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# The Response of Maize Yield to Blended Nps Fertilizer Rates: Seasonal Rainfall Variation Affected Fertilizer Application Rates

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**Abstract:** Regardless of the significant contribution for food security and huge area under maize production, its present national average yield in Ethiopia is considerably below its potential and yield of research fields. Soil fertility depletion and poor plant nutrient management are the major abiotic factors limiting the productivity of the crop. In view this, a field experiment was conducted on three farmers' fields around the Bako-Tibe district in 2016 and 2017 season to determine the best NPS rate for maize production. The treatment consisted of five NPS fertilizer application levels which constitute 25, 50, 75, 100 and 125 kg NPS $ha^{-1}$ that arranged in a randomized complete block design with three replication. Besides, one previously recommended fertilizer rate and the control plot without fertilizer were used. Significant differences ($P<0.01$) was observed between applied NPS rates for grain yield and yield components of maize. In 2016, the highest yield (8.2 t $ha^{-1}$) and maximum net benefit (33,882.00 $ha^{-1}$) with acceptable marginal rate of return (MRR) were achieved at 100 NPS kg $ha^{-1}$ during relatively uniform rainfall amount and distribution. In 2017, however, the highest net benefit (29,129.40 $ha^{-1}$) with acceptable MRR was attained when 125 NPS kg $ha^{-1}$ was used and when the rainfall is heavy and erratic patterns. In conclusion, 100 NPS kg $ha^{-1}$ rate is the best application rate and economically feasible in relatively uniform rainy seasons and hence recommended for the end-users. However, during erratic and heavy rainy seasons, 125 NPS kg $ha^{-1}$ rate could be used to obtain higher net benefit and recommended for maize production in the study area and similar agro-ecologies in general.

**Key words:** Maize · NPS · Yield · Rainfall

## INTRODUCTION

Maize (*Zea mays* L.) is one of the major valuable crops in food security and a hunger alleviating in Ethiopia, which is used as stable food as well as feed for animals and even for construction purposes [1]. It is also the most important crop leading all other cereal crops in terms of production and productivity and second in area coverage next to *tef* [2]. The total land areas of about 10,232,582 ha (81%) were under cereals of which maize covered about 17% (2,128,949ha) and 27% (83,958,872 quintals) grain yields. According to Tsedeke *et al*. [3], about 88% of maize produced in the country is consumed at home as food and it is one of the high priority crops to feed the ever-increasing Ethiopian population.

Regardless of the significant contribution for food and huge area under maize production, the present productivity far below the yield potential the crop. For instance, the late-maturing hybrid maize can produce up to 9.5 to 12 t $ha^{-1}$ at the research field and 6 to 8.5 t $ha^{-1}$ on-farmers field. The current national average yield is about 3.9 t $ha^{-1}$ [2] which is even far below the world's average yield of 5.2 t $ha^{-1}$ [4]. Although numerous factors can contribute to this yield gaps, depletion of soil fertility and poor plant nutrient management are the foremost factors to low productivity of maize [5- 8].

Soil fertility management in Ethiopia for the past 40 years was focused on the use of only $P_2O_5$ (DAP) and N (urea) containing fertilizers. This might be lead the agriculture in the country to low production per unit area and facing a serious and chronic problem of food shortage [5, 9]. Thus, the amendment of fertilizer type and the rate is a must to restore soil fertility and increase crop production. In this view, the Ministry of Agriculture and Natural Resource of Ethiopia has been recently introduced a new blended fertilizer, NPS (containing 19% N, 38% P2O5 and 7% S) [10]. This effort has been made to replace the use of DAP to a more balanced form of

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fertilizer, which is still used nationally as a blanket recommendation. The prevailing blanket recommendation throughout the country almost on all crop types justifies the existence of little information on the fertility status of Ethiopia's soil.

It is also recognized that continual use of only N and P containing fertilizers causes reduction of the quantity of K and S in most of the soils as there is also evidence of fixation of potassium and leaching of sulfur in different types of soils in addition to mining by different crops as a result of continues cultivation of land [11]. Moreover, the type of fertilizer used and its rate of application is one of the primary concerns in improving maize productivity since the growth and development of the crop is highly affected by low fertilizer application as compared to other crops [5]. Foth and Ellis [12] stated that the proper application rates of plant nutrients could be determined according to the nutrient requirement of that crop and the nutrient supplying power of the soil. In contrast, many farmers refine from applying the required amount of fertilizer by crops because of rising costs, uncertainty about the economic returns to fertilizing crops and lack of knowledge as to which type and rates are appropriate [13]. On the other hand, the excessive application is uneconomical, environmentally unsafe and potential to the crop [14, 15].

