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Original Paper

Participatory Identifications and Promotion of High-Performing Irrigated Sesame Varieties for Northwestern Amhara, Ethiopia

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***Abstract*—Irrigation-based sesame farming in Ethiopia faces challenges, including inadequate irrigation infrastructure and a lack of varieties and agronomic packages suitable for irrigation. To address this, Participatory Variety Selection (PVS) was conducted in Metema district during the 2019 cropping season under irrigation. The study aimed to evaluate the performance of sesame varieties for seed yield and related traits and to promote farmers' preferred varieties for commercial production. A Mother-Baby trial design was used, with 16 improved sesame varieties and one local check evaluated in an RCBD design replicated three times. Data on yield and yield-related traits were collected from the mother trial, while farmers' varietal and trait preferences were gathered from the baby trial. Demonstration and pre-scaling-up activities were conducted on farmers' fields in Metema district from 2022 to 2024 cropping seasons under irrigation, to assess further and identify preferences for different sesame varieties and to create demand through promotion. ANOVA was done using R-software and revealed highly significant differences ($p<0.01$) among the tested sesame varieties for traits such as plant height, number of pods per plant, and thousand seed weight. In contrast, days to physiological maturity, length of the pod-bearing zone, number of seeds per pod, and grain yield showed significant differences ($p<0.05$). The highest seed yield was recorded from the variety Ado (2084 kg ha^{-1}), followed by Adi (1891.5 kg ha^{-1}). Moreover, Adi was highly preferred by farmers due to its high productivity and white seed color. Thus, Adi was demonstrated and popularized to farmers and created considerable demand for the variety. The variety Adi produced a mean seed yield of 1,330 kg ha^{-1} during the scaling-up phase. Given its consistent performance across seasons and farmers' preference, variety Adi is recommended for commercial production under irrigation in Northwestern Amhara.**

***Keywords*—Irrigation, Participatory Variety Selection, Promotion, Sesame, Yield**

I. INTRODUCTION

Sesame (*Sesamum indicum* L.) is one of the oldest cultivated oilseed crops in the world. It is renowned for its exceptionally high oil content, which can reach up to 63%. Sesame surpasses the oil content of other oilseed crops, such as groundnut (45%–56%), sunflower (45%), rapeseed (40%), and soybean (20%) [1;2;3]. The seeds are particularly prized for their rich composition of unsaturated fatty acids, primarily oleic acid (35.9-42.3%) and linoleic acid (41.5-47.9%), which together constitute nearly 80% of the total fatty acid content. Saturated fatty acids, such as palmitic acid (7.9-12%) and stearic acid (4.8-6.1%), comprise less than 20% of the total fatty acids [4]. In addition to their high oil yield, sesame seeds are a valuable source of essential minerals such as potassium, phosphorus, magnesium, calcium, and sodium. In addition, sesame seeds contain protein (18.3- 25.4%). These nutritional qualities render sesame seeds highly beneficial for human and animal health [5; 6].

Sesame is a major oilseed crop in Ethiopia, cultivated on nearly 369,897 hectares and playing a crucial role in the country's oilseed export sector [7]. In the same year, national sesame production reached about 260,257.6 tons, with an average yield of 0.7 t/ha, while in the Amhara region alone, 224,220.3 hectares were allocated, producing 153,809.7 tons at an average yield of 0.68 t/ha during the Meher season. Sesame ranks second only to coffee in generating foreign exchange, highlighting its vital role in Ethiopia's economy and agricultural sector [8]. Northwestern Ethiopia, particularly areas such as Quara, Metema, Armachiho, Tegedie, Wolkayit, and Humera in the Amhara region, is renowned for producing sesame with exceptional qualities, including distinct color, taste, and aroma [9]. These attributes have earned Ethiopian sesame international recognition for its superior seed quality [10; 11]. With over 90% of production destined for export markets [12], sesame is a strategic crop contributing significantly to the nation's economic growth and stability. Sesame is traditionally a rain-fed commercial crop with significant potential for expansion into non-traditional areas and under irrigation. Although predominantly cultivated under rain-fed conditions, it can adapt well to irrigation, achieving seed yields as high as 2,700 kg ha^{-1} [13]. Studies by [14], reported yields of 1840 kg ha^{-1} under optimal irrigation conditions, while [15] indicated yields as high as 2044 kg ha^{-1}. Sesame is particularly well-suited as an alternative crop for irrigated agriculture due to its low water requirements [16] and drought-tolerant characteristics, making it an excellent choice for cultivation in semi-arid regions and water-scarce agricultural systems [10]. Despite this potential,

