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Pre-extension demonstration of triticale (*Trticusecole wittm. Ex A. Camus*) technology at Kamba Zuria District of Gamo Zone, South Ethiopia

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ABSTRACT

Although most of the Gamo Zone has indigenous varieties of triticale, farmers use it extensively, yet produce very little. The Dersolign variety demonstrated encouraging outcomes in the adaptation trial of the 5 triticale varieties carried out by Arba Minch Agricultural Research Center to address this issue. Thus, this study aimed to analyze the costs, preferences, and acceptance of triticale technology in the context of farmers during the 2024 Meher cropping season. Kamba Zuria district was purposively selected based on the potential of the crop, and 2 Kebeles were selected purposively based on the potential of the crop. For the study, 2 Farmers Training Centers (FTCs) and 30 farmers were purposively selected. The researchers trained farmers and other stakeholders. 30 farmers' fields and 2 FTCs at 200 m^2 sections of nearby fields were used to demonstrate Dersolign and the local check. Seed rates of 150 kg ha^{-1} and 100 kg ha^{-1} NPS, 50 kg ha^{-1} of UREA, and 20 cm between rows were used. Every field received the same application of all recommended agronomic techniques, and the fields were properly managed and regularly checked. Agronomic and social data were gathered through measurements and Focus Group Discussions, respectively. The yield, income, and cost data that were gathered were subjected to mean, percentage, and qualitative analysis. The Dersolign type produced the maximum grain yields from farmers' fields (4,326 kg ha^{-1}) and FTC (4,048 kg ha^{-1}), respectively. Additionally, the t-test result indicated that Dersolign and the local check differ statistically significantly at a 0.05% probability level. According to the results of the Costs and Benefits analysis, farmers that produce Dersolign rather than the local check might profit an extra 46,710 ETB ha^{-1} on average. Thus, the Dersolign variety's seeds should be widely multiplied by the Arba Minch Agricultural Research Centers' seed multiplication department, and the Kamba Zuria district Agricultural extension section should provide a full package by participating stakeholders.

KEYWORDS: Benefit cost ratio, Dersolign, Farmers preference, Grain yield, Kamba Zuria, Triticale technology

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INTRODUCTION

The most significant cultivated crops, cereals are a significant source of protein and energy in the diets of both humans and domesticated animals. Triticale is a crop established by mating wheat with rye. Wheat was employed as the maternal plant, and rye was used as the paternal plant. The awns resemble cereal rye, yet it appears like wheat. Out of the two crops, triticale had the finest traits. High production and superior grain quality are characteristics of wheat (Meng, 2009). The goal of crossing 2 crops is to combine their finest traits. Among small-grained cereal grains, it contains the largest seeds. Rye is inferior to wheat in terms of grain quality and yields. However, rye is more resilient to environmental stress and more resistant to disease. It can thrive in soils with a pH of more than 4.5 and is highly acid-tolerant. In an area where soil nutrients are lacking, triticale outperforms teff, wheat, and barley (Gedamu-Gobena, 2008).

Triticale combines rye's low input requirements, drought tolerance, cold hardiness, disease resistance, and adaptability to challenging soils with wheat's production potential and grain quality (FAO, 2004). Triticale can be used in rotations where stubble is retained because it is less vulnerable to the common fungal diseases of cereals (Jessop & Wright, 1991).

Triticale can be grown up to 3000 meters in a range of agro-ecologies. It needs 500-600 mm of rainfall on average, spread out throughout the growth season. But it can also function successfully with as little as 350 mm of seasonal precipitation (Gobeze *et al.*, 2007). Triticale may grow in a variety of soil types, such as shallow soils, poor fertility sands, acidic and sodic soils, and extremely high and low PH. Triticale has a more vigorous root system than wheat, barley, or oats, binding light soils and extracting more nutrients from the soil, and its vigorous root system makes growing this plant attractive in low-fertility soils, light soils, and where a crop is needed to better compete with weeds (Gobeze *et al.*, 2007). Drought and frost tolerance are the key advantages that triticale has over other cereal crops, and consequently, it decreases weather risk. Furthermore, it resists lodging better than wheat and barley and has a significant yield advantage over other small grains (Gobeze *et al.*, 2007). Triticale may be a very appealing substitute for increasing grain output worldwide because it has shown excellent yield potential even in inferior growing conditions (FAO, 2004).