An appropriate type of fertilizer application at an appropriate crop growth stage is also another main focus to increase maize productivity since leaching or runoff is one of the main challenges in high rainfall areas mainly for nutrients contains nitrogen [16]. Jamal *et al*. [17] indicated that more than 50 % applied fertilizers remain unavailable to a crop due to loss through leaching or runoff. This loss may be determinant to environments and loss of resources for resource-poor farmers. However, an optimum and the right type of fertilizer application can rise up to 30-50% of the world food production [18]. On the other hand, the crop yield fluctuates significantly from year to year, mainly because of the variable distribution of rainfall [16].

Hybrid maize grown with a high level of macronutrients are in many cases causing a depletion of micronutrients at a rate that the soil can longer make good Onwuene and Sinha [19]. Nevertheless, little information is available on the blended fertilizer requirement for maize. Besides releasing hybrid maize cultivar it is very important to have site-specific plant nutrient management packages to increase the productivity of maize in the area. Therefore, the activity was initiated to address the objectives of investigating the best rate and economically profitable NPS rate to increase maize yield in western Ethiopia and similar agro-ecologies.

## MATERIALS AND METHODS

Field trials were conducted around the Bako-Tibe district, Western Ethiopia on three farmers' fields for two consecutive years (in 2016 and 2017). The area is located in a sub-humid Western Ethiopia which is situated between 8’59'31" N to 9'01'16‘’N latitude and 37'13'29 E to 37°21'’’E longitude and at an altitude range of 1727 to 1778 meter above sea level. The ten years (2010–2019) weather information at nearby study area (Bako agricultural research center) revealed a unimodal rainfall pattern with a mean annual rainfall of 1240.5 mm with maximum precipitation being received in May to August [20]. The experimental areas' are characterized by a humid and warm climate with the mean minimum, mean maximum and average air temperatures of 14, 28.5 and 21.2°C to 13.4, 28.49 and 20.95°c, respectively (WWW.IQQO.ORG). The soil type is brown clay loam Nitisols and Alviso [21]. The farming system of the area is a mixed farming and is one of the major maize growing belts in the country.

For this experiment, one maize hybrid, BH661 was used as a test crop. The treatment consisted of five NPS fertilizer application levels which constitute 25, 50, 75, 100 and 125 kg NPS $ha^{-1}$. Additionally, a control plot without fertilizer and the previously recommended fertilizer rate of 46 kg $P_2O_5$ kg N $ha^{-1}$ was included for comparison purposes. The experiment was laid in a randomized block design with three replications. The size of each plot was 5.1 m x 4.5 m (22.95$m^2$) and the distance between rows and plants in the plot was 75 cm and 30 cm, respectively.

The experimental fields' were plowed three times at different interval times starting from the end of April and leveled before planting. Blended fertilizer NPS was applied at different rates as constituted in the treatments, while previously recommended phosphorus fertilizers in the form of DAP was used as a check. The recommended nitrogen (92 kg $ha^{-1}$) was used similarly for all plots in the form of urea which applied half at the time of planting and the rest half applied at 35 days after planting. One hybrid long maturity maize variety (BH661), which was released by Bako National Maize Research Center in 2011was used as a test crop for the execution of the experiments. This maize variety (BH66) can be grown in a range of 1600-2200 meters above sea level and it requires an annual rainfall of 1000-1500 mm with uniform distribution in its growing periods. Its yield potential varies between 9.5 and 12 t $ha^{-1}$ at the research field and 6 to 8.5 t $ha^{-1}$ at the farmers' field. All other agronomic management practices were carried out uniformly as per the recommendation for maize in the area.

