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Pre Extension Demonstration of Newly Released Groundnut Technologies in Daro Lebu and Boke Districts of West Hararghe Zone, Oromia National regional State, Ethiopia

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Abstract

The experiment was carried out in DaroLebu and Boke districts of West Hararghe Zone with the objectives of evaluating improved varieties of groundnut under farmers` field condition and to create awareness. Two kebeles were selected purposively based on groundnut production potential, one kebele from each district. Four farmers were included depending on their interest to the technology, managing the experiment, have appropriate land for the experiment and taking the risk at the time of failures. One improved variety Milkaye with standard check were demonstrated and evaluated on 10mx10m farm area of each farmer. Both quantitative and qualitative data were collected through observation, feedback from farmers and data recording sheet. Descriptive statistics, and t-test was used to analyze collected data. While qualitative data were analysed through Garret ranking and narration. The result of the study indicated that Milkaye variety show 31.5% yield advantage over the standard check under farmer's condition. On the other hand, result of T-test shows that, there is statistically significant mean difference between the yield of standard check and improved variety (Milkaye) at less than 1% probability level. Farmers were preferred Milkaye Variety due to its disease resistant, high number of pod per plant, high number of seed per pod, Early maturity, Drought resistance than Warer-96. Thus, Milkaye was recommended for further popularization and scaling up in study area and similar agro ecology.

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Keywords

Groundnut, Milkaye, Yield advantage and farmers' preference.

Introduction

Groundnut (*Arachis hypogaea* L.), a species in the family *leguminasea*, is an annual legume. It is known by many local names, including peanut, earthnut, monkey-nut and goobers. The groundnut originated in Latin America and was introduced to African continent from Brazil by the Portuguese in the 16th century (Adinya *et al.*, 2010). Groundnut is grown in nearly 100 countries. China, India, Indonesia, Nigeria, Senegal, Sudan, USA and Myanmar are the major groundnut growing countries (Taru *et al.*, 2010). The crop is mainly grown for oilseed, food, and animal feed (Pande *et al.*, 2003).

It is the world's 13th most important food crop, 4th most important source of edible oil and 3rd most important source of vegetable protein (Taru *et al.*, 2010). Developing countries in Asia, Africa and South America account for over 97% of world groundnut cultivation and 95% of total production. Production is concentrated in

Asia with 50% of global cultivation and 64% of global production. In Africa, groundnut production accounts for 46% of global cultivation and 28% of global production (Moumouni *et al.*, 2020).

Oilseed sector plays an important role in generating foreign exchange earnings and it is mainstay of rural and national economy of Ethiopia in which groundnut is the one (USAD, 2020). Groundnut is grown under rain-fed and used for oil extraction, and for confectionary in Ethiopia. Moreover, it generates considerable cash income for several small scale producers and foreign exchange earnings through export for the country (Geleta *et al.*, 2007).

For people in many developing countries, groundnuts are the principal source of digestible protein (25 to 34%), cooking oil (44 to 56%), and vitamins like thiamine, riboflavin, and niacin. In many countries, groundnut cake and haulms (straw stems) are used as livestock feed.

Groundnut is a high value crop that can be marketed with little processing; however, it is extremely versatile and can be used in a wide range of products. Groundnut is used to make oils and it is second largest source of vegetable oils next to soybeans (Savage and Keenan, 1994).

The lowland areas of Ethiopia have considerable potential for increased oil crop production including groundnut. The estimated production area and yield of groundnut in Ethiopia in 2019/2020 cropping season were 87,925.23 hectares and 1,565,331.62 quintals, respectively, and the largest groundnut production areas are found in Oromiya (50,812.48 ha), Benshangul-Gumuz (22,931 ha), Amhara (9,493.27 ha) and SNNPR (1,019.5 ha) regional states (CSA, 2020).

