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Research Article

Pre Scaling up of Soil Test Crop Response Based Phosphorous Calibration Study for Teff (*Eragoritis Teff*) Production at Guduru District, Western Oromia, Ethiopia

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Abstract

Pre scaling up of soil test crop response based phosphorous calibration study for Teff was conducted on farmer's field at Guduru district, Horo Guduru Wollega Zone of Oromia Region, with the objectives to popularize and create wider demand on the importance of site specific crop response fertilizer recommendation in the study area. The trial was scaled up on 8 farmer's fields across the district. The activity was under taken on a plot area of 50 m*50 m = 2500 m^2. A soil test was done to determine how much phosphorus fertilizer to use for crops. The recommended amount of nitrogen fertilizer is 46 kg per hectare. Teff variety "Dursi" was used with the seed rate of 15 kg/ha. A total of 4 FREG units which are having 50 male and 12 female members were established. For gender fairness, 19.4% of the participants were women farmers and 80% were men. A total of 48 farmers, 5 development agents, and 4 experts attended a training session during a mini field day that was held at the farmers' fields when the crops were ready to harvest. The highest mean grain yield (1842.5 kg/ha) was obtained from the soil test crop response based fertilizer recommendation. Finally, linkage was established with research center and district office of agriculture. Therefore, wider scaling up/out of soil test crop response based recommended P-fertilizers ought to oversee the promotion and management of phosphorus fertilizers that are recommended according to soil test results and crop reactions.

Keywords

Pre Scaling up, Teff, Dursi, Guduru, FREG

1. Introduction

Teff [Eragrostistef (Zucc.) Trotter] is an annual C4 grass that belongs to the family Poaceae [6].

It is a native grain grown in Ethiopia. Ethiopia is the original place and the first to grow this special crop. Teff straw is an important food for animals, especially when it's dry outside [12]. Soil in the Ethiopian highlands shows that phosphorus may be a key factor that limits crop growth [3].

To understand a soil test result correctly, you need to know how much of each nutrient the test measures and how much more should be added for the best crop growth. Calibration is an important tool to reach our goals [14]. However, calibrations are different for each type of crop and can also vary based on the type of soil, climate, and variety of the crop. This means that suggestions for fertilizer based on soil tests

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should be specific to each location and situation [11]. These suggestions can also change if the soil test results change or if the costs and benefits of crops change. Testing the soil to recommend fertilizers is very important for providing the right nutrients to crops [10]. So, the timing for using fertilizer should depend on how much the crops grow with the nutrients added at different soil quality levels [15]. Like in other parts of the country, the fertilizer advice in Guduru district is not based on soil tests.

A study was done to check how well soil test recommendations for phosphorus worked on teff crops in the Guduru district. Different levels of phosphorus and nitrogen were used, and the results were promising [9]. The results of a test showing the effects of phosphorus fertilizer on crops were shown to farmers using their own farming methods. A partial budget analysis showed that using phosphorus fertilizer based on soil tests is a cost-effective option for growing Teff in the area. As a result reported by [7] pre-extension demonstration of NPS fertilizer rate based on phosphorus calibration study showed a crop yield of 2100 kg per hectare with the recommended fertilizer. Accordingly, Guduru district was selected for pre-scaling up of soil test based phosphorus fertilizer recommendation to pre scale up it on farmer's field to achieve the following objectives.

Objective

1) To popularize suggestions for fertilizer use should rely on the outcomes of soil testing for Teff in the study area
2) To create wider demand on the importance of site specific crop response fertilizer recommendation through farmer pre scaling up approach
3) To strength linkage among stakeholders

2. Materials and Methods

2.1. Description of the Study Area

The research took place on 8 farms in Guduru district, Horo Guduru Wollega Zone, Oromia Region, Ethiopia. Guduru is located between 878 and 2448 meters above sea level. It is at latitude of about $9^0$16'55" N to $10^0$02'31" N; and a longitude of around $37^0$12'42"E to $37^0$42'45"E in the Horo Guduru Wollega Zone of the Oromia region in Ethiopia [5]. The land mostly has gentle hills and smooth areas [1]. The average monthly rainfall is between 10.43 mm and 344.7 mm, and the average monthly temperature is between 16.11°C and 19.11°C. The main types of soil are usually called Nitisols [4].