In Ethiopia, the straw is used for bedding, roof thatching, and animal feed, while the grain of triticale is utilized for human consumption. Triticale is one of the most promising recently introduced crop species that may exhibit superior adaptation in some regions of the nation with marginal and acidic soils, particularly in western Ethiopia. Both human meals and animal feed can be made from triticale grains. Triticale is used by farmers to make bread, injera, and boiled and roasted grain. To increase the dietary value of triticale, they typically combine its flour with other crops including wheat, barley, and teff. For use in mixed diets of beef and dairy cattle, lambs, broilers and laying hens, and pigs, grain from contemporary triticale types has been shown to have an energy value comparable to other cereal grains, and its protein is well-utilized (Myer, 2002). As a food grain, triticale has been acknowledged as a resilient crop that can aid in the fight against world hunger. Bread and other food items like pasta and morning cereals could be produced using triticale (Peña, 2004). A variety of unleavened goods, including cakes, cookies, biscuits, waffles, noodles, flour tortillas, and spaghetti, can be made from triticale. Triticale cultivation has the advantage of producing high biomass, tolerating drought and cold, and performing better on acidic and damaged soils. It can be a suitable choice for places where water may sit because it is less likely to get wet than other cereals. Additionally, it can be cultivated in any type of soil, although in certain problematic soil conditions, it yields significantly more than wheat and barley. Out of all the cereals that farmers can use, triticale is the most suitable for high pH (alkaline) and wet soils. Additionally, triticale grows well in sodic soils, is tolerant of low pH (acid soils), and can withstand high boron soils. Beer, bread, tella, spaghetti pastry, and injera are all made using it. However, according to the unpublished report in 2023 by Gamo Zone, Office of Agriculture, the total area allocated to triticale production in the Zone is estimated at 34,945 ha with a total production of 134,476 tons, which is very low in line with the production potential.To tackle these problems, Arba Minch Agricultural Research Center conducted an adaptation trial on Kombolcha, ETCL161(China), Zenkatie, Abdisa, Dersolign, Moti, TT2, TT14, Minet, Snan, and Dersolign varieties performed best and are recommended to proceed at farmers management practice. Therefore, the objective of this study was to demonstrate the performance of triticale technology in farmers' management practice at Kamba Zuria district of Gamo Zone, Southern Ethiopia.

The objective of this study is 1) to increase the level of awareness of farmers on triticale technology, 2) to estimate the costs and benefits of the triticale technology and 3) to assess farmers' preference on triticale technology.

MATERIALS AND METHODS

Descriptions of the Study Area

Kamba Zuria district is one of the districts of the Gamo Zone in Southern Ethiopia (Figure 1). It is situated at 609'0" N and 37012'0" E. It is 1,974 meters above sea level. The Kamba Zuria district experiences 10.1 to 27.5 °C of temperature on average and 800 to 1,600 mm of precipitation annually. Teff, maize, triticale, and sorghum are the main annual cereal crops farmed in the region.

Descriptions of the Variety

In stressful conditions like acidic soil and low soil fertility, where other crops yield little and are ill-suited, the Dersolign cultivar may be able to adapt. It is advised to grow it in regions that receive more than 800 mm of precipitation annually. It thrives between 2,244 and 2,784 meters above sea level (Table 1). It is resistant to septoria triticale, yellow rust, and stem rust.

Site and Farmers Selection

The Gamo Zone's Kamba Zuria district was purposefully chosen due to its potential for producing triticale. In cooperation with professionals and development agents, 30 farmers and 2 Farmer Training Centers (15 farmers and 1 FTC from each Kebele) were chosen based on their willingness to provide their land, adopt the technology, and communicate with experts and development agents. The 20 Farmers Research Group were organized and the purpose of the Farmers Research Group is to collaborate with other farmers who are not involved in the technology transfer.

Mode of Implementation and Approaches Used

Multidisciplinary methods were employed for the demonstration. Farmers are given a sense of ownership by Farmers Research Group (FRG) (Legesse, 2017). Farmers were then organized by the Farmers Research Group and given extensive training in agricultural agronomics. The group was given a leader, and they were able to collaborate closely with researchers and Development Agents on a variety of topics. It was employed to improve farmers' agronomic expertise in several facets of triticale cultivation. The training was attended by 68 individuals in total (Table 2). Arba Minch Agricultural Research Centers supplied the Dersolign type, and farmers used their own land to produce fertilizer. Techniques for preparing land, seeding, controlling weeds and diseases, harvesting, threshing, and storing are among the training titles. Researchers from the Directorate of Crop and the Arba Minch Agricultural Research

