

Demonstration of Soil Test Based NPS Fertilizer Rate Based on Calibrated for Tef in Girar Jarso District of North Shewa Zone, Oromia

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Abstract

The pre-extension demonstration of Soil Test based NPS fertilizer rate based on calibrated for Tef technology with its full packages practices was done to demonstrate and evaluate the newly adapted teff variety and thereby create awareness for farmers and agricultural extension agents. One improved teff variety (Dagim) was demonstrated in Girar Jarso district in two kebeles (Wartu and Dire doyu) two peasant associations were selected purposely from the district based on teff production potential. The experiment was demonstrated on a simple plot with a size of 10 x 10 m. teff grain yield data, and farmer perceptions and preferences were collected and analyzed by simple descriptive statistics. Soil test based NPS fertilizer rate based on p-calibrated for teff along blanket. The demonstration was undertaken on different plot 10m x 10m area for each practice with row planting recommended Seed rate 15 kg/ha and Fertilizer rate NPS 92kg/ ha and UREA 92kg/ha. Mini -field day involving different stalk holders was organized at each respective site. Yield data per plot in different practice was recorded and analyzed using descriptive statistics, while farmers preference to demonstrated technology was identified using focal group discussion and summarized. The demonstration result revealed that Dagim with Soil Test based NPS fertilizer rate based on calibrated technology was higher yielding and the most preferred technology by farmers. Dagim with Soil Test based NPS fertilizer rate based on calibrated technology had 26.5% yield advantage over the local check. Furthermore, Dagim with Soil Test based NPS fertilizer rate based on calibrated technology was selected by farmers. Thus, Dagim with Soil Test based NPS fertilizer rate based on calibrated technology Dagim with Soil Test based NPS fertilizer rate based on calibrated technology recommended for further scale-up.

Keywords: demonstration, soil-test, selection criteria, teff

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INTRODUCTION

Teff (*Eragrostis tef*) is a self-pollinated and warm season cereal crop believed to have originated in Ethiopia. Teff is a dominantly cultivated and stable crop in Ethiopia primarily grown for its grain which is used for preparing injera (Abraha *et al.*, 2020). In Ethiopia, teff is cultivated on an area of about 3,101,177.38 hectares with teff taking up about 24.11 % of the total grain crop area. This makes teff the first among cereals in the country in area coverage (CSA, 2020). Moreover, the economic contribution of teff indicates that real Teff output on average accounted for 6.1% of the real GDP, while growth in real Teff output accounted for 6.4% of the total growth in real GDP i.e., 0.67% of the 10.7 percent growth in real GDP (Fantu, 2015).

However, Declining soil fertility, poor management practices and shortage of rainfall are among the major causes of low productivity of crops in Ethiopia. In order to alleviate these problems in Ethiopia, one of the measures to be taken is to improve the soil fertility status of the soil and to use the right seed rate. Hence, identification of proper fertilizer mix is beneficial at the macroeconomic level by improving the efficiency of fertilizer procurement and resource allocation.

Understanding the principles of soil fertility is vital to efficient nutrient management, crop production, as well as environmental protection. Nutrient management is indispensable for crop production and productivity increments on different soil types. So, soil nutrient calibration study is pertinent to increase efficiency use of inorganic fertilizer like DAP and Urea (Kefyalew *et al.*, 2018). Each essential plant nutrient is needed in different amounts by the plant, varies in mobility within the plant, and varies in concentration in harvested crop components. It is useful to know the relative amount of each nutrient that is needed by a crop and the relationship to amounts removed with crop harvest. Profitable crop production requires adequate levels of phosphorus (P) and other nutrients. For this careful planning is required because of volatile grain and fertilizer prices. Soil test-based fertilizer recommendation plays a vital role in ensuring balanced nutrition to crops. Therefore, fertilizer application schedules should be based on the magnitude of crop response to applied nutrients at different soil fertility levels (Santhi *et al.*, 2002).

Oromia region is the most important teff producing area in the country; and its share in total national production is estimated to be 48% as high (Ibrahim *et al.*, 2018). In the production year of 2019/2020, the total

area covered by teff was 1,487,970.57 hectares with a production of 28,090,978.41 quintals and yield of 18.88 qt/ha from 2,742,049 holders. Tef is the main crop produced in area of North Shewa zone. The total production of tef in North Shewa zone for the year 2019/20 was 2,578,684.86 quintals produced. The average productivity was registered as 18.95 qt/ha (CSA, 2020). Previously, Fitch Soil Research Center was conducted on soil test-based crop response phosphorus calibration study and verification of soil test-based phosphorus recommendation on tef in Girar Jarso district from 2017-20 having different P and N levels and promising result was obtained.

