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Research Article

Pre-extension Demonstration and Evaluation of Improved Lentil Technologies in Bale and East Bale Zones, Southeastern Oromiya, Ethiopia

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Abstract

Lentil is one of the most important food legumes consumed widely throughout the world. It has a significant untapped potential to meet, at least partially, nutritional, soil fertility, and income requirements of smallholder farmers of Ethiopia. However, lentil production faces numerous constraints such as lack of improved seed in the country. Hence, development and dissemination of improved lentil varieties with its packages is an important task to overcome this problem. This activity was undertaken with the main objective of demonstrating and evaluating recently released Lentil technology under farmers' management condition in Goro district of Bale Zone and Gindhir district of East Bale zone. Two kebeles from each district and two farmers from each kebele were selected. An improved variety Debine was demonstrated and compared with Asano (standard check) on farmers' field. The demonstration was laid out on single plot of 10m x 10m areas for each variety by applying the recommended full packages. Yield data on plot base was recorded and analyzed using descriptive statistics while farmers' preference to the varietal attributes was identified and ranked using pairwise ranking and simple ranking methods. Mini-field day was organized in each kebele to facilitate the way in which experts and farmers can participate in varietal evaluation and selection based on their selection criteria. The average yield of Debine (1743kg/ha) is higher than Asano (1400kg/ha). Furthermore, farmers selected Debine due to its higher number of branch/plant, higher number of pod/branch, high yielder, better adaptable to environment, better drought tolerant, better plant height, and better tolerant to frost. Thus, Debine is recommended for wider scaling up/out activity in the districts.

Keywords

Debine, Demonstration, Lentil, Selection Criteria

1. Introduction

Lentil is self-pollinating annual crop originated in the near east and [7]. It was one of the first crops to be domesticated by humans, approximately 11,000 BP [10]. Lentil is one of the most important food legumes consumed widely throughout the world. Lentils are produced in diverse agro-ecological regions, such as Asia, North and South America, Africa, and Oceania. During the last two decades (2001–2020), world production of lentils increased by 107%, from 3.15 to 6.54 million metric tons [9].

Ethiopia is considered as the center of diversity for lentil,

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making Ethiopia one of the major lentil producing countries in Africa [7, 13]. The country has been among the top 10 lentil producing countries in the world and the first producer in Africa with its area allocation of close to 93 thousand hectares and production of 103 million kg per annum on average for periods between 2000 and 2020 [15].

In Ethiopia, about 69,371.01 hectare of land was covered with lentil crop and 865,386.09 quintals was produced during 2021/22 (2014 E. C.) main cropping season [2]. The major lentil producing regions in Ethiopia are Amhara, Oromia, Tigray and Southern Nations, Nationalities and Peoples (SNNP), with an area of 53446.35ha, 26837.91ha, 6930.15ha and 226.72ha, respectively, in the 2019/2020 cropping season [1].

Lentil has a significant untapped potential to meet, at least partially, nutritional, soil fertility, and income requirements of smallholder farmers of Ethiopia. It is grown in a range of cropping systems particularly in the highland vertisol of Ethiopia, mainly in rotation with tef, wheat, and barely to boost household food security and nutrition, income generation, and overall crop productivity [6]. Lentil is an ancient crop in Ethiopia where it has significant importance in the life of subsistence farmers. Since, it is traded in both local and foreign markets- generating income and consumed as food in various forms thereby satisfying protein requirements. The straw and the haulm are used as animal feed, and it ameliorates soil fertility through atmospheric nitrogen fixation and in so doing reducing the fertilizer requirement of the succeeding crop by about a third to a half [3].

However, lentil production faces numerous constraints due to extreme climate events, biophysical impacts, socioeconomic factors, and most importantly biotic stresses (insect pests, diseases and weeds) that affect its vertical as well as horizontal productivity and production [6]. Lentil yield in Ethiopia has been declining since the late 2010s and the country has turned from net exporter to importer. Although, several factors are attributed to the production decline, lack of improved seed, the recurrent occurrence of viral and fungal diseases, and poor extension system are among major constraints [3, 8, 12].

Agricultural technologies, including modern/improved crop varieties, are a critical measure for improving productivity, meeting food security needs, and bridging inequalities [11]. In line to this, it is important to develop and disseminate high yielding and disease resistant varieties to sustain the production of the crop. As a result, Sinana Agricultural Research Center has released improved lentil variety (*Debine*) with the yield potential of 22-25qt/ha [14]. Hence, this activity was initiated to demonstrate the variety under farmers' management condition in potential districts.