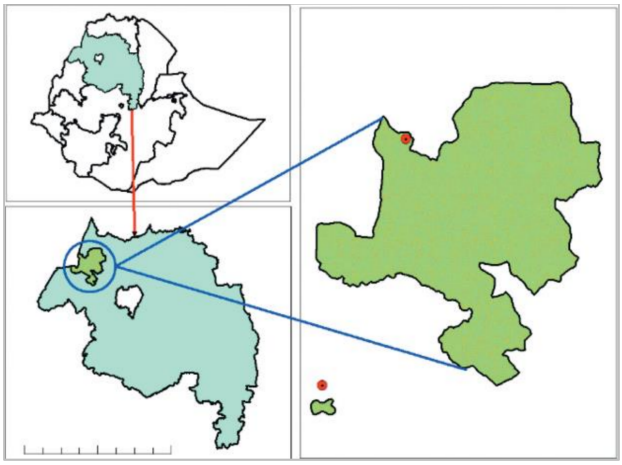


Fig. 1. Map of the study area

irrigation-based sesame farming remains underdeveloped in Ethiopia, particularly in the Amhara region. This is due to several reasons, including limited awareness among producers, inefficient irrigation infrastructure and schemes, a lack of sesame varieties specifically suited for irrigation, and insufficient research on irrigation technologies. To tackle these challenges, efforts are made to identify and select high-yielding sesame varieties adapted to irrigation environments. The initiative also aims to demonstrate and promote these selected varieties, enhancing agricultural productivity and supporting successful sesame cultivation in irrigated settings.

II. Materials and Methods

A. Description of the study area

The experiment was conducted at Metema irrigation research station of Gondar Agricultural Research Center in the Northwestern lowland of Ethiopia. Metema (Fig. 1) is located at 12°57′01″ N latitude, 36°15′28″ E longitude, and 760 meters above sea level. The irrigated season, which typically spans from December to early May, is generally dry, except for occasional random raindrops. The minimum and maximum annual long-term average daily temperature ranges from 16°C to 24°C and 30°C to 40°C, respectively. The lowland of Northwestern Ethiopia has a monomodal rainfall pattern, mainly the rainy season covering June to September, with a range of 700 to 1160 mm. The soil characteristics of the site were dark brown with clay loam texture, low salinity, neutral pH, low total nitrogen, and low available phosphorus [14].

B. Experimental materials, design and trial management

The evaluation and promotion study was done in the successive irrigation seasons starting from 2019 to 2024. The first season was to confirm the adaptability and selection of the sesame variety using the statistical procedure and farmers' evaluation. The 2nd, 3rd, and 4th seasons/years were dedicated to demonstration and promotion of the selected variety. However, following the PVS trial, the demonstration was not conducted for two consecutive seasons. Seventeen sesame varieties were evaluated under irrigated conditions (mother trial) using a randomized complete block design (RCBD) with three replications at a single location during the 2019 cropping season. In parallel, two unreplicated baby trials were established at the same location to facilitate farmers' participation in the evaluation and selection of the varieties. Details of the varieties are presented in Table 1. Seeds were sown manually in double rows on ridges that are 80 cm apart, with row spacing of 40 cm and plant spacing of 10 cm under furrow irrigating systems. The size of each plot was 2.5 x 3.2 m (8 m2) and was separated from adjacent plots within the replicates by 1 m and 1.5 m between replicas. The test varieties were randomly assigned to the plots in every replication. A seed rate of 4 kg ha-1 was consistently hand drilled across all plots and finally adjusted to require population by thinning.

A furrow irrigation system was adopted, with eight rows per plot and two rows per bed. The irrigation schedule was: every 3 days from planting to emergence, 6 - 8 days during the seedling to flowering and seed formation stages, and twelve days as the plants approached physiological maturity [17]. The blanket fertilizer application consisted of 46 kg ha-1 of nitrogen (N) and 23 kg ha^{-1} of phosphorus (P_2O_5). Nitrogen was applied in two splits: half was applied at planting, and the remaining half at the flowering initiation stage. All other recommended practices, including weeding, were applied, and timely plant protection measures and assessment were also carried out to avoid damage from insect pests and diseases.

