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Cluster-Based Demonstration of Bread Wheat Variety (Danda'a) Production Technologies Packages: The Case of Select Districts Under Gedeo Zone in SNNPRS and Sidama Region, Ethiopia

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Abstract

Wheat is an important food security crop in Ethiopia, but its productivity is low. Hence, this cluster-based demonstration was conducted to demonstrate wheat production packages, measure wheat productivity, and assess farmers' feedback. The sites were selected purposively based on production potential, land availability, and road accessibility. The training was given to farmers and development agents. Inputs were collected under the shared responsibility of the research center and the district agricultural office. Seed rate, fertilizer rate and lime rate were major used packages. The demonstration was evaluated through field visits and field days. Data were analyzed through descriptive statistics. The mean grain yield was **39** qt/ha and **40.5 qt**/ha in Gedeb and Teticha districts, respectively. The farmers' appreciated the wheat variety in terms of grain yield, number of seeds per heading, disease resistance, tilling capacity, spike length, and well-covered seed. So, extension personnel need to give due attention to full packages application.

Keywords: *Cluster-based demonstration; Danda"a; Full-package; Wheat variety.*

Introduction

Wheat is the most important crop in the world. It's cultivated in 128 countries and is the second-most important food crop in the developing world after rice. In sub-Saharan Africa, 14 countries produce wheat; Ethiopia and South Africa are the two main producers (Demeke and Di Marcantonio., 2019). Wheat is one of the most important staple crops grown in Ethiopia. It is third in the area of cultivation, following teff and maize, and is cultivated in Ethiopia on about 1.69 million hectares, delivering about 4.56 million tons of grain yields (CSA, 2016/17).

Ethiopia is the second-largest producer of wheat in Africa, next to South Africa, in terms of total wheat area coverage and the amount produced (Mussema et al,2015). Currently, Ethiopia has given top priority to wheat production, both as a source of food for consumers and as an income source for farmers (Mengistu, 2021). There are 4.7 million wheat-producing farmers in Ethiopia. Among them, 78% live in the Oromia and Amhara regions. The Southern Nations, Nationalities, and Peoples (SNNP) region consists of 13%, and the Tigray region accounts for only 8%. Less than 1% of the wheat producer farmers are found in other regions of the country (Minot et al., 2015). Those four administrative regions contribute more than 90% of national wheat production: Oromia, Amhara, SNNP, and Tigray (Abeyo et al., 2020). For their wheat production input (seed), the annual certified seed supply covers only about 10% of the area for the wheat crop (Bishaw and Louwaars, 2012).

On the other hand, production and marketing are plagued by issues, primarily due to farmers' inability to obtain improved wheat seed. It arises from many factors that are directly or indirectly affecting the rate of adoption of improved wheat varieties; farmers' low purchasing capacity due to shortage of required credit, variability in seed quality, problems with availability and timely delivery of improved seed, and insufficient quantity of delivery are major problems (Adugnaw and Dagninet, 2020). Even though wheat is an important cereal in Ethiopia's production

systems, wheat yields are relatively low. Recent estimates show that wheat farmers in Ethiopia produce, on average, 2.1 t/ha, well below the experimental level. This is due to several socioeconomic, abiotic, and biotic constraints that combine to explain these yield gaps. The use of modern production-enhancing inputs, such as certified seeds and fertilizers, among wheat farmers in Ethiopia is remarkably low. Fertilizer application rates on fertilized lands are estimated at 48 kg/ha, which is well below the average recommended rate of 200 kg/ha. (FAO, 2014),

Research findings of Kasa and Merkine (2020) reveal that only 30 per cent of the land under major crops in SNNPR was covered by improved seed, and with regards to the productivity of improved seeds, an overall productivity difference of about 35 per cent a hectare was estimated for improved seed users.

To solve the wheat productivity problem, extending the improved wheat varieties together with the recommended wheat production technology packages has a peerless role (Tsegaye and Bekel, 2012). The research finding of Tadesse, A. (2017) reveals that the effective use of full-package interventions to support smallholders' adoption of agricultural technology solves 70% of productivity constraints.

Therefore, this cluster-based, large-scale wheat demonstration was initiated, to demonstrate wheat production packages in a cluster-based approach, to measure wheat productivity on the farm level and to assess farmers' feedback on demonstrated wheat production packages. Ultimately, improving the production and productivity of wheat among smallholder farmers.

