International Journal of Research in Agricultural Sciences
Volume 10, Issue 2, ISSN (Online): 2348 – 3997

Pre-Extension Demonstration of Improved Bread Wheat Technology in Gurage and Silte Zone, Southern Ethiopia

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Date of publication (dd/mm/yyyy): 23/03/2023

Abstract **– The study was conducted in Silte Zone of Sankura Woreda and Gurage Zone of Mareko Woreda. The objective of the study was to demonstrate, the best performing bread wheat technologies based on grain yield performance and farmers' preference. In each Kebele, one FTC and five farmers (3 male and 2 female farmers) were involved during ''meher'' season of the year 2022/23. Training was given for the selected farmers and other stakeholders. Providing full packages of bread wheat technology-variety Wane and Standard check were demonstrated in both Woreda. Plot size 0.25ha per one variety was used and seeds were planted at a rate of 125kg/ha in all fields. The recommended rate of NPS (100kg/ha) and UREA (100 kg/ha) were used. The spacing between plots and row was 1m and 20cm by drilling respectively. Field days were organized; farmers evaluated and selected the best performed varieties depending on their criteria's set. The criteria were earliness, tillering capacity, spike length, tolerance to diseases and grain yield. During farmers' selection process both female and male farmers had been incorporated so as to avoid gender bias. The result showed that variety Wane was the best yielder with grain yield of 45 qtl/ha and 42quintal per ha; grain yield of standard check was 39 and 33quintal per ha at FTCs and farmers farm in Sankura Woreda respectively. While grain yield of variety Wane was 41quintal per ha and 39quintal per ha; grain yield of standard check was 35 and 32quintal per ha at FTCs and farmers farm in Mareko Woreda respectively. Therefore, based on the farmers' criteria and grain yield performance, variety Wane selected as first followed by Standard check in both Sankura and Mareko Woreda were recommended with its full packages for further pre-scaling.**

Keywords **– Varieties, Perception, Standard Check, Training, Wane.**

I. INTRODUCTION

Agriculture is a dominant sector in Ethiopia. It contributes 41.6 % to the gross domestic product (GDP), employs nearly 85% of the total labor force and generates over 70% of the country's export (foreign currency) earnings and 80% of raw materials supply for agro-industries [10]. More than 85% of Ethiopians in rural areas rely on agricultural production for their sustainable livelihood [10]; thus, the Ministry of Agriculture and Rural Development (MOARD) focuses on market-led agricultural development and the government pledges support to market integration and agro-enterprise development.

The major food crops are produced in almost all regions of the country in spite of the variation in volume of production across the regions. The variation may be attributed to the extent of area devoted to each crop type, weather change and a shift in preference for the crops grown. Ethiopia is the second largest producer of wheat in Sub-Saharan Africa next to South Africa. Recently, wheat in general has become one of the most important cereal crops in terms of production and food security in Ethiopia [3]. Wheat (*Triticum aestivum* L.) is one of the cereal crops grown and sold globally, accounting for 15% of all cereal crop sowing areas worldwide [9]. It is the fourth most important cereal next to tef, maize and sorghum that covers more than 1.7 Million ha with annual

production of 3.1-3.4 metric ton, mostly produced by small holders. At national level, during 2015/16 cropping season 1,664,564.62 ha of land was covered by wheat (bread and durum) and over 42,192,572.23 quintals was harvested with the average yield of 25.35 quintals per hectare [3]. In Ethiopia it is believed to cover up to about 25% calorie requirements of the population [8]. Despite its greater economic and nutritional contribution to our population, the national average does not exceed 2.2t ha-1. Shortage improved seed, disease, limited use of necessary inputs are among the factors that contribute to the low productivity of the crop [8].

It was reported that in 1950's Ethiopia was the next exporter of wheat, but in 2011, 1,049,000 ton was imported. Technological and natural factors (disease, weed and insects), grain quality, lack of varieties for specific growing conditions and limited of improved seed supply for the best variety are among the constraints that lowered the productivity [6, 7]. In the midland area of Gurage and Silte Zone, particularly in Mareko and Sankura woredas respectively bread wheat is most commonly produced and consumed by subsistence farm householders. Limited use of improved seed, low level of use of improved production technologies and high infestation of rust diseases associated with both edaphic and biotic factors mainly attributed to low yields of production in the area. Farmers have limited experience of use of improved varieties of seed and other farm inputs; rather they are experienced in use of local cultivator in the existing bread wheat production system in area.