2. Objectives

1) To evaluate the yield performance and profitability of the variety under farmers' condition.
2) To create awareness on the importance of the new improved lentil technologies.
3) To improve farmers knowledge and skill on lentil production and management.

3. Methodology

Description of the Study Area

Goro District

Goro district is found in the South-eastern part of the country 490km far from the capital city of Ethiopia, Finfinne. Geographically, the district is located at 6029'N and 40010'40045' latitude and longitudes respectively. Goro district is bounded by Guradhamole on southwest, Berbere on west, Sinana on northwest, Gindhir on northeast, and Somali Regional State on southeast. The district has bimodal rainfall pattern. Accordingly, there are two distinct cropping seasons locally known as bona and ganna. Bona, the main season covers from August to December, while ganna covers the season from March to May. The average annual rainfall in the area is 500 mm, with annual mean maximum and minimum temperatures of 20°C and 16°C, respectively. Its soil properties are mostly vertisol. The most widely produced crops both under rain fed and irrigation in the district are cereal crops such as barley, wheat, maize and teff; pulse crops such as common bean, chickpea and lentil; spice crops like black cumin, Lentil and fenugreek and vegetable crops such as onion, potato, tomato and pepper.

Gindhir District

Gindhir district is located in Southeastern part of Oromia at 557 km from Finfinne. The district is situated at 7^0 10'42.02" N latitude and 40^0 42'58.64"E longitudes. The area receives 531 mm and its mean annual minimum and maximum temperatures are 13.4°C and 25.5°C, respectively. Gindhir is bordered on the south by the Goro, on the west by Sinana, on the northwest by Gasera and Gololcha, on the northeast by Sawena, and on the east by Rayitu. The area receives 531 mm and its mean annual minimum and maximum temperatures are 13.4°C and 25.5°C, respectively. The soil type is Vertisol. The major crops grown by fanners in the district are wheat (bread, durum and emmer), barley (food and malt), field pea, faba bean, lentil, chickpea, haricot bean, linseed, maize, hot pepper, potato, fenugreek, black cumin, coriander, garlic, onion, cabbage, banana, sugar cane, orange and papaya.

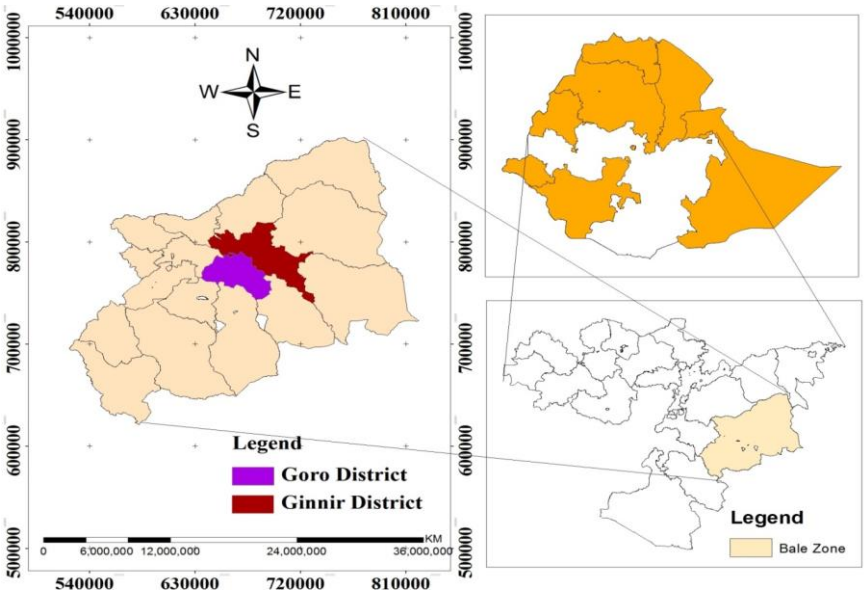

Figure 1. *Map of the study Area.*

Site and Farmers' Selection

Site Selection

Pre-extension demonstration and evaluation of improved lentil technologies was conducted in two potential lentil producing districts (Goro and Gindhir) of Bale and East Bale zones. Purposive sampling techniques were employed to select one representative districts from each zone based on their potential for lentil production. Two kebeles from Goro district and one kebele from Gindhir district were also selected purposefully based on their accessibility and production potential of the crop.

