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Participatory Adaptation and Demonstration of Improved Mung Bean (*Vigna radiata L.*) Varieties in Selected Districts of Gamogofa and Wolayta Zones, Southern Ethiopia

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ABSTRACT

This study was conducted in two selected potential areas of South region in Wolayata and Gamo Zones of Ethiopia during 2016 and 2017 cropping seasons. The participatory grandmother and mother Trial methodology were for varietal evaluation and selection. The main objective of the study was to evaluate and select the best performing Mung bean varieties that meet farmers' criteria using participatory varietal selection method in order to speed up their adoption. Five improved varieties were evaluated at the two districts on farmers' fields. The farmers were involved in varietal selection process at maturity and harvest. Farmers classified the Mung bean varieties' selection criteria according to their order of importance: uniform maturity, earliness, high yield, large seed size, large pod number, medium plant height and drought tolerance as 1st, to 7th, respectively. The most chosen varieties by farmers were Boreda-1, Rasa and Show a robit. In general, the high-yielding varieties Bored-1, Rasa, and showarobit had a yield advantage of 12.8% to 14.5 % over the grand mean, and other improved varieties included in the trial. Based on yield performances, farmers and breeders' selections, those three varieties were selected and should be recommended in the study areas and similar agro ecology for wider dissemination and production.

Key words: *Farmer; Criteria; Mung bean; Participatory variety selection; Improved varieties*

Introduction

Mung bean (*Vigna radiate L.*) is an important pulse crop grown in drier areas in south Ethiopia for household consumption and as a source of family cash income. It is regarded as a poor man's crop because of its low input requirements, chief protein source, short duration, ease of production and ability to produce under adverse weather and soil conditions. In Southern Ethiopia, the food security role of Mung bean during hunger is currently critically important due to the failure of late maturing crops as a result of terminal drought/erratic rainfall at critical crop growth period. In nutritional terms, mung bean is an excellent source of protein, especially in improving children protein deficiency. Production statistics indicate that about 271,589.80 quintals of mung bean were produced on 27,085.92 hectares of land over 50 % of which is found in the densely populated areas of Rift valley and Northern parts of Ethiopia [1,2].

Mung bean production in Southern Ethiopia is constrained by widespread use of low yielding and late maturing landrace varieties, pests and diseases. The current cowpea yield in South Ethiopia (6 qt ha-1) is lower than the National average (10.027 qt ha-1). The national as well regional average productivity were 10 qt /ha and 6 qt/ha which is very far below its potential [3].

Nevertheless, the demonstrated potential in Ethiopia reaches 1.5 tons under experimental station and 0.5 to 1.0 t/ha under farmer field with research recommended practices. The low acreage and yield are attributed to the absence of links to seed suppliers and hence a lack

of improved seeds, poor farmers participation in varietal selection process and a high use of local varieties (on more than 95% of the total pulse cropped area) was the major production constraints. Thus involving farmers in the selection process would therefore confirm that criteria of importance to mung bean farmers that does not get ignored or given

insufficient weighting. Therefore, the objective of this study was to evaluate and select the best performing Mung bean varieties that meet farmers' desires and preferences in different mung bean growing agro-ecologies of southern Ethiopia [4,5].

Materials and Methods

Experimental Site

The experiment was conducted during the cropping seasons of 2016 and 2017 in Gamogofa and Wolayata zones, Southern Nations, Nationalities, and Peoples' Region, at Kucha and Humbo districts. The coordinates and altitudes for the districts are as follows: Kucha (6º 29N, 37º 28E, 1357 masl) and Humbo (6º 39N, 37º 48E, and 1401 masl). The area receives annual rainfall of 923.1-1313.5 mm, with mean minimum and maximum temperature of 16.4 0C and 32 0C for kucha while Humbo receives annual rainfall of 386.7-1033.5 mm (National meteorological agency, South Branch, 2017). The soils of both districts are mostly heavy clay.

The experiment was conducted at Humbo and Kucha districts. Four improved Mung bean varieties Rasa, NV, Chinesemungbean, Boreda, and one popular local variety Showarobit were used for the study. Farmers for the PVS trials were selected from target woreda with extension staff and kebele chief. The plot size of 4.8 sq.m (3m*1.6 m) and a spacing of 40 cm*5 cm were used. All recommended mung bean agronomic practices were applied.

