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Cluster Based Improved Maize Technologies Popularization in Selected AGP-II Districts of Harari Region and Dire Dawa Administration

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Abstract: Despite the large area under cultivation, the mean yield of maize per hectare is low. Limited access to improved maize varieties is among the contributing factors for low productivity. Popularization of better performing maize varieties is important to solve these problems. Therefore, this study was undertaken to enhance the productivity of maize through pre-scaling up of early maturing and high yielding maize varieties with improved management practices at Harari region and Dire Dawa administration under AGP-II fund. It was conducted at Wahil from Dire Dawa and at Dodota as well as Kile kebeles from Harari region through cluster approach. A total of 100 Farmers were selected based on their interest and land ownership. Melkassa-2 and Melkassa-6 were provided to farmers with full packages. Each variety was planted on a plot size of 50mx50m/farmer, with seed rate of 25kg/ha and 75cm*25cm space between row and plant respectively. Likewise, fertilizer (NPS) was applied with rate of 100kg/ha. Training and field day were organized as a means to facilitate uptake and diffusion of technologies through farmers as well as to evaluate performance of the varieties and share the lessons with different stakeholders. The combined mean yield for melkasa-2 and melkasa-6 is 29.36qt/ha and 26.67qt/ha respectively. The mean score for knowledge test before and after implementation is 4.47 and 7.37 respectively. These results indicate an improvement in the awareness, production and productivity of beneficiary farmers. Therefore, it is better if respective bureau of agriculture and natural resource take the responsibility to exert their effort for wider scaling up of the technologies.

Keywords: Pre-Scaling Up, Cluster, Maize Varieties, Knowledge Test

1. Introduction

Maize is one of the most important food crops grown world-wide over a wide range of environmental conditions [1]. It has the highest average yield per hectare and is third after wheat and rice in area cultivation and total production in the world [12]. The estimated total world production of maize during 2018 was 1,147,621,938 tons, where, United States, China, and Brazil share 34%, 22%, and 7.2% of this production, respectively [10]. In Sub-Saharan Africa, maize is the main staple crop covering over 38 million hectares and it accounts for 30% of the total area under cereal production [10]. Ethiopia is the second largest maize producer in Africa next to South Africa with high average productivity as compared to African countries, even if there is low productivity compared to the world average [7, 9]. Maize is cultivated on about 2.526 million hectares of land in the country [5]. It ranks first in total production with over 10.557 million tons of produce whereas it ranks second in area coverage next to Teff. The national average yield of maize under subsistence production is about 4.18 ton/ha [4, 5]. In Oromia region, maize covers about 1.372 million hectares of land with total production of 5.889 million tons and average yield of 4.29 tons/ha. It also covers about 76,655 hectares of land with 0.22 million tons of production and average yield of 2.9 tons/ha in east hararghe zone [5].

Farmers produce maize mostly for subsistence, with 88% of maize produced is consumed by the farming households [6, 16]. Maize is popular for its high value as a food crop as well as the growing demand for animal fodder and source of fuel for rural families [16]. It is the cheapest source of calorie, providing 16.7 % of per capita calorie intake nationally [14]. It contains about 72% starch, 10% protein, and 4% fat, supplying an energy density of 365 Kcal/100g [11]. It also provides many of the B vitamins and essential minerals along with fiber [13]. It is also one of the strategic crops considered in the national agricultural sector development plan of the country. The role of maize in meeting the food security requirements of the population and in promoting emerging agro-industries will therefore continue to be important in the country. Therefore, increasing maize production and productivity sustainably without jeopardizing the production environment assumes a fundamental position to better address food security and poverty, and putting agriculture in a transformative state. Despite the large area under maize cultivation, its national average yield is low [3, 5, 15]. It is by far below the world's average yield which is about 5.21 t/ha [8]. This is due to factors such as frequent drought, declining soil fertility, lack of access to improved maize varieties, poor agronomic practice, limited use of input, poor seed quality, and disease [2].