Methodologies And Used Approaches

Before starting the demonstration tasks, as part of the starting phase, strong linkages and discussions were held with stakeholders (extension personnel) at the zone and district levels on the objectives and merits of the activity. The site (district and kebele) selection was done purposefully, based on the convenience of the area to the technology (production potential and accessibility). The farmers' selection was done in collaboration with development agents and district experts by considering cluster-based demonstration principles. The number of host farmers was limited by the amount of area coverage that had been planned to be implemented, so the basic consideration was the adjacency of farmland up to the achievement of a Each demonstration task was performed by applying a participatory and responsibility-sharing approach, planned hectare of land.

Training

Before implementation of the demonstration, training was given to host farmers, DAs, and selected experts from the Woreda farm and natural resource development office on agronomic practices, objectives, and the merits of a cluster-based demonstration. Also, researchers and other stakeholders (administrative members) participated in the training.

Mode of implementation intervention

All necessary inputs were collected through the collaborative contributions of both HwARC and Woreda Farm and the natural resource development office. Indeed, improved wheat seed (40 quintals), fertilizers (60 quintals of NPSB and 80 quintals of Urea), awareness creation and capacity building training, and field day ceremonies were adjusted from the research centre. Additionally, soil lime and chemicals have been collected under the responsibility of the Woreda farm and natural resource development office. Then input distribution was done by considering the selected land size for a demonstration from each beneficiary farmer, which was accomplished by the collaborative responsibility of Kebele Das coordinators, the Kebele chief admirative or chairman, experts from the woreda farm and natural resource development office, and respective researchers from the research center.

All necessary agronomic practices were done carefully, starting from land preparation up to yield harvesting, under the joint responsibility of host farmers, kebele officials, and woreda agricultural officers and researchers in their respective roles. 4 times (twice before sowing plus during sowing) the farming frequency was done; at the time of sowing, 5 tons per hectare of lime was applied by dressing in a row; 100% NPSB and 25% urea were applied at the sowing session; and the remaining 75% urea was applied at the 35–40-day stay after sowing; continuous weed and pest management (applying tilt chemicals to control leaf rust) was done.

Integrative continuous follow-up (inclusive of researcher-farmers-extension) was done periodically by strengthening good practices and taking corrective measures for missed field management practices by visiting each host farmer's field and making frequent visits to each host farmer's demonstration field to make communication with DAS.

starting from the planning phase to harvesting, which was done by making effective communication with all

stakeholders at each stage (researchers, extension personnel, administrative staff, and host farmers). This approach was done by sharing input costs, taking common field management steps, following up, and controlling leaf rust management by participating in multidisciplinary research teams.

Table 1: Participant list in training

Location	Participant list in training												Grand Total
	Farmer			Agri- expert			Researcher			Other officers			
	M	F	Total	M	F	Total	M	F	Total	M	F	Total	
Teticha	52	20	72	10	-	10	6	2	8	7	2	9	99
Gedeb	37	5	42	6	1	7	6	2	8	7	2	9	66
Sub-total	89	25	114	16	1	17	12	4	16	14	4	18	165

Achievements

Field day is a method of motivating people to adopt new practices by showing what has already been achieved under field conditions. In other words, it is to show the performance and profitability of new technologies and to convince them about their applicability. Furthermore, it is a method of facilitating people's visits to innovation centers to achieve mass mobilization. Thus, at both locations (Gedeb and Tetich), field days were conducted with the inclusive participation of all stakeholders (zone, woreda, and kebele extension personnel, farmers, SARI, HwARC researchers, and management members). On field day, media (southern radio and television) coverage was employed.

Table 2: Participant list in Field Day

Location	Participant list in training												Grand Total
	Farmer			Agri- expert			researcher			Other officers			
	M	F	Total	M	F	Total	M	F	Total	M	F	Total	
Teticha	52	7	59	10	-	10	9	1	10	24	3	27	106
Gedeb	71	20	91	9	-	9	9	1	10	23	3	26	136
Sub-total	123	27	150	19	-	19	18	2	20	47	6	53	242

Fig 1: Photo from the field day session at Teticha and Gedeb

Grain Yield performance

The collection of sample grain yield data was done collaboratively with crop and PED researchers from HwARC and woreda and kebele crop experts from each location. Accordingly, grain yield data were collected from 30 randomly selected farmer fields among a total of 112 beneficiaries at both locations by randomly selecting a 4 m by 4 m sample area twice from each farmer field. Then carefully weigh clean grain seed.