Experimental Material

Four mung bean varieties Rasa, NV, Chinese mung bean, and Boreda released from Federal and Regional agricultural research centers and Showarobit (popular local) were used as experimental material. The treatments were laid out in a randomized complete block design in three replications as grandmother trial on one model farmer field. Three other host farmers planted one replication each as mother trial. The grandmother trial was used to generate researcher's data while the three mother trials were used for participatory varietal selection and to value farmers' preferences during evaluation. Each experimental plot had an area of 4.8 m2 with four rows of 3 m length spaced at 40 cm between rows and 5 cm between plants. All the cultural operations like, main field preparation, weeding, plant protections were carried out equally for all experimental units as per the recommendations in order to raise a successful crop.

Data Collection

Agronomic data, days to flowering, days to maturity, plant height (cm) and yield and yield components were taken from grandmother trial on plant and plot basis. The grain yield per plot was adjusted to storage moisture content determined using digital Grain Moisture Meter (DRAMINSKI, POLAND).In this paper only seed yield data were considered for analysis. Farmers' evaluation and selection was collected from single plot observation on farmers' field. Farmers perception on plant establishment, overall performance, number of pods, number of branches, earliness, drought tolerance were taken as the rate of 5= very good, 4=good, 3=average, 2=poor and 1=very poor.

Farmers' Evaluation of Mung Bean Varieties and Selection Criteria

For PVS trials the selection criteria were set by participating farmers based on group discussion and consensus. Unfortunately, the selection criteria for two districts were relatively similar and farmers identified the selection criteria with respective weight on the basis of their interest. Farmers set their own selection criteria for mungbean varieties and participated to evaluate the performance of Mung bean varieties based on their selection criteria which includes tolerance to drought, earliness, seed size, pod number, taste, short cook ability and grain yield. During the participatory varietal selection, male and female headed households for kucha (male=15, female=7) and for Humbo district (male=10, female=5) a total of 37 farmers were participated. The evaluation was conducted at two developmental stages (maturity and at harvest). The varieties were ranked accordingly. Two procedures i.e. direct matrix ranking and preferential score were used to rank the varieties. Direct matrix ranking was particularly useful in identifying the important traits of interest.

A direct matrix was prepared as per the selection criteria for the Mungbean varieties listed in the column and criteria in the row. The ranking procedure was explained to participants and then each criterion was ranked from 1 to 5 (5=excellent, 4=very good, 3=good, 2=poor and 1=very poor) for each variety, ranking was done on consensus where differences were solved by discussion. During direct matrix ranking farmers have given rating of importance (a relative weight) of a selection criterion ranked from 1 to 3 (3=very important, 2=important and 1=less important) and rating of performance of a variety for each traits of interest was given based on their level of importance on the basis of common agreement of evaluators'. The score of each variety was multiplied by the relative weight of a given character to get the final result and then added with the results of other characters to find out the total score of a given variety. In the case of pairwise ranking the varieties were compared and ranked pairwise and hence both direct matrix and pairwise ranking were done for the cowpea varieties.

Results and Discussion

Mung Bean Varieties Performance in the Study Sites

Analysis of variance revealed that there was highly significant (P<0.01) to significant (P<0.05) variation among the tested mung bean varieties. Mung bean varieties such as Boreda,Rasa and Shawarobit were the top performed with mean grain yield of 1039.3 kg/ha, 1028.9 kg/ha,1023.8kg/ha and test variety Chinese Mung bean was the least performed at both districts with average grain yield of 661.2 kg/ha. The statistical result indicated that Boreda was the highest in yield performance as described in Table 1. Significant difference of mung bean genotypes on seed yield had been reported by found that Mung bean cultivars had significant effect on grain yield [5-9]. Besides, this result is found in agreement to results of sorghum. (Table 1) (Table 2).

