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Participatory on farm evaluation of improved mungbean technologies in the low land areas of North Shewa Zone Amhara Region, Ethiopia

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The study was conducted in four selected potential areas of North Shewa zone namely; Kewot, Efratana gidim, Ensaro and Merhabete district. The main objective of the study was to evaluate, select the best performing mungbean varieties and to assess farmer's technology preference. The experiment was done using three improved varieties namely; Rasa (N-26), NLV-1, and Arkebe improved varieties and local variety as a check. The analytical result showed that Rasa (N-26) variety was preferred by the farmers followed by NLV-1. The result gotten from the analysis of variance indicated that the difference among the means of the mungbean varieties for grain yield, pod length and hundred seed weight are significant at 5% probability level for both locations. The highest yield (1541.3 kg/ha) was recorded from Rasa (N-26) variety at Jema valley followed by the local variety (1243.3 kg/ha), while the lowest yield (735.7 and 676.3 kg/ha) was obtained from the varieties NLV-1 and Arkebe, respectively. The partial budget analysis result also revealed that only Rasa (N-26) had the highest net benefit return compared to the local variety. The marginal rate of return for changing from using local variety to improved Rasa (N-26) variety was 1074%. Therefore pre-scaling up of Rasa (N-26) variety with its improved management practice should be done.

Key words: Mungbean, farmer preference, participation, rasa variety.

INTRODUCTION

Endowed with varied agro-ecological zones and diversified natural resources, Ethiopia has been known as the home land and domestication of several crop plants. Pulses, which occupy approximately 13% of cultivated land and account for approximately 10% of the agricultural value addition next to cereal crops, are critical to smallholder livelihoods in Ethiopia (CSA, 2016; Chilot et al., 2010). It is ranked 13th among pulse producing countries in the world (FAO, 2015).

Pulse crops are important components of crop production in Ethiopia's smallholders' agriculture, providing an economic advantage to small farm holdings as an alternative source of protein, cash income, and food security (CSA, 2016; USAID, 2014). The crops have been used for many years in cropping system practices. Some of them have played an important role in the export sector generating foreign currency for the country (ATA, 2015; Boere et al., 2015). Although the availability of

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pulses have never been in surplus in the subsistence farming community, recently it is observed that the production and supply of some pulses is increasing due to the demand increase both in local and international markets.

Mungbean (*Vigna radiata* L.), which is introduced recently, is an annual herb of the legume family. It has green skin and is also called green bean (MoA, 2011). It is sweet in flavor and cold in nature (EPP, 2004). The crop matures early; special features include high yield, good nutritive value, the earliness, drought resistant features and the reasonable cost of production. It is a warm season annual grain legume and the optimum temperature range for good production is 27 to 30°C and requiring 90 to120 days of frost-free conditions from planting to maturity depending on the variety (Itefa, 2016).

According to Asfaw et al. (2012) in Ethiopia mungbean is mostly grown by smallholder farmers under drier marginal environmental condition and the production capacity is lower than other pulse crops. Green mungbean is less used domestically, but it is a common ingredient in Chinese and Indian cuisines. It is attributed with having high nutritional value, including protein content (24 to 26%), and helps reduce cholesterol and diabetes (Ali and Gupta, 2012; Habte, 2018).

Despite its growing demand in the international market, there is a huge gap of production in Ethiopia. Ethiopia's mungbean export trend has grown slightly mainly due to Ethiopian Commodity Exchange that installed mungbean as the sixth commodity to be traded on its floor since 2014 (ECX, 2014). This inspired many farmers to get involved in mungbean production. More than 136,392 small holder farmers were engaged in mungbean production (CSA, 2016).

According to CSA (2014), mungbean grown in 2013/2014 covered only 0.09% (10,692.38 hectares) of the grain crop area and 0.03% (about 8,064.01 tones) of the grain production nationally with average productivity of 0.75 t/ha. About 91.73% (9,808.22 hectares) of the total national mungbean production area and 99.97% (8,062.36tone) of the total production of the country was from Amhara region (CSA, 2014). The regional average productivity was 0.82 t/ha which is very far below its potential.

