Research & Development
2025, Vol. 6, No. 4, pp. 85-90
https://doi.org/10.11648/j.rd.20250604.13

Research Article

Pre-extension Demonstration of Under-limed Improved Food Barley Variety in Burka Jiren Community Watershed of Buno Bedele Zone, Southwestern Oromia, Ethiopia

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Abstract

The pre-extension demonstration trial was conducted during the 2024 main rainy season in Burka Jiren Community Watershed of Gechi District, BunoBedele Zone. The objectives were to evaluate grain yield, economic profitability and collect farmers' feedback. The study evaluated lime treated against untreated Adoshe variety across three demonstration sites (at upper, middle and lower watershed). Data were collected on yield, cost incurred, profit gained, and farmers' feedback. The analysis involved descriptive statistics, independent t-test, and benefit-cost ratio. The descriptive analysis result revealed that, the mean grain yield of 26.7 and 13.6 qt ha^{-1} were obtained from lime treated and untreated Adoshe variety respectively. There was statistically significant mean grain yield difference at (P<.01) between the treated and untreated Adoshe yield with 96% yield advantage over the untreated one. The lime treated Adoshe variety was also preferred by the farmer research group members due to high number of productive tillers per plant, spike length, number of seeds per spike, big seed size and grain yield. Likewise, higher net benefit of 97,062 ETB ha^{-1} was obtained from lime treated Adoshe variety with benefit-cost ratio 2.5 compared to untreated one. This implies, farmers can recover all the incurred costs and gain an additional 2.5 ETB for every 1 ETB they invest when using lime treated food barley variety. The overall result showed that lime treated food barley variety had a significant yield advantage, net benefit, and were preferred by farmer research group members, leading to the recommendation for scaling up this technology in similar agro-ecologies.

Keywords

Demonstration, Farmers, Food Barley, Soil Acidity, Yield, Watershed

1. Introduction

Barley (*Hordeum vulgare L.*) is one of the earliest cultivated crops and its cultivation started before 5000 years ago in Ethiopia [10]. Nowadays, Ethiopian farmers grow barley in various climatic and soil types with an elevation ranging from 1,400 to over 4,000m above sea level (m.a.s.l) [3]. Barley is the principal food for smallholder farmers and can be used as beverages and animal fodder. For instance, it can be used to make bread, porridge, soup, and roasted grain and for preparing alcoholic and non-alcoholic drinks [1]. Furthermore barley straw can serve as animal feed, thatching roofs, and bedding [5].

Despite its great significance in the farming system of the

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Received: 6 October 2025; **Accepted:** 16 October 2025; **Published:** 26 November 2025

country, barley production is constrained by many confounding factors [7]. The major production limiting factors are poor soil fertility and soil acidity [5]. According to Kassahun [6] report, approximately 43% of the fertile soil of the country is influenced by soil acidity. Further, Mesfin [9] pronounced that soils with a pH of less than 5.5 prominently affect crop development. As a result of low soil productivity, the countrywide mean barley yield is generally reduced with an average of 2.18 t ha^{-1} Tunebo *et al.*[9] compared to the world average production (2.89 t ha^{-1}).

The extent of soil acidity is high in southwestern country where there is high rain-fell. Liming is a major and effective practice to overcome soil acidity constraints and improve crop production on acidic soils. Sufficient lime application is a central method for enhancing crop growth in acid soils. However, the unpublished CALM P4R baseline survey show that high poor soil fertility and crop productivity declines due to high soil acidity were the top ranked low soil productivity related constraints in Burka Jiren Community watershed in one hand and there is information scarcity on lime application on the other. Therefore, this activity was initiated to demonstrate previously well-adapted improved food barley (Adoshe variety) with and without lime application.