Due to the above mentioned facts, the national and regional research systems in the country have been conducting a series of research activities on improvement of the crop and have been releasing many varieties. Worabe Agricultural Research Center (WARC) undertaken adaptation trials and participatory varieties selection of best performed and high yielding bread wheat variety (Wane) for midland in order to improve bread wheat production and productivity in the study area, but the selected and highly performed varieties were not demonstrated to the farmers yet. Hence, this activity was undertaken with the objective of pre-extension demonstration and popularization of the best performing improved bread wheat technology under farmers' condition and to create awareness on the farmers about the technology.

1.1. *Objectives*

- To increase the yield performance of the bread wheat in the study area.
- To develop skills, knowledge and attitudes of farmers, women, DAs and experts about the improved bread Wheat technology and it packages.
- To examine farmers preferences and feedbacks about demonstrated bread Wheat technology.

II. MATERIALS AND METHODS

2.1. *Description of the Study Area*

This activity was carried out in Sankura Woreda from Silte Zone and Mareko Woreda from Gurage Zone. Sankura Woreda is one of the Woreda in the Southern Nations, Nationalities, and Peoples' Region of Ethiopia. It is bordered on the West by the Hadiya Zone, on the North by Wulbareg, on the North East by Dalocha and Lanfuro, and on the South East by the Halaba Zone. The administrative center is Alem Gebeya. Based on the [4] conducted by the CSA, this Woreda has a total population of 84,736, of whom 42,480 are men and 42,256 women; 3,656 or 4.32% of its population are urban dwellers [4]. The dominant soil type of the area is vertic and

osols.

Mareko Woreda is located 110km from South of Addis Ababa and 10km from south east of Butajira. The Woreda is generally characterized by the slope with altitude ranging from 1350-1800masl. The agro ecological zone of the study area is comprised of mid altitude (Woina-Dega), low altitude (Kola and high altitude (Dega). The annual rainfall distribution of the area is 801-1200 ml. The temperature during day time is 17.6-20c^0. This area has loom soil type and its agricultural system is mixed farming system or livestock production and crop production. The major crops grown in Mareko Woreda are maize, teff, barley, wheat and sorghum [1]. The major livestock widely reared in the study area are cattle, donkey, horse, mule, sheep and goat [1].

2.2. *Site and Farmers' Selection*

This activity was conducted in Mareko Woreda from Gurage Zone and Sankura from Silte Zone. The districts were selected purposively based on their potential for bread wheat production and accessibility for supervision. In communication with the Woreda Agriculture and Rural Development Office and the extension department, potential Kebeles were selected in order to conduct the demonstration activity. Two potential Kebeles from each district was selected based on accessibility and potentiality for bread wheat production. Accordingly, Hadasha Ziko and Enjamo Gutanicho from Sankura Woreda; Didamidore and Didalibo Kebele from Mareko Woreda were selected respectively. In each Kebele, communication was made with Kebele extension agents and selected 5 farmers and 1FTC from each Kebele based on their willingness and availability of land. Gender and youth balance in each farmer was strictly considered. Development agents, researchers and experts were collaborating in site and farmer selection. At the end a total of 12ha in Sankura Woreda (Hadasha Ziko and Enjamo Gutanicho Kebele) and Mareko Woreda (Didamidore and Didalibo Kebele) were covered. Farmers' research and extension groups (FREGs) in each Kebele was formed consisting of 5 members (males = 3 and females = 2). FGERs were composed of participant farmers of the respective Kebeles.

2.3. *Organizing Multi-Disciplinary Team*

One technical team consists of five members was organized to conduct demonstration of improved wheat technology in the area. It was composed of agronomist, breeder, pathologist and Agricultural Technology and Extension researchers were established. The team members had shared duties and responsibilities of; providing training to farmers and key stakeholders, conducting follow up and monitoring throughout implementation of the activity to final harvesting. Land preparation, plantation, conducting recommended agronomic managements and yield harvesting activities were undertaken by host farmers, while FREG members jointly with DAs of the respective Kebeles conducted periodic follow up and support to farmers throughout the practices of land preparation to final harvesting. Besides, the FREG' members were responsible for actively participating and conducting demonstration activities jointly with the team at Farmers' Training Centers (FTCs) in the targeted Kebeles.