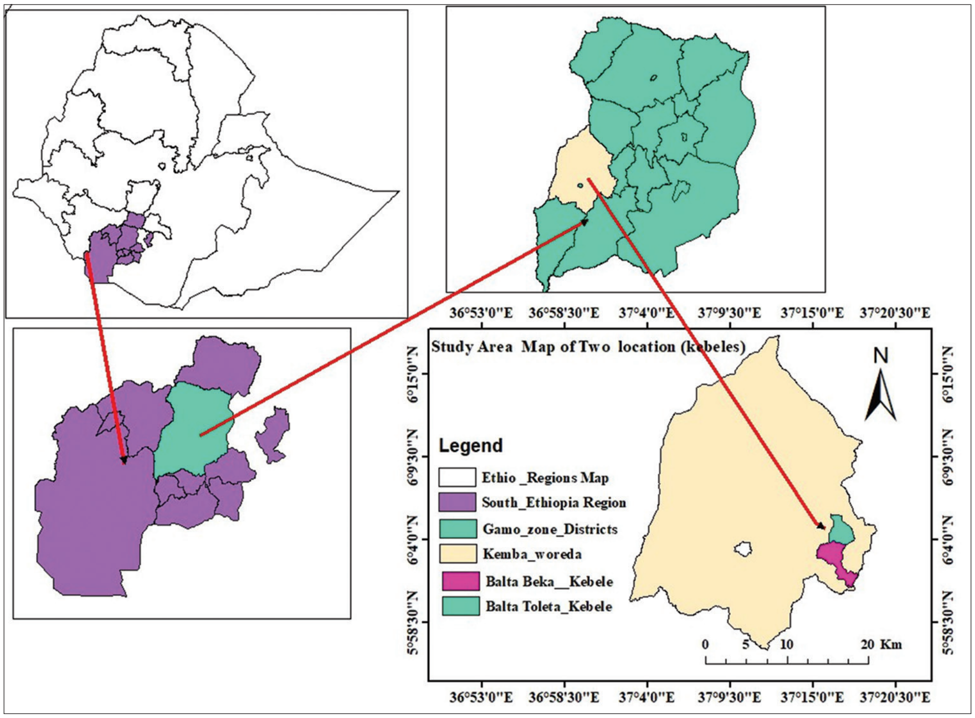

Figure 1: Description of study area

Table 1: Descriptions of the dersolign variety

Name of the variety	Year of release	Growing ecosystem	Maturity (Days)	Grain yield (kg ha^{-1})		Released research center
				Farmers field	Research center	
Dersolign	2012	Mid to high land	141	3,900	5,100	Adet

Table 2: Number of training participants

Participants	Balta bake			Toleta		
	Male	Female	Total	Male	Female	Total
Farmer	20	2	22	17	1	18
Development agent	1	2	3	2	0	2
Administrates	1	0	1	0	0	0
Subject matter specialist	4	0	4	1	0	0
Total	26	4	30	20	1	18

Center, which specializes in agricultural technology transfer and communication, were actively involved in every phase of the project, from its conception to its outcomes. During the field day, extension materials such as banners, posters, brochures, and leaflets were utilized (Figure 2).

Research Design and Agronomic Practices

Improved variety of triticale, Dersolign, and Local check were planted side by side on adjacent plots of 200 m^2 at Farmers' Training Centers and farmers' fields with their production packages. The demonstration boundaries were marked by placing permanent sticks. A seed rate of 150 kg ha^{-1} was drilled in the line of rows, 20 cm between rows. NPS 100 kg ha^{-1} and UREA 50 kg ha^{-1} were used (Table 3). Fertilizer application rate was met by applying all NPS and half of UREA at planting, and the other half of UREA at the tillering stage of the crop. Weed was controlled by hand and herbicide application (2-4-D). Harvesting and threshing were done by hand. In order to meet the fertilizer application rate, all of the NPS and half of the UREA were applied at planting, and the remaining half of the UREA was applied when the crop was tillering. Herbicides and manual labor were used to suppress weeds (2-4-D). Threshing and harvesting were done by hand. As needed, further agronomic techniques were used in accordance with the guidelines. Each row was planted with a hand drill.

Methods of Data Collection

A data sheet was used to gather the information. Planting date, maturity date, grain production statistics, the kind and quantity of stakeholders by gender who took part in training, field visits, and farmers' preferences regarding the various features of the technology, expenses, and revenue received were among the data gathered. Harvesting yielded an estimated grain yield per hectare (adjusted to 12.5% moisture content). The researchers measured 2x2 m patches in the field using quadrat estimation to gather grain yield data, which was then translated to hectares for study. Additionally, farmers who took part in a short field day were interviewed and asked about their preferences for the technology. The participants indicated how much they preferred each of the introduced types' features over the local check.