C. Biological data collection and statistical analysis

All plant and plot-based data were taken from the central six rows. However, plant-based data were taken from ten randomly selected plants in the central rows. The collected data were days to 75% maturity, plant height at maturity (cm), number of primary branches per plant, length of pod-bearing zone (cm), number of pods per plant, number of seeds per pod, 1000 seed weight (grams), and seed yield (g $plot^{-1}$ and kg ha^{-1}). All measured parameters were subjected to analysis of variance (ANOVA) using R-software to assess the difference among the tested varieties. Treatment means were compared using the least significant difference (LSD) test at 5% probability level.

D. Farmers' participation in variety evaluation and procedures

Farmers' research extension group (FREG), which comprised 25 male and 2 female farmers, was established. The selection of farmers for this study was based on their willingness to participate as well as their knowledge of the sesame crop and its production. The representative participant farmers' selection was conducted in collaboration with the district's agricultural office. Farmers evaluated the tested sesame varieties using direct matrix ranking during the PVS stage, setting their own traits for varietal evaluation and selection. The traits were number of pods per plant, plant height, number of primary branches per plant, lodging tolerance, uniformity in maturity and earliness. The farmers' traits of preference were recorded using 1 to 5 scales of ranking, in which 1 refers to poor, 2= fair, 3 = moderate, 4= good and 5 is excellent [18]. Finally, varieties were ranked using the product of the rank of the total acceptance of the farmers and the weight of the traits given by farmers.

TABLE I. DETAILS OF THE TESTED SESAME VARIETIES

Varieties	Year of release	Seed color	Oil (%)	Maturity date	Yield (kg ha^{-1})	
					Rain-fed	*Irrigation*
Humera-1	2011	white	54-56	90-110	800 -1000	-
Setit-1	2011	white	52-54	80-90	700 -1000	2000-2400
Setit-2	2016	white	53.7	80-87	930	-
Abasena	1990	white	44-48	110-120	900	1200-1400
Gondar-1	2016	white	50.0	101	500 - 900	-
Mechal	2013	white	50.4	105-120	700 - 800	-
Setit-3	2017	white	54.4	87	900 -1300	-
Benshangul-1	2016	white	54.0	90-115	800-1000	-
Obsa	2010	white	51.5	120-137	800-1000	-
Tate	2000	grey	47 -49	110-120	700	1500-1800
BaHa-Zeyit	2016	grey	56.0	113-134	1300	-
BaHa-Necho	2016	white	52.0	114-129	1200	-
Chalsa	2013	white	51.0	95-120	1050-1200	-
Dangur	2015	grey	56.7	124	750	-
Ado	2017	white	51-55	110-114	1274	900-1300
Adi	1993	white	40-58	85-91	-	1600-2000
Local	-	white	-	90 -100	-	-

E. Demonstration of farmer-selected varieties

The selected varieties, namely Adi, Ado and Abasena from the PVS trial, were demonstrated at six farmers' fields/sites on a plot size of 10 x 10 m in 2022 under irrigation. A simple plot design was used to demonstrate the varieties. The recommended agronomic recommendations were applied at the demonstration trial sites. It was managed in coordination with researchers and host farmers. Prior to conducting selection, agricultural extension workers (3 M), host and other farmers (15 M, 11 F), and research staff (4 M) were trained and aware on sesame production under irrigation. Those farmer groups and agricultural staff participated in the follow-up of the activity and selection of varieties. Farmers were selected by considering the gender disaggregation, experience in growing sesame, and willingness to participate in the varietal evaluation and selection process. Before the start of evaluation and selection in the field, the participants were oriented about the objective of the demonstration and their role in the course of varietal evaluation and selection. During variety selection, farmers establish their own criteria for evaluating and selecting varieties. The farmers' traits of preference were recorded using 1 to 5 scales of ranking, in which 1 refers to not preferred, 5 is excellent one depending on their degree of importance [18]. The rank of each criterion was considered as the weight of the criterion. The pairwise ranking method conducted by individual farmers for each trait was compiled into a direct matrix to provide the overall ranking. Finally, varieties were ranked using the product of the rank of the total acceptance of the farmers and the weight of the traits given by farmers.

