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Research Article

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

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Abstract

Wheat is a major crop grown in the highlands of Ethiopia, especially in the study area, which is a key food source. In 2020, a pre-extension demonstration was carried out in Gechi district of Buno Bedele Zone to show how soil testing can help decide the right amount of phosphorus fertilizer for bread wheat. The study aimed to look at how much wheat is produced and how profitable it is when using phosphorus fertilizer based on soil testing results, and to teach farmers about using fertilizer rates that are specific to their fields. Two types of fertilizer plans were tested: one based on general recommendations that farmers usually follow, and another based on soil testing results. The improved bread wheat variety called Liban was used. The demonstration took place on one FTC and 10 fields owned by farmers, with each treated area being 12 meters by 20 meters. The rows were spaced 20 cm apart and the right amount of seeds and nitrogen fertilizer was used as recommended for the area. A field visit was held for 59 people when the wheat was ready to be harvested. The best yield came from the method that used soil test results, giving more than a 49.54 increase in grain production compared to the general recommendation. Also, the economic analysis showed that, the highest average profit was made with the soil testing method, earning 40,112.7 Ethiopian birr. Therefore, it is important to start scaling up the use of soil test based phosphorus fertilizer recommendations for bread wheat in the study area, and similar agro ecology.

Keywords

Pre-Extension Demonstration, Bread Wheat, Soil Test, Blanket Recommendation

1. Introduction

Bread wheat is one of the main crops grown by small farmers in the highlands of Ethiopia, mostly without irrigation [6]. In terms of food, wheat is the second most important crop in the country after maize [8]. However, Ethiopian farming is still not very productive. Farmers use few outside inputs, follow traditional methods, and have trouble dealing with changes in the environment [3-5]. Shiferaw [10] says that most Ethiopian soils lack the nutrients needed for crops to grow well. Phosphorus is especially important because many soils in the highlands are low in phosphorous [2, 7]. So, cops

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in these areas need fertilizers with nitrogen and phosphorous. But the amount used depends on many things like soil type, environment, how farmers feel about fertilizers, and what resource they have. Despite this, most of the fertilizer recommendation given to farmers is the same for everyone. These blanket recommendation ignore the type of soil, climate and nutrients already [11]. Kenea et al. [9] say that the ministry of Agriculture and Rural Development set the same recommendation for all farmers 100 kg per hectare of DAP and 100 kg per hectare of Urea. This can lead to using too much or not enough fertilizer, which can harm crops by causing either too much or too little of essential nutrients [1]. Because of this, fertilizer recommendations should take into account the nutrients already in the soil.

But for many years, no much research has been done on making recommendations that fit each place. To help, a study was done in Gechi District. They tested how much phosphorous and nitrogen fertilizers work best for wheat, and they found good results. That's this trial was done to show farmers how using soil tests to choose the right amount of phosphorous fertilizer can improve their crops.

2. The Objectives of the Study

1) To look at how well different levels of phosphorous fertilizer work and how profitable they are for farmers.
2) To help farmers understanding the value of choosing the right fertilizer rate based on their own soil type and crops.
3) To get feedback on how much wheat grows when using soil test-based phosphorous fertilizer recommendations under real farming conditions.

3. Methodology

3.1. Description of the Study Areas

Gechi District is located in Buno Bedele Zone of Oromia Region, south western Ethiopia. It lies at coordinates 8°27'N 36°21'E and 8.450°N 36.350'E, and is about 462 km by road from Addis Ababa to the southwest. The area's altitude ranges from 1500-2100m above sea level, and it has humid agro ecology. The average yearly rainfall is between 1000 to 1200 mm and the minimum and maximum daily temperatures are 13℃ and 18℃ respectively. The district has various economic activities. The most common ones are farming and raising animals. The main crops grown here include maize, tef, sorghum, barley, wheat, legumes, and coffee.