However, Groundnut production is constrained and declined in Ethiopia due to poor management practices including delayed harvesting, lack of improved varieties, socioeconomic constraints, moistures or drought, diseases, mechanical damage at the time of harvesting, and limited curing and drying before storage (Berhe *et al.*, 2020).

Oromia region have considerable potential for increased oil crop production including groundnut. Groundnut is mainly grown in Oromia region mainly in East and West Harerghe, Wollega, Kelem Wollega and Ilubabor. West Hararghe has a suitable environment for the production of low land pulse and oil crops especially for the production of ground nut with area coverage of 3,873 83 hectar in 2019/20 cropping season (CSA, 2020). Particularly areas such as DaroLabu, Babile and Gursum are the major producers of groundnuts for local and commercial consumption.

Ground nut is mainly produced by small scale farmers and used as cash crops income generation for local farmers. Beside income for farmers, groundnut provides an inexpensive source of high quality dietary protein and edible oil.

The production of ground nut is relatively easy and it has been found to be reliable under circumstances where other pulse crops would have failed due to drought.

Production of groundnut is influenced by many factors such as climatic factors (rainfall, temperature, humidity, wind, solar radiation, edaphic), soil factors (very low organic carbon and very low available phosphorus) and biological factors (pests and diseases) and agronomic factors (fertilizer, spacing and weed management).

Based on practical problem of shortage of improved variety and low productivity of local varieties in the area, Mechara Agricultural Research Center have been conducting selection of genotypes in different breeding nurseries for last years and then advanced to variety trial to see its varietal performance across locations and years in Groundnut producing low lands areas of West Hararghe and released improved Groundnut variety namely Milkaye in 2019 cropping season for lowland of west Hararghe and similar agro ecologies.

The newly released varieties give 22 Qt/ ha and show 14% yield advantage over standard check Werer-962 variety during the evaluation period. In addition the variety showed moderately resistant to bacteria leaf blight and leaf spot diseases in the tested environments, early maturing and relatively good oil and protein content as compared to standard check. Therefore, this activity was initiated with objectives for to demonstrate and evaluate improved groundnut technologies in the study area.

The main objectives of this study to evaluate the performance of improved variety of groundnut under farmers condition and to create linkage among stakeholders. Also collect farmers feedback on groundnut variety production and management in the study area.

Materials and Methods

Description of the study Area

DaroLebu is one of the districts found under West Hararghe Zone. The capital town of the district Mechara is found at about 434 km South East of Addis Ababa. The district is situated between 7°52'10" and 8°42'30" N and 4°023'57" and 41°9'14" E at 08°35'589" North and 40°19'114" East (Abduselam, 2011). The district is characterized mostly by flat and undulating land features with altitude ranging from 1350 to 2450 m.a.s.l.

Ambient temperature of the district ranges from 14 to 26°C, with average of 16°C and average annual rainfall of 963 mm/year. The pattern of rain fall is bimodal and its distribution is mostly uneven. Generally, there are two rainy seasons: the short rainy season 'Belg' lasts from mid-February to April whereas the long rainy season 'kiremt' is from June to September. The rainfall is erratic; onset is unpredictable, its distribution and amount are also quite irregular (Asfaw *et al.*, 2016).

Boke is one of the districts of West Hararghe zone well known in moisture stress. It bordered on the south by the Shebelle River which separates it from Bale zone, DaroLebu on the South-west, Habro on the North-west, Kunion the North-east, and Galetti River on the east which separates it from the East Hararghe Zone.

Boke Tiko is administrative town of the district. It located at latitude of 10°56'26.5''N and a longitude of 14°16'49.07''W (Encyclopedia, 2013). Coffee is an important cash crop produced in the district. Among the coverage of the district the crop covers over 50 square kilometers.

Farmer's selection and demonstration field establishment

The study was conducted in DaroLebu and Bake districts of west Hararghe zone in 2019/2020 cropping season. Site and farmers selection was conducted with participation of respective district of Agricultural and natural resource Office based on groundnut production potential.

