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Cluster-based large-scale demonstration of improved sesame production technology

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Cluster-based large-scale demonstration of improved sesame technology through irrigation was done in the Bena-Tsemay district of South Omo zone, Belg season. A total of 6 agro-pastorals participated in the demonstration and one pastoral and agro-pastoral research group containing 16 members was established to share experiences with each other starting from planting to harvesting. The demonstration was done on a land size of 10 hectares in a cluster base. Participatory training was given to all participants on important agronomic practices and management measures. All the recommended agronomic management was applied with close supervision and follow-up of researchers. Agronomic data and grain yield was collected and analyzed. Accordingly, an average grain yield data of 0.725 tons ha^{-1} was obtained. Feedback was also collected from participants and they preferred the technology based on its early maturity, yield per plant, branch per plant, disease resistance, pod per plant, seed color, marketability, and overall yield. Thus, using this improved sesame (Mehando-80) variety with its agronomics management is advisable.

Key words: *cluster, demonstration, oil seed, production, sesame, yield*

INTRODUCTION

Sesame (*Sesamum indicum*) is the main home-grown oil crop in Ethiopia and is utilized as a source of oil for internal demand, and they also boost the economy by replacing imports that would otherwise be used to import cooking oil (Ojonugwa et al., 2022; Zerihun, 2012). Oilseeds cover a total of 6.68% of the grain crop area and 2.79% of yield production to the national grain production and sesame covers 2.92% of the grain crop area respectively (CSA, 2018). It is a significant cash crop in Ethiopia growing in a hot area with well adapted (Kafiriti & Deckers, 2001) and contributing millions of dollars to the industrial sector and supporting the livelihoods of thousands of small farmers, agro-pastorals, and medium to large-scale private farms, as well as thousands of other participants in the continuum of production, consumption, and export (CSA, 2020). It is the second most significant crop in terms of generating foreign exchange following coffee because of its attractive domestic and international markets (Fiseha & Zenawi, 2019). With the growing demand for sesame as the main input for oil production by industries in Ethiopia and the international market (Belayneh et al., 2022) and the available resources like water and land could capacity to improve sesame production and promote the economic growth of Ethiopia (CSA, 2020). Despite its economic importance, sesame production in Ethiopia is facing a lot of challenges including a lack of improved seeds, pesticides, and a traditional production system that could reduce the productivity of the crop (Girmay, 2018). Similarly, in the south Omo zone, Bena-Tsemay woreda is one the main sesame-producing areas with huge potential for land irrigation water access. But the production and productivity are declining due to the lack of improved and every-season use of their local seed. In response, the Jinka agricultural research center conducted adaptation research to select the sesame variety that best suits the area and gives a higher yield. Accordingly, the one that gave a higher yielder variety Mehando-80 was recommended for further demonstrations and promotion in the area. Therefore, this study was conducted to demonstrate improved sesame technology through cluster-based approach and to create awareness of pastorals' and agro-pastoral on improved sesame technology and get feedback for further technology development.

MATERIALS AND METHODS

Description of the study area

Benna-Tsemay district is one of the ten districts in the South Omo Zone with a total land coverage of 254,905 hectares. The district is about 483 kilometers from the regional center, Hawassa, and 42 kilometers from the zonal administrative city, Jinka. It is bordered to the south by Konso, to the north by Ari, to the west by Hammer, and to the east by Malle. Agro-ecologically, the district is predominantly semi-arid. The agro-climate zone of the community consists of Kolla (78%), Dry Woyna Dega (19%), and Bereha (3%). The district is located at an altitude range of 526–1800 meters above sea level. The district is covered with different varieties of vegetation, mainly indigenous trees, shrubs, and bushes. The major crops grown in the lowland areas of the Bena-Tsemay district are maize, sorghum, sesame, onion, and tomato (Asmera & Yidnekachew, 2021; Lebiso & Mada, 2021).