2.4. *Training*

Before starting the demonstration trial, training were given to the participant farmers and members of FREGs, researchers, experts and DAs on improved agronomic and management practices of wheat technology in collaboration with agronomic researchers and Kebele development agents on FTCs demonstration fields.

2.5. *Agronomic Practices*

One improved Wane variety with Standard checks (Ogolicho) was planted in Sankura and Mareko Woreda. All the necessary recommended agronomic practices were applied for all demonstration sites. For wheat, the spacing of 20 cm between rows was used. The recommended seed rate of 125kg ha-1 was used by drilling in the prepared rows. The recommended fertilizer rate of UREA 100 kg ha-1 and NPS 100 kg ha-1 were applied. All NPS was applied at sowing/planting time while 1/2 of UREA was used at sowing/planting and the remaining 1/2 was applied at the time of tillering of the crop. Shallow planting of 2-4 cm depth was employed in the presence of ample soil moisture. The variety inputs were provided by the center timely like seed 125 kilogram per hectare. For joint monitoring and evaluation, the demonstration sites were supervised at a 15 days interval to check the status and to identify gaps. Before sowing, farmers prepared their land appropriately and sowed the variety on time and the necessary management were done like weed management and chemical applying. The main traits of farmers' selection criteria used were spike length, tillering capacity, disease resistance, and grain yield. Each selection and evaluation criteria were rated from scale 1 to 5: 1 = Very poor 2 = Poor 3 = Good 4 = Very Good 5 = Excellent.

2.6. *The Responsibility Sharing and the Way of Follow Up*

Based in responsibility sharing all responsible bodies were participated for example the Worabe agriculture research center by facilitating the logistics and inputs; Extension researchers were participated from developing the activities up to its achievements through all stages (by giving training and creating awareness of the farmers) and finally the Woreda experts and DAs were participated by giving the potential Kebele and model farmers. After sowing, relevant follow up had been preceded appropriately and conducted in depth in communication with concerned stakeholders. Weed management, disease and pest control, data collection and other related activities conducted accordingly.

2.7. *Evaluation and Monitoring*

Evaluation of the varieties at different stages had been conducted in participation of farmers. Especially, during germination, flowering and harvesting times, farmers took a chance to evaluate the varieties through observation.

Field days has its great role on demonstration of new technologies because it gives the chance for the farmers to learn through observing on the field. Thus, in order to demonstrate and popularize the technology widely, field days were arranged and all concerned stakeholders were invited at the end of the days.

2.8. *Data Collection Methods*

Farmers were expected to select and prioritize important criteria by providing physical and agronomic characteristics of wheat technology. Hence, a total of five important selection criteria were selected as variety selection criteria to collect farmers' preference data on wheat technology. Beside that farmers' preference data were collected on goodness of disease tolerance, early maturity, spike length, grain yield and plant height for each of wheat varieties during field day demonstration. Field day and participatory varieties demonstration, assessment and evaluation were organized at crops maturity stage at all trial sites (Hadasha Ziko, Enjamo Gutancho Kebele from Sankura Woreda; Didamidore and Didalibo Kebeles from Mareko Woreda). Grain yields data were taken by measuring representative sample which is 1mx1m three times triangularly from each demonstration plot. Total number of farmers participated on extension/promotional events such as training, field

days were recorded by gender composition.

2.9. *Data Analysis Methods*

The collected data were analyzed using SPSS (Simple descriptive statistics) were utilized for the data analysis like Minimum, Maximum, and Mean, SD, Likert scale (average score) was used to measure farmers' perception data.