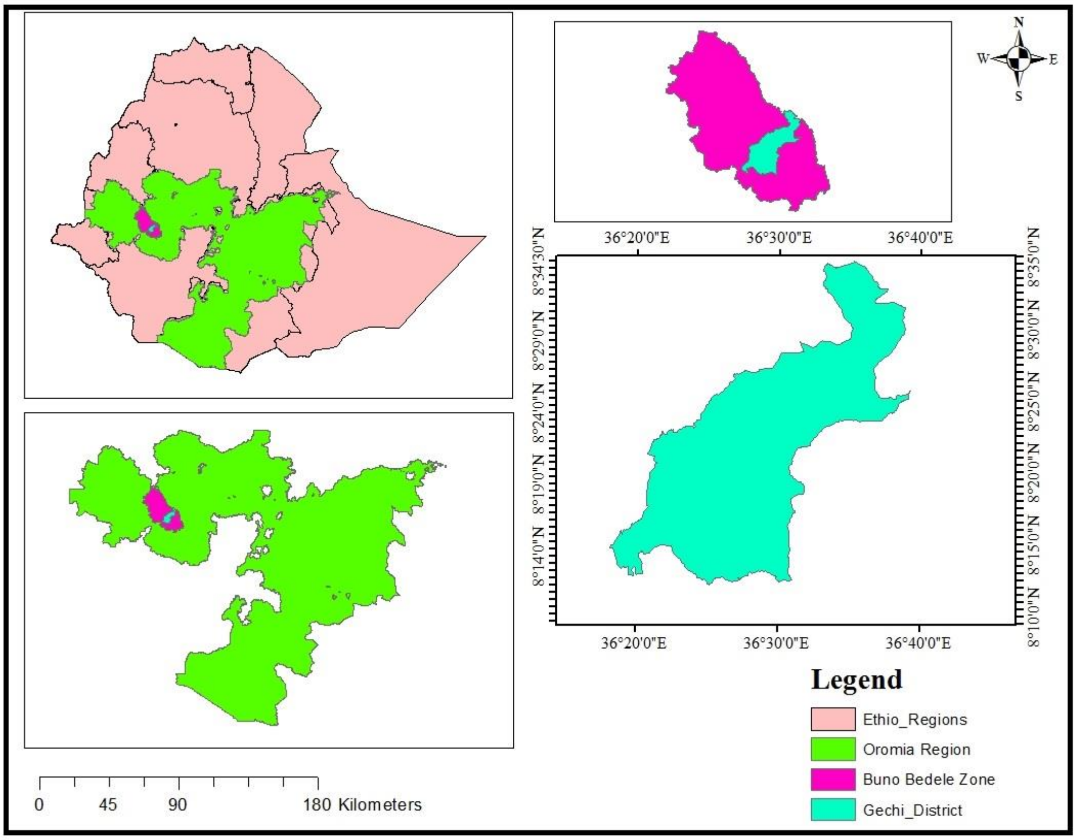

Figure 1. Map of Gechi District.

3.2. Site and Farmers' Selection

A purposive sampling method was used to choose Gechi District from the Buno Bedele Zone based on its wheat production potential and previous calibration and verification studies. From the district, three representative kebeles were chosen based on road access and production potential. Two well represented farmers training centers were selected to make the demonstration process easier and involve more farmers and stakeholders during technology extension activities.

Farmers were chosen based on the availability of suitable and enough land for trials, their willingness to provide land, closeness to roads for easy access, their commitment to implement the activity well, good field management practices, and their willingness to explain the technology to others. In each kebele, one farmer research group (FRG) with 10-12 members including the host farmers, was formed in collaboration with community leaders, Das and subject matter specialist (SMS). The experiment was conducted on one farmers training center (FTC) and 10 farmer's fields, (three hosting farmers per kebele), which are used as replication.

3.3. Field Design and Materials

The trial was done on soil test crop response using the recommended phosphorous fertilizer rate for bread wheat (Liban). Each treatment had an experimental plot size of 12 meters by 20 meters. The spacing between rows was 20cm, and the seed rate was 125 kg per hectare. Surface composite soil samples were collected from the experimental fields at a depth of 0-20cm using an auger to check available phosphorous and pH levels, following standard lab procedure before planting.

The phosphorous fertilizer rate was calculated using the formula (kg P/ha) = (Pc-Po)*Pf, where: Pc = Critical Pvalue, Po = Initial P value at the site, and Pf = P requirement factor based on the soils initial phosphorous levels. The recommended nitrogen fertilizer rate was 92 kg per hectare, applied in two parts: one third at planting time and two-thirds one month after planting, with appropriate agronomic practices. The experimental fields were prepared using oxen plow, following conventional farming methods used by the local community. Hosting farmers were responsible for preparing the fields. The activity like planting, first and second weeding, harvesting and threshing were handled by FRG members, under close supervision from the researchers.

3.4. Technology Demonstration Approaches

Training sessions and field visit were organized at the selected site to encourage learning and experience sharing among farmers. FRG members and other stakeholders were encouraged to participate in these extensions events. Field visit were arranged for farmers, DAs and experts to raise awareness about the soil test based fertilizer application technology.

3.5. Data Collected

The data on wheat yield and the number of farmers who took part in field visit and training were recorded. The data on costs and profits were also collected.

3.6. Methods of Data Analysis

Simple descriptive statistics were used to analyze the numerical data. Qualitative data were explained through narrative descriptions. Economic data were analyzed using gross margin analysis.