Objectives:

1) To evaluate yield performance of under-limed food barley variety
2) To evaluate economic profitability of under-limed food barley variety
3) To collect farmers' feedback on sustainable lime utilization

2. Research Methodology

2.1. Descriptions of the Study Area

The watershed is situated in the Gechi district of BunoBedele zone, southwestern Ethiopia (Figure 1). The specific place of the watershed is BidoJirenKebeles, and so the local communities named the watershed Burka Jiren Community Watershed. The watershed lies between 8°12'50.4" and 8°14'52.8 N latitudes and between 36°25'27.48" and 36°26'52.8" E longitudes. Burka Jiren Community Watershed is about 15 km from Gechi town in Gechi district and about 35 km from Bedele town in BunoBedele zone. The watershed covers about 535.13 hectares, and 148 smallholder households benefit from the watershed. According to the Google Earth Pro software, the length of the Burka Jiren Community Watershed is about 6 kilometers from the watershed in-late to the outlet. Based on slope gradient, Burka Jiren Community Watershed is characterized mostly by slop, gently slop, and strongly slop. The dominant soil type of the watershed is nitosols, and the common crops produced by the communities are tef and wheat.

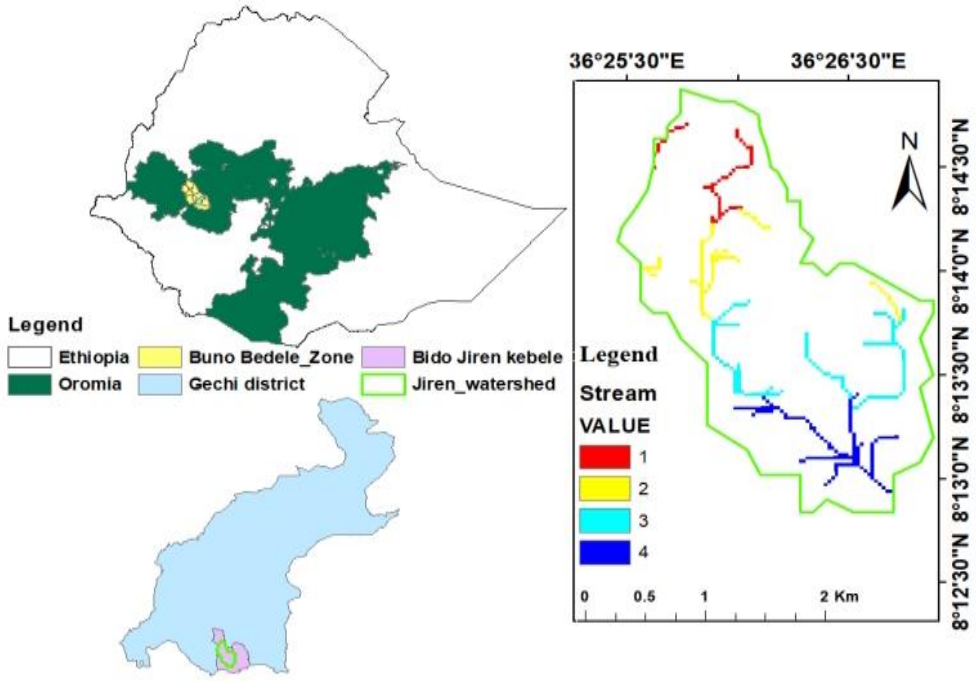

Figure 1. *Map of Burka Jiren Community Watershed.*

2.2. Site and Farmers Selection Ideological

The activity was carried out in Burka Jiren Community Watershed of Gechi district. The watershed was selected based on the prioritized constraint of poor soil fertility and low crop yield due to high soil acidity, being part of previously conducted food barley adaptation trail and the project targeted area. For effective activity implementation and representation, the watershed was classified into upper, middle and lower strata. Accordingly, a total of three interested and committed farmers were selected (one farmer per strata) in collaboration with DAs. One FRG having 15 members comprising both male and female was established as the watershed.

2.3. Research Design, Treatment and Procedure

The gross land size of 10 m x 20 m was used for both improved food barley with and without lime application treatments replicated across three farmer's field. Before one month of sowing food barley, lime was homogeneously applied to the experimental plot. The well adapted improved food barley here after Adoshe variety was used with the recommended seed rate of 125 kg ha^{-1} sown by drilling, row spacing of 20 cm, NPS fertilizer rate of 100 kg ha^{-1} at the time of planting and 150 kg ha^{-1} of urea at vegetative stage. Lime requirement in the field was determined based on exchangeable acidity, bulk density and 15 cm plough depth (equation 1). It was assumed that one mole of exchangeable acidity would be neutralized by an equivalent mole of $CaCO_3$ [4].