F. Pre-scaling up of the selected variety

Pre-scaling up of the selected variety (Adi) was conducted on a wider scale both in 2023 and 2024 under irrigation in Metema areas. Host farmers were selected and supplied with seed of the selected variety. All the field management activities were done by host farmers. The host farmers were informed and agreed to deliver seeds of their harvest to the other farmers either in the form of cash or seed exchange for the subsequent irrigation cropping season. Before the start of the pre-scaling-up activity, training was given to the participant farmers, Kebele development agents, and district experts on the recommended sesame production and management package under irrigation by a team of researchers. A multi-disciplinary team of researchers and agricultural experts made regular field visits to observe the progress, fix problems, and give advice on proper field and crop management practices, starting from land selection to harvesting.

G. Field day event

To further a technology on a wider scale, a field day was organized in 2023 during the physiological maturity stage of the sesame crop. The field day event participants were targeted based on sesame production under irrigation. Each host farmer had the opportunity to share their experiences and observations with the field day participants regarding the activities involved in cultivating the new variety. The feedback from field day participants on the performance of the varieties was gathered and documented. In conclusion, discussions were held on strategies to improve sesame production and productivity under irrigation.

III. RESULTS AND DISCUSSION

A. Agronomic performance of varieties

The mean performance of the tested sesame varieties for phenological, growth, seed yield, and yield-related traits under irrigation in the Metema district is presented in Table 2. The analysis of variance revealed highly significant differences ($p < 0.01$) among the varieties for plant height, pod length, pods per plant, and 1000-seed weight, while significant differences were also observed for days to maturity, pod-bearing zone, seeds per pod and seed yield. However, the number of branches per plant did not differ significantly among the evaluated varieties.

Maturity date in irrigation production is an important component. The result of the maturity date for the sesame varieties ranged from 111 to 127 days. Sesame variety BeHa-Necho was identified as an early-maturing variety, reaching maturity in 111 days, while Tate was the late-maturing variety, taking 127 days. The observed variation in maturity duration can be attributed to genetic and environmental differences in how the varieties respond to environmental factors. The prolonged maturity period observed in this study compared with the varietal release descriptions may be attributed to differences in production environments, including soil type, irrigation regime, moisture availability, temperature, and other location-specific factors that influence crop phenology. These findings are consistent with [19], who reported that Setit-2 (82 days) had the shortest maturity period, while Humera-1 (120 days) took the longest to reach 75% maturity. Plant height among the sesame varieties ranged from 123.3 cm to 175.6 cm, with a mean of 149 cm. The highest plant height (175.6 cm) was found at variety Benshangul-1, while the lowest value (123.3 cm) was found at Setit-2. Similarly, [20], [21] and [15] noted significant plant height among sesame genotypes and varieties. The highest pod-bearing zone (86.7 cm) was recorded on the Setit-2 variety, while the lowest (53.8 cm) was recorded on the Dangur variety. Local variety gave the highest pod length (3.4 cm), followed by Setit-2 variety (2.9 cm), whereas the lowest pod length (2cm) was recorded at BeHa-Necho. The results align with [22] and [19], who reported significant differences in the length of the pod-bearing zone among sesame genotypes.

The highest number of pods per plant was observed in the Ado variety (83.1), followed by Adi (82.1), while the lowest was recorded in the Dangur variety (48.0). The local variety recorded the most seeds per pod (67.3), with Setit-1 having the least (42.1). These findings agree with [19] on varietal effects on the number of pods per plant and seeds per pod. Adi also exhibited the highest 1000-seed weight (3.7 g), followed by Tate (3.6 g) and Ado (3.5 g), while the local variety had the lowest (2.2 g) (Table 2). This agrees with [23], who found significant variation in pods per plant, seeds per pod, 1000-seed weight, and seed yield among sesame varieties.