However, the demonstrated potential in Ethiopia reaches 1.5 tons under research field and 0.5 to 1.0 t/ha under farmer field with research recommended practices (MoA, 2011). The low acreage and yield are attributed to the absence of links to seed suppliers and hence a lack of improved seeds and a high use of local varieties (on more than 95% of the total pulse cropped area) (Chilot et al., 2010) was the major production constraints.

Therefore, the study aims to evaluate and select the best performing mungbean varieties and to identify farmers preference and selection attributes in the study sites.

MATERIALS AND METHODS

Description of the study area

The experiment was conducted in the low lands of North Shewa areas of Efratana gidim, Kewot, Ensaro and Merhabete district, during main cropping season of 2015 under rainfed condition. These sites are known to be suitable for mungbean production and selected purposively based on their potential (CSA, 2016).

Materials and research design

The experiment was done using three improved varieties including Rasa (N-26), NLV-1 and Arkebe varieties which were released and recommended by the national research system of the country. The experiments were laid out in a simple plot design with six farmers' fields as a replicates. A unit plot size of 100 m2 (10 m ×10 m) with plant spacing of 30 cm × 5 cm was used. A seed rate of 38, 33.7, 24.7 and 25 kg/ha was administered to Rasa (N-26), NLV-1, Arkebe and Shewa Robit local varieties. NPS was used at the rate of 30 kg/ha. The experiment was planted starting from third week of July depending on the rainfall intensity and distribution.

Data collected

Farmers and experts participated during the evaluation of the experiment from all study sites while three varieties were evaluated against their local by setting the criteria and giving weight for each attributes by them. A total of 94 (3.2% female) farmers and 24 (1 female) experts were participated during the evaluation of the experiment from each experimental site. Agronomic data like yield and other attributes of the variety was examined both on plant and plot basis in order to evaluate the performance of the technologies across each agro ecologies. Ten plants were taken randomly from each plot to determine plant height at maturity, number of primary branches, number of pods per plant and number of seeds per pod. Hundred seed weight (g), biomass yield (kg/ha) and grain yield (kg/ha) were collected on plot basis. Cost and benefit analysis was also done by using partial budget analysis method.

Data analysis

Finally, social data and farmers' preference was analyzed by using pair wise and preference ranking techniques. To estimate difference among the varieties all measured variables were subjected to analysis of variance (ANOVA) using SAS software version 9.00 (SAS Institute, 2004). Analysis of variance was done following the standard procedure given by Gomez and Gomez (1984). Mean separation was carried out using least significant difference (LSD) test at 5% of significance.

RESULT AND DISCUSSION

Mean values of different agronomic traits

The result was presented based on two categories as Jema valley (Ensaro and Merhabete district) and Kewot, and Efratana gidim district as one location. The result gotten from the analysis of variance for Jema valley indicated that the differences among the means of the mungbean varieties for only grain yield, pod length and

Table 1. Mean values of yield and yield components of Ensaro and Merhabete district.

Varieties	ppp	spp	pmbr	plh	pl	Hsw	Gy	bm
Rasa (N-26)	9.75	11.9	4.15	39.35	9.65[ab]	5.05[a]	1541.3[a]	4688
Local	13.25	11.3	4.45	45.05	8.45[bc]	3.48[c]	1243.3[a]	4583
NLV-1	10.75	12.15	3.85	39.8	10.5[a]	4.65[ab]	735.7[b]	5000
Arkebe	10.65	11.25	3.65	41.65	7.95[c]	4.05[bc]	676.3[b]	3750
Mean	11.1	11.65	4.03	41.46	9.14	4.31	1049.2	4505.2
CV (%)	20.56	8.72	15.56	15.29	8.79	9.43	22.12	21.15
LSD (0.05)	NS	NS	NS	NS	1.28	0.65	371.3	NS

Where: ppp = Number of pods per plant; spp = Number of seeds per pod; pmbr = Primary Branching; plh = Plant height (cm); pl = Pod length (cm); hsw = Hundred seed weight (g); gy = Grain yield (kg/ha); bm = Biomass (kg/ha).

Table 2. Mean values of yield and yield components for Kewot and Efratana gidim areas.