Adaptation and popularization of better performing maize varieties are important to solve these problems. In doing so, Fedis Agricultural Research Center (FARC) adapted Melkassa-2 and Melkassa-6 maize varieties which were first released from Melkassa Agricultural Research Center (MARC) to the study environment. These varieties were some of the drought tolerant and nitrogen-use efficient maize varieties specifically adapted to the semi-arid agro-ecologies of Ethiopia. On-farm demonstration of these varieties was undertaken at Harari region and Dire Dawa administration during 2017/2018 and 2018/2019 cropping seasons by FARC under AGP-II fund. Farmers have evaluated and selected Melkessa-2 as first and Melkassa-6 as second based on criteria such as grain yield, diseases tolerance, growth stage performance, adaptability, moisture stress tolerance, biomass and labor demand. Therefore, this study was undertaken to boost the productivity of maize through pre-scaling up of early maturing and high yielding maize varieties with improved management practices in the study area.

2. Methodology

2.1. Description of the Study Area

The activity was conducted in nationally selected Agricultural growth program-II implementation districts of Harari region and Dire Dawa administration. Harari region is located at distance of 526 km from the national capital city finfinne to the Eastern parts of the country. It is bordered by Oromia region and hosts the capital town of East Hararghe zone of Oromia national regional state. Agro-ecologically, the region is classified as highland, midland and lowland. The region is characterized by clay, loam, and sandy soil types. The selected district has the potential for the program to be succeeded in terms of solving the practical problems of farming society.

Dire Dawa administration is located on distance of 515kms from capital city Finfine in direction of country's Eastern part. It is bordered by Somali, and Oromia regions in all directions. Agro-ecologically, Dire Dawa is characterized as dry lowland with 38°C max and 25°C min annual temperature.

In general, the study sites are characterized by drought and erratic nature of rain fall which are challenging crop production in general and maize production in particular. Recurrent drought and long dry spell, especially in the main season, has become a common problem.

2.2. Site and Farmers' Selection

One district from Dire Dawa and two districts from Harari Region were selected. One kebele (Wahil) from Dire dawa and two kebeles (Dodota and Kile) from Harari region were selected. Farmers were selected based on their interest, land ownership, willingness to share experiences for other farmers in collaboration with experts from wereda agriculture and natural resource office and development agents. The selected farmers were clustered into two according to their land adjacent with the member of 15-18 farmers per cluster taking gender issues (Women and Youth constitute 40% of the total participant farmers) into consideration. A total of 100 farmers were addressed within one year duration of this project.

2.3. Approaches Used

2.3.1. Cluster Approach

To effectively demonstrate the potential impact of the technology and also to link farmers with different service providers, it is preferable to conduct pre-scaling up business in clustered farms. Accordingly, in this study, participant farmers whose farms are adjacent to each other were selected to form clusters. Cluster of farmers producing similar crops were selected in areas where it is difficult to get farmers with adjacent farms. Farmers in a cluster were organized into farmers' research and extension groups (FREGs) of 15 members. Such clusters can enhance access to markets and information.

2.3.2. Technology Dissemination Approach/Process

Scaling up is best achieved by dynamically combining generalized and context specific approaches with careful attention to sequencing of activities, integration of local experiences with external knowledge and mainstreaming new processes and principles (World bank, 2003). Hence, different community groups and institutions are linked through information to work with different stakeholders in order to enhance technology diffusion and adoption thereby facilitating interaction and information exchange among farmers' groups, community members and other relevant stakeholders.

2.4. Implementation Procedure

Two improved maize varieties (Melkassa-2 and Melkassa-6) were provided to the farmers with full packages. Both varieties were first released from Melkassa Agricultural Research Center (MARC) and they were adapted to the study environment by Fedis Agricultural Research Center (FARC). Then, on-farm demonstration of these varieties was undertaken for two years by FARC through the support of AGP-II. Again, pre-scaling up was undertaken for one year under AGP-II fund. Each variety was planted on a plot size of 50mx50m/farmer, with seed rate of 25kg/ha. Space between row and plant was 75cm*25cm respectively. Likewise, fertilizer (NPS) was applied with rate of 100kg/ha. Each variety was replicated across 20farmers. Fields were managed by participant farmers with close supervision of researchers and DAs.