Table 3: Yield performance

District	Kebele	Variety	Grain yield in quintal per hector			Average grain yield in quintals per hector
			Min	***Max***	***Mean***	
Teticha	*Tinbiro (N=10)*	*Danda 'a*	*38.2*	*46*	*40*	*40.5*
	Wonjela (N=8)	*Danda 'a*	*34.2*	*47.6*	*41*	
Gedeb	*Gubata (N=12)*	*Danda 'a*	*32.3*	*43.9*	*39*	*39*

As shown in above Table 3, the grain yield of the demonstrated bread wheat variety (Danda'a) is relatively the same (40 quintals/ha) and is best performed at both demonstration locations. This yield performance has resulted from the actualization of recommended full packages. Thus, results reveal that appropriately using recommended full packages is a major solution for the bread wheat productivity constraints of smallholder farmers, specifically in Sidama and Gedeo zones, and sustaining the result could play an important role in the household food security of smallholder farmers in the region.

Given Feedbacks

Different stakeholders evaluated the demonstration at periodic follow-up sessions and intensively evaluated it at field days, FGD sessions, and yield harvesting sessions. According to those concerns, each concerned body had given their perspective feedback concerning the demonstrated technology, the applied approach of the demonstration, the advantages of the demonstration by focusing on bread wheat productivity improvement, the merits of the demonstration to sustain positive results of the demonstration, and concerns about issues needing further refining.

Therefore, farmers are highly motivated by seeing the result of a demonstration approach and the accomplishment of the activity. They forwarded their initiation and commitment to sustain the good results of the demonstration and requested continuous support and supervision to sustain and expand the practices to wide-area coverage. Additionally, they appreciated the demonstrated bread wheat variety by listing its preferable productivity (grain yield) several seeds (65–70) single heading, tilling capacity, and disease resistance requested continuous support and supervision to sustain and expand the practices to wide-area coverage. Additionally, farmers appreciated demonstrated bread wheat variety by listing its preferable traits of productivity/grain yield, several seeds per a single heading (65-70 seed), tilling capacity, and disease-resistant Also, farmers expressed that cluster-based production is a good method for efficient use of resources, focused support from experts, and creating motivation.

Also, agricultural experts (extension personnel) expressed that the approach of the activity showed intensive use of recommended full packages could improve the bread wheat productivity of smallholder farmers, which immediately contributes to household food security and regional food security in general. The accomplishment of this cluster-based approach created a peerless awareness of the efficient use of production factors (land, labor, and technology) to increase the product and productivity of smallholder farmers, and it inspired the farmers to use full packages to increase the product and productivity of agricultural technologies. Also, this integrative approach of sharing responsibility among key players in agricultural productivity (researchers, farmers, and extension) is the best practice to increase agricultural productivity, facilitate agricultural technology transfer, and solve productivity constraints. Finally, agricultural experts expressed that the concerned bodies (breeders and pathologists) work on wheat rust (leaf and stem) incidences.

Challenges faced

Agricultural activities, by their nature, are challenging when performed in an open, uncontrolled environment, since they are highly susceptible to natural uncertainty and farmers' and other stakeholders' actual condition bottlenecks (technical support, agronomic practices, and conditional attitudes related to personal benefit). The cumulative effects of the aforementioned factors hinder agricultural production and productivity as a whole, besides the goal of the agricultural project.

Accordingly, when performing these demonstration

tasks, some challenges have indeed been faced, including the out breaking of wheat leaf rust and falling heavy rain at the time of the mid-maturity stage, which made it difficult to control leaf rust by using chemical treatment by immediate washing off chemicals. However, the challenges passed through without bringing negative results by working cooperatively with farmers, extension personnel, and researchers

Lessons learned

The cluster-based (on-farm) demonstration is a bidirectional process where farmers and researchers learn from each other. During the study, farmers had a first-hand observation of the actual performance of the full-package improved bread wheat demonstration. Farmers got familiar with and had access to improved bread wheat technologies demonstrated to them, had better knowledge and/or skill on improved bread wheat production and management, and the research team was exposed to collaborative full-package improved wheat evaluation and feedback for future research work to improve production and productivity of the varieties, and linkages among the research team, experts, DAs, farmers, and other stakeholders were strengthened for the dissemination of the technologies.