LR, $CaCo_3$ (kg/ha)=EA (cmol/kg) of soil *0.15m*$10^4$$m^2$*B.D ($mg/m^3$)*1000/2000

Where: LR- Lime requirement; EA- Exchangeable acidity; B.D- Bulk density.

2.4. Soil Sampling and Analysis

Initially, a composite soil sample was collected before lime application from the experimental field and subjected to decide lime requirement. Composite soil samples were randomly collected per farmer's field up-to 0-20 cm soil depth using an auger. The collected samples were ground and air-dried to pass 2 mm sieves, prepared, and analyzed for soil pH, and exchangeable acidity. The pH of the soils was measured potentiometrically and in water suspension of 1:2.5 (soil: water ratio) [10] whereas the exchangeable acidity was determined by saturating the samples with potassium chloride solution with sodium hydroxide titration [8].

2.5. Technology Promotion Methods

Technology promotion events were used to facilitate further under-limed food barley promotion and dissemination. Accordingly, experience sharing and mini-field day were organized with the involvement of farmers on Adoshe production and its management methods at its maturity stage.

2.6. Data Type and Methods of Data Collection

All necessary data like experimental field pH status, number of farmers participated on mini-field day, farmers' feedback, Adoshe yield, cost-incurred and profit gained were collected through both quantitative and qualitative methods of data collection.

Yield advantage

The yield advantage of lime treated Adoshe variety over the untreated Adoshe variety is calculated in the following formula.

Yield advantage (%)=Yield of lime treated Adoshe variety-Yield of untreated Adoshe variety/yield of untreated Adoshe variety*100

2.7. Method of Data Analysis

Simple descriptive statistics like mean, standard deviation, and independent t-test were used for quantitative data analysis. Benefit-cost analysis was employed for cost incurred and benefit obtained. The host farmers and FRG members' feedbacks towards the under-limed Adoshe variety were narrated.

3. Results and Discussion

3.1. Soil Physicochemical Properties Before and After Lime Application

Soil acidity is a useful concept relating to pH, aluminum toxicity, base saturation of cation exchange capacity, cationic ratios, lime requirement, and nutrient availability that impact crop yield. Accordingly, soil acidity status of the experimental field was assessed before and after lime application. The result indicated that there is a significant change of pH status shown on Table 1 which is 5.27 and 5.66 on Table 2 for lime treated plot.

Table 1. *Soil Chemical properties of experimental sites before planting.*

Soil properties	Site 1	Site 2	Site 3	Mean
pH (H_2O)	4.91	5.39	5.52	5.27

Soil properties	Site 1	Site 2	Site 3	Mean
Exchangeable acidity (meq/100gm soil)	2.44	0.12	0.12	0.89
Available P (ppm)	0.58	0.92	0.98	0.83
Organic carbon (%)	5.46	5.85	3.25	0.45
Total nitrogen (%)	0.47	0.5	0.28	0.42
CEC (cmol(+)/Kg soil)	17.2	16	14.5	15.90

Table 2. *Soil Chemical properties of experimental sites after harvesting.*

Treatments	Mean of soil pH	Mean of organic carbon	Mean of total nitrogen
Adoshe variety without lime application	5.09	2.56	0.22
Adoshe variety with lime application	5.66	4.39	0.38

3.2. Yield Performance

Descriptive result indicated that, the mean yield of Adoshe variety with and without lime application were 26.7 and 13.6 qt ha^{-1} respectively (Table 3). The result indicated that the higher yield obtained from lime treated Adoshe variety was double fold increased due to biological yield enhancement by the application of lime might have improved the availability of some plant nutrients. Achalu*et al.*[2] described that lime application decreased the soil acidity adverse effect on the growth and development of plants because of the high concentration of Al^{3+} and H^{+} ions. Oluwatoyinbo*et al.*[8] also indicated that the biological yield increment is related to the application of P fertilizers and lime through increasing soil acidity.

Table 3. *Yield performance of Adoshe variety with and without lime application in q ha-1.*

Treatments	N	Min.	Max.	Mean	SD
Adoshe variety with lime application	3	23.8	29.3	26.7	+2.762
Adoshe variety without lime application	3	12.1	14.8	13.6	+1.401

As indicated on Table 4 below, independent t-test was conducted to compare the yield for Adoshe variety with and without lime application. There were significant mean yield differences t (df) = 4, p = 0.002) in scores for Adoshe variety with lime application (M = 26.7, SD = 2.762) was higher than Adoshe variety without lime application (M = 13.6. SD = 1.401).