III. Result and Discussions

3.1. *Training for Capacity Building of Stakeholders*

Awareness was created through training & discussions with the participation of all the concerned stakeholders (Farmers and DAs, and Experts). Both theoretical and practical is very important for awareness creation and to bring improvement on the job after filling the gap on knowledge, skill and attitude (KSA). Hence, stakeholders such as district level Agriculture Office experts and DAs were invited and participated during consultation meeting and training. Multidisciplinary team of researchers from Worabe Agricultural Research Center delivered training to the participant. Training were given for different stakeholders at different stage on agronomic practice of wheat, chemical applications, safety mechanisms, diseased, economic, nutritive importance of wheat and post-harvest managements. Accordingly, a total of 21 participants 12 farmers, 4 researchers, 3 DA and 2 in Sankura Woreda and a total of 18 participants 12 farmers, 2 researchers, 4 DA and 2experts in Mareko were participated in training Woreda experts at different stage on production practice of improved wheat technology (Table 1).

Table 1. Number of participants during training in Sankura and Mareko Woreda.

No	Participants	Gender		Total
		Male	Female	
A	Sankura Woreda			
1	Farmers'	8	4	12
2	Experts	2	-	2
3	DA	1	2	3
4	Researchers	4	-	4
Total		15	6	21
B	Mareko Woreda			
1	Farmers'	6	4	10
2	Experts	2		2
3	DA	3	1	4
4	Researchers	2	-	2
Total		13	5	18

3.2. *Field Days Organized*

Field days have vital roles in technology demonstration and adoption process to popularize technologies and

innovations in a wider scale. At maturity stage of the crop, a field day was organized by inviting different stakeholders such as Zone and district agricultural offices, administrative bodies, District Government Communications Affairs Office and Broadcasting Corporation (BC), posters were used. The field day program included field visit, detail discussion on the activity, farmers and stakeholder's reflection on the performance of the variety. Moreover, future direction on seed exchange system, seed collection and marketing were settled by participants. Male 52, females 27 and total 79 participants were participated from different discipline and sectors in Sankura Woreda and male 38 female 12 and total 50 were from Mareko Woreda (Table 2). Here is the photo at maturity and after germination stages in Sankura and Mareko Woreda.

Fig. 1. Photo at maturity and after germination stages in Sankura and Mareko Woreda.

Table 1. Field day participants in Sankura and Mareko Woreda.

No	Participants from	Participants in Gender		
		Male	Female	Total
A	Sankura Woreda			
1	Researcher	2	-	2
2	Drivers	1	-	1
3	DA	5	1	6
4	Farmers	45	26	71
Total		52	27	79
B	Mareko Woreda			
1	Researcher	2	-	2
2	Drivers	1	-	1
3	DA	4	1	5
4	Farmers	31	11	42
Total		38	12	50
Grand total		90	39	129

3.3.1. *Farmer's Reflection and Opinions During Field Day*

During the field day, farmers said, "The performance of the crop was interesting so that we will continue to plant this variety if we have market demand or linkage". As they said that, there was a knowledge, skill and attitude gap on use of improved seed in the area. Participant farmers highly emphasized the constraint of weed management technology options, lack of timely seed supply, and emerging big challenge of steam and yellow rust disease epidemics of wheat in the area.

3.3.2. *Experts and Administrative Body Feedbacks*

Experts said that, the improved variety is a high yielder compared to the local variety and also the improved practice helped farmers to increase production and productivity of the technology in their locality. Early planting of wheat helped the crop to escape from frost and terminal moisture deficits. They also added that, they are responsible to expand the technology to other potential districts and Kebele.

3.4. *Grain Yield of the Wheat Varieties*

The sample of yield estimation was taken from sampled farmers and calculated in order to estimate the yield of the variety. Hence, the results of descriptive statistics were presented below the Table 3. The mean grain yield of Wane variety 42, standard check 33quintal per ha in farmers farm at Sankura Woreda and **Wane** variety 45, standard check 39 quintal per ha in FTC while the mean grain yield of **Wane** variety 39, standard check 32quintal per ha in farmers farm and Wane variety 41, standard check 35quintal per ha in FTC at Mareko Woreda (Table 3). This result is in line with the findings of [5] the highest grain yield and the net income gains were obtained from wane variety when compared to others varieties demonstrated in the area. The result showed that there were statistical variations in grain yield performance between improved varieties and local check in both Woredas as shown below Table 3. The mean productivity of wheat reported by this study in Silte and Gurage Zone (more than 32 qtl/ha) was greater than the mean yield of Silte and Gurage Zone which was reported by [3] during meher cropping season (28.45 qtl/ha). The difference was because of the new technology utilization by the farmers during the demonstration of improved wheat varieties. The mean productivity of the improved varieties was in line with the given mean yield of wheat reported by ATA crop package manual.