Therefore; the result of soil test-based phosphorus critical value (18ppm) and phosphorus requirement factor (3.03ppm) for teff production in Girar Jarso district. The economic analysis also indicated that soil test-based phosphorus-fertilizer recommendation is economically feasible for Tef production in the district. Fertilizer application based on soil test was increased efficient use of fertilizer for improving agricultural production. This activity was demonstrated to evaluate yield performance and profitability of Soil test based NPS fertilizer rate based on p-calibrated for tef under farmers' condition and create awareness on Soil test based NPS fertilizer rate based on p-calibrated for tef in Girar Jarso District.

MATERIAL AND METHODS

Description of the Study Area

The study was conducted in Girar Jarso district North Shewa Zone Oromia, Ethiopia. The district is located at 112 km from the capital Addis Ababa. Geographically location of the district is lies between 09°38'52.8"N to 10°00'10.8"N latitude and 38°34'22.8"E to 38°50'20.4"E longitude. The elevation ranged from 1300 and 3419 meters above sea level. The mean annual rain fall is 1200mm According to Fitch Station Meteorological data (Haile Mariam, 2014). The maximum and minimum mean temperature of the area is 35°C and 11.5°C respectively.

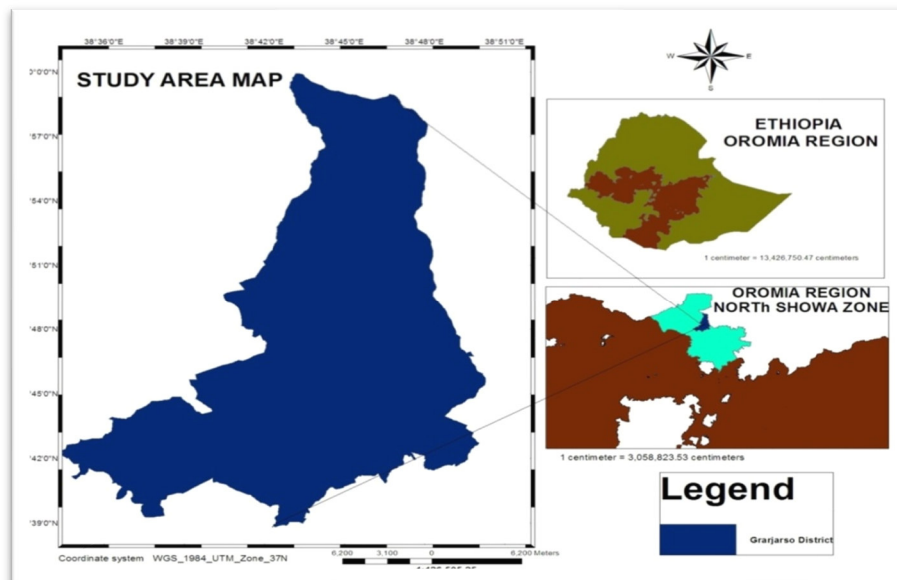


Figure 1: Location map of Girar Jarso district.

Site and farmers selection

Farmers were selected purposively based on soil sample result and their interest land provision for this pre-extension demonstration, interest in cost-sharing, willingness to share experiences for other farmers, and studying their profile with the participation of DAs and community leaders. The selected farmers were grouped in form of Farmers Research Group (FRG) with the member of 15 farmers per PAs in consideration of gender issues (women, men and youth). In the establishment of FRG in the study areas total of 3FRGs (FRG/ PA) from one PA 15 farmers and a total of 45 farmers were grouped in 3 FRG. In the FRG 5 farmers target farmers (3 male trial farmers and 2 female target farmers) and the remaining farmers worked with targeted farmers. PAs was selected purposively based on the potentiality of tef, appropriateness of the area by considering lodging, slop's land escape, access to road, suit for repeatable monitoring and evaluation in progress of sowing to harvesting.

Research Design

One improved variety with different fertilizer application (blanket and STB Fertilizer recommendation) Dagim variety and one local check, were replicated across fifty trial farmers. One improved and one local check was transplanted on 9 farmers' land. 10m*10m plot size of land from individual trial farmer for each pre-extension demonstration of Soil Test based NPS fertilizer rate based on calibrated for Tef and Dagim varieties. Each variety

sowing at the spacing of 20cm between rows on 10m*10m. Fertilizer rate NPS 92kg/ ha and UREA 92kg/ha, Seed rate 15 kg/ha

Technology evaluation and demonstration methods/technique

The evaluation and demonstration of the trials were implemented on farmers' fields to create awareness about the Soil Test based NPS fertilizer rate based on calibrated for Tef and Dagim varieties. The evaluation and demonstration of the trials followed process demonstration approach by involving FRGs, development agents and experts at different growth stage of the crop. The activity was jointly monitored by FRGs, researchers, experts and development agents.

