

doi: <https://doi.org/10.20546/ijcrar.2025.1309.005>

Pre-Extension Demonstration of Soil Test Based Recommended P-Fertilizer Rate for Bread Wheat at Chora Districts of Buno Bedele Zone, Oromia Regional State, Ethiopia

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Abstract

Pre-extension demonstration of soil test based recommended fertilizer rate for bread wheat was conducted Chora districts of Buno Bedele Zone in 2020 cropping season. The main objectives of the study were to evaluate yield performance and profitability of soil test crop response based phosphorus fertilizer recommendation and to create awareness on site specific crop response fertilizer recommendation rate of bread wheat under farmers' condition. Two treatments: blanket recommendation/farmers' practice and soil test based crop response P-fertilizer recommendation rate were used with improved bread wheat (Liban) variety. The demonstration was conducted on one FTCs and 10 hosting farmers' fields by considering FTCs and farmers' fields as replication. The trial was conducted on a single plot of 12 m x 20 m area for each treatment with the spacing of 20cm between rows using recommended seed rate of 125 kg/ha and recommended N-fertilizer rates of 138 kg/ha for Chora Districts. Field visit was organized for a total of 59 participants during physiological maturity of the crop. The highest mean grain yield was obtained from soil test based fertilizer recommendation rate with more than 84.5 % yield advantage over blanket fertilizer recommendation. Similarly, the economic analysis result shows that the highest average net income (29012.7ETB) was obtained from the soil test based fertilizer recommended rate. Hence, the pre-scaling up of soil test based P fertilizer recommendation rate for bread wheat should be carried out in the coming main cropping season in the study areas.

Article Info

Received: 16 July 2025

Accepted: 24 August 2025

Available Online: 20 September 2025

Keywords

Pre-extension demonstration, Bread wheat, Soil test, Blanket recommendation, FRG, FTC, fertilizer

Introduction

Bread wheat is one of the main crops that small scale farmers grow in the highlands of Ethiopia usually without irrigation [6]. In terms of production, wheat is the second most important food crop in the country next to maize [8]. However, Ethiopian agriculture still has low productivity, uses too many nutrients from the soil without replacing them, doesn't use much in the way of outside farming inputs, follows traditional farming methods, and isn't very good at dealing with changes in the environment [3-5]. As reported by Shiferaw [10],

Ethiopian soils are missing most of the nutrients that crops need to grow well. Phosphorus is a big concern when looking at the soil of Ethiopia because many of the soils in highland areas don't have enough phosphorous [2, 7]. So, a crop in these areas needs fertilizers that have nitrogen and phosphorus. However, the rates applied differ with diverse factors such as soil types, agro-ecology, farmers' perception to fertilizer and resource endowment. In contrast to this, variability to fertilizer application, blanket fertilizer recommendations have been adapted through extension program in the Ethiopia. The blanket recommendations are regardless of

considering the physical and chemical properties of the soil as well as does not taken to account climatic condition and available nutrient present in the soil [11]. As indicated by [9], 100 kg ha⁻¹ of DAP and 100 kg ha⁻¹ of urea were set by the Ministry of Agriculture and Rural Development and these blanket recommendation lead to excess or low application of chemical fertilizers, that aggravates stunted growth of plants due to toxicity or deficiency of the essential elements [1]. Consequently, fertilizer recommendations should take into account the available nutrient already present in the soil. However, for many years there have been no studies on site specific fertilizer recommendations.

To find a solution, a trial was conducted in Chora Districts that used soil test based crop response for phosphorus recommendations and verified the results. The trial also determined the best amount of nitrogen fertilizer, the critical level of phosphorus, and the phosphorus requirement factor, and promising results were found. Therefore, the trial was carried out to show farmers how to apply phosphorus fertilizers based on soil tests under real farming conditions.

The objectives of this study are to evaluate the yield performance and profitability of phosphorus (P) fertilizer recommendations under farmers' field conditions, to create awareness among farmers about the importance of site-specific crop response-based P fertilizer recommendations, and to collect feedback on the yield outcomes of soil test-based crop response P fertilizer application rates for maize grown under real farming conditions.

