ISSN: 2224-0616
Int. J. Agril. Res. Innov. Tech. 12(2): 96-100, Dec 2022
DOI: https://doi.org/10.3329/ijarit.v12i2.64092
OPEN ACCESS
Available online at https://ijarit.webs.com
https://www.banglajol.info/index.php/IJARIT

Participatory demonstration of newly recommended nitrogenous fertilizer application rate on maize and evaluation of its effect on maize Productivity case of Halaba zone SNNPR, Ethiopia

Merknehi Bekele*, Zerihun Dotora and Mekonen Debara

Received 7 October 2022, Revised 9 December 2022, Accepted 22 December 2022, Published online 31 December 2022

A B S T R A C T

Nutrient deficiency is one of among major problems constraining the development of economically successful agriculture. Specifically, this resulted from lower crop performance. To enhance crop performance, the application of the newly recommended fertilizer rate is among the necessary measures. Hence, this pre-extension demonstration of the newly recommended fertilizer rate on maize and evaluated the change in its profitability. The demonstration was conducted at two farmers' training centers and ten beneficiary farmers' fields. Partial budget analysis was employed to evaluate the change in profitability from the new recommended rate. Based on the result, the average yield performances that were obtained from farmer's fields were 40.0 Q ha^{-1}, 29.4 Q ha^{-1} of the new rate, and blanket recommendation rate, respectively. In addition, the yields obtained from the farmers' training center were 47.0 Q ha^{-1} and 33 Q ha^{-1} of the new recommendation rate and blanket recommendation rate, respectively. This might be due to the effective monitoring and follow-ups in the farmers' training center than the farmers' field. The result of the partial budget analysis revealed that adopting of newly recommended rate increases the overall profit, which is 8680 ETB per hectare. Therefore, it is better if increase the adoption rate of the newly recommended fertilizer rate on maize to improve the production and productivity of maize producers.

Keywords: Fertilizer application rate, Maize, Nitrogenous fertilizer, Participatory demonstration

Southern Agricultural Research Institute, Hawassa Agricultural Research Center, P.O. Box 06, Hawassa, Ethiopia

*Corresponding author's email: merknehibekele@gmail.com (Merknehi Bekele)

Cite this article as: Bekele, M., Dotora, Z. and Debara, M. 2022. Participatory demonstration of newly recommended nitrogenous fertilizer application rate on maize and evaluation of its effect onmaze productivity case of Halaba zone SNNPR, Ethiopia. *Int. J. Agril. Res. Innov. Tech.* 12(2): 96-100. https://doi.org/10.3329/ijarit.v12i2.64092

Introduction

Current fertilizer recommendation in Ethiopia is based on very general, or more often, a single recommendation for all crops 100 kg DAP (18-46-0) and 100 kg Urea (46-0-0). Moreover, the nutrients in the blanket recommendation are not well balanced ergonomically and its continued use will gradually exhaust soil nutrient reserves. Therefore, neither yields nor profits can be sustained using the imbalanced application of fertilizers, as the practice results in accelerating deficiencies of other soil nutrients. Since the absence of one or more nutrients besides N and P can depress yield significantly. Today, in addition to N, P, S, B, and Zn deficiencies are widespread in Ethiopian soils, while some soils are also deficient in K, Cu, Mn, and Fe (Tamene *et al.*, 2018).

Maize is one of the strategic field crops targeted to ensure food security in Ethiopia (Keno *et al.*, 2018). Despite the importance of maize as a principal food crop, its average yield in Ethiopia is about 3.6 tons ha^{-1} and it is still lower than that of the world's average, which is 5.6 tons ha^{-1} in 2016 (Tamene *et al.*, 2018). The major causes for the lower productivity of maize are the application of unbalanced nutrients.