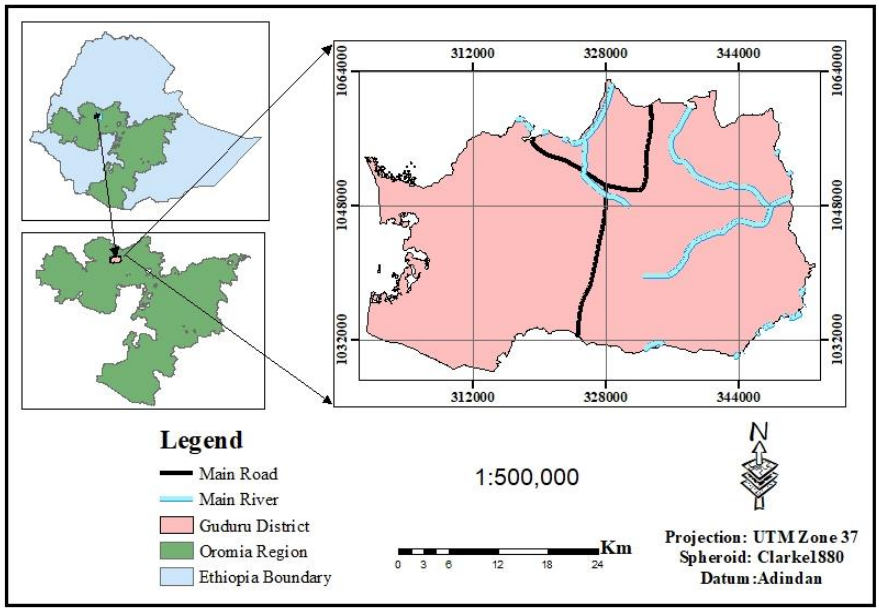

Figure 1. *Here's a map of the area where the study was done.*

2.2. Location and Farmer'S Selection

The study area was selected by considering willingness of farmers, road accessibility for supervision and management criteria. Pre scaling up approach was followed to scale up the technology as it strengthens stakeholders linkage, accelerate technology dissemination and increases production and productivity of the farmers. Using the formula below, we determined the required quantity of phosphorus fertilizer.

Amount of phosphorus fertilizer (kg per hectare) = *(Pc-Pi)*Pf;*

Where; Pc- Critical phosphorus concentration 6 ppm,
Pi- Initial available Phosphorus
Pf- Phosphorus requirement factor (17.33)

The experiment was done on a farmer's field. The number of farmers chosen was based on the starting amount of phosphorus in the soil, having enough suitable land for the tests, and how easy it was to reach them. Each farmer used an area of 0.25 hectares of land. The amount of phosphorus used was determined from soil tests, and a recommended amount of phosphorus fertilizer was applied along with an economic level of nitrogen (46 kg per hectare). The improved Teff variety "Dursi" was used with the seed rate of 15 kg/ha.

2.3. Soil Sampling and Analysis

Soil samples were collect from the 0-20 cm depth from farm land of the cluster and the results was pull together and used to calculate the average soil available phosphorus. The composite soil was placed in a clean plastic bag and taken to the lab to check the amount of available phosphorus and the pH level using standard lab methods. Based on the starting levels of phosphorus and pH in the field, we applied phosphorus fertilizer and lime. The suggested N-fertilizer was used in two parts: one third was added when planting and the remaining two thirds were added 30 to 35 days later.

2.4. Data to Be Gathered

We used the right ways to gather information, such as observing directly in the field, having group discussions, and giving knowledge tests, to collect both types of data: descriptive and numerical. The types of data collected include information on crop production, how much farmers learn and improve their skills, how farmers feel about the new technologies, the total number of farmers who took part in events like training sessions, field visits, and open farm days, and the involvement and role of others in showing and testing these technologies.

2.5. Technology Demonstration, Evaluation Techniques and FREGs Establishment

Farmers in the FREGs group were chosen because they were willing to take part, could be easily supervised, and their age and gender were taken into account. Each site formed one FREG with 15 to 20 members, including both men and women. FREGs members and other farmers were encouraged to join different events held at each location to learn more and promote their work. Training was provided on why testing soil is important for giving fertilizer recommendations based on how crops respond, along with the farming practices that should be followed when growing Teff. These were methods used to help farmers learn from each other and share information, like training sessions, field visits, sharing experiences, and special days on the farm.

2.6. Field Day

Field days and field visits are important ways to help people learn more and share information and experiences among farmers. A mini field day was arranged near the end of the trial, when the crops were ready to harvest, to help farmers and others learn more about it. Discussion session and communication forum was organized.

2.7. Data Management and Analysis

Grain yield, farmers' perception and soil data were collected and properly managed using the EXCEL computer software. The collected data was analyzed using descriptive statistics and SPSS software.

3. Result and Discussion

3.1. Soil Physical Properties of the Test Field

3.1.1. Soil pH

The soil in the study area was very acidic, with pH values between 4.02 and 4.93 based on the ratings from a previous study [13]. So, the pH level of the tested soil was good for growing plants.

3.1.2. Available Phosphorous

The amount of phosphorus in the soil was low, ranging from 1.56 to 5.61 ppm, based on the ratings from the source mentioned [8]. So, the soil in the study areas needs fertilizers that have phosphorus to help grow crops.

Table 1. *Soil properties chosen for the experiment before planting in Guduru District.*

Farmers field (Sites)	pH (H_2O)	Av. P(ppm)
1	4.83	5.61
2	4.02	3.48
3	4.73	4.51
4	4.71	4.44
5	4.93	1.56
6	4.84	4.62
7	4.49	4.98
8	4.67	4.80

3.2. Establishment of Farmers Research Extension Group (FREGs)

A total of 4 FREG units which are having 50 male and 12

female members were established. Among the participants, 19.4% were women farmers, while 80.6% were men. They were capacitated with different trainings, experience sharing and on working together to help themselves solve their own problems.