Table 2. Grain yield of wheat varieties in quintal per hectare.

Woreda	**Variety**	**Yield**			
		Max	**Min**	**Mean**	**SD**
Sankura Woreda					
Farmers farm (N = 10)	Wane	49	35	42	3.5
	Standard check	38	28	33	3.9
FTC (N = 2)	Wane	45		45	
	Standard check	39		39	
Mareko Woreda					
Farmers farm (N = 10)	Wane	42	30	39	2.5
	Standard check	36	25	32	3.6

Woreda	Variety	Yield			
		Max	Min	Mean	SD
FTC (N = 2)	Wane			41	
	Standard check			35	

Source: Own field data, 2022.

Combinations of physical and agronomic characteristics selected by wheat farmers were considered as farmers' selection criteria during interviewing respondents and discussion held on field day in both Sankura and Mareko Woreda. These include tolerance to disease, tillering capacity, spike lengths, plant height and grain yield of wheat varieties. Hence, during the selection process, **Wane** is selected by farmers as best with its good disease tolerance and early maturity characteristics whereas standard check is selected as first with its good spike length and height of plants. As the below Tables showed the mean scores of farmers' selection criteria ranged from 3.5 (Standard check) to 4.25 (Wane variety) at Hadasha Ziko Kebele in Sankura Woreda. The highest score (5) recorded for grain yield for Wane and the lowest record recorded (3) for standard check in both Sankura and Mareko Woreda (Table 4, 5). In both Kebeles, improved variety Wane was selected first by farmers based on farmers' preference criteria (spike length, tillering capacity, disease tolerance and grain yield) in case of Sankura Woreda (Table 4). Average score of Mareko Woreda ranged from 2.75 (Standard check) to 4 (Wane variety) and 3.5 to 4 at Didalibo and Didamidore Kebele respectively (Table 5). In both Sankura and Mareko Woreda variety Wane was selected over Standard check (Table 4, 5). In general Wane is the first preferred variety whereas standard check is second preferred variety by the sample respondent farmers in the study area.

Table 4. Farmer's Preference Ranking of Wheat Varieties at Sankura Woreda.

Variety	Hadasha Ziko Kebele Farmers Preference ranking						
	SL	TC	DT	GY	Overall	Average	Rank
Wane	4	4	4	5	17	4.25	1st
Standard check	4	4	3	3	14	3.5	2nd
Enjamo Gutanicho Kebele Farmers Preference ranking							
Wane	4	4	4	4	16	4	1st
Standard check	4	4	3	3	13	3.5	2nd

SL = Spike length, TC = Tillering Capacity, DT = Disease Tolerance, GY = Grain Yield; Scores: - 1 = very poor, 2 = Poor, 3 = Good, 4 = Very Good 5 = Excellent.

Table 5. Farmer's preference ranking of wheat varieties at Mareko Woreda.

Variety	Didamidore Kebele Farmers Preference ranking						
	SL	TC	DT	GY	Overall	Average	Rank
Wane	3	4	4	5	16	4	1st
Standard check	3	4	3	3	13	3.25	2nd
Didalibo Kebele Farmers Preference ranking							

Variety	Didamidore Kebele Farmers Preference ranking						
	SL	TC	DT	GY	Overall	Average	Rank
Wane	4	4	4	4	16	4	1st
Standard check	3	3	2	3	11	2.75	2nd

SL = Spike length, TC = Tillering Capacity, DT = Disease Tolerance, GY = Grain Yield; Scores: - 1 = very poor, 2 = Poor, 3 = Good, 4 = Very Good 5 = Excellent.

3.5. *Cost Benefit Analysis*

The farmer wants his wheat crop to be high-yielding which improve net income. Therefore, comparison of net income gain on-farm trial was set up to evaluate the recommended varieties, as compared with the standard check. Accordingly, the highest net income (104,728 ETB) gain was recorded for Wane variety followed by standard check (77,128ETB) in 2022/23 production year (Table 6). This result shows that high income from the improved variety Wane due to its high yield performance in the study area.