Data Collection

Both quantitative and qualitative data were collected through personal field observation and Focus Group Discussion. Types of collected quantitative data were number of farmers participated in FRG, yield performance, number of stakeholders participated in training and field days while qualitative data were farmers' perception toward the new technology, awareness created and farmers' technology selection criteria

Data analysis

Quantitative data was summarized using simple descriptive statistics (Mean, Frequency and Percentage) while the qualitative data collected using group discussion and key informant interviews, field observation and oral histories was analyzed using narrative explanation or PRA (Participatory Rural Appraisal) tools and argument. Finally, data from different sources were triangulated to get reliable information.

Economic Analysis

Partial budget analysis was done to identify economic feasibility among the Demonstration of Soil Test based NPS fertilizer rate based on calibrated for Teff. The average open market price (Birr kg⁻¹) of teff, at field level and fertilizers was used for analysis. For a Demonstration of Soil Test based NPS fertilizer rate based on calibrated for to be considered a worthwhile option to farmer, the minimum acceptable rate of return MRR. This enables to make recommendations from marginal analysis. Marginal rate of return (MRR) was calculated by using the formula given below;

$$MRR = \frac{\text{Net Income STB(dagim)} - \text{Net Income from blanket(dagim)}}{\text{Total Variable Cost of input}}$$

Results and Discussion

Training of target group (Farmers, DAs and Experts)

Multidisciplinary research team; crop, extension and socio-economic research team and other stakeholders (Offices of Agriculture and Natural Resource) actively participated by sharing their experience and knowledge. Development agents, experts and farmers were participated on the training given on Soil Test based NPS fertilizer rate based on calibrated for Tef and Dagim variety. Field day was also organized for more awareness creation.

Table 1: Type of profession and number of participants on the training at Girar district

No.	Participants	Girar/Pas		
		Male	Female	Total
1	Farmers	20	5	25
2	Das	6	-	6
3	District experts	3	1	4
Total		29	6	35

Source: Own computation 2021/22

Among the training participant stakeholders, 71.43% were farmers. This showed that most of the training participants were farmers. From those farmers, 25% are female farmers' participant.

Mini-field day organized

Table 2: Type of profession and number of participants on the mini field day at Girar District

No.	Participants	Girar/Pas		
		Male	Female	Total
1	Farmers	32	7	39
2	Das	9	1	10
3	District experts	4	-	4
4	Others	5	2	7
	Total	50	10	60

Source: Own computation 2021/22

During mini- field days and farm visit, different questions, opinions and suggestion were raised and reacted from the concerned bodies. Most farmers showed high interest towards improved teff variety (Dagim) variety with Soil Test based NPS fertilizer rate based on calibrated technology production because of better grain yield and earned income by selling seeds for different stakeholders (neighbors' farmers) as compare to the local seeds. Generally, all farmers were very interested to have the technology for their future production. Therefore, all concerned bodies were shared their responsibility for the future intervention and wider reach out of the technology.

Agronomic and Yield performance

The following table describes the yield performances of the demonstrated dagim variety with Soil Test based NPS fertilizer rate based on calibrated technology across the study site. The yield performance of the improved varieties (Dagim and local) was 16.1qt/ha and 6qt/ha at wartu and statistically significant yield difference at 26.5% probability level was observed between Dagim and local one.

Table 3 yield performances of the demonstrated dagim variety with STB NPS fertilizer rate based on calibrated

District	Varieties	Mean(qt/ha)
Girar Jarso	Dagim with STB	13.81qt/ha
	Dagim blanket	10.12qt/ha
	Local	5.9qtl/ha

Data source: Own data

Table 4. Yield performance of improved Dagim varieties across districts on Farmer's land.

PA	Varieties	Mean (Qt/ha)
Wartu	Dagim with STB	16.18
	Dagim blanket	12.65
	Local	6
Koticho	Dagim with STB	11.24
	Dagim blanket	8.5q
	Local	5.5
Dire Doyyu	Dagim with STB	14
	Dagim blanket	9.2
	Local	6.2

Summary of yield performance of the varieties

The result indicated that demonstration of improved dagim varieties with Soil Test based NPS fertilizer rate based on calibrated technology and local obtained the higher yield advantage (16.18qt/ha) compared to local check (5.5qt/ha) respectively. The percentage increases of the improved varieties over the local check were 26.5% under farmer condition. This showed that improved tef varieties with Soil Test based NPS fertilizer rate based on calibrated technology had advantages over the local check.