Methodology

Description of the study areas

Chora is one of the Districts in the Buno Bedele Zone of Oromia Region of Ethiopia. Chora is bordered on the south by the Jimma Zone, on the west by Yayo, on the north by Dega, and on the east by Bedele and its major town is Kumbabe. The district is located at 519 km and 36 km from the capital city of Ethiopia, Addis Ababa and Buno Bedele zonal capital town, Bedele, respectively. It is located at an average elevation of 2000 m.a.s.l and located at 080 13'33.7" to 080 33'55.0" N latitude and 0350 59'59.7" to 0360 15'15.8" E longitude. It is characterized by warm climate with a mean annual maximum temperature of 25.5°C and a mean annual minimum temperature of 12.5°C. The annual rainfall ranges from 1000- 1500mm. The economy of the area is

based on mixed cropping system and livestock rearing agricultural production system among which dominant crops are maize, teff, sorghum and wheat.

Site and farmers' selection

Purposive sampling method was employed to select Chora Districts from the Buno Bedele Zone based on wheat production potential, completed calibration and verification studies. From the District, three representative kebeles were selected purposively by considering road accessibility and production potentialities and two well-represented farmers' training centers (one FTC per District) were used to simplify the demonstration process and enhance the participation of follower farmers and other stakeholders during technology extension events. Availability of suitable and sufficient land to accommodate the trials, willingness to contribute the land, vicinity to roads to facilitate the chance of being visited by many farmers, initiatives to implement the activity in high-quality, good in field management and willingness to explain the technologies to others were the criteria used to select the hosting farmers. One FRG having 10-12 members including hosting farmers were established in each kebele in collaboration with community leaders, DAs, SMS, and FRG members. Accordingly, the experiment was carried out on one FTCs and 10 farmer's fields (three hosting farmers per kebele), which are used as replication.

Field design and materials

The trial was conducted on soil test crop response based recommended Phosphorus fertilizer rate for bread wheat (Liban) and blanket recommendation on 12 m x 20 m experimental plot size for each treatment with the spacing and seed rate of 20 cm between rows and 125 kg ha⁻¹, respectively. Surface composite soil samples were collected from the experimental fields at a depth of 0-20 cm by using an auger to analyze available P and pH with standard laboratory procedures before planting time.

The rate of fertilizer applied was calculated by the formula (kg P ha) = (Pc-Po)*Pf, where: Pc = Critical P-value, Po = Initial P- values for the site and Pf = P requirement factor based on initial phosphorus status in the soil. The recommended N fertilizer rate 138 kg/ha was used in Chora Districts and applied in split application of 1/3 at planting time and 2/3 at one month after planting with the necessary agronomic and management practices. The experimental fields were prepared by using oxen plow following conventional

farming practices followed by the farming community in the area.

Thus, experimental field preparation was carried out by hosting farmers whereas activities such as planting, first and second weeding, harvesting and threshing were handled by FRG members with close supervision of the researchers.

Technology demonstration approaches

The extension events such as training and field visits/tours were organized at the representative site to enhance farmer to farmer learning and experience sharing. FRGs members and concerned stakeholders were motivated to participate on these different extension events.

Field visit was arranged for farmers, DAs, and experts to create awareness on the soil test based fertilizer application technology.

Data collected

The grain yield data and the total number of farmers participated on field visit and training were recorded. The cost incurred and profits gained data were collected.

Methods of data analysis

Simple descriptive statistics were also used to analyze quantitative data; while qualitative data were analyzed using narrative explanation. The economic related data were analyzed using gross margin analysis.

Results and Discussions

Yield performance of Wheat technologies

Application of site specific p-fertilizer recommendation and optimum N-fertilizer causes higher yield performance over blanket fertilizer recommendation/farmers' practice. Fertilizer application based on soil test also correct the imbalances in nutrients according to crop requirements, increases produce and efficient use of fertilizer for improving wheat production. Farmers were observed different experimental sites and appreciated the performance of Wheat technologies. Participants reflect their feedback as soil test crop response based fertilizer recommendation generates higher return and yield over blanket

recommendation/farmers' practice based on variability between treatments of demonstration sites.

Soil testing is the most reliable tool for making good economic and environmental decisions about applying fertilizers; hence it is helpful for efficient and effective use of urea and P-fertilizers.

The result obtained from the trial conducted at Chora district indicates that fertilizer application based on site specific soil test was higher bread wheat grain yield over blanket recommendation.

The use of site specific fertilizer application enhanced the mean bread wheat grain yield from 13.5 qt/ha (blanket recommendation) to 24.9 (soil test crop response based p-fertilizer recommendation) in Chora district.