Farmers' Participatory Evaluation and Farmers Selection Criteria

The farmers who participated and evaluated the study were truly representatives of community/kebele that had long experience in growing of mung bean. The selection criteria of farmers in the study sites were based on a wide discussion and consensus. Male and female participants were evaluated together. The selection criteria were assigned by farmers and each variety was evaluated by male and female household headed farmers. The selection criteria suggested by farmers were grain yield, earliness, tolerance to drought, resistance to diseases and insect pests, plant height, seed size, pod number, taste and short cooking time. Male and female farmers across test sites listed 9 important traits. Selection criteria applied by farmers across test sites over seasons were more consistent except some rank change for rating of traits. Pair-wise matrix ranking of selection criteria was used to identify and prioritization order of the farmers' selection preference. In pair wise ranking traits such as grain yield, earliness, drought tolerance, pod number, tolerance to disease and insect pests and seed size were proposed as very important criteria as indicated. Early maturity was considered as the most selection criteria for each mung bean varieties. The second most selection criteria were grain yield drought resistance in mung bean growing areas.

Farmers ranked early maturity and grain yield in the first and second places, respectively. The third most selection criteria were drought resistance. Plant height and seed size were given lower rank by farmers. Therefore, while farmers reflect many traits, there are a few traits that they often use and these need to be recognized. Earlier studies by working on mung bean, working on cowpea and working on common beans reported similar findings of farmers using a combination of a few traits when evaluating new genotypes [10,11].

The evaluation result of farmers' selection criteria described in Tables 3 and 4. The selection criteria that farmers depend on for evaluation are seed yield, yield components, drought tolerance, earliness, taste, short cook ability,and disease resistance; which are similar to selection criteria identified for bean [12-15]. At the time of criteria selection women and men farmers grouped separately; and women farmers chosen seed yield, short cook ability and taste (especially at kucha) traits, while men focused on seed yield and other yield related characters. The interest of selection depends on the demand to generate income in local market and home consumption (Table 3) (Table 4) (Table 5).

Farmers' Varieties Selection Based on Direct Matrix Ranking

Based on farmers selection criteria comparison was conducted among the tested mung bean varieties [16]. The Mung bean varieties were identified for their morphological performance and ranked as indicated in (Tables 6) (Table 7) (Table 8).

In direct matrix, the total score ranged from 41 to 70. The highest score given to the variety Showarobit (70) followed by Rasa (69), Boreda (64) and NV (57). Based on direct matrix ranking evaluation, farmers of Humbo identified Rasa and Sowarobit as the best while Chinese Mung bean as the least preferred mung bean varieties .

In direct matrix, the total score ranged from 41 to 72. The highest score given to the variety Boreda (72) followed by Rasa (71), Showarobit (58) and NV (57). Based on direct matrix ranking evaluation, farmers of kucha identified Rasa and Boreda as the best while Chinese Mung bean as the least preferred mung bean varieties [17,18].

In direct matrix, the total score ranged from 41 to 72. The highest score given to the variety Rasa (70) followed by Boreda (68), Showarobit (64) and NV (57). Based on direct matrix ranking evaluation, farmers identified Rasa and Boreda as the best while Chinese Mung bean as the least preferred cowpea varieties.

Table 1: Mean square values of seed yield of mung bean varieties at Kucha and Humbo district during 2016 and 2017.

Variety	Seed yield (kg)			Combined		
	Kucha	Humbo	combined	Rank	YADG%	YASR %
MH-97-6(Boreda)	1143.27a	935.33a	1039.30a	1	14.5	1.5
Rasa(N-26)	1126.47a	931.40a	1028.93a	2	13.4	0.5
NV	924.87b	644.03b	784.45b	4	-	-23.4
Showarobit	1153.63a	894.00a	1023.82a	3	12.8	-
Chinese mungbean	774.43c	548.07b	661.25c	5	-	-35.4
mean	1024.5	790.6	907.6			
LSD (5%)	144.6	2018.9	120.6			
CV (%)	7.49	14.7	10.8			

Table 2: Analysis of Variance (ANOVA) for measured seed yield of mung bean varieties tested at Humbo and Kucha districts during 2016 and 2017.