Table 3: Summary of yield performance in study areas

Varieties	Average yield/ha	Yield difference	Yield advantage over the local check (%)
Dagim STBR	13.80	3.69	26.5
Dagim blanket	10.12	4.22	14.1
Local check	5.9		

Source: Own computation 2021/22

Farmers' perception/Opinion

Farmers in the study area also selected the best performing improved tef variety/Dagim with Soil Test based NPS fertilizer rate based on calibrated technology by using their own criteria. Farmers set these criteria after having know-how about the variety and using those criteria they could select the varieties at harvest time. The opinion of farmers on varietal preference was collected from participants during variety demonstration. The major criteria used by farmers were yield, diseases tolerance/rust, color, number of tiller and maturity period. Based on the above criteria's; farmers evaluated the varieties and ranked first Dagim with Soil Test based NPS fertilizer rate based on calibrated technology followed by Dagim with blanket over the local. Therefore, the most farmers selected Dagim with Soil Test based NPS fertilizer rate based on calibrated technology to reuse on their farm for the future. The following table describes farmers' selection criteria and their perception (feedback) toward the varieties

Partial budget analysis

To estimate the economical significant of Soil Test based NPS fertilizer rate based on calibrated technology, partial budget analysis was employed to calculate the Marginal rate of return (MRR) to investigate the economic feasibility of technology and variety. Based on actual unit prices during the year 2020/21 harvesting season farm gate price of 43 ETB (Ethiopian Birr) per kg of teff, 16.35 and 15.01 Birr per kg of DAP and Urea, respectively were used to calculate variable cost. The economic analysis showed that the highest net income (61106.35 ETB per ha) and marginal Rate of Return (393.64%) was obtained from soil test-based fertilizer recommendation (Table 3). Thus, the MRR showed that it would yield 3.94 birr for every birr invested. Therefore, soil test-based fertilizer recommendation records the highest MRR that is in acceptance range. So, farmers and other end users in the study area advised to use this soil test crop response-based recommended fertilizer which is cost effective, economically feasible and environmentally safe.

Table 3. Partial budget analysis for demonstration STB fertilizer recommendation of tef in Girar Jarso District

Treatment	Variable Input (Kg ha ⁻¹)		Unit price (ETB)		TVC	Output (Kg ha ⁻¹)	Unit price (ETB)	Gross Income (ETB ha ⁻¹)	Net Income (ETB ha ⁻¹)	MRR (%)
	DAP	Urea	DAP	Urea						
Local	100	100	16.3	15.01	3135.52	764	43	32852	32852.00	
Dagim Blanket	100	100	16.35	15.01	3135.52	1031	43	44333	41197.48	266.16
Dagim with STB	398.62	44.02	16.35	15.01	7177.65	1588	43	68284	61106.35	393.64

Where: ETB = Ethiopian Birr, TVC = Total Variable Cost, MRR = Marginal Rate of Return

Conclusion and Recommendation

The result of this study indicated that Dagim with Soil Test based NPS fertilizer rate based on calibrated technology was higher yielding and the most preferred technology by farmers at Girar district. Local variety was the low yielding variety and also the least preferred varieties by farmers in the study district. Dagim with Soil Test based NPS fertilizer rate based on calibrated technology has 7.9qt/ha yield advantages over the local one in the study area. Therefore, based on these findings, could be recommended to teff growers in the north Shewa Districts for further promotion. Farmers also liked Dagim with Soil Test based NPS fertilizer rate based on calibrated technology for enhanced attractive color. Therefore, the Dagim with Soil Test based NPS fertilizer rate based on calibrated technology could be used by teff producers for scaling up.

REFERENCES

- Abraha Refine, Daniel Adhanom, and Negasi Tekeste, 2020. Response of teff (*eragrostis tef* (zucc) trotter) to seeding rate and methods of sowing on yield and yield attributes in a subhumid environment, northern Ethiopia.
- Central Statistical Agency (CSA), 2020. Report on Area and Production of Major Crops (Private Peasant Holdings, 2019/2020 (2012 E.C.). Meher Season) Volume I.
- Fantu Nisrane Bachewe Bethelhem Koru, and Alemayehu Seyoum Taffsse, 2015. Summary of ESSP Working Paper 89, Productivity and efficiency of small holder Teff farmers in Ethiopia.
- Kefyalew Assefa, Tilahun Firomsa and Tadesse Hunduma, 2018. Phosphorus Critical Level and Optimum Nitrogen Rate Determination on Bread Wheat for Sustainable Soil Fertility Management and Economical Production at Lume Area of Oromia Region, Ethiopia. *Journal of Biology, Agriculture and Healthcare*, 8(1).
- Santhi R, Natesan R, and G. Seh'akumari, 2002. Soil test-based fertilizer recommendation under IPNS for aggregatum onion in Inceptisols of Tamil Nadu. Department of Soil Science and Agricultural Chemistry. Tamil Nadu Agricultural University. Coimbatore MI 003. India. *Agrupedolo R. V*, 12: 141-147.