Seed yield is one of the most critical and complex quantitative traits in crops. Although significant varietal differences in grain yield were detected ($p < 0.05$), the level of significance was lower than that observed for several agronomic traits ($P < 0.01$). Grain yield is a complex quantitative trait that is influenced by the cumulative effects of multiple yield components and environmental factors. Consequently, greater variability in grain yield is commonly observed under field conditions, resulting in relatively weaker statistical significance compared with individual agronomic traits. Previous research has demonstrated that seed yield in sesame is controlled by multiple loci [24]. Seed yield results from the interaction of various traits and genotypes with environmental factors [25]. In the current study, key traits contributing to sesame seed yield included pod-bearing zone length, pod length, number of pods per plant, number of seeds per pod, and thousand-seed weight. The analysis of variance for seed yield revealed a range from 1095.3 to 2084 kg ha^{-1}, with an overall mean of 1504.1 kg ha^{-1}. The highest seed yield was recorded from variety Ado (2084 kg ha^{-1}), followed by Adi (1891.5 kg ha^{-1}) and Chalesa (1728.9 kg ha^{-1}), while the lowest yield was observed in Setit-1 (1095.3 kg ha^{-1}) (Table 2). The observed yield differences may be attributed to genetic variation among the varieties, with environmental factors also potentially contributing to these variations. These results are consistent with the findings of [26] and [27], who observed significant differences among sesame varieties.

B. Farmers' varietal preferences

Participatory varietal selection was proposed [28] as a method for identifying acceptable varieties and eliminating the constraints that force farmers to grow landraces or obsolete cultivars. Participatory varietal selection (PVS) plays a crucial role in identifying farmers' preferred improved varieties, offering a sustainable solution to the challenges that force farmers to cultivate low-yielding, stress-prone landraces [29]. The number of participants involved in the PVS process is indicated in Table 3. The results of farmers' varietal preference analysis based on their varietal selection criteria are indicated in Table 5. Farmers set their own varietal selection criteria. The farmers were eager to compare and rank the criteria based on their importance using pair pairwise ranking method. Accordingly, the number of pods, uniform maturity, number of branches, lodging tolerance, plant height and earliness were the listed traits and ranked as 1st, 2nd, 3rd, 4thth, 5th and 6th, respectively (Table 4). Farmers' perception of earliness is intended as a short growing period, similar to what a breeder would normally interpret. The rank of each criterion was considered as the weight of the criterion.

Farmers of both genders participated in the variety preference process. All members of the farmers' group, comprising females and males, have had a strong discussion during the evaluation of the test varieties of sesame at physiological maturity. Varietal preferences were determined during the organized mini field day, with farmers using their own selection criteria as outlined in Table 4. The results of the farmers' varietal preference analysis, based on their selection criteria, are presented in Table 5. The preference ranking analysis revealed that Adi and Ado were the top-ranked varieties, with local variety being the third preference, under irrigation conditions in the Metema district (Table 5). [29] and [31] also emphasized the importance of farmer participation in variety selection. Accordingly, there was some disparity observed between the social data (farmers' preferences) and the biological data (yield performance). Farmers evaluate and select new varieties using multiple criteria, assigning different levels of importance to agronomic, quality, and socioeconomic traits according to their production objectives and market needs.

C. Demonstration of farmer-selected varieties

The demonstration results for the selected sesame varieties - Adi, Ado, and the check variety Abasena are summarized in Fig. 2, showcasing the mean seed yield. Among these, variety Ado demonstrated the highest seed yield at 1586 kg ha^{-1}, followed closely by Adi. In contrast, the check variety, Abasena, produced the lowest mean yield at 887 kg ha^{-1}. These findings highlight the distinct performance and adaptability of sesame varieties under similar environmental conditions