Table 6. Cost Benefit Analysis of the varieties.

Items	Unit	Unit Price		Quantity on Each Variety	
		Quantity	Unit Cost	Wane	Standard Check
Average yield from ha	Quintal	-		45	39
Adjusted yield (-10%)	Quintal	-		41	35
Sales in qt	Birr	-	4600	188,600	161,000
Total gain				188,600	161,000
Item cost	Unit	Quantity	Unit cost	Total cost for each variety	
				Wane	Standard Check
Seed cost	Quintal	10.5	5000	52,500	52,500
Fertilizer cost	NPS	Quintal(7)	1	14,602	14,602
	UREA	Quintal(7)	1	13,300	13,300
Labor cost	Land preparation	Oxen (pair)	16	1600	1600
	Sawing	Person	10	350	350
	1st and 2nd weeding	Person	20	700	700
	Fertilizer application	Person	4	120	120
	Harvesting and trashing	Person	20	700	700
Total cost	-	-	-	83,872	83,872
Total Revenue	-	-	-	188,600	161,000
Net benefit (total gain-total cost)	-	-	-	104,728	77,128

3.6. *Lessons Learnt*

The two ways learning was learnt by the farmers and researchers. Researchers transfer the scientific knowled-

-ge about the full packages of the technology and again farmers share their indigenous knowledge to the researchers. Farmers learnt that about the amount of the input used per ha and the distance between the plants and rows. In addition to that, they learned that, the practices from land preparation to harvesting in general while the researchers learn about the study area planting time, harvesting time that was used by the farmers. The way cluster demonstration was very effective way in order to popularize the new technology in observable way. After these procedures, lessons learnt regarding to the demonstration carried out was success by recording high yield. Regarding the grain yield, farmers reported that the variety had a potential to give high yield than they were used if it were managed consequently. Farmers learned the role of the agronomic practice on the productivity and production on the variety. In short, Institutional linkage and intensive communication among all stakeholders are important for technology scaling up to promote easy access of farmers to improved seeds; the role of multi stakeholder approach is effective for technology dissemination; mass media and primary cooperatives are important for technology promotion and the role of Seed Producers and Marketing Cooperatives (SPMCS) is vital for technology diffusion and improving seed production and marketing system.

IV. Conclusion and Recommendations

Generally, in the study areas wheat production is more experienced with traditional farming practice and use of local varieties by farmers. The farmers' feedbacks received show that, there was a knowledge, skill and attitude gap on use of improved seed in the area. In addition, the participant farmers highly emphasized the constraint of limited improved seed, weed management, technology options, lack of timely seed supply, and emerging big challenge of steam and leaf rust disease epidemics of wheat in the area. Accordingly, training was given before starting the work to develop the capacity of the farmers, experts and DAs in the study area. Farmers used combinations of physical and agronomic attributes as selection criteria to identify their own preferences for the wheat technology. Hence, Spike length, Tillering Capacity, Disease Tolerance, Grain Yield were important farmers' preference criteria seated by them. Therefore, based on the farmers' criteria and grain yield, Wane variety was selected over standard check in Sankura and Mareko Woreda. In addition to its better grain yield, variety Wane had better performance score in spike length, tillering capacity and grain yield when compared with standard check in both Woreda. The study revealed that standard check had poor mean farmers' preference score especially because of its susceptibility to diseases such as yellow rust. Even though poor traditional weed management practices was the major influencing factor of wheat production and productivity, the higher grain yield and net income gained recorded from Wane variety compared to the standard check.

Thus, use of improved wane variety with its associated agronomic practices significantly improves/increases production and productivity of bread wheat in the areas. Therefore, Office of Zonal and Woreda level Agriculture and Rural Development in collaboration with Agricultural Research Centers and other stakeholders should popularize the selected improved wheat variety with its associated agronomic practices to smallholder farmers' at large scale in the same agro-ecology.

Acknowledgement

The authors would like to express their appreciation to Southern Agricultural Research Institute, Worabe Agricultural Research Center (**Capital**) for the financial support towards this research. The authors also wish to thank all the researchers, Woreda experts, Farmers and DAs who support us by creating conducive environment

for work.

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