Similarly, trial farmers were selected collaboratively with respective Developmental Agent by considering different selection criteria's like farmers interest to the technology, model farmers and managing the field as required. Thus, a total of four (4) farmers were selected from both districts (three farmers from Boke district of cabikebele and one farmer from Daro Lebu district of milkaye kebele).

One improved variety of groundnut namely Milkaye and standard check (warer 962) were evaluated under farmer's` field condition. The experiment was demonstrated on 100 m^2 demonstration plots for each variety on each trial farmers and seed rate of 90 kg/ha. A spacing of 60cm X 10cm between row and plant spacing was used, respectively during the demonstration. Before conducting the trial, farmers were trained about improved groundnut production practices like seed rate, planting dates, crop management aspect and recommended agronomic practices. In addition, mini field day was organized at vegetative stage to create awareness and collect farmers' feedbacks on evaluated varieties.

Data Types and Method of Collection

Both qualitative and quantitative data were collected for the study. Qualitative data like farmer preference on demonstrated varieties was collected through personal interview of farmers during mini field day organized. On the other hand quantitative data like gained yield from demonstrated variety from each was collected directly from the field by researchers.

Method of Data Analysis

Descriptive statistics were used to analyze the crop performance concerning yield and yield components of the experiment harvested from demonstration plot. While qualitative data were analyzed through garret ranking technique and narration.

Results and Discussion

Crop performance and yield advantage of improved variety on the farmer's field

The mean yield of milkaye and warer 962 varieties was 8.9 and 6.1 Qt/ha with standard deviation of 3.9 and 3.2, respectively. The percentage increase in the yield of milkaye variety over standard check was observed during demonstration time.

Accordingly, milkaye variety show 31.5% yield advantage over the standard check under farmer's condition. Even though, Milkaye variety's more yield than standard check (warer-962), it didn't show its potential yield during its release, 22Qt/ha. This reduction of yield was caused by moisture stress at different stages of the crop at sowing, vegetative and flowering time which resulted in decrement in pod per plant, seed per pod, pod length and seed yield as well as high rainfall after maturity.

This problem was true with the report of Dahanayake Nilanthi, Alawathugoda CJ and Ranawake AL, (2016) on ‘Effects of water stress on yield and some yield components of three selected oil crops; Groundnut, sunflower and sesame’; Water stress had a highly significant impact on seed yield and biological yield. Water stress in groundnut production during flowering period may have resulted in death of pegs before pod initiation.

After re-watering, the plants resumed flowering reaching physiological maturity with small pods without mature seeds. Plants stressed during maturity stage had a higher number of seeds per plant compared to other stressed treatments. The plants stressed during the vegetative stage also reduced pod number and seed yield. The reduction in seed yield agrees with previous findings on legumes under water stress such as black beans (Nielson *et al.,* 1998); faba beans and Bambara groundnuts (Mwale *et al.,* 2007), European Union FP-5 INCO-DC, 2002) and cereals like oats (Sandha *et al.,* 1977) and maize (Kamara *et al.,* 2003).

Table 2 showed that the mean yield of standard check was less than that of Milkaye variety which indicated that using improved variety enhance the yield gain of farmers from their land. As shown in Table 2 the t-test value shows that, there is statistically significant mean difference between the yield of standard check and improved variety (Milkaye) at less than 1% probability level. This implies that, using improved variety increases the probability farmers to harvest more yield from their land than using local variety.

Farmers’ Preference on Groundnut Technologies

Farmers’ preferences data on improved groundnut technologies were collected at maturity stage of the crop through organizing field day. The data were collected from farmer’s field and Farmer Training Center (FTC) of Chabikebele in Boke district. A total of Forty Eight (48) participants were participated on mini field day for technology evaluation and selection at farmer’s field.