TABLE II. MEAN VALUES OF SESAME VARIETY TESTED UNDER IRRIGATION AT METEMA

Varieties	MD	PH (cm)	NBPP	LPBZ (cm)	PL (cm)	NPPP	SPP	TSW (g)	GY (kg ha^{-1})
Humera-1	120.	136.4	2.9	79.1	2.2	67.9	42.7	3.3	1307.9
Setit-1	121	127.2	3.5	85.9	2.2	70.4	42.1	3.2	1095.3
Setit-2	116	123.3	2.4	86.7	2.9	53.5	54.4	3.1	1462.2
HuARC-4	119.	130.9	2.9	82.7	2.6	70.4	49.2	3.4	1552.3
Abasena	123	167.7	3.6	82.6	2.7	70.3	60.3	2.4	1570.3
Adi	121	161.5	3.6	73.2	2.5	82.1	45.3	3.7	1891.5
Tate	127	147.2	4.6	71.9	2.1	56.7	52.2	3.6	1649.2
Ado	121	139.9	3.7	68.6	2.1	83.1	58.5	3.5	2084.0
Obsa	119	146.4	3.6	66.2	2.2	61.9	55.5	2.4	1292.2
Chalesa	122	152.3	3.1	67.9	2.2	60.4	59.6	2.4	1728.9
Dangur	124	151.7	2.5	53.8	2.1	48.0	52.9	2.4	1411.9
Gondar-1	115	161.1	3.5	71.8	2.4	64.5	59.3	2.5	1551.3
Mechale	115	151.6	2.9	70.9	2.2	58.0	57.0	2.5	1175.3
Benshangul-1	116	175.6	3.7	65.6	2.4	64.2	55.5	2.5	1559.0
BeHa-Necho	111	152.6	3.3	62.4	2.0	55.7	58.5	2.6	1511.7
BeHa-Zeyit	114	154.1	3.5	71.0	2.2	56.6	52.8	2.7	1518.1
Local	120	148.7	3.3	63.3	3.4	58.0	67.3	2.2	1208.6
Mean	119	149	3.3	71.9	2.3	62.9	53.7	2.8	1504.1
CV (%)	3.24	6.29	21.88	15.2	8.7	8.3	13.1	5.3	16.3
LSD $_{(0.05)}$	6.4	15.5	1.21	18.05	0.35	8.7	11.8	0.25	408.0
Sig.	*	**	NS	*	**	**	*	**	*

* Means followed by the same letter (s) for a variable are not significantly different at P > 0.05. DM= Days to 90% maturity PH= Plant height (cm) NBPP= Number of primary branches per plant, LPBZ= Length of pod bearing zone (cm) PL=Pod length NPPP= Number of pods per plant NSPP= Number of seeds per pod TSW= Thousand seed weight (gm) GY= Grain yield (kg ha^{-1})

TABLE III. NUMBER OF PARTICIPANTS INVOLVED IN THE SESAME PVS UNDER IRRIGATION IN METEMA DISTRICT

Category	Male	Female	Total
Farmers	24	2	26
Expert	1	0	1
Total	25	2	27

during the irrigation season. Consistent with these results, previous studies have also observed significant yield variations among sesame varieties grown under irrigation [15; 31; 32]. This suggests that both genetic factors and environmental conditions influence the yield potential of sesame varieties, making it crucial to select the appropriate variety for optimized performance under irrigation.

Farmers and other stakeholders identified key criteria for selecting sesame varieties, including pod length, number of branches per plant, plant height, pods per plant, disease tolerance, maturity date/earliness, and stalk thickness. Using a pairwise ranking method, farmers ranked these traits based on their importance. Pod per plant was ranked first, followed by branches per plant (2nd), plant height (3rd), disease tolerance (4th), pod length (5th), stalk thickness (6th), and maturity date/earliness as the 7th preferred trait (Table 6). A total of 33 participants were involved, including 26 farmers, 3 agricultural extension officers, and 4 agrarian researchers (Table 7). This diverse group represents a well-rounded approach to the demonstration, integrating practical farming experience with expert agricultural support and research insights. The involvement of both practitioners and experts highlights the collaborative effort aimed at optimizing sesame cultivation practices under irrigation.

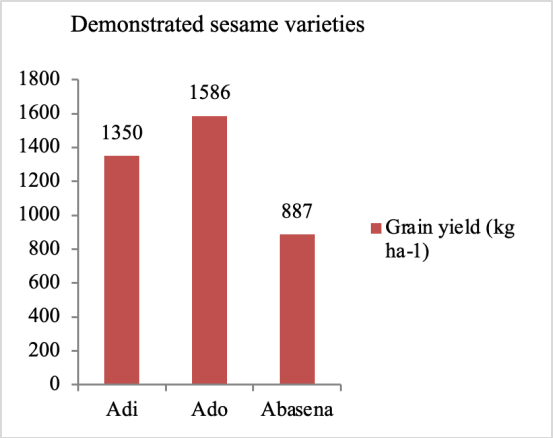


Fig. 2. Mean seed yield of sesame varieties demonstrated under irrigation

The results of the farmers' varietal preference analysis, based on their selection criteria in demonstration plots, are presented in Table 8. The evaluation was conducted using the criteria detailed in Table 6. The ranking analysis indicated that Adi was the preferred variety among farmers, reflecting its high suitability and desirability based on the traits most valued by the farmers. Ado and Abasena followed as the second and third preferences, respectively. These rankings underscore the specific merits of these varieties that align with the needs and expectations of local farmers, highlighting the importance of matching crop selection to