Farmers' Selection

Participatory approach using Farmers Research Group (FRGs) was the main strategy during demonstration of the technology. Selection of FRGs members was based on farmers' willingness to be held as member, accessibility for supervision of activities (vicinity), good history of compatibility with groups and genuineness and transparency to share innovations to other farmers. Therefore one FRG was selected to conduct the activity at each kebele.

Trial Farmers' Selection

Having suitable and sufficient land to accommodate the trials, willingness to contribute the land, vicinity to roads so as to facilitate the chance of being visited by many farmers, initiatives to implement the activity in high-quality, good in field management and willingness to explain the technologies to others were the criteria used to select the hosting farmers. Accordingly, two representative trial farmers from each kebele were selected. Farmers (FRG members and other follower farmers) were encouraged to participate in the physical activities from the beginning up to the end and at each stage of the demonstration activity.

Materials Used and Field Design

One recently released lentil variety (Debine) with one standard check (Asano) was planted on selected farmers' land with simple plot design (10m x 10m) in the main cropping season. The varieties were treated with full recommended Lentil production and management packages. SARC was the source of agricultural inputs (seeds, fertilizer and agro-chemicals in case needed during the implementation of the activity).

Hosting farmers provided their land. Farm operations (land preparation-ploughing four to five times using oxen plough) were carried out by trial/hosting farmers, whereas land leveling, planting, first and second weeding, follow up and visit, harvesting, threshing were handled and managed by SARC. Depending on weed infestation, two effective hand weeding were applied; the first at one month after sowing and the second at two months after sowing of the varieties.

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 focus group discussions (FGDs). Yield data per plot in all locations were recorded. Total number of farmers participated on field visits and mini field days were recorded. Farmers' preference to the demonstrated varieties (likes and dislikes, which is the base for plant breeding process and perceptions towards the performance of the technologies) was identified.

Data Analysis

SPSS was used as statistical package (descriptive statistics was used to analyze the data). Pair wise ranking and simple ranking method was used to rank the varieties in order of their importance.

Technology Demonstration and Evaluation Methods/Techniques

FRGs members and other follower farmers were encouraged to participate on different extension events organized at each site. These were mechanisms used to enhance

farmer-to-farmer learning and information exchange such as field visits/tours, field days, etc.

4. Result and Discussions

Training

Training was given for farmers, development agents and experts on lentil production and management packages at each district. Participants of the training were listed in the Table 1 below. Accordingly, a total of 91 farmers, 18 development agents and 13 subject matter specialists participated on the training.

Table 1. *Participants of training in Goro and Gindhir districts.*

District	Farmers		Total	DAs		Total	SMS		Total
	Male	Female		Male	Female		Male	Female	
Goro	45	6	51	9	3	12	4	1	5
Gindhir	36	4	40	4	2	6	6	2	8
Total	81	10	91	13	5	18	10	3	13

Yield performance of Demonstrated varieties

The yield performance of the demonstrated varities was presented in Table 2 below. Accordingly, the new variety Debine gave relatively higher average yield of 1743kg per hectare with standard deviation of 1.61. Similarly, the standard check also gave mean yield of 1400kg per hectare with standard deviation of 1.67. The yield obtained was above the national average [5] which indicated the variety has a potential to improve the production and productivity of the crop. Moreover, yield performance evaluation was carried using t-test to reveal the yield difference between the new variety and standard check. Consequently, the result of t-test revealed that there was statistically significant mean difference between the yields of demonstrated varieties at less than 5% significance level.

Table 2. *Yield Performance and t-test result among the varieties.*

Lentil varieties	Yield/ha (kg)	Std. Deviation	t-value
Asano	1400	1.61	-3.313**
Debine	1743	1.67	

Comparison of Yield Advantage of Improved Varieties

Comparison of yield advantage of the varieties was computed. Thus, an improved variety Debine has 24.5% yield advantage over the standard check Asano.

$$\text{Yield advantage\%} = \frac{\text{Yield of new variety} - \text{Yield of commercial variety}}{\text{Yield of commercial variety}} \text{x} 100$$

$$= \frac{1743 - 1400}{1400} \text{x} 100 = 24.5\%$$

Cost benefit analysis

The cost benefit analysis revealed that Debine has the higher net return (76280 ETB) than than the standard check Asano (52310 ETB). The benefit cost ratio of Debine (1.67) is also higher than Asano (1.14).