Source of variation	DF	GY(kg)
Location	1	410553.0083**
Rep(Loc)	4	69167.5207*
variety	4	182140.8208**
Loc*variety	4	1913.9875
Error	16	9705.751
CV (%)		10.86
Mean		907.6

YADG=yield advantage over grand mean and YASR=yield advantage over showrobit, (23.4) =23.4 % yield reduction over showrobit.

Table 3: Pair-wise ranking of farmers selection criteria at different growth stages.

No	Selection criteria	GY	DR	E	SZ	PH	RS	PN	T	CA	Total	Rank
1	Grain yield	*	GY	E	GY	GY	GY	GY	GY	GY	7	2
2	Drought resistance		*	E	DR	DR	DR	DR	DR	DR	6	3
3	Early maturity			*	E	E	E	E	E	E	8	1
4	Seed size				*	SZ	RS	PN	T	CA	1	8
5	Plant height					*	RS	PN	T	CA	1	8
6	Resistance to diseases and insect pests						*	PN	RS	RS	4	5
7	Pod number							*	PN	PN	5	4
8	Taste								*	T	4	5
9	Cook ability									*	2	7

Where: GY=Grain Yield, SC= seed color, SS= seed size, DR=drought resistance, PH=plant height, E =Earliness, RS=Resistance to diseases and insect pests, PN=Pod number=taste and CA=cook ability.

Table 4: Farmers selection criteria applied in mungbean across sites at Humbo and Kucha districts.

Selection criteria	Rank across sites				Overall mean
	Kucha		Humbo		
	2016	2017	2016	2017	
Grain yield	1	2	3	1	1.75(2)
Drought resistance	3	4	2	3	3(3)
Earliness	2	1	1	2	1.5(1)
Seed size	8	9	9	8	8.5(9)
Plant height	7	7	8	9	7.75(8)
Resistance to diseases and insect pests	5	6	4	5	5(5)
Pod number	4	3	5	4	4(4)
Taste	7	8	6	7	7(7)
Short cook ability	6	5	7	6	6(6)

Table 5: Summary for pair wise ranking by farmers at sites in Humbo and Kucha.

Trait	1	2	3	4	5	6	7	8	9	scores	Ranking
1.Grain yield	*	1	3	1	1	1	1	1	1	7	2
2.Drought resistance		*	3	2	2	2	2	2	2	6	3
3.Earliness			*	3	3	3	3	3	3	8	1
4.Seed size				*	5	4	7	8	9	1	6
5.Plant height					*	5	7	8	9	1	6
6.Tatse						*	7	8	9	0	7
7.Pod number							*	7	9	4	4
8.RS								*	9	3	5
9.Short cook ability										5	4

Table 6: Direct matrix ranking evaluation of mung bean varieties by of group of farmers' at Humbo district.

S/C	Relative Weight	Mung bean varieties				
		A	B	C	D	E
1.Grain yield	3	15(5)	15(5)	15(5)	12(4)	6(2)
2.Drought resistance	2	8(4)	8(4)	8(4)	4(2)	6(3)
3.Earliness	3	12(4)	12(4)	12(4)	6(2)	6(2)
4.Seed size	1	3(3)	4(4)	3(3)	5 (5)	3(3)
5.Plant height	1	3(3)	2(2)	5(5)	3(3)	3(3)
6.Taste	1	3(3)	4(4)	3(3)	3(3)	3(3)
7.Pod number	2	8(4)	8(4)	8(4)	10(5)	2(1)
8. RS	2	6(3)	8(4)	8(4)	10(5)	6(3)
9. Short cook ability	2	8(4)	8(4)	8(4)	4(2)	6(3)
Total score	17	64	69	70	57	41
Rank	-	3	2	1	4	5

Note: Number of farmers participated in the variety evaluation= 15 (M = 10 and F=5) Where: S/C=selection criteria, A=Boreda, B=Rasa, C=Showarobit, D=NV, E= Chinese Mung bean ,numbers in parenthesis indicated the performance rating value of each variety given from 1-5 (5= excellent, 4=very good, 3= good, 2= poor and 1=very poor) and numbers written in the bold indicate total score of a variety as per each selection criteria, which was obtained by multiplying the relative weight of each selection criteria with that of the performance rating number in the parenthesis. Ranks are in ascending order from one to five.