Implementation procedure: The site and Agro-pastorals selection

Cluster-based large-scale demonstration of improved Sesame technology was undertaken in the Bena-Tsemay district of the South Omo zone. Enchate kebele was selected from the district based on high access to irrigation, access to roads, and access to suitable farmland for cluster base sesame production. Totally, 6 agro-pastorals participated in the cluster-based large-scale demonstration of improved sesame technology conducted in the district. Also, a pastor and agro-pastoral research group (PAPREG) containing 16 members was established. The area of land of 10 hectares was covered in all PAPREG members' farmland. The selection of participants and host kebele was undertaken by the active participation of Jinka agricultural research center researchers jointly with the Zonal and respective district and kebele agricultural experts as well as the administrator.

Implementation design

Improved sesame technology was used for the demonstration on each agro-pastoralist farm. The sesame production technology was implemented on agro-pastoralist land in the main cropping seasons in 2021. The row planting method was employed and spacing of 40 cm between rows and 10 cm between plants was used for the demonstration trial. The recommended seed rate of 5 kg/ha was used by drilling.

Training

Practically, on-farm training was given to agro-pastoralists, members of PAPREG members and development agents of Keble to create awareness and improve the associated skill gap on improved agronomic practices of sesame technology. At each stage of the sesame production, different awareness creation works were done regarding planting, weed management, chemical application and at the flowering stage.

Data collection and analysis

Agro-pastoralists' perception, trait preference and yield data were collected and data were analyzed by using descriptive statistics like maximum, minimum, and mean. Besides, constraints ranking method was to used rank sesame production constraints.

RESULTS AND DISCUSSION

Achievement through the provision of training

Training is one way of information delivery method that agropastoral and other stakeholders enhance the level of awareness and practical skill of the target groups. Both theoretical and on-farm practical training sessions were arranged by Jinka agricultural research center. Theoretical training on sesame technology and post-harvest handling was given to 16 (male=12, female=4) participant agro-pastorals on demonstration on improved Sesame technology, six (male= 4, female=2) model agro-pastorals, four DAs and one administrator of the selected kebele, On-farm practical training was specifically given to participant agro-pastorals and DAs at planting time in host kebele demonstration site (Table 1).

Table 1. Summary of participants during training on sesame technology

No	No's	Participants	Enchate kebele		Total
			M	F	
1		Agro-pastoralists	12	4	16
2		DAs	2	2	4
3		Chairman	1	-	1
		Total	15	6	21

Source: own participation, 2021

Monitoring and evaluation

Monitoring was conducted from land preparation until the final yield harvesting. During monitoring frequent contact with participant agro-pastoralists and kebele development agents, getting feedback, and providing technical advice were done. The stakeholders discussed the next steps, and potential new positions were identified. The roles and duties for the subsequent contributions toward improving sesame production and cluster-based demonstration along the production chain were distributed.

Field day

A field day was conducted to the popularization of improved sesame technology to agro-pastorals, DAs, and other stakeholders. Thus, a field day was organized at Bena-Tsemay District on Enchate Kebele demonstration clusters at the plant maturity stage. Model agro-pastorals, host agro-pastorals DAs, and administrative body from three kebeles who were potential to sesame production and key stakeholder from districts were invited to visit field performance of crop and share the experiences on the field day. Totally, 70 agro-pastorals, six DAs, three administrators from kebeles, and one key stakeholder from districts and Zone stakeholders participated in the field day (Table 2). During the field day, a discussion section was organized to enhance awareness of agro-pastoral through experience sharing, and also brochures and local media were used to boost the popularization of the technology.

Table 2. Summary of participants on improved sesame demonstration field day

No	Participants	Enchate kebele		Total
		M	F	
1	Agro-pastoralists	46	24	70
2	Kebele DAs	4	2	6
3	Chairman	2	1	3
4	District expert	2	-	2
5	Zone experts	2	-	2
6	JARC researchers	3	-	3
	Total	59	27	86

Source: own participation, 2021

Pastorals' Feedback

At the end of the activity, feedbacks were collected from participants of agro-pastorals to know their perception of the technology. Accordingly, they show their interest regarding the new sesame variety in comparison with their local ones. The criterias used to evaluate sesame production technology was its early maturity, yield per plant, branch per plant, disease resistance, pod per plant, seed color, marketability, and overall yield relative to local.

