

Full Length Research Paper

Participatory evaluation cum demonstration of improved faba bean cultivars with inorganic and bio-fertilizers in West Gojam Zone, Amhara Region, Ethiopia

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Received 14 October, 2015; Accepted 17 February, 2016

The trial was conducted in Yilemana Densa district of the Amhara Region in 2013 with the objectives to evaluate the performance of improved faba bean cultivars with P-fertilizer and bio fertilizer under on-farm conditions, while demonstrating such a technology package to farmers thereby paving the way for wider adoption. The trial consisted of four treatments (two improved cultivars with and without fertilizers) was established on fifteen farmers' fields selected from three Kebeles of the district. The trial was laid out as a simple design, considering Kebeles as blocks and host farmers as replications. The fertilizer inputs applied for this trial were 25 kg DAP and inoculated seed with FB-EAL-110 bio fertilizer at rate of 500 g per hectare at planting. Host farmers were participated in the whole process of the trail from land preparation to harvesting. Field days were organized whereby three groups of farmers evaluated the four treatments with their own evaluation criteria by scoring. Agronomic data were also collected on plant height, biomass and grain yields, and analyzed using analysis of variance. CIMMYT partial budget analysis was used for economic analysis. The result of farmers' preference analysis showed that Wolki and Tumssa with fertilizers; Wolki and Tumssa without fertilizers were ranked 1st, 2nd, 3rd and 4th, respectively with the overall evaluation criteria. The result of ANOVA showed that there was significant difference in mean grain yield between Tumssa and Wolki cultivars, between treated and non-treated plots with fertilizers, between Tumssa with and without fertilizers, and between Wolki with and without fertilizers. The result of partial budget analysis indicated that Tumssa and Wolki cultivars with fertilizers can give marginal rates of return of 254% and 300%, respectively over their respective cultivars without fertilizers. The overall result showed that Wolki cultivar with fertilizers gave the highest grain yield and economic benefit and farmers' also ranked it first among the four treatments evaluated. Therefore, to increase the productivity of faba bean with low cost, Wolki cultivar with fertilizers should be promoted in the district and elsewhere in the Amhara region for wider adoption.

Key words: Faba bean improved cultivars, bio-fertilizer, inorganic fertilizer, farmers' evaluation criteria.

INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the most important cool season grain legumes in Ethiopia in terms of hectareage, total production, foreign exchange earnings

and soil amelioration (Amare, 1990). Faba bean contributes to smallholder livelihoods in multiple ways. It can play a significant role in improving smallholders' food

Table 1. Treatment structure.

Treatment	Faba bean variety	DAP	Inoculants
1	Tumsa	-	-
2	Wolki	-	-
3	Tumsa	+	+
4	Wolki	+	+

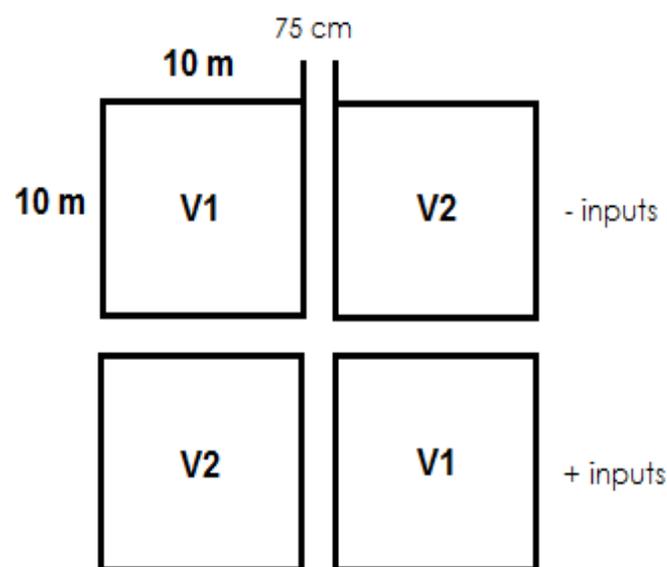
security, as an affordable source of protein and other essential nutrients.

Faba bean can have an income benefit for smallholders as it yields a higher gross margin than cereals (IFPRI, 2010). Its crop residue is also widely used as animal feed. In addition to improving food and nutritional well-being, faba bean can improve soil fertility through its ability of fixing atmospheric nitrogen to the soil. According to Somasegaran and Hoben (1994), faba bean is the efficient N fixer (240 to 325 kg ha⁻¹ yr⁻¹) when inoculated with *Rhizobium leguminosarum* bv. *viciae*.