Table.1 List of experimental treatments, fertilizer compositions and their descriptions

No.	Treatments		Total composition of fertilizer in the treatment (kg ha^{-1})			
	Blended NPSB rate (kg ha^{-1})	Nitrogen rate (kg ha^{-1})	N	P_2O_5	S	B
1	0	0	0	0	0	0
2	0	23	23	0	0	0
3	0	46	46	0	0	0
4	0	69	69	0	0	0
5	50	0	9.45	18.85	3.475	0.05
6	50	23	32.45	18.85	3.475	0.05
7	50	46	55.5	18.85	3.475	0.05
8	50	69	78.5	18.85	3.475	0.05
9	100	0	18.9	37.7	6.95	0.1
10	100	23	41.9	37.7	6.95	0.1
11	100	46	64.9	37.7	6.95	0.1
12	100	69	87.9	37.7	6.95	0.1
13	150	0	28.35	56.55	10.425	0.15
14	150	23	51.35	56.55	10.425	0.15
15	150	46	74.35	56.55	10.425	0.15
16	150	69	97.35	56.55	10.425	0.15

Table.2 Physical and chemical properties of pre planting and post harvesting at Adola Kiltu Sorsa on farm during 2021 and 22 main cropping season

Pre planting	Physical and Chemical Property	Value	Rating	Reference
	Sand	32%	-	-
	Clay	44%	-	-
	Silt	24%	-	-
	Textural class	Clay	-	USDA ,1987
	pH (1: 2.5 soil H_2O ratio)	5.97	moderately Acidic	EthioSIS,2014
	Organic matter (%)	2.89	low	EthioSIS,2014
	Organic carbon (%)	1.68	low	Tekalign, 1991
	Total N (%)	0.29	medium	EthioSIS,2014
	CEC (meq/100 g soil)	23.79	medium	Murphy, 2007
	Available P (ppm)	9.20	low	EthioSIS,2014
	Available S (ppm)	14.08	low	EthioSIS,2014
	Available B (ppm)	0.97	low	EthioSIS,2014
	Ex. K [$Cmol_{(+)}kg^{-1}$soil]	1.10	high	FAO,2006
	Ex.Mg [$Cmol_{(+)}kg^{-1}$soil]	3.48	high	FAO,2006
	Ex.Ca [$Cmol_{(+)}kg^{-1}$soil]	15.53	high	FAO,2006
	Ex.Na [$Cmol_{(+)}kg^{-1}$soil]	0.11	low	FAO,2006
Post harvesting	Sand	30%	-	-
	Clay	48%	-	-
	Silt	22%	-	-
	Textural class	Clay	-	USDA ,1987
	pH (1: 2.5 soil H_2O ratio)	6.07	moderately Acidic	EthioSIS,2014
	Organic matter (%)	5.79	Medium	EthioSIS,2014
	Organic carbon (%)	3.36	high	Tekalign, 1991
	Total N (%)	0.28	medium	EthioSIS,2014
	CEC (meq/100 g soil)	24.13	medium	Murphy, 2007
	Available P (ppm)	7.21	low	EthioSIS,2014
	Available S (ppm)	10.52	low	EthioSIS,2014
	Available B (ppm)	0.81	low	EthioSIS,2014
	Ex. K [$Cmol_{(+)}kg^{-1}$soil]	0.71	high	FAO,2006
	Ex.Mg [$Cmol_{(+)}kg^{-1}$soil]	2.87	medium	FAO,2006
	Ex.Ca [$Cmol_{(+)}kg^{-1}$soil]	13.71	high	FAO,2006
	Ex.Na [$Cmol_{(+)}kg^{-1}$soil]	0.07	very low	FAO,2006

Table.3 Mean squares of ANOVA for Black Cumin Phenology, growth, yield and yield component effects of blended NPSB and N fertilizer rates at Adola, Southern Ethiopia in 2021 and 2022 growing season