Harvesting was done from a net plot size of 2.25 m x 5.1 m (11.475 $m^2$) by excluding border rows from each side. Plant height, biomass yield, grain yield, harvest index and thousand kernel weight and other relevant agronomic traits were recorded at appropriate growth stages. Costs that vary between treatments were also assessed using the CIMMYT partial budget analysis [22]. The cost of NPS, the cost of DAP, the cost of labor required for the application of fertilizer and cost for maize shelling were estimated by assessing the current local market prices. The price of NPS (1199.00 ETB 100 $kg^{-1}$), DAP (1468.00 ETB 100 $kg^{-1}$), maize shelling (120 ETB t $ha^{-1}$) and daily labors (35 ETB per a person day based on governments' scale in the area) were used to get the total variable cost among the treatments. One person per day was estimated based on eight working hours per day. Other non-varied costs were not included as all practices were uniformly applied to each plot. Before estimating gross revenue, grain yields harvested from each plot were adjusted down by 10%. Moreover, gross revenue was calculated by multiplying the total yield attained with the current field price (ETB 6.00 $kg^{-1}$). The marginal rate of return (MRR) and the net benefit was calculated using [22] manual. Lastly, analysis of variance the across season was done using Gen Stat 15th Edition software and the Duncan multiple range test at 5 % probability level was used for comparing treatment means [23].

## RESULTS AND DISCUSSION

The result of the analysis of variance depicted that grain yield, dry biomass, plant height and harvest index (HI) were highly (P<0.01) affected by seasonal variations (Table 1). However, seasonal variations did not show significant variation between treatments for thousand kernel weight (TKW). Further, highly (P<0.01) significant effects to plant height, grain yield, dry biomass, harvest index and thousand kernel weight of maize due to the various applications of NPS fertilizer rates. Furthermore, HI was significantly affected by the application of the NPS rate, while the main effect of the NPS rate did not show significant variation to TKW. Moreover, the application of NPS rates show significant variation to all parameters, except for thousand kernel weight on over farmers field in 2016 and 2017 cropping season, this is due to the interaction of seasonal variations (Table 1). Hence, separate analysis for each season was done because the seasonal rainfall variability significantly affected the response of applied treatments.

As indicated in Figure 1, the use of NPS significantly affected the grain yield of maize. In 2016, the highest grain yield (8.2 t $ha^{-1}$) was attained at 100 NPS kg $ha^{-1}$ followed by 125 NPS kg $ha^{-1}$, however, both are statistically at par. Additionally, statistically comparable yield (7.9 t $ha^{-1}$) was attained when 75 NPS kg $ha^{-1}$ was used compared to 100 and 125 kg $ha^{-1}$ applications. But more than 3% and 74% yield increase were achieved when 100 kg NPS $ha^{-1}$ was used compared.

To 75 and the plot receiving no NPS application. Conversely, the lowest amount of yield (4.7 t $ha^{-1}$) was obtained from the control plots that receiving no fertilization (Figure 1). However, in 2017, the highest grain yield (7.1 t $ha^{-1}$) was attained when 125 kg NPS $ha^{-1}$ was applied followed by the previously recommended practice which is statistically at par. Whereas, the lowest yield (2.9 t $ha^{-1}$) was attained from the plot receiving no fertilization.

Table 1: Analysis of variance for phenological growth, grain yield and yield traits of maize under different levels of NPS fertilizer and the interaction effects in 2016 and 2017 at Bako-Tibe, Ethiopia.

| Source of variation | df | PH (m) | GY (t $ha^{-1}$) | DB (t $ha^{-1}$) | HI (%) | TKW (g) |
|---|---|---|---|---|---|---|
| | MS | | | | | |
| NPS | 6 | 0.37** | 35.43** | 254.98** | 77.24** | 8629.7** |
| Yr | 1 | 1.06** | 47.45** | 3129.24** | 985.36** | 181.9ns |
| Frm | 2 | 0.99** | 12.92** | 130.95** | 37.88** | 186.3ns |
| NPS x Yr | 6 | 0.09** | 0.78** | 10.12* | 13.63** | 649.6* |
| NPS x Frm | 12 | 0 .02ns | 0.89** | 24.05** | 11.00** | 1215.4** |
| NPS x Yr x Frm | 12 | 0.04* | 1.95** | 17.28** | 23.68** | 2039.7** |
| Replication | 2 | 0.07* | 0.14ns | 7.44ns | 1.77ns | 226.2ns |
| Residual | 82 | 0.01 | 0.15 | 3.33 | 1.80 | 171.5 |
| Total | 125 | - | - | - | - | - |
| SE | | 0.12 | 0.39 | 1.82 | 1.34 | 13.1 |
| CV (%) | | 4.0 | 6.1 | 7.8 | 4.8 | 3.9 |

* and ** significant at 5% and 1% probability level, MS= Mean square, Frm= farmers.

