International Journal of Research in Agricultural Sciences
Volume 8, Issue 3, ISSN (Online): 2348 – 3997

Participatory Demonstration and On-farm Evaluation of Improved Bread Wheat Technologies in Highland Area of South Omo Zone, Ethiopia

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Date of publication (dd/mm/yyyy): 12/05/2021

Abstract **– Ethiopia has an enormous scope and potential for increasing wheat productivity, though, it is predominantly cultivated by small holder farmers at a subsistence level. Therefore, the demonstration was undertaken to introduce the best adapted and performing improved bread wheat varieties in the area. Target farmers were selected purposively based on availability of suitable farm land, willingness to participate and undertake management practice of the demonstration fields of his/her own land. Both on farm and practical trainings were given to target farmers and FREG members in the area. Field day was conducted at crop maturity stage to facilitate experience sharing among farmers and other stakeholders in the area. Data on farmers' preferences, grain yields, and inputs and labor costs and yield prices were collected using appropriated data collection instruments. Descriptive statistics and likert scale ranking were used to analysis the data. Wane variety was selected first due to its high resistance to disease, good spike length, early maturity and good plants height. The highest grain yield of 4.47 t/ha and the net income gain of 37,144 ETB were obtained from wane variety when compared to others varieties demonstrated in the area. Therefore, use of improved wane wheat variety significantly helps farmers to improve wheat productivity in the area.**

Keywords **– Bread Wheat Variety, Participatory Demonstration, Field Day, Yield, Preference.**

I. INTRODUCTION

In Ethiopia, crop production and marketing are the dominant means of livelihoods for millions of smallholder households and it contributes to the county's GDP accounting approximately 28% from the sub-sectors of agriculture [9]. Grain crops such as cereals, pulses, and oil seeds are produce in large volume compared with other crops, whereas cereals are the major food crops in terms of area cultivated and volume of production obtained. CSA report indicated that about 81.27% area of land was covered by cereals out of the total land cultivated by grain crops and it contributes about 87.42 % to annual food crop production in 2016/17 production year [1]. Its contribution was estimated about 45% for food expenditure, and the remaining production was used as seed and sale for income [11]. Considerable growth in production of cereals in terms of the area of land cultivated and yields produced, although the yield potentials were low compared with the average yield of the world [9]. Cereal crops such as maize, *teff*, wheat and sorghum are mainly cultivated by most of small holder farmers' through subsistence farming in rain fed condition.

Ethiopia is the second largest wheat producer next to South Africa in sub-Saharan Africa [5]. Wheat is an important staple food crop in the country, especially in urban areas. It is a staple food in the diets of several population, and providing about 15 percent of the caloric intake for the country's over 90 million population [4], placing it second after maize and slightly ahead of teff, sorghum, and *enset*, which contribute 10-12 percent each [7]. Wheat is the fourth major cereal crops next to maize, *teff* and sorghum both in area coverage and volume of production in the country and it covers approximately 15.17% of the total grain crops production and contributes

about 17.34% of country's total cereal production [2]. Even though, the production of wheat is increasing in terms of area coverage, the average national yield production was about 2.74 t ha^{-1}, which is far below the average yield of 6.4t ha^{-1} and 5.78t ha^{-1} in Africa as well as in the world respectively [10].

The country has an enormous scope and potential for increasing wheat productivity, and it is predominantly cultivated by small holder farmers at a subsistence level. Wheat production is mainly constrained by wheat rust disease, high cost of inputs (fertilizer, improved seed and herbicides) and shortage of improved seed in all wheat growing areas [6]. Further, lack of effective seed production and delivery system, week integration between researcher and farmers, and less adaptation of varieties to the local environments were contributed to the low adoption rate of improved wheat varieties by small scale farmers in the country including the study areas [3, 8 and 12].

In the highland area of South Omo Zone, particularly in Semen and Debub Ari districts wheat is most commonly produced and consumed by subsistence farm householders. Lack of improved varieties of seed, low level of use of improved production technologies and high infestation of wheat rust diseases associated with both edaphic and biotic factors mainly attributed to low yields of production in the area. Farmers have no experience of use of improved varieties of seed and other farm inputs; rather they are experienced in use of local cultivator in the existing wheat production system in area. Due to the aforesaid facts, Jinka agricultural research center (JARC) undertaken adaptation trials and participatory varieties selection best performed and high yielding bread wheat varieties in order to improve wheat productivity in the highland area of target zone, but the selected and highly performed varieties were not introduced to the farmers yet. Hence, this activity is undertaken to conduct pre-extension demonstration and popularization of the best performing improved bread wheat varieties under farmers' condition and to create awareness on the newly adapted and highly performing bread wheat varieties in the area.