Source of Variables	Parameters					
	DF	DM	PH(cm)	NCPP	NSPC	Syld qt/ha
Rep.	5.32Ns	72.80Ns	49.68*	2.51Ns	122.99Ns	6.91*
Year	32.66**	600.00**	27.22Ns	4.86Ns	1565.58*	942.32***
NPSB	35.66***	48.26Ns	46.04*	7.59*	853.05*	12.45***
N	37.55***	78.82*	38.91*	20.38***	387.94Ns	11.27***
NPSB*Year	14.11*	Ns	11.9Ns	Ns	400.83Ns	3.11Ns
N*Year	6.67Ns	Ns	5.63Ns	Ns	95.66Ns	9.45*
NPSB*N	3.88**	162.15***	53.13*	4.06*	189.75Ns	7.28***
NPSB*N*Year	6.78*	Ns	20.53Ns	Ns	59.19Ns	3.16*

Significant'***' 0.001, '**' 0.01, '*' 0.05 and Non Significant (NS) at P>0.05.DF= Days to 50% Flowering, DM= Days to 90% Maturity, PH= Plant height(cm),NCPP= No. capsule per plant, NSPC=No. of Seed per capsule, and Syld= Seed yield qt/ha

Table.4 Over year Pooled mean interaction effects of NPSB and N fertilizer rates on days to 50% flowering and days to 90% physiological maturity of black cumin

NPSB Rates (kg ha^{-1})	Days to 50% flowering				Days to 90% physiological maturity			
	Nitrogen (kg ha^{-1})				Nitrogen rates (kg ha^{-1})			
	0	23	46	69	0	23	46	69
0	67.5d	67.67d	69cd	70cd	114.2de	117.5b-e	115.8cde	115.8cde
50	67.67d	69.33cd	69.67cd	70.67c	117.5b-e	125.8a	114.2de	115.8cde
100	68.67cd	69.33cd	69.33cd	70cd	122.5abc	114.2de	114.2de	125.8a
150	69.17cd	69.83cd	73ab	73.67a	114.2de	112.5e	114.2de	124.2ab
Mean=69.66					Mean= 117.8			
LSD(0.05)=0.9					LSD(0.05)=3.06			
CV (%) =2.4					CV (%) = 4.5			

Table.5 Over location and year Pooled mean interaction effects of NPSB and N fertilizer rates on plant height and Number of capsule per plant of black cumin

NPSB Rates (kg ha^{-1})	Plant height(cm)				Number of capsule per plant			
	Nitrogen (kg ha^{-1})				Nitrogen rates (kg ha^{-1})			
	0	23	46	69	0	23	46	69
0	31.11e-i	36.62a-d	30.32f-i	31.97d-i	5.17cde	5.5b-e	4.38de	6.44bc
50	33.90b-h	32.64c-i	36.51a-d	39.48a	4.05e	6.55bc	7.11ab	8.55a
100	34.49b-f	29.90gi	37.08abc	35.22a-e	4.33e	5.39cde	6.11bcd	6.44bc
150	36.35a-d	29.24gi	35.61a-e	37.61ab	5.11cd	4.99cde	5.33cde	6.22bc
Mean=34.5					Mean= 5.73			
LSD(0.05)=1.98					LSD(0.05)=0.83			
CV (%) =9.99					CV (%) = 24.9			

Table.6 Over year Pooled mean main effects of NPSB and N fertilizer rates on Number of seed per capsule of black cumin

Treatments	**Yield related parameter**
NPSB rate (kg ha^{-1})	Number of seed per capsule
0	51.39b
50	65.82a
100	60.07ab
150	57.92ab
Nitrogen rate (kg ha^{-1})	
0	53.04
23	62.1
46	59.21
69	60.84
Mean=58.8	
LSD (5%)=17.58	
CV (%)=26	

Table.7 Over year Pooled mean interaction effects of NPSB and N fertilizer rates on Seed yield of black cumin