Table 2. Number of established farmer's research extension group and their members.

District	Kebele	FREG established	Number of FREG		
			Men	Women	Total
Guduru	Gobu	4	50	12	62
Total		4	50	12	62

3.3. Awareness Creation

A total of 48 farmers, 5 development workers, and 4 experts were trained during a mini field day held on farmers' fields when the crops were mature. The main goals of the training were to share technology and help farmers, development agents, and district experts understand it better. Participants also shared their experiences and information about using soil tests for applying fertilizers and managing soil acidity.

Table 3. Number of farmers taking part in the mini field day training.

Topic of training	Location	Farmers		DAs		SMS		Total
Testing soil to see how well it supports crops, focusing on phosphorus recommendations for Teff and managing soil acidity.	Guduru	M	F	M	F	M	F	
		48	-	5	-	4	-	**57**

Where; M = male and F = female

Figure 2. Photos taken during mini field day training based.

3.4. Average Grain Yield

The findings show that adding 46 kg of nitrogen per hectare and using a fertilizer based on soil tests led to an increase in Teff grain yield, reaching an average of 1842.5 kg per hectare. The maximum grain yield (2160 kg/ha) and minimum grain yield (1360 kg/ha) was obtained from the technology. Currently the national average yield of Teff is about 1.7 t ha-1 [2].

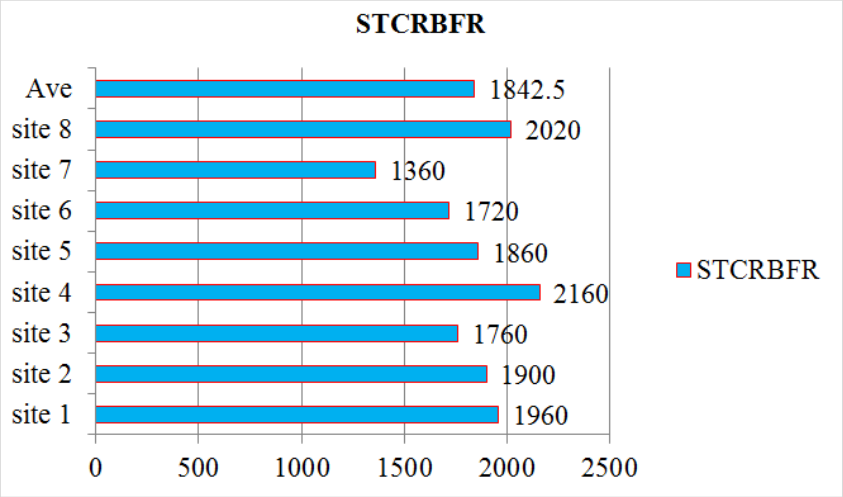

Figure 3. *Average grain yields of Teff across the sites.*

3.5. Farmers' Feedback

During the mini field day training based, different people took part, including farmers who hosted the event and those who didn't, as well as development agents, and experts. They shared their thoughts on what they saw. The improved technology was tested according to what farmers wanted, like: high grain production, strong plant growth, tall plants, and good biomass that can be used for animal feed and mud plaster for building houses. Finally, farmers were asked if they could get free tests of their soil samples to help recommend how much phosphorus fertilizer to use based on the soil's needs.

3.6. Exit Strategy

The mandate and scope of Nekemte Soil Research Center is demand creation through demonstration and pre-scaling up activities on limited farmers fields. Therefore; the research center will promised to provide soil samples analysis and the wider scope dissemination or scaling up/out of the technology should be handled/over taken and implemented by district agricultural offices as well as other stakeholders'. To this effect, NSRC and the respective agriculture offices discussed, agreed and promised on how the technology is to be promoted sustainably and on wider scale.

4. Conclusion and Recommendations

Pre-scaling up of recommend fertilizer for crops was done on 8 farmers fields in the Guduru district of Horo Guduru Wollega Zone. Four FREGs were established in chosen areas, and training was given on how to recommend fertilizers based on soil tests for farmers, development agents, experts, and other interested parties in the district. Mini-field day was arranged to creating awareness and promotion of technology. The technology produced an average grain yield of 1842.5 kg per hectare. Finally, linkage was established with research center and district office of agriculture. Therefore, wider scaling up/out of soil test crop response based recommended P-fertilizers should be owned and handled by respective agriculture offices working together with various partners.

Abbreviations

FREG	Farmers Research Extension Group
NSRC	Nekemte Soil Research Center
OARI	Oromia Agricultural Research Institute
Ppm	Parts per million
STCRBFR	Soil Test Crop Response Based Fertilizer Recommendation

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Conflict of Interests

The authors declare no conflicts of interest.

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