2.5. Capacity Building and Experience Sharing

As part of the intervention activities, training on agronomic practices and post-harvest handling were given to farmers, DAs and experts before plantation and harvesting time. Finally, field day was organized on the fields of beneficiary farmers in order to evaluate the performance and final outputs of the varieties and share the lessons with different stakeholders. Famers, development agents (DAs), experts from agriculture and natural resource office, researchers and other relevant stakeholders had attended the field day.

2.6. Data Collection

Number of beneficiary farmers by age and sex, plot size and amount of input provided were collected with checklist. The grain yield data was collected with checklist through yield assessment survey. Knowledge level of participant farmers concerning improved maize production technologies was measured before and after implementation with developed knowledge test items.

2.7. Data Analysis

Quantitative data was analyzed using SPSS software version 20. Descriptive statistics such as frequency, percentage, mean, standard deviation minimum, maximum, were used and presented using tables. Knowledge level of participant farmers regarding improved maize production technologies was analyzed with paired-sample t-test.

3. Results and Discussion

3.1. Demographic Characteristics of Beneficiary Farmers

The mean age of beneficiary farmers is 38.13 years, whereas the minimum and the maximum age is 21years and 65years respectively. Out of the total beneficiary farmers, 60% are males and the remaining 40% are females.

Table 1. *Demographic Characteristics of beneficiary farmers.*

Locations	Age of beneficiary farmers				Sex of beneficiary farmers	
	Minimum	Maximum	Mean	St. dev	Female	Male
Dodota	21	65	37.97	12.86	12	18
Kile	22	62	37.38	11.94	14	20
Wahil	22	57	38.97	10.84	14	22
Combined	21	65	38.13	11.75	40	60

Source: computed from own data (2020)

Table 2. *Descriptive results for yield per plot and per hectare.*

Locations	Varieties	parameter	Minimum	Maximum	Mean	St. dev
Dodota	Melkasa-2	Yield per plot	4	12	8.08	2.04
		Yield per hectare	16	48	32.32	8.15
	Melkasa-6	Yield per plot	4.7	11	7.05	2.11
		Yield per hectare	18.8	44	28.2	8.44
Kile	Melkasa-2	Yield per plot	7	14	10.48	2.25
		Yield per hectare	28	56	41.92	8.99
	Melkasa-6	Yield per plot	6	12	9.18	1.89
		Yield per hectare	24	48	36.7	7.57
Wahil	Melkasa-2	Yield per plot	2	6.3	3.93	1.23
		Yield per hectare	8	25.2	15.74	4.95
	Melkasa-6	Yield per plot	2	7	3.8	1.28
		Yield per hectare	8	28	15.18	5.11
Combined	Melkasa-2	Yield per plot	2	14	7.34	3.08
		Yield per hectare	8	56	29.36	12.3
	Melkasa-6	Yield per plot	2	12	6.67	3.01
		Yield per hectare	8	48	26.67	12.06

Source: computed from own data (2020)

3.2. Descriptive Results for Productivity of the Varieties

The maximum yield recorded for melkasa-2 and melkasa-6 is 56qt/ha and 48qt/ha respectively; and both are recorded at Kile. The mean yield for Melkasa-2 is 32.32qt/ha, 41.92qt/ha and 15.74qt/ha at Dodota, Kile and Wahil respectively. Similarly, the mean yield obtained for Melkasa-6 is 28.2qt/ha, 36.7qt/ha and 15.18qt/ha at Dodota, Kile and Wahil respectively. Comparing the mean yield obtained at three locations, the mean yield obtained at Kile for both varieties is better than that of the remaining locations. The lower mean yield is recorded at Wahil for both varieties due to extreme environmental stresses. The combined mean yield for melkasa-2 and melkasa-6 is 29.36 and 26.67 respectively. This implies that melkasa-2 maize variety has 10% yield advantage over melkasa-6 maize variety. There is also empirical evidence that melkasa-2 has 9.3% yield advantage over melkasa-6 maize variety [17].