Variety	ppp	spp	pmbr	plh	PL	Hsw	Gy	bm
Rasa	11.28	9.24	3.92	43.26	9.42[a]	5.38[a]	1342[a]	3837[a]
Local	14.04	9.6	3.72	46.08	7.11[b]	3.54[b]	1267[ab]	3703[a]
NLV-1	9.76	9.8	3.24	34.28	9.60[a]	5.22[a]	1021[bc]	3000[ab]
Arkebe	12.32	9.44	3.64	41.84	7.92[b]	3.92[b]	690.3[c]	2413[b]
Mean	11.85	9.52	3.63	41.36	8.51	4.52	1080.2	3237.97
CV (%)	22.39	13.77	11.98	20.13	8.48	6.24	18.48	21.52
LSD	NS	NS	NS	NS	0.995	0.388	275.14	960.04

hundred seed weight are significant at 5% probability level. The highest yield (1541.3 kg/ha) was gained from Rasa (N-26) variety followed by the local variety (1243.3 kg/ha), while the lowest yield (735.7 and 676.3 kg/ha) was obtained from NLV-1 and Arkebe varieties, respectively.

Similarly, Adhiena et al. (2015), Habte (2018), Rasul et al. (2012), Teame et al. (2017) and Wedajo (2015) found that mungbean cultivars had significant effect on grain yield. As revealed in Table 1, yield gained from Rasa (N-26) was almost more than two folds of NLV-1 and Arkebe varieties. However, no big difference of yield was observed in between the local and Rasa (N-26) varieties in all sites. The highest hundred seed weight was obtained from Rasa (N-26) variety, while the lowest was gotten from local cultivar. The longest pod length (10.5 cm) was recorded from NLV-1 variety followed by Rasa (N-26) variety. Likewise, Mondal et al. (2012) reported the existence of significant difference in thousand seed weight among different cultivars.

Similarly, Table 2 indicated that the differences among the means of the mungbean varieties for grain yield, pod length, hundred seed weight and biomass are significant at 5% probability level for Kewot and Efratana gidim districts. Here also, the highest yield (1342 kg/ha) was gotten from Rasa (N-26) followed by the local variety (1267 kg/ha). The variety NLV-1 has relatively good compared to Jema valley with average yield of 1021 kg/ha even though it still remains below the local variety. The lowest yield (690.3 kg/ha) was still recorded from Arkebe. The highest hundred seed weight (5.38 g) was obtained from Rasa (N-26) variety; however it was statistically at parity with NLV-1 (5.22 g). The lowest value was recorded from Arkebe and local varieties. The variety Rasa (N-26) performs well in all the study location. It returns higher yield in Jema valley when compared to Kewot and Efratana gidim district. Figure 1 shows the average yield obtained from each variety for the two sites.

Farmer's selection criteria

Farmers from Ensaro and Merhabetie districts identified and listed all the attributes which was very important for them and gave weight according to their importance. The major selection attributes identified by farmers were disease resistance, number of pods per plant, pod length, biomass yield and grain size for boldness. The matrix aforementioned compares the different attributes of varieties showing which of the attributes are of greatest importance for mung bean production in the area (Table 3). Using the same procedure for farmers at Kewot and Efratana gidim districts, they were also setting major attributes and prioritizing disease resistance first, pod per plant, branching ability, earliness, pod length, grain size for boldness and yield of biomass in its order of importance. It indicates that the major problems of the area for mungbean production were disease and pest

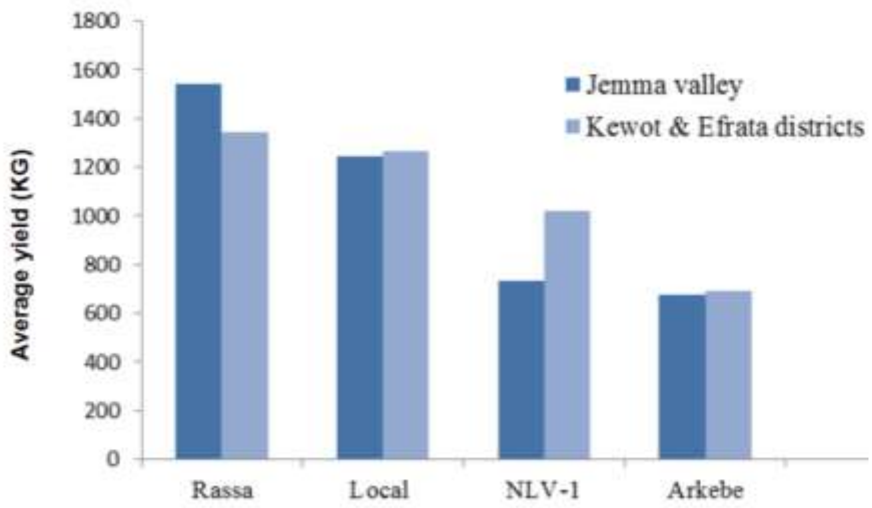

Figure 1. Average yield in kg per hectare.