The most common mineral N fertilizer source employed in Ethiopia is urea. However, the price of mineral fertilizers has tremendously increased and reached to the level that a good proportion of the subsistence farmers often face difficulty to purchase and utilize it so that the productivity of faba bean and cereal crops are generally far below the potential. Biological N fixation, on the other hand, the major means of recycling of N in the biosphere, is an economically justifiable and ecologically safe N source to agriculture. It is a relatively low-cost source of N for small-holder farmers in Ethiopia where chemical N input is not affordable for most farmers (Amanuel et al., 2000).

Research on cropping systems in Ethiopia indicated that the improvements in soil fertility from planting wheat after faba bean in rotation can improve grain yield of wheat by more than one ton per hectare and can reduce fertilizer usage for cereals in the next season by up to 60% (Amanuel and Daba, 2006). Different research works made in recent years revealed that inoculation of faba bean with *R. leguminosarum* can increase yield by 10 to 50% (Abere et al., 2009).

However, as most of the research works on faba bean with inoculants were conducted in the controlled conditions in green houses, farmers have no awareness about the existence of such technology to utilize. Therefore, this study was conducted with the objectives to evaluate the performance of improved faba bean varieties with P-fertilizer and bio fertilizer under on-farm conditions while introducing such a technology package to farmers thereby paving the way for wider adoption.

**Figure 1.** Trial design (Note: V1=Tumsa; V2=Wolki).

MATERIALS AND METHODS

The trial was conducted in Yilemana Densa district, West Gojam Zone of the Amhara Region in the 2013 main cropping season. From the district three representative Kebeles and from each Kebele five host farmers were selected. The trial consisted of four treatments (two improved faba bean cultivars that is, Tumsa and Wolki, each treated with and without fertilizer inputs) was established on each host farmer's field (Table 1 and Figure 1). The trial was laid out as a simple design, considering Kebeles as blocks and host farmers as replications.

The fertilizer inputs applied for this trial were 25 kg DAP per hectare banded, 10 cm away from the planting line, in a 2-cm deep trench, and inoculated seed with FB-EAL-110 bio fertilizer at rate of 500 g per hectare at planting with a planting density of 30 cm between rows and 10 cm between plants. All plots were weeded by hand two times as recommended. Host farmers were participated in the whole process of the trial from land preparation to harvesting.

Field days were organized at podding stage of the crop to collect farmers' opinion about the treatments under evaluation. During the field days, three groups farmers by site were asked to evaluate the four treatments with their own evaluation criteria by scoring 1 to 4

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Table 2. Farmers' preference scores and ranking.

Treatments of cultivars	Adet Hana site rank (n=11)	Debre Mewi site rank (n=9)	Geregera site rank (n=8)	Location mean score (Rank)
Tumssa with fertilizers	2	3	1	2 (2nd)
Tumssa without fertilizers	4	4	4	4 (4th)
Wolki with fertilizers	1	1	2	1.33 (1st)
Wolki without fertilizers	3	2	3	2.67(3rd)

Source: Own computation.

(1= the best). Farmers' scores given to each treatment by three groups of farmers independently were analyzed by summing the scores given by all the three groups and divided by the number of groups and the lowest sum was ranked first. Agronomic data were also collected on plant height, biomass and grain yields. For agronomic data analysis, simple statistics, mean and percentage were used to compare mean grain yields and analysis of variance (ANOVA) was used to see whether there was significant difference or not among the four treatments in plant height, biomass and grain yield using SPSS 16 Software.

CIMMYT partial budget analysis was used for cost-benefit analysis. For partial budget analysis, fertilizers prices used were 14.97 Ethiopian birr (ETB) per kg of DAP and 160 ETB per 500 g for bio fertilizer. Farm gate price of faba bean at harvesting and improved seeds at planting were 11.75 and 15.00 ETB/kg respectively.

Daily wage was set at 30 ETB/day. Estimated labor for planting, fertilizers application, hand weeding, harvesting and threshing were 50, 36, 25 and 20 man days/ha respectively. Grain yield was adjusted down by 10% to more accurately reflect yields obtained under farmers' conditions.