NPSB Rates (kg ha^{-1})	**Seed Yield(qt/ha)**			
	Nitrogen (kg ha^{-1})			
	0	23	46	69
0	3.71b	7.41ab	5.78ab	7.05ab
50	6.37ab	7.27ab	7.55ab	7.59ab
100	7.14ab	7.68ab	9.75a	6.26ab
150	6.37ab	7.28ab	7.23ab	6.34ab
Mean=6.96				
LSD(0.05)=0.68				
CV (%) =17.16				

Table.8 Correlation analysis on phenology, growth, yield, yield components Characters/traits of Black Cumin at Adola on-farm in 2021 and 2022 cropping season

Characters/Traits	**Characters/Traits**					
	DF	DM	PH	NCPP	NSPC	SYLD
DF	1					
DM	0.116	1				
PH	0.24	0.134	1			
NCPP	0.177	0.079	0.304	1		
NSPC	0.113	0.129	0.263	0.23	1	
SYLD	-0.137	0.311	0.049	0.194	0.399	1

Table.9 Partial budgets and marginal rate of return analysis effect of blended NPSB and Nitrogen fertilizer rates to Black cumin variety at Adola on-farm in 2021 and 2022 cropping season

Treatments		Un Adjusted Seed Yield (kgha^{-1})	Adjusted Seed yield (kgha^{-1})	Total variable cost(ETB)	Total Revenue(ETB)	Net benefit(ETB)	MRR%
NPSB rate (kg ha^{-1})	Nitrogen rate (kg ha^{-1})						
0	0	371	333.9	0	50085	50085	-
0	23	741	666.9	2300	100035	97735	D
50	0	637	573.3	2300	85995	83695	D
0	46	578	520.2	4600	78030	73430	D
50	23	727	654.3	4600	98145	93545	D
100	0	714	642.6	4600	96390	91790	D
0	69	705	634.5	6900	95175	88275	D
100	23	768	691.2	6900	103680	96780	D
150	0	637	573.3	6900	85995	79095	D
50	46	755	679.5	6900	101925	95025	692.61
50	69	759	683.1	9200	102465	93265	D
150	23	728	655.2	9200	98280	89080	D
100	46	975	877.5	9200	131625	122425	2148.478
100	69	626	563.4	11500	84510	73010	D
150	46	723	650.7	11500	97605	86105	622.39
150	69	634	570.6	13800	85590	71790	D

Where, blended NPSB cost = Birr 20 kg-1of blended NPB, N cost = Birr 20 kg^{-1}, blended NPSB and N fertilizers application cost=Birr 6 kg^{-1} of blended NPSB and N, Application cost of blended NPSB and N fertilizers 6 persons 100 kg ha^{-1}, each 75 ETB day^{-1}, Field price of black cumin during harvesting= Birr 150 birr kg^{-1}, MRR (%) = Marginal rate of return and D= Dominated treatment.

The result of Garret ranking techniques on Table 4indicate that seed size, disease resistant, number pod per plant, number of seed per pod, early maturity and drought resistance were used as major criteria rank and evaluating groundnut varieties on farmers field.

Farmers were preferred Milkaye Variety due to its disease resistance, high number of pod per plant, high number of seed per pod, Early maturity, Drought resistance than warer-962 (Table 4). Therefore, based on farmers', preference milkaye variety was ranked as 1st for further dissemination in the study area.

Recommendation

Oilseed sector plays an important role in generating foreign exchange earnings and it is mainstay of rural and national economy of Ethiopia in which groundnut is one. Hence, this study was conducted to evaluate yield performance of improved variety of groundnut under farmer's condition. The result of paired t test revealed that there is yield difference between improved and local varieties in terms of grain yield and showed grain yield advantage over the standard check by 31.5% with similar management.

On the other hand ranking analysis also indicated that milkaye variety was preferred due to its disease resistance, high number of pod per plant, high number of seed per pod, Early maturity, Drought resistance than Warer-96 variety under farmer's condition. Therefore, this variety was recommended for production at west Hararghe Zone and similar agro ecological conditions to improve groundnut production and productivity.

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