Yield advantage of the wheat was calculated using by formula

Where, STCRBFR = Soil test crop response based p - fertilizer recommendation

Yield advantage % = $\frac{\text{Yield of STCRBFR (qt/ha)} - \text{Yield of FP (qt/ha)}}{\text{Yield of FP (qt/ha)}} \times 100$ FP = Farmers' practice

As the result of the above table 2 indicates STCRBFR is more strategic toward increment of farmers production and hosting farmers had obtained more than 84.5% of yield advantage from soil test crop response based p-fertilizer recommendation over the blanket recommendation (farmers' practice).

Economic Analysis

Economic analysis was done using gross margin analysis at prevailing market value of the grain and inputs during the cropping period. Only total costs that varied were used to compute costs.

All costs and benefits were calculated on hectare basis in Ethiopian birr (ETB/ha). Accordingly, inputs that vary like NPS, N-fertilizer and labor price were 1622 ETB/qt, 1581.51 ETB/qt and 75/day whereas; bread wheat grain output was 1500 ETB/qt at farm gate price. The economic analysis result shows that the highest net income (29012.7ETB) was obtained from soil test based fertilizer recommended rate and Chora district.

Table.1 Yield data collected from each site

Trial farmers	BR yield qt/ha	STCRBF yield qt/ha
1	4.8	12.8
2	20.4	26
3	12.8	26
4	19.8	24
5	10	26
6	8.3	30.4
7	16.8	24.4
8	10.4	24
9	13.5	24.9
10	18	30.4
Total	134.8	248.9
Mean Yield	13.5	24.9

Table.2 Yield advantage of STCRBFR over farmers practice

Treatments	Mean grain yield (qt/ha)	Yield advantage (%) over Farmers' practice
Farmers' practice	13.5	-
soil test crop response based fertilizer recommendation	24.9	84.5

Table.3 Economic analysis for bread wheat technologies

Parameters	Treatments	
	Farmers practice	STCRBFR
Yield obtained (qt/ha)	13.5	24.9
Unit price (ETB/qt)	1500	1500
Total variable cost (ETB/ha)	4028.51	8337.3
Gross return	20250	37350
Net return (GR-TVC)	16221.5	29012.7