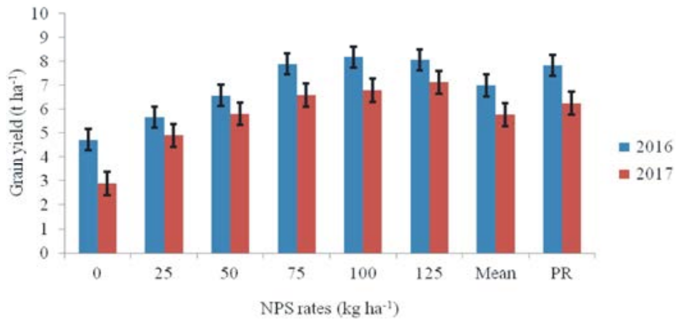


Fig. 1: The effects of NPS rates on the grain yield of maize in the 2016 and 2017 season at Bako, Ethiopia.

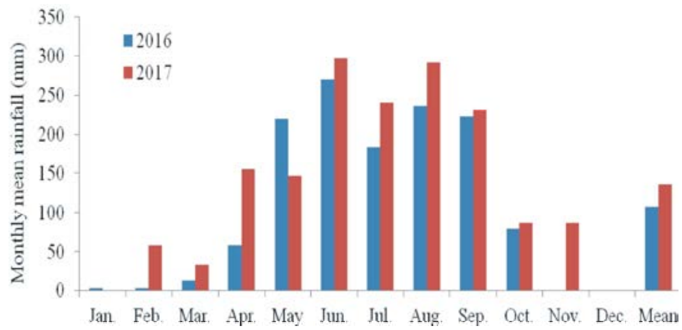


Fig. 2: The nearby mean monthly rainfall of Bako agricultural research site of 2016 and 2017 seasons.

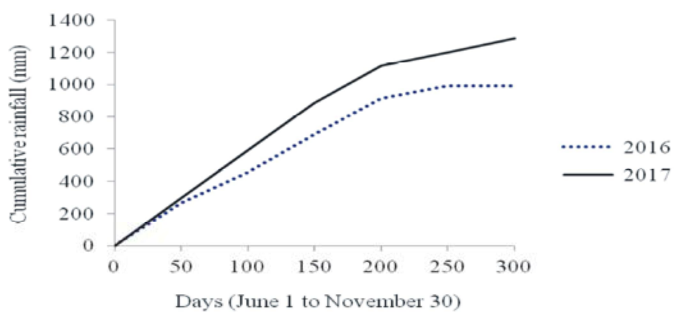


Fig. 3: Cumulative rainfall received in growing periods of 2016 and 2017 seasons of the Bako area, Ethiopia.

The overall mean grain yield despite treatment variations revealed that significantly higher grain yield was recorded in 2016 than in the 2017 rainy season. For example, in 2016 season, higher grain yield (8.2 t $ha^{-1}$), biomass yield (32.3 t $ha^{-1}$) and TKW (359.6 g) were recorded than in 2017 (7.1 t $ha^{-1}$ grain yield, 21.4 t $ha^{-1}$ biomass yield and 343.8 g TKW). This variation might be associated with the effect of monthly rainfall amount and distribution throughout the growing season that possibly lead to leaching and runoff applied fertilizers during heavy and erratic rainfall seasons. For instance, in 2016, the monthly rainfall amount in pick rainy months during the growing period of the maize crop, the period from June to November was lower than the 2017 season (Figure 2). In 2017, however, the monthly amount and distribution of rainfall at an early growing period, mainly from the months of June to November were considerably higher which might be leading to washing away and leaching of applied fertilizer. Besides rainfall amount and distribution, the cumulative rainfall during the early growing periods of maize was much higher in 2017 which might be favor loss of applied nutrient, mostly N through runoff and leaching (Figure 3). Moreover, daily rainfall distribution in the entire growing period was erratic and sometimes heavy rainfall occurred in 2017 (Figure 4) compared to 2016 (Figure 5) that may lead to runoff and leaching of plant nutrients. There is also evidence that the amount and distribution of rainfall during the growing period of maize can affect the amount and time of N application as well as the yield of maize crops [16].