Table 4. *Independent samples t-test result of yield per lime treated and untreated Adoshe variety.*

Parameter		t-test for Equality of Means			
		t	df	Sig. (2-tailed)	Mean Difference
Yield	Equal variances assumed	7.29	4	.002	13.03
	Equal variances not assumed	7.29	2.97	.006	13.03

Table 5. *The yield advantage of lime treated Adoshe variety.*

Treatments	Mean grain yield (qt ha^{-1})	Yield difference (qt ha^{-1})	Yield advantage (%)
Lime treated Adoshe variety	26.7	13.1	96
Untreated Adoshe variety	13.6	-	-

Source: Own computation 2024

3.3. Economic Profitability

The benefit-cost ratio was employed and the result revealed that, the treated Adoshe variety was more than one (>1) implying that producing Adoshe variety with lime application was economically feasible. Accordingly, farmers those prefer to produce Adoshe variety with lime application could get about more than two times net benefit of 97,062 ETB ha^{-1}. The comparative advantage of producing lime treated Adoshe variety over non-treated one was 86,160 ETB ha^{-1}.

Table 6. *The result of benefit-cost ratio.*

Variables	Treatments	
	Adoshe with lime application	Adoshe without lime application
Yield obtained (qt ha^{-1})	26.7	13.6
Sale price (ETB/qt)	6,000	5,400
Total Revenue (Price * Qt)	160,200	73,440
Variable Costs/ha in ETB.		
Land preparation	4,800	4,800
Seed purchase	6,500	6,500
Fertilizers purchase	7,638.31	7,638.31
Cost of lime	600	0
Cost of labor for weeding	3,200	3,200
Cost of labor for lime application	3,200	3,200
Cost of Labor for harvesting	3,200	3,200
Cost of Labor for threshing	4,000	4,000
Total Variable Costs	33,138	32,538
Cost of Land ETB/ha	30,000	30,000
Total cost (TVC + TF C)	63,138	62,538
Gross Margin (GM)=TR-TVC	127,062	40,902
Net Profit=TR-TC or GM-TFC	97,062	10,902
Benefit-cost ratio=Total Revenue/Total Cost	2.5	1.2

3.4. Farmer Research Group (FRG) Members' Feedback

About 15 Farmer research group (FRG) members (13 male and 2 female) who are experiment hosting farmers and their surrounding farmers were provided feedback related to the performance of lime treated and untreated Adoshe variety. The summarized feedback indicated lime treated Adoshe variety was preferable due to having a number of productive tillers per plant, spike length, number of seeds per spike, big seed size and higher grain yield compared to untreated Adoshe variety. By appreciating the convinced performance of lime treated Adoshe variety, FRG members stressed that if agricultural expertise supported us on time availability of lime, its proper time and rate application, we are ready to use lime.

4. Conclusion and Recommendation

The lime treated and untreated Adoshe variety was demonstrated on three farmers' fields. The lime treated Adoshe variety had more yield/yield advantage, net benefit and was appreciated by the farmers due to having a number of productive tillers per plant, spike length, number of seeds per spike, big seed size and higher grain yield compared to untreated Adoshe variety. Therefore, lime treated Adoshe variety was recommended for further scaling up in Gechi district and other similar agro-ecologies.

Abbreviations

CEC	Cation Exchange Capacity
Kg	Kilogram
P	Phosphrous
N	Nitrogen
DA	Development Agent
m	Meter
FRG	Farmers Research Group
M	Mean
SD	Standard Deviation
ETB	Ethiopian Birr

Acknowledgments

The authors would like to acknowledge Climate Action through Landscape Management Program for Result (CALMP4R) for funding these research activities and Oromia Agricultural Research Institute (OARI) for attracting such life sustaining program. Bedele Agricultural Research Center (BeARC) is also appreciated for vehicle support. All Bedele Agricultural Research Center (BeARC) researchers and supportive staffs those have direct or indirect contributions for the achievement of this activity are also kindly acknowledged.

Author Contributions

Dechasa Mengistu: Conceptualization, Data curation, Methodology, Writing – original draft

Suleiman Aman: Data curation, Methodology, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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