RESULT AND DISCUSSION

Field days were organized at full podding stage of the crop where, three groups farmers, from three kebeles (Adet Hana, n=11; Debre Mewi, n=9 and Geregera, n=8) were asked to evaluate the four treatments (without labels to avoid bias) with their own evaluation criteria by scoring 1 to 4 (1= the best).

Farmers' evaluation criteria for faba bean were found number of pods per plant, pod length and plant height and ultimately grain yield. The result of farmers' preference analysis showed that Wolki with fertilizers, Tumssa with fertilizers, Wolki cultivar without fertilizers and Tumssa cultivar without fertilizers were ranked 1st, 2nd, 3rd and 4th, respectively across locations and with the overall evaluation criteria (Table 1). The result of mean score ranking predicted by farmers before harvest by seeing different parameters for grain yield is found exactly the same as the actual mean grain yield obtained after harvest (Table 2). However, farmers suggested that their own local faba bean variety with and without fertilizers inputs should have been included in the trial.

Out of 15 farmer's fields, 14 were successfully harvested and data were analyzed for grain yield

parameter using simple statistics, mean and percentage, to compare mean grain yield among the four treatments (Table, 3). In addition, Wolki faba bean cultivar with fertilizers gave the highest mean grain yield with mean grain advantage of 48.1% over without fertilizers. Tumssa cultivar with fertilizers gave the second highest mean grain yield with mean grain advantage of 51.8% over without fertilizers.

To see whether there was significant difference or not among the four treatments in plant height, biomass and grain yield (these parameters were used to capture farmers' evaluation criteria: number of pods per plant, pod length and plant height and ultimately grain yield), ANOVA was used. The result of ANOVA showed that there was significant difference in mean grain yield between Tumssa and Wolki varieties, but there was no significant difference in biomass and in plant height between the two cultivars. This implies that by using Wolki faba bean cultivar regardless of fertilizers, a mean grain yield advantage of 20.12% (2.64qt/ha) can be obtained over using Tumssa cultivar.

There was significant difference between treated and non-treated plots with fertilizers in all of the three parameters regardless of varieties. This implies that, by using fertilizers alone, regardless of varieties, an additional mean grain yield advantage of 49.83% (5.76qt/ha) can be obtained over non-using fertilizers (Tables 1 and 4). This result is in agreement with the result of (Abere et al., 2009) which revealed that inoculation of faba bean with *R. leguminosarum* can increase yield by 10 to 50%.

Regarding cultivars and fertilizers, there was significant difference in grain yield between Tumssa cv. with and without fertilizers, and between Wolki cultivar with and without fertilizers. But there was no significant difference between Tumssa and Wolki with fertilizers and Tumssa and Wolki without fertilizers (Table 4).

Partial budget analysis

Using fertilizers on faba bean gave higher net benefits and higher Marginal rates of return over not using fertilizers. Growing improved faba bean varieties, Tumssa

Table 3. Mean grain yield and yield advantage of treated over non-treated plots by cvs.

Tumssa with fertilizers (qt/ha)	Tumssa without fertilizers (qt/ha)	Yield advantage of Tumsa with fertilizers over with out (%)	Wolki with fertilizers (qt/ha)	Wolki without fertilizers (qt/ha)	Yield advantage of Wolki with fertilizer over with out (%)
15.82 (2)	10.42 (4)	51.8	18.81(1)	12.70 (3)	48.1

Source: Own Computation; Figure in () is rank.

Table 4. Analysis of variance.

Block	Bio mass yield (qt/ha)	Grain yield (qt/ha)	Plant height (cm)
Debre Mewi	53.63a	16.13a	97.44a
Adet Hana	42.88a	13.70a	98.24a
Geregera	42.81a	13.49a	76.38b
Cultivars	-	-	-
Tumssa	45.38a	13.12b	90.15a
Wolki	47.50a	15.76a	91.22a
Fertilizers			
With	51.58a	17.32a	94.51a
with out	41.29b	11.56b	86.86b
Cultivar x fertilizers			
Tumssa x Fertilizers	49.58a	15.82ab	93.18a
Tumssa x without Fertilizers	41.17a	10.42c	87.12a
Wolki x Fertilizes	53.58a	18.81a	95.84a
Wolki x without Fertilizers	41.42a	12.70bc	86.61a
CV %	12.6	10.4	4.8

Source: Own Computation; Means with the different letter are significantly different at the 0.05 level of significance.

and Wolki, with fertilizers can give a marginal net benefit of 4,096.25 and 4,848.25 ETB, over their respective varieties without fertilizers.