TABLE IV. PAIRWISE RANKING MATRIX OF TRAITS FOR SESAME PVS UNDER IRRIGATION AT METEMA DISTRICT

Traits	Pod No.	Plant height	No. of branch	Lodging tolerant	Uniform maturity	Earliness	Total	Rank
Pod No. (1)							5	1st
Plant height (2)	1						1	5th
No. of branches (3)	1	3					3	3rd
Lodging tolerant (4)	1	4	3				2	4th
Uniform maturity (5)	1	5	5	5			4	2nd
Earliness (6)	1	2	3	4	5		0	6th

TABLE V. RANKS OF SESAME VARIETIES UNDER EVALUATION BY FARMERS' SELECTION PREFERENCE WEIGHT

Varieties	Pod/plant	Plant height	Uniform maturity	Earliness	Branch/plant	Lodging tolerance	Total	Rank
Humera-1	6	2	5	3	12	3	31	16th
Setit-1	6	2	5	2	4	3	22	17th
Setit-2	12	2	5	4	12	6	41	15th
HuARC-4	12	6	20	3	12	6	59	14th
Abasena	12	10	20	3	12	15	72	10th
Adi	24	10	25	4	16	15	94	1st
Tate	18	6	25	3	16	15	83	6th
Ado	24	10	25	4	12	15	90	2nd
Obsa	12	6	20	4	8	15	65	12th
Chalesa	12	6	20	3	8	15	64	13th
Dangur	18	8	20	3	12	15	76	8th
Gondar-1	24	10	15	4	12	15	80	7th
Mechale	12	6	25	5	4	15	67	11th
Benshangul-1	18	10	25	4	12	15	84	5th
BeHa-Necho	24	10	25	4	12	12	87	4th
BeHa-Zeyit	12	8	25	4	12	15	76	8th
Local	24	10	25	4	12	15	90	2nd

TABLE VI. PAIRWISE RANKING MATRIX OF TRAITS FOR SESAME VARIETIES DEMONSTRATION UNDER IRRIGATION

Traits	PL	BPP	PH	PPP	DT	MD	ST	Total	Weight	Rank
Pod length (PL) (1)		2	3	4	5	1	1	2	3	5th
Branch/plant (BPP) (2)			2	4	2	2	2	5	6	2nd
Plant height (PH) (3)				4	3	3	3	4	5	3rd
Pod/plant (PPP) (4)					4	4	4	6	7	1st
Disease-tolerant (DT) (5)						5	5	3	4	4th
Maturity date (MD) (6)							7	0	1	7th
Stalk thickness (ST) (7)								1	2	6th

TABLE VII. PARTICIPANTS DURING THE EVALUATION OF SESAME VARIETIES IN A DEMONSTRATION TRIAL UNDER IRRIGATION

Category	Male	Female	Total
Farmers	15	11	26
Agricultural extension	3	0	3
Agricultural research	4	0	4
Total participant	22	11	33

local agricultural practices and preferences. Even though the biological data and farmers' preferences did not exactly coincide, farmers' voices were given priority since it was a farmer-based participatory trial. Hence, the Adi variety has been identified as the top preferred and has been further pre-scaled up. Moreover, this participatory approach is crucial for aligning agricultural research with farmers' practical needs and preferences. Tripathi and Singh (2012) similarly emphasized the significance of active farmer participation in crop variety selection, highlighting how this approach enables the identification of the best-performing varieties among those evaluated.

D. Pre-scaling up of selected varieties

The farmer-selected sesame variety Adi was pre-scaled up using a cluster approach at two sites, covering a total of 5 hectares of land (Fig. 3). This cluster approach is important as it facilitates easier adoption of the technology by farmers, allowing for better dissemination and collective learning.