Agro pastoralists' trait preference of improved sesame production

A cluster-based approach has multiple advantage of improving beneficiaries' involvement in selecting technologies that fulfill their preference for sustainable technology diffusion and it enables beneficiaries to share experience, work together, use resource efficiently, access inputs and irrigation water and has opportunity to maximize yield (Abady et al., 2017). Thus, agropastoral identified six common preference parameters to compare improved variety (Mehando-80) with local variety. The parameters were weighted according to their importance to be used as comparison, then technology with greater percentage from the total was selected as primary choice. The overall weighted ranking matrix results shows that improved sesame variety (Mehando-80) was the first choices of agro pastorals in all parameters except drought resistance whereas their local variety is the first choice only in drought resistant (Table 3). This implies that their local variety is not productive as improved one but they still appreciate the local variety in drought resistance as compared to improved variety. However, as the study area is agro-ecologically classified as dryland and described by recurrent rainfall shortage and their production practice of sesame is with irrigation from woito river by furrow irrigation system, agropastoral given high score for early maturation, disease resistance and marketability of improved sesame as compared to the locally available sesame variety.

Table 3. Preference of agropastoral on improved variety (Mehando-80) and local variety

	Improved (Mehando-80)			Local variety		
Parameters	Score	weight	Score*weight	Score	weight	Score*weight
Early maturity	3	1	3	1	1	1
Disease/pest/ resistance	3	2	6	1	2	2
Seed color	3	3	9	2	3	6
Yield	3	5	15	1	5	5
Drought resistance	2	6	12	3	6	18
Marketability	3	4	12	2	4	8
Sum of Score*weight			57			40
Rank			1			2

Score = (1= Low 2= Medium 3= High) & Weight = (1=Early maturity 2=Disease resistance 3=seed colour 4=Marketability 5=yield 6=Drought resistant

Success factors

The coordination of zonal-level agricultural management, district-level agricultural management, and the strong linkage between kebele development agents, researchers, and agro-pastoralist contributed to the success of this activity. Collaborative efforts of all stake holders are the success factor of the demonstration of the sesame production technology in the area. The other most important success factor during the demonstration of the sesame production technology was the motive of agropastoral to the new technology to adopt and use it.

Learning outcome

Mostly, the participants are agro-pastoralists and the formation of groups makes them learn from each other. This helped the participatory group to undertake all the crop management activities. The other is the use of improved sesame and row planting were not common in the area. So, the participatory team spirit and the influence of group members on one another made a sense of competition between members. So, the formation of a participatory group is a main tool for technology adoption and the further diffusion of the sesame production technology in the study area and the surrounding communities. Thus, the demonstration of sesame production technology with pastoral and agro pastoral groups in one cooperative member had given the chance to share different experience of their local sesame production and other crops and further enhance the production of improved sesame (Mehando-80) production.

Performance of yield and yield components of sesame technology

The result of the study revealed that the productivity of improved sesame with its technology packages was better than the local variety with existing agro pastoralists' practice (Table 4). Thus, the mean grain yield of improved sesame was 0.725 ton/ha and the yield of the local variety was 0.21 ton/ha in similar production years in the study area. This implies that improved sesame had higher a yield advantage over the local variety. This greater yield advantage was achieved through the proper use of recommended technology packages such as the use of the improved variety, chemicals, seed rates, and good management practices. A similar yield result was also reported by (Abady et al., 2017; Kinfe

& Tesfaye, 2018; Birhane et al., 2019). The result also conformity with (EIAR, 2016) suggested the positive effects of improved technology demonstrations over the existing farmers' practice towards enhancing the yield of sesame with its positive effect on yield attributes. The minimum and maximum yield attained by each agro pastorals from a plot area of 1.67ha was 0.9 and 1.51 tons, whereas the mean yield was 1.2 tons.