Extension personnel pointed out that the implementation of this cluster-based demonstration approach approved the efficient use of production factors (land, labor, and technologies) to increase the production and productivity of smallholder farmers. Using research-extension linkage by putting farmers in the center and making effective communication a priority could play a key role in easily disseminating research findings and thereby increasing the agricultural production and productivity of smallholder farmers.

Farmers learned about the advantages of appropriately using recommended full packages to improve the productivity of specific agricultural technologies. Also, farmers believed that effectively using recommended full packages could increase the productivity of specific agricultural technology. And using research-extension linkage by putting farmers in the centre and making effective communication a priority could play a key role in easily disseminating research findings, thereby increasing agricultural production and the productivity of smallholder farmers.

Summary

Wheat is one of the most important staple crops grown in Ethiopia but its average productivity is low due to biotic factors (rust, pests) and abiotic factors (inappropriate usage of production packages, inappropriate application of agronomic practices). To overcome the low wheat productivity demonstrating research-proven wheat technologies to farmers is important means to boost farmers' wheat productivity specifically thereby improving the country’s wheat productivity in general.

Hence this cluster-based demonstration of wheat production technology package was conducted to demonstrate wheat production technology packages to the farmer, to measure farm-level wheat productivity and to assess farmers' feedback on wheat technology packages.

To operationalize the objectives demonstration site was selected purposively by considering the wheat production potential of the area, land availability and road accessibility to the demonstration site. Accordingly, one woreda (Gedeb woreda) was selected from the Gedeo zone and Teticha woreda was selected from the Sidama region. Also, under each woreda, two sample kebele were selected.

Before implementation the demonstration awareness creation training was given to selected farmers (host farmers) and woreda and kebele agricultural experts. Focused production packages for the demonstration were land preparation, improved wheat seed rate, fertilizer rate, lime application rate and agrochemical usage.

Evaluation of the demonstration was done at field visits, field days and evaluation at harvesting and threshing stages to meet the aim of popularization of wheat technology packages by demonstrating field performance of the demonstration.

The demonstrated bread wheat variety (Danda'a) is best performed. Its average grain yield is 39.1 quintals per hectare at Gedeb and 40.5 quintals per hectare at Teticha. The result of the demonstration showed that using recommended full packages for agricultural technology could increase the production and productivity of farmers. The farmers' appreciated the wheat variety in terms of grain yield, number of seeds per heading, disease resistance, tilling capacity, spike length, and well-covered seed. Hence the obtained lesson from the demonstration pointed out that making effective communication with farmers and strengthening the research-farmers-extension linkage is an important way to disseminate research findings to farmers and further improve agricultural productivity.

Recommendation

Appropriately operationalization of wheat production

technology packages was boosted on the farm level which productivity to on average 40 quintals per hectare. Therefore, agricultural extension personnel and other concerned bodies need to give special attention to extending the newly introduced wheat variety with its full package to increase production volume and wheat productivity in demonstration locations and similar agro ecologies.

Farmers appreciated the demonstrated wheat variety for its disease resistance and high-yielding capacity. Additionally, farmers expressed that they were more aware of the application of wheat technology packages on wheat productivity. Therefore, farmers need to expand the technology as demonstrated packages and further refine agronomic practices (farming frequency, weed control, etc.) to maintain the wheat productivity of the demonstration as well as further improve grain yield by incorporating their indigenous knowledge.

Also, farmers indicated that the inaccessibility of improved wheat seed is the main challenge in their production, hence agricultural offices and seed multiplying cooperatives need to play their role in providing seed access to farmers and interested parties who are interested in working on this technology.

At field day and field visit sessions hosted and surrounding farmers participated and they expressed that they shared experience. So Agricultural officers need to play their role in facilitating communication among farmers, cooperatives, and researchers and giving technical support on agronomic practices (farming frequency, weed management, pest management, and rust-preventing and controlling mechanisms).

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Conflict Of Interest

The authors declare no conflict of interest.

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