Methods of Data Analysis

Yield was analyzed using mean, minimum, maximum, frequencies, and percentages, and the results were displayed in tables. A straightforward ranking ranking was used to examine farmers' preference data according to the specified value (de Boef & Thijssen, 2007). Farmers' preferences were analyzed using a Likert scale, which implies an ordinal measure range from very poor to very good. Farmers' preferences are measured by a number in each Simple ranking approach that uses a Likert scale response. Additionally, the method was utilized to determine the profitability analysis that was used to compare the economic value of the improved technology (CIMMYT, 2004; Drury, 2006). Method of Data Analysis

NB = TR-TC...(1)

Where NB=Net Benefit, TR=Total Return

Farmer's feedback and suggestion was also incorporated in qualitative form.

Monitoring and Evaluation

Researchers and Development Agents assigned to each Kebele kept an eye on the activity. Recognizing the significance of field days for technology adoption, Emerick and Dar reported a 12.2% increase in adoption (Emerick & Dar, 2020). Both the target farmers and the nearby communities are affected more broadly by field days and experience-sharing. These gatherings give farmers a chance to work together and share knowledge with specialists, researchers, and other farmers. In order to assess the performance of the types and raise knowledge of the availability and significance of the technology demonstrated for beneficiaries, field days were conducted at various stages.

Figure 2: Concept of the technology demonstration adopted (Habremariam, 2014)

Table 3: Agronomic recommendations and design for triticale in this study

No	Practices	Dersolign variety	Local check
1	Plot size for the varieties	10 m* 20 m=200 m^2	10 m* 20 m=200 m^2
2	Land preparation	2-3 times	2-3 times
3	Seed rate (kg/ha)	150	150
4	Spacing (cm)	20 b/n rows and	20 b/n rows
5	Fertilizer rate (NPS) (kg ha^{-1})	100	100
6	UREA Fertilizer (kg ha^{-1})	50	50
7	Threshing	Manual	Manual

During the field day, extension materials including banners and pamphlets were used to advertise the technology

RESULTS AND DISCUSSION

Grain Yield Performance of Triticale at Farmer's Field

Experiment was conducted at Farmers Training Centers and on farmers' fields at 2 eles to evaluate the grain production performance of the recently released triticale variety, Dersolign. According to the data, the Dersolign variety produced the maximum grain production at farmers' fields (4,326 kg ha^{-1}) and Farmers Training Centers (4,048 kg ha^{-1}), respectively (Table 4). The result exceeded the findings of the Assosa Zone districts of Hawa, Bambasi, and Assosa (2022).

The yield advantage of the varieties can be calculated to show additional benefit that farmers received as a percentage of the enhanced types they produced. In farmers' fields, the Dersolign variety has a 23.89% yield advantage over the local check and a 10.95 quintal yield increase. Additionally, making recommendations based on the relative yield advantage over alternative kinds is helpful. The yield difference between the Dersolign and the local check was 10.95 quintals per hectare, according to the findings of the independent t-test. It shows a significant yield difference between the 2 varieties at <0.05% (Table 5).

Costs and Benefits Analysis

The farmers themselves provided the land, and the other associated expenses such as the cost of labor, fertilizer, and seed were computed as follows. The Benefit-Cost Ratio (BCR) is an indicator used in cost-benefit analysis to estimate the profitability of a research project. It contrasts the present value of all research-related benefits with the present value of all expenses.

Farmers obtained an extra 46,710 ETB ha^{-1} on average if they produce Dersolign rather than the local check, according to the results of the Costs and Benefits Analysis (Table 6). In the Amhara Region's Farta District, triticale was found to boost farmers' net benefits when compared to wheat and barley (Gerema *et al.*, 2020). Additionally, Bednarz (2018) noted that in the Amhara region, strip rust reduced wheat output more than triticale.

Farmer's Preferences

In order to choose and promote a better-performing variety, a farmer's preference would be very important. Farmers were

Table 4: Mean grain yield performance of triticale at Kamba Zuria District, 2024 (n=31)

Kebele	Farmers field (n=30)		FTC (n=2)	
	Dersolign	Local check	Dersolign	Local check
Balta Bake	4,240	3,272	4,109	3,502
Toleta	4,412	3,190	3,907	3,351
Grand mean	4,326	3,231	4,048	3,426

Table 5: Mean yield difference analysis of triticale (n=31)

