varieties option developed. To attain these objectives, YPDARC and both districts of Agricultural and Natural Resource of Yabello and Abaya offices have discussed on how to ensure the sustainability of dissemination of technology and wider scaling up of the technology to a wide range of farmers and agro pastoralists and then decided to own the technology by office of Agricultural and Natural Resource of the respective districts and with the facilitation of YPDARC in technical and close supervision.

6. Conclusion

Haricot beans is the most economically important pulse crop grown in Ethiopia and is considered as the main cash crop and protein sources for many lowlands and mid-altitude. Generally, the result of the present study showed that the newly introduced improved haricot beans varieties gave high yielder, early matured and had increased income and

improved the livelihoods of small scale farmers in the district. Moreover, Knowledge and skill of development agents and agricultural experts also enhanced as a result of training given and exchange visits organized.

Better accessing of Haricot bean varieties, change in the level of farmers' skill, knowledge and attitude on the importance and application of all recommended packages were the impacts attained during the pre-scaling up activity. Furthermore, popularization and pre-scaling up of improved Haricot bean varieties enhanced through farmer to farmer seed dissemination mechanism. The study has shown that the production and productivity of haricot bean of participated small scale farmers and agro pastoralists has increased at household level. However, during field day farmers indicated that the Hawassa –Dume variety was not demanded at market because of its color (Red). Finally, both varieties (Hawassa-Dume and Batu) haricot bean varieties were recommended for further scaling up and out in the study districts and similar agro-ecologies.

7. Recommendations

Based on our results, we suggested the following recommendations:

All concerned bodies should give due attention on enhancing farmers' capacity building (knowledge and skill) before introducing any technologies through training, strengthening linkage, widely extending improved haricot bean varieties at large in order to boost the production and productivity of Haricot bean varieties in the study area in particular and Borana and Westi Guji Zone in general.

It is vital that efforts should be made by agricultural research centers and academician to work on generating, adapting and releasing alternate haricot bean varieties (Colorful) which are highly demanded by the local and international market so as to improve the livelihood of small scale farmers in both Yabello and Abaya districts to fill this research gap.

There should be a strong linkage among relevant stakeholders: farmers, agro pastoralists, research centers, zonal and district agricultural offices so as to build the capacity for future sustainable dissemination of the haricot bean technologies for a wider community at large in the study area in particular and other similar agro ecology in general.

Acknowledgements

The authors would like to thank the Oromia Agricultural Research Institute (OARI), Yabello Pastoral and Dryland Agriculture Research Center (YPDARC) for financing and providing working facility of the research study. Many thank also goes agro-pastoralists who are actively participated in research and provide their lands for free.

Conflict of Interests

The authors have not declared any conflict of interests.

Appendix

A simple assessment survey conducted on change in level of knowledge and skill of farmers before and after the intervention.

Fill the following table by putting scales of agreement/disagreement ranging from strongly disagree to strongly agree (1-5) for the level of knowledge and skill before and after you engaged in pre-scaling up of improved Haricot bean (Hawassa-Dume and Batu) variety.

Table 4. A simple assessment survey conducted on change in level of knowledge and Skill of farmers before and after the intervention.

S. No	Items/statements	Before pre-scaling up (Score)	After pre-scaling up (Score)
1	My Knowledge & skill on the application of seed rate with regard to Hawassa-Dume and Batu have improved		
2	My Knowledge & skill on the application of fertilizer with regard to Hawassa-Dume and Batu have improved		
3	My Knowledge & skill on between rows and plants have improved		
4	My Knowledge & skill on sowing with regard to Hawassa-Dume and Batu have improved		
5	My Knowledge & skill on agronomic practices with regard to Hawassa-Dume and Batu have improved		
6	My Knowledge improved on seed preference have improved		
7	My Knowledge & skill on the importance of Hawassa-Dume and Batu have improved		
8	My Knowledge & skill on post harvesting have improved		

Note: Put your response by giving rate to the five Score level of knowledge and skill in the above table (1= Strongly disagree, 2= Disagree, 3= Undecided, 4= Agree, 5= Strongly agree) in the increasing order.

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