Table 3. Pair-wise ranking matrix for selected farmers variety evaluating criteria.

Major attributes	Disease resistance	Pod per plant	Pod length	Biomass yield	Grain size	No. of times preferred	Rank
Disease resistance (DR)	-	DR	DR	DR	DR	4	1st
Pods per plant (PPP)	-	-	PL	PPP	GS	1	4th
Pod length (PL)	-	-	-	PL	GS	2	3rd
Biomass yield (BY)	-	-	-	-	GS	0	5th
Grain size (GS)	-	-	-	-	-	3	2nd

infestation which results to yield penalty according to farmers point of view.

Farmer preference ranking matrix

The common and most important selection criteria's in all locations that farmers identified were disease resistance, pod per plant, pod length, seed size for boldness and biomass in their order of importance, respectively (Figure 2). As highlighted in Table 4 in Jema valley farmers were selecting Rasa (N-26) variety. Similarly based on their selection criteria's in Kewot and Efratana gidim woreda Rasa (N-26) variety was preferred by the farmer (Table 5). As illustrated earlier in Figure 2 in almost all attributes, farmers were selecting Rasa (N-26) first and NLV-1 second. On the other hand, Arkebe was not adaptable to the area and hence farmers did not prefer it.

Partial budget analysis

Partial budget analysis helps to evaluate the profitability level of the agricultural production practices due to treatment effects on a business venture. The cost of production for mungbean technology in different areas is relatively similar with no significant differences in both Jema valley and Kewot and Efratana gidim areas. The costs of production included costs of seed, labour, chemical and fertilizer costs. According to the data collected from the activity only seed costs vary along the varieties due to differences in seed rate. Seed rates for Rasa (N-26), NLV-1, Arkebe and local varieties were 38, 33.7, 24.7 and 25 kg/ha, respectively. The data collected from the local market shows that the cost of a kilo of mungbean seed during planting season was 35Birr, while the price of grain and its straw at immediate harvest was respectively 23 and 0.48 birr per kg (Table 6). In the experiment, the net benefits for Rasa (N-26) variety are higher than that of the local variety (Table 6). The net benefits from Rasa (N-26) variety at Jema valley and Kewot and Efratana gidim districts are 32,600.9 and 28,107 birr per hectare, while for the local varieties are 26,841.2 and 26,951 birr per hectare, respectively. On the other hand, the varieties NLV-1 and Arkebe has a return below the local variety in both study sites and are

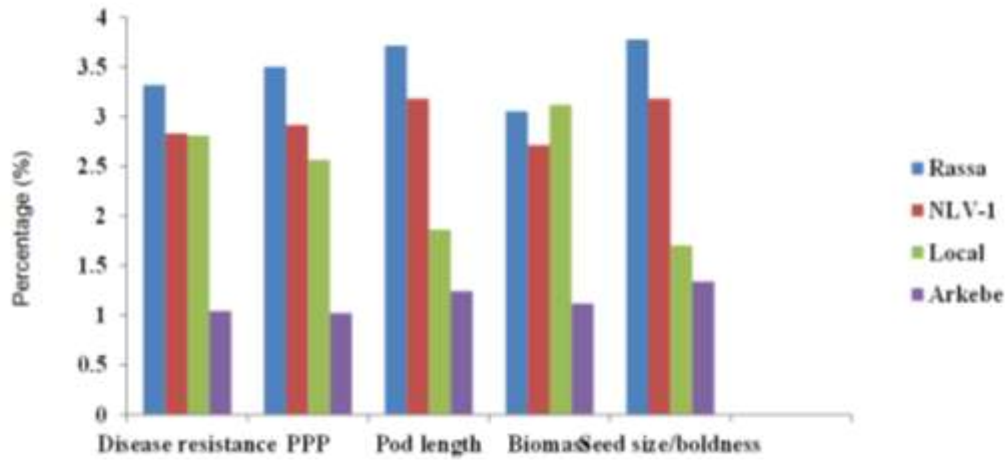

Figure 2. Combined farmers' most important variety selection criteria's.