To solve the constraint of low maize productivity, there are several solution options, among those several management options; site-specific fertilizer direction is currently increased noticeably to tackle the problem. However, fertilizer trials involving multi-nutrient blends that include micronutrients are at an initial stage in Ethiopia. After the soil fertility map is developed by Agricultural Transformation

Agency (ATA) in 2016, 13 blended fertilizers containing N, P, K, S, B, Zn, and Cu in different mix forms have been recommended for the SNNPRS. In addition to macronutrients applying different blends including micronutrients can increase maize yield, to come up with this deficiency problem, the newly recommended location-specific fertilizer rate is the solution for the problem (260 kg Urea and 100 kg NPSB) (Boke *et al.*, 2018). Therefore, to solve this problem HwARC natural research teams released crop and location-specific fertilizer use recommendation rates on maize in 2018. Hence before, the scale-up of these soil fertility management options to the wider areas, it was demonstrated on 10 representative farmers' fields and two FTC to popularize the technology, to evaluate feedback information on the technology, and to evaluate the profitability of the technology.

Methodology

Site and farmers Selection procedures

Shewako and Guba shiraro kebeles were purposef ully selected for demonstration based on maize production potential. Based on PED protocol, from each kebele, one farmer's training center and 5 farmers were selected for conducting the demonstration and evaluating the demonstration plots. After that, the beneficiary farmers were selected based on their willingness to participate in the demonstration, representativeness to other farmers, and accessibility (land and road).

Demonstration design

Two plots employed the demonstration. The first plot was considered for the newly recommended fertilizer rate (100 kg NPSB and 260 kg Urea) and the second plot was considered for the blanket recommendation fertilizer rate (100 kg NPSB and 100 kg Urea). Lemmu maize variety was used for both demonstration plots with size 2500 m² for each recommendation on 2 FTC and 10 farmers' field. The seed intra and interspacing were 40 cm and 80 cm, respectively.

Mode of implementation and agronomic practices

Before starting implementation, as an activity opening phase, farmers were well trained about the application of the newly recommended rate of blended fertilizer on maize and agronomic practices and overall awareness of actualization of practices from planting to marketing (consumption) by soil fertility researchers.

Table 1. Participant list in training.

S.no	Participants	Sex			Location /District
		Male	Female	Total	
1	Farmers	5	5	10	Atoti Uli
2	Agri-experts	7	-	7	
3	Researchers	4	1	5	
4	Technical assistance	1	1	2	
5	Other stakeholders	6	1	7	
6	Total	23	8	31	

The newly recommended blended fertilizers rate (100 kg NPSB and 260 kg Urea per hectare) was provided from Hawassa agricultural research center, was demonstrated with its respective standard check/ blanket recommendation rate (100 kg NPSB and 100 kg Urea), planted with improved maize variety (Lemmu) on 10 farmers' field and 2 FTC. The seed intra and interspacing were 40 cm and 80 cm, respectively. 30% of Urea and 100% NPSB were applied at sowing time and 70% of Urea was applied after 35 days stay after sowing. In addition, continuous follow-ups and essential support (technical) were given by respective researchers. Farmers evaluated the demonstration plots four times (at late germination, at knee height, early maturity/seed setting, and late maturity/harvesting stages). Finally, field day was conducted by participating beneficiary farmers, Das, woreda, zone and regional agricultural experts, and other stakeholders.

Mode of popularization and communication

To bring dissemination and diffusion rate of newly introduced technology and to collect farmers' feedback for further technology improve ment, making effective communication with concerned bodies at a grassroots level is an important tool. Therefore, to make effective communication to the beneficiary and surrounding farmers about the performance of demonstration plot, field day was conducted by inclusively participating all stakeholders (regional, zone, woreda and kebele extensional personnel, regional and center multidisciplinary researchers, kebele and woreda chairmen's, hosted and surrounding farmers). At the field day, session participants comparatively evaluated the demonstration plots and made deep and participatory discussions. Finally, farmers listed out their interest/preferences on demonstration plots by consideration of field performance, economical consideration to sustain, and comparative yield advantages of each treatment plot.

Table 2. Participant list in field day.

S.no	Participants	Sex			Location
		Male	Female	Total	
1	Farmers	42	28	70	Atoti Uli
2	Agri-experts	6	2	8	
3	Researchers	6	2	8	
4	TA	1	1	2	
5	Other stakeholders	15	5	20	
6	Total	71	37	108	

Plate 1. Photo from field day ceremony at Halaba.

Methods of data collection

The agronomic data were collected by observing the growth stage and field performance of the plant. Also, yield data was directly collected at the harvesting time and farmers preference related data like seed cob per single plant, ability to lodging, cob size, productivity, profitability, and affordability data were collected through focused group discussion (FGD) and the individual interview was made with hosted farmers, Keble development agents and surrounding farmers at the time of the different evaluation session.