Table 7: Direct matrix ranking evaluation of mung bean varieties by of group of farmers' at Kucha district.

S/C	Relative Weight	Mung bean varieties				
		A	B	C	D	E
1.Grain yield	3	15(5)	15(5)	15(5)	12(4)	6(2)
2.Drought resistance	2	8(4)	8(4)	8(4)	6(3)	4(2)
3.Earliness	3	15(5)	12(4)	12(4)	12(4)	6(2)
4.Seed size	1	3(3)	5(5)	3(3)	3(3)	3 (3)
5.Plant height	1	3(3)	3(3)	3(3)	3(3)	3(3)
6.Taste	1	4(4)	4(4)	3(3)	3(3)	3(3)
7.Pod number	2	8(4)	8(4)	4(2)	6(3)	6(3)
8. RS	2	8(4)	8(4)	4(2)	6(3)	6(3)
9. Short cook ability	2	8(4)	8(4)	6(3)	6(3)	4(2)
Total score	17	72	71	58	57	41
Rank	-	1	2	3	4	5

Note: Number of farmers participated in the variety evaluation= 22 (M = 15 and F=7) Where: S/C=selection criteria, A=Boreda, B=Rasa, C=Showarobit, D=NV, E= Chinese Mung bean ,numbers in parenthesis indicated the performance rating value of each variety given from 1-5 (5= excellent, 4=very good, 3= good, 2= poor and 1=very poor) and numbers written in the bold indicate total score of a variety as per each selection criteria, which was obtained by multiplying the relative weight of each selection criteria with that of the performance rating number in the parenthesis. Ranks are in ascending order from one to five.

Table 8: Summary of direct matrix ranking evaluation of mung bean varieties by of group of farmers' at Kucha and Humbo districts.

S/C	Relative Weight	Mung bean varieties				
		A	B	C	D	E
1.Grain yield	3	15(5)	15(5)	15(5)	12(4)	6(2)
2.drought resistance	2	8(4)	6(3)	8(4)	6(3)	4(2)
3.Earliness	3	12(4)	15(5)	12(4)	12(4)	6(2)
4.Seed size	1	3(3)	3(3)	3(3)	3(3)	3 (3)
5.Plant height	1	3(3)	3(3)	3(3)	3(3)	3(3)
6.Taste	1	3(3)	4(4)	3(3)	3(3)	3(3)
7.pod number	2	8(4)	8(4)	8(4)	6(3)	6(3)
8. RS	2	8(4)	8(4)	6(3)	6(3)	6(3)
9. short cook ability	2	8(4)	8(4)	8(4)	6(3)	4(2)
Total score	17	68	70	64	57	41
Rank	-	2	1	3	4	5

Note: Number of farmers participated in the variety evaluation= 37 (M = 25 and F=12) Where: S/C=selection criteria, A=Boreda, B=Rasa, C=Showarobit, D=NV, E= Chinese Mung bean ,numbers in parenthesis indicated the performance rating value of each variety given from 1-5 (5= excellent, 4=very good, 3= good, 2= poor and 1=very poor) and numbers written in the bold indicate total score of a variety as per each selection criteria, which was obtained by multiplying the relative weight of each selection criteria with that of the performance rating number in the parenthesis. Ranks are in ascending order from one to five.

Conclusion

The results of this study indicated that three Mung bean varieties were superior to the grand mean in tested areas of Southern Ethiopia. Considering maturity and harvesting stage performance evaluation of 3 tested varieties, it was observed that Boreda, Rasa and showarobit performed well in farmer's field at both Kucha and Humbo districts. Boreda (935 kg/ha) gave high yields in Humbo site while chinese mung bean (548.1kg/ha) gave the lowest. In kucha site showarobit (1153.6kg/ha) gave high yields while chinese mung bean (774.4kg/ha) gave the lowest. Through farmers field evaluation these varieties found 1st to 3rd rank in preferences and accepted by the farmers because of their high grain yield, early maturity, and diseases and pests resistance. All the above three varieties were adaptable in two growing areas. Involving farmers in the study has improved interaction between researchers, extension staff, and farmers.. From the above results it may be concluded that Boreda, Rasa and showarobit recommended for cultivation largely for commercial purpose.

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