The result of t-test (table 3) for mean difference indicates that there is no significant combined mean difference between the two varieties.

Statistically non –significant difference between melkasa-2 and melkasa-6 varieties was also reported by [17].

Table 3. *The result of t-test for combined mean difference.*

Parameters	Melkasa-2 (n=46)		Melkasa-6 (n=54)		
	Mean	St. Dev	Mean	St. Dev	T-value
Harvested Yield per plot	7.34	3.08	6.67	3.01	1.095
Estimated Yield per hectare	29.36	12.3	26.67	12.06	1.099

Source: computed from own data (2020)

Table 4. *Percentage of Respondents for each knowledge test Items.*

No	Test Items	Respondents' percentage			
		After		Before	
		Correct	Incorrect	Correct	Incorrect
1	Name at least one improved maize variety	73.3	26.7	53.3	46.7
2	What is the seed rate of maize required for one hectare?	70	30	53.3	46.7
3	What is the recommended fertilizer rate per hectare for maize?	66.7	33.3	66.7	33.3
4	What is the recommended space between rows for maize	66.7	33.3	40	60
5	What is the recommended space between plants for maize	66.7	33.3	40	60
6	What is the Potential productivity (yield/ha) of the variety	53.3	46.7	26.7	73.3
7	The maximum maize plant density (plant population) per hectare recommended for good harvest is 53,333.33plants/ha	30	70	0	100
8	Environmental yield losses due to particular biotic and abiotic constraints	60	40	50	50
9	Potential yield losses due to environmental stresses	56.7	43.3	33.3	66.7
10	Actual yield/farmer yield/realized yield losses due to misuse of recommended agricultural practices and environmental stress	60	40	46.7	53.3
11	Economic yield losses due to post-harvest losses	53.3	46.7	36.7	63.3
12	The recommended grain moisture content for maize harvest is 13%	30	70	0	100

Source: computed from own data (2020)

3.3. Capacity Building

A total of 86 farmers out of which 55 are males and 31 are females have participated on field day. 5 experts (4males and 1female) and 7 development agents have also participated on the event. Likewise, a total of 30 farmers (20males and 10females), 5 development agents and 3 experts have participated on training.

3.4. Results of Knowledge Test

A simple knowledge test items were developed based on the contents of training and production package practices and knowledge level of participant farmers regarding improved maize production technologies was measured before and after implementation. Score of 1 is given for correct answers and 0 for incorrect answers. As one can observe from table 4, the percentage of respondents for correct answers is increased after intervention. As a result, the percentage of respondents for incorrect answers is decreased.

The mean score for knowledge test before intervention and after intervention is 4.47 and 7.37 respectively. The result of paired-sample t-test indicates a significant difference between the mean score for knowledge test before intervention and after intervention at 1% significant level. This implies an improvement of farmers' knowledge regarding the improved maize technologies due to technological intervention.

Table 5. *Results of paired-sample t-test for knowledge test.*

	Mean	St. Dev	T-value
Total score after	7.37	1.94	10.98***
Total score before	4.47	1.8	

Source: computed from own data (2020)
Note: ***: refers to significance at 1% level.

4. Conclusions and Recommendations

The result for the productivity of improved maize varieties indicates an improvement of production of beneficiary farmers. Hence, it is good if all farmers residing in the study areas adopt the improved maize varieties in sustainable manner in order to increase their production. Since there is no significant combined mean difference between the two varieties, it is better if both varieties are adopted. It is also better if respective bureau of agriculture and natural resource take the responsibility to exert their effort for wider scaling up of the technologies. The result of paired-sample t-test implies an improvement of farmers' knowledge regarding the improved maize technologies due to intervention. Therefore, it is better if pertinent government and non-government organizations focus on capacity building in order to increase awareness and knowledge of farmers towards the new and improved technologies.

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