TABLE VIII. FARMERS' VARIETAL PREFERENCE RANKING ON DEMONSTRATION PLOTS UNDER IRRIGATION

Trait	Adi	Ado	Abasena
Pod number	96	110	64
Branch number	116	102	108
Plant height	120	66	120
Disease tolerant	104	118	76
Pod length	114	68	76
Stalk thickness	102	66	106
Maturity date	76	114	58
Total value	1867	1639	1553

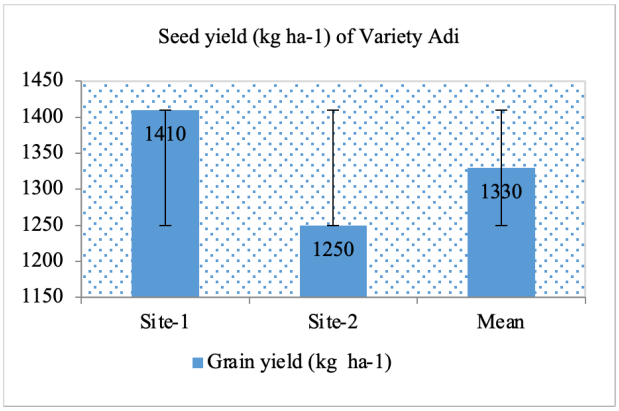


Fig. 3. Mean yield of variety Adi during pre-scaling up under irrigation

The variety produced a mean seed yield of 1330 kg ha-1 under irrigation conditions. This result indicated the variety's adaptability to the irrigation environment in the test areas. Moreover, variety Adi has consistently performed well, from the participatory varietal selection trials through to the pre-scaling up trials. These findings signify that Adi is well-suited to irrigation environment and practices, and could contribute significantly to improving sesame yields and production in the district.

A primary objective of farmer-based participatory varietal selection, demonstration, and promotion is to identify and promote varieties that are both favored by farmers and exhibit the best biological performance. To support this, a field day was organized at the physiological maturity stage of the crop to raise awareness among farmers and other stakeholders about the Adi variety during the pre-scaling-up activity. The event, held during the crop's maturity phase, was attended by 185 participants, including 163 farmers, 10 Kebele experts, 5 district experts and administrators, and 7 zonal experts and administrators. Among the attendees, 165 were male, and 20 were female (Table 9). The field day provided a platform for participants to share experiences and insights, with a group discussion focused on gathering feedback about the variety's performance and irrigation packages. Participants commend the Adi variety for its excellent performance in terms of branch number, plant height, pod length, stalk thickness, pod number and uniform maturity. The variety's overall adaptability to the area was also noted. The host farmers were commended for adhering to proper seed production protocols and were excited about the variety's production benefits. Participants,

TABLE IX. NUMBER OF PARTICIPANTS IN THE PRE-SCALING UP OF ADI VARIETY'S FIELD DAY UNDER IRRIGATION

Participant category	Male	Female	Total
Farmers	151	12	163
Kebele experts/DAs	6	4	10
District agri. experts & administrator	4	1	5
Zonal agri. experts & administrator	4	3	7
Total	165	20	185

regardless of gender, recommended further scaling up of the Adi variety and expressed their commitment to acquiring seeds for expansion in their locality and district.

IV. CONCLUSION AND RECOMMENDATION

The analysis of variance of the participatory varietal selection revealed significant differences among sesame varieties across most traits, including seed yield under irrigation. Varieties Ado and Adi produced the highest seed yield, with yield advantages of 72.4 and 56.5%, respectively, over the local cultivar during the participatory varietal selection phases. Farmers, using their own criteria for varietal selection during the PVS trial, ranked Adi as their top preference, followed by Ado. However, despite Adi being the first preference, Ado yielded the highest grain output (1586 kg ha^{-1}), followed by Adi (1350 kg ha^{-1}) during the demonstration experimentation. Based primarily on farmers' preferences, complemented by its agronomic performance in the PVS and demonstration trials, Adi was selected and promoted for pre-scaling up in Metema district under irrigated conditions. During the pre-scaling phase, Adi demonstrated continued well performance, producing a yield of 1330 kg ha^{-1}. Moreover, the promotion of Adi throughout these phases generated significant demand for the variety to produce and cultivate under irrigation. As a result, the Adi sesame variety is recommended for wider-scale promotion and production in irrigated areas of Metema and similar areas in Northwestern Amhara. To ensure the effective dissemination of this variety, it is crucial to focus on improving the seed system and exchange mechanisms to facilitate its widespread adoption.

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