4. Results and Discussions

4.1. Yield Performance of Wheat Technologies

Using site-specific phosphorous fertilizer recommendations and the right amount of nitrogen fertilizer led to better yields than using a general fertilizer recommendation or the farmer's usual practices. Applying fertilizer based on soil tests corrected nutrient imbalances according to the crops needs, which increases production and makes fertilizer use more efficient. Farmers visited different experimental sites and liked the performance of the wheat technologies. The participants shared their feedback, saying that using soil test based fertilizer recommendation gave higher returns and yields than general recommendations. This is because there are differences in how treatments performed at the demonstration sites.

Soil testing is the most dependable method for making economic and environmental decision about fertilizers. It helps in using urea and phosphorous fertilizers more effectively. The trial in Gechi showed that using soil-test based fertilizer recommendations increased wheat grain yield more than using general recommendations. In Gechi, the average bread wheat grain yield went up from 21.6 quintals per hectare (general recommendation) to 32.3 quintals per hectare (soil-test based phosphorous fertilizer recommendation).

Table 1. Yield data collected from each site.

Trial farmers	BR yield qt/ha	STCRBF yield qt/ha
1	20	28.4
2	8.4	16.8
3	16.8	26
4	24.4	27.2
5	36.2	42.4
6	28	39.2

Trial farmers	BR yield qt/ha	STCRBF yield qt/ha
7	18	50
8	20.4	31.6
9	21.6	32.3
10	22	28.8
Total	215.8	322.7
Mean Yield	21.6	32.3

4.2. Yield Advantage of the Wheat Was Calculated Using by Formula

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

Yield advantage % = Yield of STCRBFR (qt/ha) - Yield of FP (qt/ha) X 100 Yield of FP (qt/ha) FP = Farmers' practice.

Table 2. Yield advantage of STCRBFR over farmers' practice.

Treatments	Mean grain yield (qt/ha)	Yield advantage (%) over Farmers' practice
Farmers' practice	21.6	-
Soil test crop response based fertilizer recommendation	32.3	49.54

As seen in Table 2 STCRBFR is more effective in increasing farmer production. Farmers participating in the trial gained more than 49.54% in yield from using soil-test based fertilizer recommendations compared to blanket recommendations.

Table 3. Economic analysis for bread wheat technologies.

	Treatments	
Parameters	Farmers practice	STCRBFR
Yield obtained (qt/ha)	21.6	32.3
Unit price (ETB/qt)	1500	1500
Total variable cost (ETB/ha)	4028.51	8337.3
Gross return	32400	48450
Net return (GR-TVC)	28371.5	40112.7

Source: Own computing Data, 2020
Note: STCRBFR = soil test crop response based P-fertilizer recommendation, ETB = Ethiopian Birr

4.3. Economic Analysis

Economic analysis was done using gross margin analysis, based on the prevailing market praises of the grain and inputs during the growing season. Only the costs that changed were used for the calculation. 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 (40112.7 ETB) was obtained from soil test based fertilizer recommended rate at Gechi district.

4.4. 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' (27 Male and 9 Female), 9 DAs (7 Male and 2 Female) and 9 Experts (7 Male and 2 Female) were participating on training. In addition to the training, participatory field visit was arranged in Gechi 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.

Table 4. Gender composition stakeholders participated on field visit.

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

Source: Own Data, 2020

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.

5. Conclusion and Recommendation

The pre-extension demonstration on bread wheat in the study areas showed that using soil-test based fertilizer recommendations gave the highest average wheat yield, with more than 49.54% higher yields compared to blanket recommendation. The net return from soil-test based phosphorous fertilizer recommendation was also more profitable. Farmers expressed that using soil test is a more effective way to use fertilizers compared to blanket recommendations. Therefore, the soil laboratory at Bedele Agricultural Research Center (BeARC) should be more functional with free cost, so that farmers can easily test their soil. BeARC, Zonal and District agricultural bureau should work together to transfer this technology to farmers. As a result, the pre-scaling up of soil-test based phosphorus fertilizer recommendation for bread wheat should be carried out to further spread the technology in the study area and similar agro-ecology.

Abbreviations

BeARC	Bedele Agricultural Research Center
BR	Blanket Recommendation
DA	Development Agent
DAP	Di-Ammonium Phosphate
EB	Ethiopian Birr
FAO	Food and Agricultural Organization
FP	Farmer Practices
FRG	Farmers Research Group
FTC	Farmers Training Center
GR	Gross Return
ha	Hectare
Pc	P-critical
Pf	P-requirement factor
Po	P-initial
qt	Quintal
SMS	Subject Matter Specialist
STCRBFR	Soil Test Crop Response Based Fertilizer Recommendation
TVC	Total Variable Cost

Conflicts of Interest

The authors declare no conflicts of interest.

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