II. MATERIALS AND METHODS

2.1. *Description of the Study Area*

The demonstration was conducted in South Omo zone of Debub Ari Woreda. Debub Ari woreda is one of the eight Woredas in the zone with an area of 1,520 km^2 and is located at 50.67'-60.19' N & 360.30'-360.73'E and has a human population of 219,708. The traditional agro-ecologies; Dega, woina-dega and kolla are 30, 65 and 5 percent respectively of the total areas. The Woreda has a rain fall pattern of bimodal type /Belg, February – April and Meher, July – September/. The mean annual rainfall ranges between 601- 1600 mm. The mean annual temperature ranges between 10-10 ^0_C and greater than 27.5 ^0_C.

The major crops grown in the mid land areas of Debub Ari Woreda are cereals (maize, sorghum, wheat and teff), pulse and oils (common bean and ground nut) root and tuber (Enset, taro, sweet potato, cassava and yam), fruits (avocado, banana, mango, and papaya), coffee and spices (coffee, kororima, ginger and turmeric) and vegetables (cabbages, onion, beet root, garlic, hot pepper, tomato, carrot) in respective order of their total production and potential. The woreda is dominantly characterized by mixed /crop- livestock/ farming system.

2.2. *Site and Farmers Selection*

The demonstration was carried out during 2018/2019 cropping seasons in Gadir and Senegal kebeles of Debu-

-b Ari Woreda on 22 model farmers' field and 2 farmers training center (FTCs). Farmers were selected purposively based on availability of suitable farm land, willingness to participate and access to road, and 30% of female farmers were considered as farmers' selection criteria while kebeles were selected based on the status of wheat production potential and criteria and objectives of Agricultural Growth Program-II (AGP-II). One mixed FREG was established in each kebele.

2.3. *Organizing Multi-Disciplinary Team and Group*

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 PED 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. Totally two participatory farmers' research and extension groups (FREGs) (one at each *kebele*) consisting of 40 members (males = 28 and females = 12) were established in the *kebeles*. FGERs were composed of participant farmers, model farmers, DAs and administrative bodies of the respective *kebeles*. 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 40 participant farmers and members of FREG and 8 *kebele* administrators 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. *Planting Materials and Agronomic Practices*

Two improved varieties of wheat (Wane and Hidase) and one standard check with their associated full package were used in demonstration trials through active participation of participant farmers, members of FREGs, *Kebele* administrators and DAs, and both PED and agronomic researchers. The plot size of 10 m x 20 m area of land was used for each variety at each demonstration field. The seed rate of 100 kg/ha and the spacing between two adjust rows of 20 cm was applied. Fertilizer rate of 100 kg/ha NPS and 100 kg/ha Urea was used.

2.6. *Methods of Data Collection and Analysis*

Farmers were expected to select and prioritize important criteria by providing physical and agronomic characteristics of wheat technology. Hence, a total of four 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 resistance, maturity period, and goodness of spike length 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 (Gedir and Senegal *kebeles*). During field day demonstration variety evaluation and assessments, a total of 100 farmers, 8 DA, 2 SMS and 6

Kebele administrators were participated. Whereas, grain yields data were taken by measuring representative from each demonstration plot. Simple descriptive statistics were utilized for the data analysis.

III. RESULTS AND DISCUSSION

3.1. *Socio-Economic Characteristics of Participant Farmers*

Out of 100 participants of the field day conducted in Gadir and Senegal *kebeles*, 50 sample respondent farmers were selected to assess farmers' preferences on pre-extension demonstration of different wheat varieties technology in the area. Out of the total sample respondents, about 74% were male-headed household. Age of the total sample respondents ranged from 23 to 57 years with a mean of about 34 years. On average, the sample respondents have been engaged in wheat farming for 6 years and own an average land holding of 0.735ha (Table 1 below).

Table 1. Socio-economic characteristics of participant farmers.

No.	Indicators	N	Mini	Max	Mean
1	Age	50	23	57	34
2	Farm land size	50	0.125	3.125	0.735
3	Experience	50	1	20	6.62

N = number of respondent farmers.

3.2. *Preference Ranking on Field Performances of Wheat Technology*

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 Gadir and Senegal *Kebeles*. These include resistance/tolerance to disease, early maturity/maturity period, spike lengths, and plant height of wheat varieties. Hence, during the selection process, Wane is selected by farmers as best with its good disease resistance and early maturity characteristics whereas standard check is selected as first with its good spike length and height of plants. The highest mean score (4.45) of farmers' varieties selection criteria indicates that *Wane* is ranked fist with its good disease resistance, early maturity, spike length and plant height and the mean score of 4.06 for standard check indicates that it is ranked as second due to its good disease resistance, early maturity, spike length and plant height of the variety (Table 2. below). In general Wane is the first preferred variety whereas standard check is second preferred variety by the sample respondent farmers in the area.

Table 2. Farmers' preference towards field performances of bread wheat varieties.