Table 4. Yield data of sesame produced by PAPREGS

Beneficiaries	Land coverage (ha)	Average yield ton/ha	Total yield
6 agro pastorals	10	0.725	7.25
Per agro pastorals	1.67	1.2	1.2
Per agro pastorals plot of 1.67ha	Min (ton)	Max (ton)	Mean (ton)
	0.9	1.51	1.2

Source: own result, 2022

Constraints of sesame production

The low access to irrigation water is the main constraint that hinders the production of sesame in the area. As the production is based on irrigation water access and lack of water may cause the planted crop to dry. Thus, the low access to irrigation water is ranked as the first serious problem for sesame production. The weakness of water use association in the area is another constraint that hinders the production of sesame and ranked as the second serious problem. As they are agropastoral, they are not capable enough to clean canals as per scheduled. The study Asmera & Yidnekachew (2021) reported that the poor management of canal and its breakdown due to inconvenience among water use association in the Bena-Tsemay district caused less production and productivity of agriculture (Table 5).

Table 5. Constraints of sesame production in the area

Constraints of sesame production	The level of constraints					
	High	Medium	Low	Score	Index	Rank
Low water access	14	8	0	82	0.198	1
Weakness of water use association	12	10	0	76	0.183	2
Extensive drought	6	12	4	62	0.149	5
Market linkage problem	6	16	0	72	0.173	3
Lack of training regarding production	8	6	8	60	0.145	6
Poor extension services	5	15	2	63	0.152	4

Note: the value is given for the level of constraints: High=3, Medium = 2, Low =1

Extensive drought is the key factor that causes the sesame to dry and hinders the sustainable production. The beneficiaries reported that the recurrent drought is the third serious problem that hinders sesame production and lets them to food insecurity. On the other hand, poor extension services are the fourth important constraints that hinder the sesame production in the area. Thus, poor extension services in irrigation system regarding irrigation water use may cause the failures of the sustainable production and may be associate to food insecurity problems in irrigation-based production dependent areas. Market linkage is another important constraint of sesame production as output markets are the main driving force for the products to be sold and ensure the economic feasibility of irrigation projects and ensures sustainable production and economic returns. Failure of market for irrigation based agricultural products like sesame may cause the failures of the irrigation projects and challenges the sustainable use of irrigation. Lastly, they reported that lack of enough training and support on production and irrigation water by district and stakeholders hinders sesame production in the study area.

CONCLUSION

Sesame is one of the crops produced in the area but they follow a traditional agronomic practice and use local seeds. As a result of these and other problems sesame production and productivity are low in the area. Accordingly, adaptation trials of highly performed improved varieties with associated agronomic practices were undertaken by Jinka agricultural research center in the targeted areas. Therefore, the activity was carried out to demonstrate the improved sesame technology through cluster-based large-scale demonstration in the study area of the South Omo zone. The demonstration was carried out in a selected cluster of the Bena-Tsemay district. During implementation, training was given to all participants with respect to land preparation, sawing, and all other agronomic management practices. So, in conducting the demonstration, all the recommended agronomic practices such as seed rate and spacing were applied with close supervision and follow-up of kebele development agents and researchers. Agronomic and grain yield data were collected and analyzed. Accordingly, a mean grain yield data of 0.725 tons ha^{-1} is obtained. Feedback was also collected from participants and they liked the technology based on its early maturity, grain yield, market demand, pod per plat, seed color, disease resistance, and branch per plant. Therefore, sesame technology in agro-pastoral areas is a source of income and home consumption and the technology should be scaled up in the area. Since there are opportunities for sustainable water resources, suitable land for irrigation, and fertile soil in the area, district experts and development agents in the area should assist agro-pastoralists in improving sesame production.

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AUTHOR CONTRIBUTIONS

Mr. Melkachew H/M. wrote and edited the entire manuscript in addition to writing the proposal, securing the funding, and conducting the research and data collection. Mr. Asmera A. took part in land acquisition, preparation, planting, monitoring activities, and field day arrangements. Mr. Kassahun K. took part in proposal writing and planting.

COMPETING INTERESTS

The authors declare they have no conflict of interest. The manuscript has not been submitted for publication in another journal.

ETHICS APPROVAL

Not applicable.

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