Method of data analysis

Yield data collected from selected sample areas of the field were analyzed by using descriptive statistical methods such as mean, average, minimum, and maximum were used to analyze yield data. A partial budget analysis procedure was employed for the evaluation of change in the profitability of the newly recommended alternative. Likert scale was used to analyze the farmer's preferences data.

Results and Discussion

Yield performance

This analysis was based on data collected from ten farmers' plots each demonstrated both fertilizer rates. Table 3, below shows deceptive statistics of the result.

Table 3. Grain yield performance in Q ha^{-1}.

Types of fertilizer rate	Min	Max	Mean	St. Dev	Yield on FTC
New rate (N=8)	39.0	49.5	40.0	5.7	46
Blanket rate (N=8)	28.4	33.5	29.4	4.8	33
t-value 8.1***					
Relative yield advantage 35.05					

**** is statistically significant at less 1 percent probability level. Source: Own calculation*

The average grain yield of the newly recommended rate of inorganic fertilizer was 40 quintals per hectare whereas the average grain yield of blanket recommendation rate was 29.4 quintals per hectare on farmers' fields. The application of the newly recommended rate of blended fertilizer on maize resulted from a 36.5 percent yield advantageous over the blanket recommendation rate on maize.

The t-value reveals that there is a significant mean maize yield difference between a new recommendation and standard check of fertilizer application. The above table also portrays that there is a big grain yield difference between application of newly recommended rate (NPS: 100 kg and Urea: 260 kg per a hectare) and blanket recommendation rate (NPS: 100 kg and Urea: 100 kg per a hectare) on the same maize variety (Lemmu). In addition, this grain yield

difference of maize resulted was from different application rates of only Urea, but the same NPSB rate with the same agronomic practices on two plots. Therefore, the result approves that the demonstrated location is exposed to nitrogen element deficiency, this nitrogen deficiency highly affecting the production and productivity of maize, to reach full maize productivity and production potential.

The findings of Woldesenbet and Haileyesus (2016) suggested that the effects of various N fertilizer rates had a bearing on the maize yield and growth components. According to Jena *et al.* (2021), the majority of farmers use less fertilizer than is recommended for maize production, which results in a stagnation of the crop's productivity. According to findings of Kandil (2013), all N fertilization levels, maize hybrids, and their interactions had a substantial impact on the growth and composition of the crop as well as the yield of the maize plant. Thus, sustainably using this newly recommended nitrogenous fertilizer rate with its full packages in wide-area coverage is a strategic solution up to the next new research result.

Partial budget analysis

Table 4 below shows that adopting the newly recommended rate will increase the overall profit of farmers, due to increased revenue. This shows that on average the farmers who will apply the newly recommended rate will get revenue of 8680 ETB compared with those who will apply blanket rate. In analysis, only the cost component that revealed change compared with blanket rate were considered.

Table 4. Partial budget analysis.

Positive impacts of adopting the new recommendation				Negative impacts of adopting the new recommendation			
	Quantity (Kg)	Price/Kg	Total (ETB)		Quantity (Kg)	Price/Kg	Total (ETB)
Added revenue	1060	10	10600	Cost added	160	12	1920
Cost saved	-	-	0	Revenue lost	-	-	0
Total positive impact	1060	10	10600	Total negative impact	160	12	1920
Overall effect = 8680 ETB							

Source: Own computation of 2021 field data

Farmers' preferences

The demonstration was evaluated different follow-up periods by farmers, researchers, and extension personnel Accordingly, the evaluation was undertaken at the location of the demonstrati on, starting from the early establishment stage to the late maturity stage, thus, farmers evaluated the demonstration based on their preference criteria which depending on the physical characteristics of each variety show. Additionally, final farmers' preferences data were collected from beneficiary farmers on a prepared check by using the listed preference criterion listed in table-5 below. Farmer's preference result present in table-5, the mean score value of listed criteria of new fertilizer recommendation rate is greater than that of blanket recommendation. This shows farmers preferred and ranked the new fertilizer recommendation rate over the blanket recommendation rate.

Table 5. Farmers feedback information on newly introduced fertilizer recommendation rate.