The marginal rates of return (MRR) for Tumsa and Wolkie cultivars with fertilizers were 254 and 300%, respectively (Table 5). This implies that for one birr additional cost incurred on the use fertilizers for example, on Wolkie variety, an additional birr of 3.00 can be obtained after paying the input cost.

CONCLUSIONS AND RECOMMENDATIONS

The result of farmer's preference analysis showed that Wolki and Tumssa cultivars with and without fertilizers ranked 1st, 2nd, 3rd and 4th, respectively across locations and with the overall evaluation criteria. The result of mean score ranking predicted by farmers before harvest by seeing different parameters for grain yield is found exactly the same as the actual mean grain yield obtained after harvest .

The result of ANOVA showed that there was significant difference in mean grain yield between Tumsa and Wolki cultivars. This implies that by using Wolki faba bean cultivar regardless of fertilizers, a mean grain yield advantage of 20. 12% (2.64qt/ha) can be obtained over using Tumsa variety. The result of ANOVA also indicated that there was significant difference between treated and non-treated plots with fertilizers in all of the three parameters. This implies that, by using fertilizers alone, regardless of cultivars, an additional mean grain yield advantage of 49.83% (5.76qt/ha) can be obtained over non-using fertilizers. This result is in agreement with the result of Abere et al. (2009) which revealed that inoculation of faba bean with *R. leguminosarum* can increase yield by 10 to 50%. Regarding varieties and fertilizers, there was significant difference in grain yield between Tumsa variety with and without fertilizers, and between Wolki cultivar with and without fertilizers. But there was no significant difference between Tumsa and Wolki cultivars with fertilizers and Tumsa and Wolki cultivars without fertilizers.

Table 5. Partial budget analysis.

Variable	Treatments of the tested cultivars			
	Tumsa without fertilizers	Tumsa with fertilizers	Wolki without fertilizers	Wolki with fertilizers
Mean grain yield (kg/ha)	1.042	1.582	1.270	1.881
Adjusted yield (kg/ha)	938	1424	1.143	1.693
Gross field benefit (ETB/ha)	11.021.50	16.732.00	13.430.25	19.892.75
Cost of seed (ETB/ha)	3.000	3.000	3.000	3.000
Labor cost for planting (ETB/ha)	1.500	1.500	1.500	1.500
Cost of P-fertilizer (ETB/ha)	0	374.25	0	374.25
Cost of bio-fertilizer (ETB/ha)	0	160	0	160
Labor cost for P-fertilizer application (ETB/ha)	0	1.050	0	1.050
Labor cost for bio-fertilizer application (ETB/ha)	0	30	0	30
Labor cost for weeding ETB/ha)	750	750	750	750
Labor cost for harvesting and threshing ETB/ha)	600	600	600	600
Total cost that vary (ETB/ha)	5.850	7,464.25	5.850	7.464.25
Net benefit (ETB/ha)	5.171.50	9.267.75	7.580.25	12.428.50
Marginal cost (ETB/ha)	-	1.614.25	-	1.614.25
Marginal net benefit (ETB/ha)	-	4.096.25	-	4.848.25
Marginal rate of return (%)	-	254	-	300

Source: Own computation.

The result of partial budget analysis indicated that growing improved faba bean varieties, Tumsa and Wolki, with fertilizers can give a marginal net benefit of 4,096.25 and 4,848.25 ETB, over their respective varieties without fertilizers. The marginal rates of return (MRR) for Tumsa and Wolkie cultivars with fertilizers were 254 and 300 %, respectively. This implies that for one birr additional cost incurred on the use fertilizers on Tumsa and Wolkie cultivars an additional birr of 2.54 and 3.00 can be obtained, respectively after paying the input cost. All the analysis showed that Wolkie variety with fertilizers can give the highest grain yield and economic benefit and farmers' also ranked it first among the four treatments evaluated. Therefore, to increase the productivity of faba bean with low cost, Wolkie cultivar with fertilizers should be promoted, while evaluating Wolkie cultivar and farmers own local faba bean cultivar with and without fertilizers to fine-tune this recommendation as farmers suggested.

Conflict of interests

The author has not declared any conflict of interests.

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