Yield	t-Test for equality of means (Qt ha^{-1})						
	t	df	Sig. (2- tailed)	Mean difference	Std. Error difference	95% Confidence interval of the difference	
						Lower	Upper
Equal varience assumed	2.712	29	0.98	0.043	0.237	-0.038	0.065
Equal varience not assumed	2.714	29	0.96	0.032	0.44	0.0367	-0.065

Qt refers to quintal per hectare which is 1 Qt=100 kg

Table 6: Costs and Benefits Analysis result of triticale production of the 2 Kebele's (n=30)

No	Variables	Kebele			
		Balta Bake		Toleta	
		Dersolign	Local check	Dersolign	Local check
1	Yield obtained (Qt/ha)	42.40	32.72	44.12	31.9
2	Selling price (ETB/Qt)	4,200	4,200	4,200	4,200
3	Gross Returns price	178,080	137,424	185,304	133,980
4	Hired Labor cost	4,000	4,000	4,000	4,000
5	Seed purchase	12,500	12,500	12,500	12,500
6	Fertilizers purchase (NPS)	2,228	2,228	2,228	2,228
7	Fertilizers purchase (UREA)	2,000	2,000	2,000	2,000
8	Pesticide cost	--	720	--	720
9	Total Cost (ETB/ha)	20,728	21,448	20,728	21,448
10	Net Return (GR-TC)	157,352	115,976	164,576	112,532
11	Benefit cost ratio (NR/TC)	9.68	6.28	9.02	5.78

Table 7: Farmers' preference

Varieties	SE	E	RS	RD	SS	SC	M	Y	T	W	Total score	Mean score	Rank
Dersolign	5	5	4	5	5	5	4	4	5	5	47	4.7	1st
Local check	5	5	4	5	4	4	5	4	4	4	44	4.4	2nd

SE=Seed emergency, E=Earliness, RS=Resistance to shattering, RD=Resistance to drought, SS=seed size, SC=seed color, M=Marketability=yield, T=Taste, W=weed-suppressing potential

asked to rate each crop attribute on a scale of 1 to 5, with 1 denoting extremely poor, 2 poor, 3 neutral, 4 good, and 5 very good based on the ten frequently established standards listed below. Following the rating of each value, the scores were totaled, divided by the number of criteria that the farmers had listed, and then ordered using the mean score.

In a number of crucial factors, including seed size, disease resistance, early maturity, and high yield performance, Dersolign variety is favored over local check (Table 7). Due to food security concerns, the local check's late maturity restricts its viability for grain production. The Dersolign variety usually reaches maturity six weeks ahead of the local check.

The grain yield of the Dersolign variety is up to 10-20% higher than that of the local check reduced plant height, improved performance in unfertile and degraded soils, tolerance to yellow rust, big seed size, and resistance to lodging. Local check can be a suitable choice for places where water may sit because of its high straw yield, extended panicle length, susceptibility to stem rust, and lower risk of water lodging. When evaluating and choosing triticale, taking into account the farmers' perspectives and expertise guarantees that the chosen varieties suit their requirements and tastes. This is consistent with Teklay's (2015) approach, which was grounded in farmers' experiences. This demonstrates how crucial it is for researchers to include farmers in the transmission of technology.

CONCLUSION AND RECOMMENDATIONS

In order to increase the technology's diffusion and acceptance, the recently introduced triticale variety Dersolign was tested locally on 30 farmers' fields and 2 Farmers Training Centers in the Kamba Zuria District of Gamo Zone. Dersolign and a local check from farmers' fields yielded mean grain yields of 4,326 kg ha^{-1} and 3,231 kg ha^{-1} respectively, from the 2 Kebeles. Similarly, the mean grain yields from Dersolign and local check at the Farmers Training Center were 4,048 ha^{-1} and 3,426 ha^{-1}, respectively. Additionally, the results of the Cost-Benefit Analysis demonstrated that Dersolign can increase farmers' profits compared to local checks. In both sites, Dersolign had a high mean preference score. Due to its large seed size, good grain production performance, six-week early maturity, and disease resistance, farmers chose the Dersolign variety as their top option. The early-maturing Dersolign cultivar features a large seed size, strong yield, resistance to disease, and ease of threshing. Therefore, by addressing production restrictions, involving stakeholders, and employing demonstration methodologies, the Arba Minch Agricultural Research Center, Kamba Zuria District Office of Agriculture should collaborate on the Dersolign technology in the area and related agro-ecology.

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AUTHORS' CONTRIBUTION

LL: Conceptualization, material preparation, writing the original draft and editing analyzed data and wrote the whole manuscript, ANB, ME and AB: field investigation, data curation, reviewed the whole manuscript. All authors approved the complied and submitted version manuscript.

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