No.	Criteria (N=8)	Farmers' Rank					
		Newly recommended fertilizer rate			Blanket recommendation		
		Very good (3)	Good (2)	Poor (1)	Very good (3)	Good (2)	Poor (1)
1	Productivity	7	1	-	3	1	4
2	Affordability	2	2	4	8	-	-
3	Profitability	4	3	1	4	1	3
4	Lodging resistant	5	2	1	2	4	2
	Mean score	1.35	0.40	0.15	1.30	0.30	0.90
	Rank	1st			2nd		

Conclusion and Recommendation

Lower crop performance is mainly manifested due to nutrient deficiency. This resulted from the mining of nutrients, inappropriate application of nutrients, and removal of crop residues from the fields. To halt this problem, it needs the attention of conducting nutrient improvement mechanisms. As a result, it is very important to remind farmers about the possibility of production enhancement of crops with a pre-extension demonstration of the newly recommended fertilizer rate. In this study, an attempt was made to demonstrate the newly recommended rate and analyze the change in profitability. The main interest of the demonstration was to enhance the adoption of new technology. For the study, the demonstration was conducted on 10 farmers' fields from each kebele and two FTC's. Grain data was collected after harvesting maize.

The newly recommended nitrogenous fertilizer application rate on maize is upgraded the average grain yield of maize to 40 quintals whereas the average grain yield of blanket recommendation application rate is 29.4 quintals, on sample representative farmers' field, under two kebeles (Guba shiraro and Shewako). In addition, the average grain yield obtains from the new recommended nitrogenous fertilizer rate and blanket recommendation rate on FTC were 46 quintals and 33 quintals, respectively. The average grain yield of maize in FTC is greater than farmers' fields, this is due to management differences. In addition, the new application rate of blended fertilizer practices on maize is preferred first by farmers over-application of blanket recommendation rate, due to the new rate resulted in high grain yield, profitable, affordable, and strong plant stand (lodging resistant).

As this demonstration result approving, in the Halaba zone nitrogen deficiency is highly affecting the maize production and productivity. So, all the concerned bodies need to work on expanding this newly recommended nitrogenous fertilizer (urea) application rate of 260 kg urea/ha to boost production and productivity of maize for smallholder farmers and other bodies invested on maize production.

Acknowledgment

The authors would like to acknowledge the Southern Agricultural Research Institute for its financial support. Also, the Authors would like to acknowledge biological researchers of soil fertility research teams at Hawassa research center for their technical supports. Farmers and development agents directly involved in the completion of the activity are also heartily acknowledged. During implementation, different follow-up stages, and field days the agricultural office expert and demonstrated kebeles development agents of the Halaba zone, also contribute a lot so the authors also acknowledge them for their commitment.

References

Boke, S., Habte, M., Assefa, A. and Ayalew, A. 2018. Macro and Micro Nutrients for Optimizing Maize Production at Hawassa Zuria District, Southern Ethiopia. *J. Agric. Biol. Healthcare* 8(5): 27-31.

Jena, P.R., De Groote, H., Nayak, B.P. and Hittmeyer, A. 2021. Evolution of fertiliser use and its Impact on maize productivity in Kenya: Evidence from multiple surveys. *Food Sec.* 13(1): 95-111.

Kandil, E.E.E. 2013. Response of some maize hybrids (*Zea mays* L.) to different levels of nitrogenous fertilization. *J. Appl. Sci. Res.* 9(3): 1902-1908.

Keno, T., Azmach, G., Wegary, D., Worku, M., Tadesse, B., Wolde, L., Deressa, T., Abebe, B., Chibsa, T. and Suresh, L.M. 2018. Major biotic maize production stresses in Ethiopia and their management through host resistance. *African J. Agril. Res.* 13(21): 1042-1052.

Tamene, D., Anbessa, B., Legesse, T.A. and Dereje, G., 2018. Refining fertilizer rate recommendation for maize production systems in Assosa, North Western Ethiopia. *Adv. Tech. Biol. Med.* 6(253): 2379-1764.

Woldesenbet, M. and Haileyesus, A. 2016. Effect of nitrogen fertilizer on growth, yield and yield components of maize (*Zea mays* L.) in Decha district, Southwestern Ethiopia. *Int. J. Res. Granth*. 4(2): 95-100.