Table 4. Farmer variety preference ranking matrix summary sheet for Jema valley.

Varieties	Farmers selection Attributes						
	DR	PPP	PL	BM	GS	Mean	Rank
Rasa, N-26	3.18	3.41	3.56	3.26	3.66	3.41	1st
NLV-1	3.18	3.32	3.41	3.07	3.34	3.26	2nd
Arkebe	1.02	1	1.09	1	1.22	1.06	4th
Local	2.62	2.27	1.94	2.66	1.78	2.25	3rd

Scoring value: 4- Best, 1- Poor.
Where DR= disease resistance, PPP= Number of pods per plant, PL= pod length, BM= biomass, GS= seed size (boldness).

Table 5. Farmer variety selection ranking matrix for Kewot and Efratana gidim districts.

Varieties	Farmers selection attributes							
	DR	PPP	PL	Earliness	BM	GS	BA	Mean
Rasa, N-26	3.53	3.63	3.87	3.88	3.04	3.91	2.38	3.46
NLV-1	2.51	2.57	2.96	2.94	2.34	2.99	1.82	2.59
Arkebe	1.08	1.06	1.38	1.43	1.19	1.47	1	1.23
Local	2.88	2.74	1.79	1.76	3.43	1.63	2.03	2.32

Where DR= disease resistance, PPP= Number of pods per plant, PL= pod length, BM= biomass, GS= seed size/boldness and BA= Branching ability).

dominated by the local variety (Figure 3).

Marginal analysis

Although the calculation of net benefits accounts for the costs that vary, it is necessary to compare the marginal costs with the extra net benefits. Higher net benefits may not be attractive if they require very much higher costs. Therefore if the farmers were to adopt Rasa (N-26) variety, it would require an extra investment of 455 birr per hectare; in return, they will obtain extra benefits of 4884.7 and 1155.9 birr for Jema valley and Kewot and Efratana gidim districts, respectively. The marginal rate of return (MRR) is a ratio of the change in net benefits (NB) to change in total variable input costs (TVC) between treatments.

[MRR = ΔNB/ΔTVC *100]

In this case, the marginal rate of return for changing from using local variety to improved Rasa (N-26) variety at

Table 6. Partial budget analysis.

Cost and benefit components	Jema valley				Kewot and Efratana gidim districts			
	Rasa	NLV-1	Arkebe	Local	Rasa	NLV-1	Arkebe	Local
Total grain yield (kg/ha)	1541.3	735.7	676.3	1243.3	1342	1021	690	1267
Adjusted grain yield (kg/ha)	1387.2	662.13	608.67	1118.97	1207.8	918.9	621	1140.3
Total straw yield (kg/ha)	4688	5000	3750	4583	3837	3000	2413	3703
Adjusted straw yield (kg/ha)	4219.2	4500	3375	4124.7	3453.3	2700	2171.7	3332.7
Benefit from grain/ETB	31905.6	15229	13999.4	25736.3	27779.4	21134.7	14283	26226.9
Benefit from straw/ETB	2025.25	2160	1620	1979.86	1657.58	1296	1042.42	1599.7
Gross field benefit/ETB	33930.9	17389	15619.4	27716.2	29436.98	22430.7	15325.42	27826.04
Seed rate (kg/ha)	38	33.7	24.7	25	38	33.7	24.7	25
Total costs that vary/ETB	1330	1179.5	864.5	875	1330	1179.5	864.5	875
Net benefit/ETB	32600.9	16209.5D	14754.9D	26841.2	28107	21251.2D	14460.9D	26951