Table 3. Return and benefit cost ratio.

Variables	Varieties	
	Debine	Asano
Yield obtained (kg/ha)	1743	1400
Sale price (ETB/kg)	70	7000
Total Variable Costs TVC (ETB/ha)	15730	15690
Total Fixed Cost TFC (ETB/ha)	30000	30000
Total Cost TC (ETB/ha)	45790	45690
Gross Returns (Price X kg) TR	122010	98000
Net Return (GR-TVC)	76280	52310
Benefit cost ratio (NR/TVC)	1.67	1.14

Participatory variety evaluation and selection

To enhance farmers' participation on evaluation of varieties' field performance, mini-field days were organized and finally selected the variety that fits their criteria. Before leading the participant farmers and experts to focus group discussion, brief orientation was given to the evaluators on why variety/technology evaluation and selection is necessary in research process. Then evaluators were grouped in to small manageable groups (by selecting one group leader) and encouraged to set their own criteria to select the demonstrated varieties in order of their preference, 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 respective group leaders. Accordingly, the task of variety evaluation and selection was carried out at Gindhir and Goro districts.

Table 4. Participants of mini-field days at Goro and Gindhir.

Locations	Farmers		Total	Experts		Total
	Male	Female		Male	Female	
Goro	16	2	18	3	1	4
Gindhir	15	0	15	2	0	2
Total	31	2	33	5	1	6

Farmers' preference to demonstrated varieties

Consulting the intended end users to assess which quality/ies of a particular variety they desire 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 [4]. The farmers' preferences toward the demonstrated varieties were assessed by enhancing them to reflect their preference to varietal attributes by setting their own varietal selection criteria.

Table 5. Rank of the varieties based on farmers' selection criteria.

No	Varieties	Rank	Reasons
1	Debine	1st	Higher number of branch/plant,

No	Varieties	Rank	Reasons
			higher number of pod/branch, high yielder, better adaptable to environment, better drought tolerant, better plant height, better tolerant to frost.
2	Asano	2nd	Early maturity

Pair wise Ranking Result to Rank Variety Traits

Pair wise ranking was used to identify farmers' preference of accession traits. Accordingly, yield, number of branch/plant, number of pod/plant, adaptability to the environment and frost tolerance are the five priority concern given by participant farmers.

Table 6. Pair wise ranking result to rank variety traits in order of importance.

Variety Traits	A	B	C	D	E	F	G	Frequency	Rank
A								5	2nd
B	B							5	2nd
C	C	C						6	1st
D	A	A	C					3	4th
E	A	B	C	D				1	6th
F	A	B	C	D	E			0	7th
G	A	B	C	D	G	G		2	5th

A = number of branch/plant, B = number of pod/branch, C = yield, D= adaptable to environment, E = drought tolerant, F= plant height, G= tolerant to frost.

5. Conclusion and Recommendations

Pre-extension demonstration and evaluation of lentil technologies was carried out on farmers' field. Improved variety viz. Debine was demonstrated, evaluated and compared against the standard check Asano. The mean yield of the varieties was analyzed using simple descriptive statistics. Accordingly Debine is high yielder than the standard check variety.

Moreover, Debine variety was selected by participant farmers due to its higher number of branch/plant, higher number of pod/branch, high yielder, better adaptable to environment, better drought tolerant, better plant height, and better tolerant to frost. Thus, Debine variety was recommended for further scaling up/out in the districts and similar agro-ecology.

Abbreviations

CSA	Central Statistical Agency
FGD	Focus Group Discussion
ETB	Ethiopian Birr
SARC	Sinana Agricultural Research Center
SNNP	Southern Nations Nationalities and People of Ethiopia
ha	Hectare
kg	Kilogram

Author Contributions

Bayeta Gadissa: Conceptualization, Data curation, Formal Analysis, Methodology, Project administration, Software, Supervision, Writing – original draft, Writing – review & editing

Ayalew Sida: Conceptualization, Data curation, Methodology, Project administration, Supervision

Conflicts of Interest

The authors declare that there is no conflicts of interest.

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