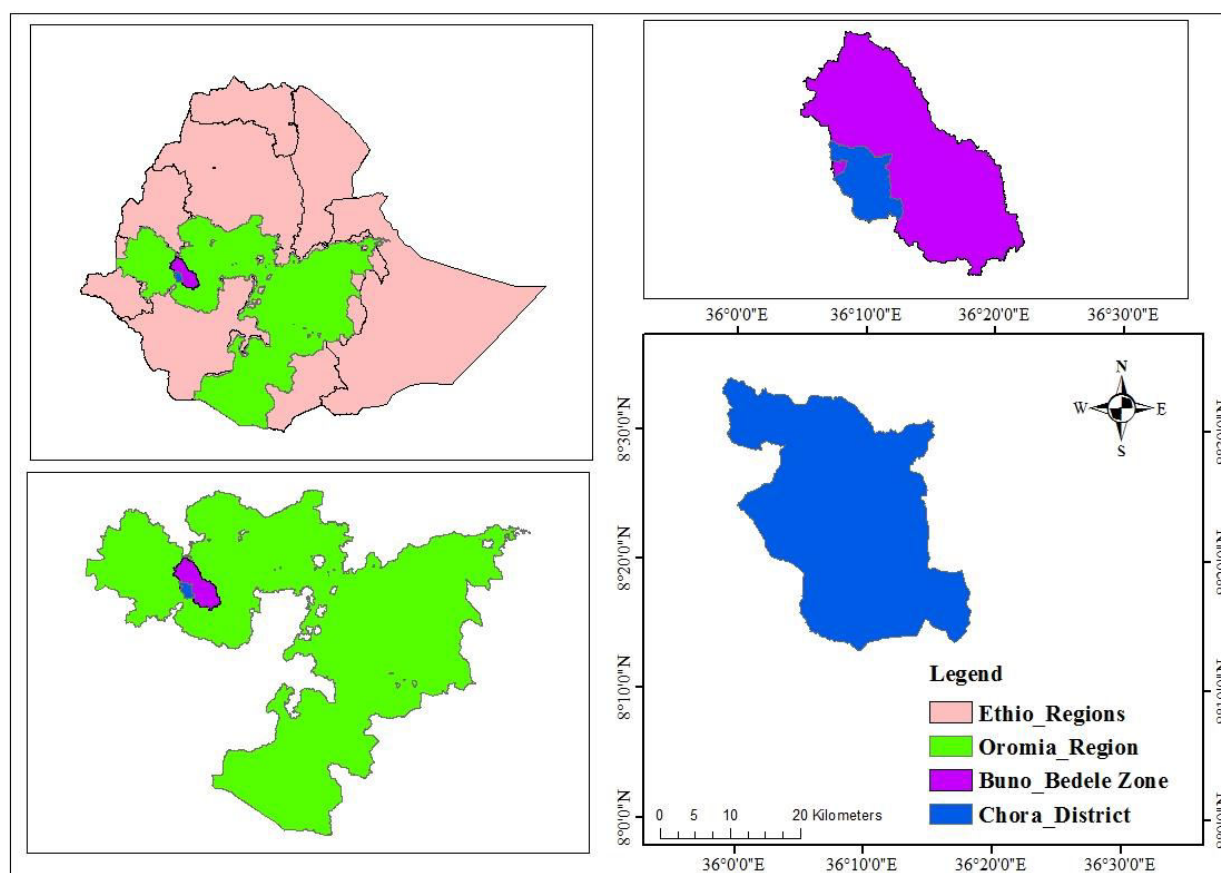
Source: Own computing Data, 2020

Note: STCRBFR = soil test crop response based P-fertilizer recommendation, ETB = Ethiopian Birr

Table.4 Gender composition stakeholders participated on field visit

District	Participants	Male	Female	Total
Chora	Farmers	29	7	36
	DAs	5	4	9
	Other stakeholders	12	2	14
Total		46	13	59

Source: Own Data, 2020

Figure.1 Map of Chora district

Training and Field visit

Training was given to the participants on the concepts of FRG establishment, role and responsibility of FRG members in executing the trial, importance and method of soil sampling and significance of soil test based crop response P-fertilizer recommendation. A total of 36 farmers' (29 Male and 7 Female), 9 DAs (5 Male and 4 Female) and 9 Experts (7 Male and 2 Female) were participating on training. In addition to the training, participatory field visit was arranged in Chora districts of Buno Bedele Zone for a total of 59 participants with the aims of sharing experiences especially on how to practice the trial and as all FRG members practice on their own farm.

Farmers' Feedback

On the exchange visit demonstration site, the participants exchanged their views, opinions and shared their experience. During this time an assessment was made to know how the farmers perceived the technology. Result of the assessment revealed that soil test crop response

based fertilizer recommendation was appreciated by farmers in terms of its efficient use of fertilizers and advanced yield advantage over blanket recommendation. Farmers 'requests for soil laboratories accessibility with affordable charge and they also ask technical support to be benefitted from technologies.

Recommendation

As a result of conducted pre-extension demonstration on bread wheat in study areas indicates, the highest mean bread wheat grain yield was obtained from soil test based fertilizer recommendation rate with more than 84.5% yield advantages over blanket fertilizer recommendation. Similarly, net of return gained from soil test based p-fertilizer recommendation was more profitable than that of blanket recommendation. Due to these results, the farmers reflect their opinion as fertilizer application based on soil tests is an efficient and effective use of fertilizers over blanket recommendations. So, Bedele Agricultural Research Center (BeARC) soil laboratory should be more functional with free/in low charge so that farmers will get access to test their soil. BeARC, Zonal

and districts Bureau of Agriculture should work and harmonize on the transfer of the technology to end users/farmers'. Therefore, the pre-scaling up of soil test based p-fertilizer recommendation rate for bread wheat should be conducted for further dissemination of technology in the study areas.

Conflicts of Interest

The authors declare no conflicts of interest.

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How to cite this article:

Suleiman Aman and Dechasa Mengistu. 2025. Pre-Extension Demonstration of Soil Test Based Recommended P-Fertilizer Rate for Bread Wheat at Chora Districts of Buno Bedele Zone, Oromia Regional State, Ethiopia. *Int.J.Curr.Res.Aca.Rev.* 13(09), 108-113. doi: <https://doi.org/10.20546/ijcrar.2025.1309.005>