Wheat Verities	Mean score of farmers' preferences on characteristics of wheat variety (N = 50)				Total Mean Score	Rank
	Disease Resistance	Early Maturity	Spike Length	Plant Height		
Wane	4.9	4.86	4.06	3.98	4.45	1st
Hidase	1.7	4.04	3.56	3.4	3.195	3rd

Wheat Verities	Mean score of farmers' preferences on characteristics of wheat variety (N = 50)				Total Mean Score	Rank
	Disease Resistance	Early Maturity	Spike Length	Plant Height		
Standard check	3.84	3.12	4.84	4.44	4.06	2nd

NB. Likert scale: 1 = Very poor, 2 = Poor, 3 = Undecided, 4 = Good, 5 = Very good.

During group discussion held in both *Kebeles* farmers mentioned that incidence of wheat disease particularly leaf and stem rust were the major bottle neck problem of wheat production practices. Wheat rust damages the plants at growth stage as well as at maturity stage which causes total product loss or decrease yield. Tolerance to disease is an important attribute of the varieties which affects wheat productivity/yield. Accordingly, majority (64%) of the respondent farmers participated during interview had expressed their willingness to continue Wane variety in future production season and also willing to recommend the variety to others followed by standard check (Table 3. below).

Table 3. Farmers' willingness towards the usage of bread wheat seed varieties in the future.

Wheat Variety	Farmers willing to continue in future (N = 50)		Farmers willingness to recommend to others (N = 50)	
	Frequency	%	Frequency	%
Wane	32	64	32	64
Hidase	0	0	0	0
Standard check	18	36	18	36
Total	50	100	50	100

3.3. *Yield Performance of the Wheat Varieties*

In this study, the two preferred varieties, Hidase and Wane were evaluated for their field performance and Danda'a as standard check on twenty two trial farmers and two FTCs. Accordingly, the field performance result shows that, wane variety had the highest (4.469 t/ha) average grain yield followed by the average yield (4.251 t ha^{-1}) from standard check. The lowest average grain yield was obtained for Hidase variety in the area (Table 4 below).

Table 4. Grain yield performances of bread wheat varieties in the area.

Variety	Grain Yield in t/ha			Std-deviation
	Minimum	Maximum	Mean	
Standard check	3.333	5.266	4.251	5.59
Wane	3.066	5.366	4.469	6.18
Hidase	2.333	3.93	3.217	5.18

3.4. *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 (37,144 ETB) gain was recorded for Wane variety followed by slandered check (35,192 ETB) whereas the lowest net income was recorded for Hidase variety in 2018/19 production year (Table 5 below).

Table 5. Summary of cost-benefit analysis.

Item	**Unit**	**Unit Price**		**Quantity on Each Variety**		
				Wane	**Hidase**	**Standard Check**
		Quantity	**Unit cost**			
Average yield from hectare	Quintal			44.69	32.16	42.51
Adjusted yield (-10%)	Quintal	-		40.22	28.94	38.26
Sales in qt	Birr	-	1200	48,264	34,728	45,912
Total gain				48,264	34,728	45,912
Item cost	Unit	Quantity	Unit cost	Total cost for each variety		
				Wane	Hidase	Standard check
Seed cost	Quintal	1	-	2100	2100	1700
Fertilizer cost	NPS	Quintal	1	1300	1300	1300
	Urea	Quintal	1	1260	1260	1260
Labor cost	Land preparation	Oxen (pair)	24	100	2400	2400
	Sawing	Person	16	35	560	560
	1st and 2nd weeding	Person	40	35	1400	1400
	Fertilizer application	Person	20	35	700	700
	Harvesting and trashing	Person	40	35	1400	1400
Total cost	-	-	-	11,120	11,120	10,720
Total Revenue	-	-	-	48,264	34,728	45,912
Net benefit (total gain-total cost)	-	-	-	37,144	23,608	35,192

IV. Conclusion and Recommendations

In the study areas, wheat production is dominantly experienced with traditional farming and use of local cultivators by substance smallholder farmers. According to group discussion reports show that there was a knowledge and information gap on use of quality seed by smallholder farmers in the area. Moreover, the participant farmers highly emphasized the constraint of 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.

Farmers used combinations of physical and agronomic attributes as selection criteria to identify their own preference wheat technology. Hence, resistance to disease; early maturity, spike lengths, and plant height were highly important farmers' preference criteria established during group discussion undertaken in the vicinities.

Finally, Wane variety was selected first followed by standard check for its high resistance to disease, good spike length, early maturity and good height of the plant. Even though poor traditional weed management practices was the major influencing factor of wheat production and productivity, the highest grain yield and net income gained recorded from Wane variety compared to the others and followed by standard check, whereas the lowest grain yield and net income gained from Hidase variety.

Thus, use of improved wane variety with its associated agronomic practices significantly improves/increases production and productivity of wheat sectors in the areas. Therefore, Office of Zonal Agriculture and Natural Resource Management 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.

ACKNOWLEDGMENTS

The authors would like to acknowledge Agricultural Growth Program (AGP-II) for funding the research work. The authors also thank Jinka Agricultural Research Center and all staff members of the Crop Technology Generation and Adaptation Team for implementation of the technology demonstration, and all the respective *Kebeles*' Development Agents (DAs) for participating in data collection.

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