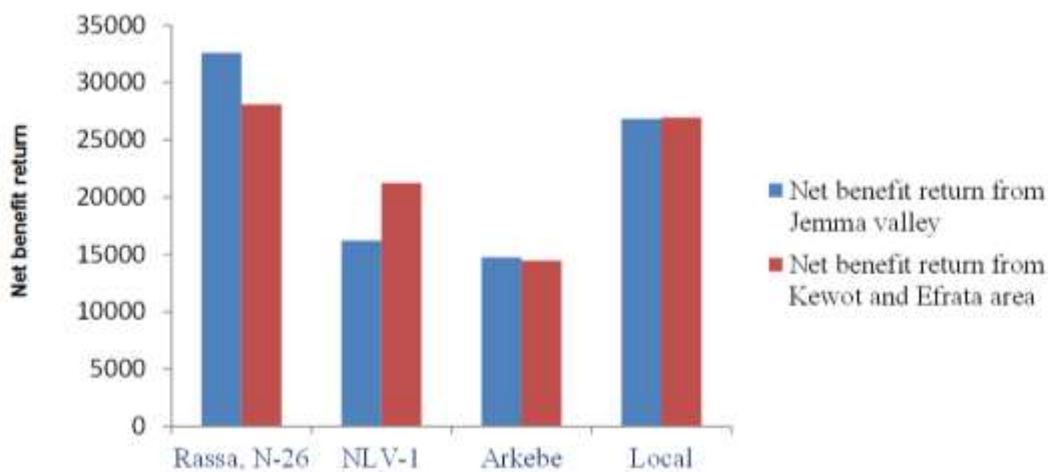

Figure 3. Net benefit return of each variety per location.

Jema valley was 1074%, while for Kewot and Efratana gidim districts it was 254%. This means that for every 1.00 birr invested in improved Rasa (N-26) variety, farmers can expect to recover their 1.00 birr, and obtain an additional 10.74 and 2.54 birr for Jema valley and Kewot and Efratana gidim areas, respectively.

Farmers experience in mungbean production

The farmers were growing mungbean mainly for cash. Most of the time farmers preferred bulge season for producing mungbean. All the participants were preferring bulge season to grow mungbean. It was due to low pest and disease incidence, high seed quality, yield advantage and to avoid land resource competition in main season according to the farmers during focus group discussion. So far, farmers were planting it before and they were plough only one time to cover the seed. But now they started plouging 3 to 4 times. They were planting through broadcasting because of lack of awareness and experience. They were also practicing intercropping and/or mixed cropping system with maize, sesame and sorghum mungbean as a major crop. To improve soil fertility through nitrogen fixation, they had to generate additional income, to break the disease and pest cycle and also as an alternative source of animal feed. Farmers were using local seed due to lack of access to improved seed with seed rates ranging from 16 to 20 kg per hectare and they were harvesting a yield which is very far below the potential of the area according to the farmers. They also said that in the area there is no experience of applying any inorganic chemical fertilizer. However they were applying pesticide chemicals especially in the main production season intensively three to four times on average and they were using a mixture of chemicals at a time. Farmers gave reasons why they were growing mungbean and the potential opportunities of the area as: As a potential rotational crop, it fits well in Teff and sorghum cropping system where there are no other options, it has high market value, it can easily grow with a few available soil moistures with no land resource competition in bulge, it has short date of maturity, an alternative source of animal feed and it can be easily grown with a minimum labor requirement. Although improved mungbean is a profitable crop in the study areas, there are several constraints to its higher production. Lack of access to improved varieties was the most important challenge for mungbean production. It was also identified that disease (mungbean yellow mosaic virus) and insects (apeon) are challenges of the farmer in the growing area. It was also constrained as lack of access to quality chemicals with reasonable cost. Moreover, farmers had no awareness on the stage that chemicals would be use and its amount. They were gotten from traders that sell the chemical with high cost and they don't know which chemical is appropriate. Farmers have also suffered from lack of access to improved seed, low market price during harvesting and price fluctuation across traders and time, and postharvest loss due to weevils.

CONCLUSION AND RECOMMENDATION

Mungbean is a widely grown cash crop in the low land areas of North Shewa. However its productivity was very low due to lack of improved seed and high pest and disease infestation problem. According to farmers evaluation and the agronomic data, variety Rasa (N-26) perform better with grain yield and yield components. So by introducing the new variety and integrated pest and disease management practice, the productivity of mungbean can be improved to 1.54 t/ha. Therefore based on the findings, this variety will be prescale integrated next with pest and disease management practice.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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