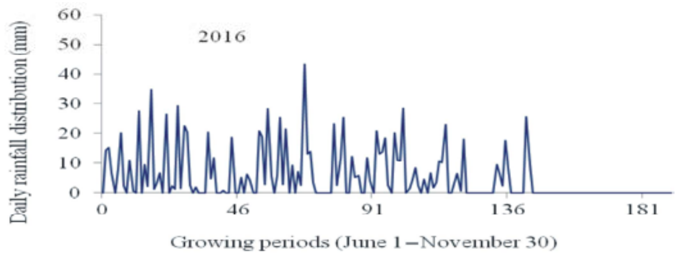


Fig. 4: Daily rainfall distribution of 2016 cropping seasons around Bako, Ethiopia

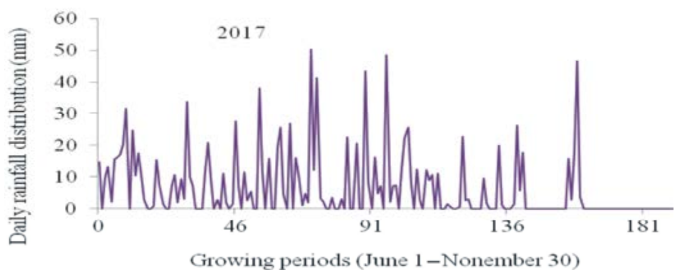


Fig. 5: Daily rainfall distribution of 2017 cropping seasons around Bako, Ethiopia

Table 2: The mean effects of NPS rates on dry biomass yield, harvest index, thousand kernel weight and plant height of maize at Bako-Tibe, Western Ethiopia in 2016 and 2017 cropping season

| NPS level (Kg ha⁻¹) | 2016 DB (t ha⁻¹) | 2016 HI %) | 2016 TKW (g) | 2016 PH (m) | 2017 DB (t ha⁻¹) | 2017 HI (%) | 2017 TKW (g) | 2017 PH (m) |
|---|---|---|---|---|---|---|---|---|
| 0 | 22.3 | 21.6 | 281.5 | 3.0 | 9.7 | 29.2 | 298.0 | 2.5 |
| 25 | 25.8 | 22.2 | 317.8 | 3.0 | 17.1 | 29.4 | 323.5 | 2.9 |
| 50 | 27.5 | 23.8 | 334.2 | 3.1 | 18.9 | 30.5 | 338.0 | 2.9 |
| 75 | 29.5 | 27.3 | 350.4 | 3.2 | 20.7 | 31.9 | 338.8 | 3.0 |
| 100 | 32.3 | 28.8 | 359.6 | 3.1 | 21.2 | 31.8 | 343.8 | 3.0 |
| 125 | 31.8 | 27.3 | 356.8 | 3.2 | 21.4 | 33.0 | 342.8 | 3.1 |
| PR | 29.3 | 26.9 | 342.6 | 3.1 | 19.9 | 31.2 | 341.2 | 3.0 |
| LSD (5%) | 2.2 | 1.88 | 13.5 | 0.11 | 1.20 | 0.91 | 11.6 | 0.12 |
| CV (%) | 8.1 | 7.8 | 4.2 | 3.9 | 6.9 | 3.1 | 3.7 | 4.2 |

Yield components of maize were also significantly affected by applied NPS rates in each season. To this, maximum biomass yield (32.3 t $ha^{-1}$) in 2016 was obtained when 100 NPS Kg $ha^{-1}$ was applied compared to other treatments even with previous recommendations (Table 2). Interestingly, a significant biomass yield increment by 44% and 19% were observed when 100 NPS Kg $ha^{-1}$ was used compared to the plot receiving no fertilizer and 25 NPS Kg $ha^{-1}$, correspondingly. The highest HI (28.8%) and TKW (359.6 g) similarly were obtained at 100 NPS Kg $ha^{-1}$ compared to other treatments even with previous recommendations. The lowest significant biomass yield (22.3 t $ha^{-}$), however, was recorded from the plot receiving no fertilizer. In the same way, the lower TKW (281.5 g), plant height (3.0 m) and HI (21.6 %) were observed from the plot without NPS fertilizer followed by 25 NPS Kg $ha^{-1}$. In 2017, however, the application of 125 NPS Kg $ha^{-1}$ showed the highest biomass yield (21.4 t $ha^{-1}$) followed by. 100 NPS Kg $ha^{-1}$, but both are statistically at par. As well, maximum HI (33%) was achieved when 125 NPS Kg $ha^{-1}$ was used. While the highest TKW (343.8 g) was recorded at the application of 100 NPS Kg $ha^{-1}$. In the contrary, lower results for all yield traits H were observed from the use of plots which receiving no NPS followed by 25 NPS Kg $ha^{-1}$. These variations response across the season might be also related to the amount and distributions of rainfall. The monthly amount and cumulative rainfall at the begging of growing periods, mainly from June to August was higher in 2017 than in 2016 which may lead to runoff and leaching of applied fertilizer (Figure 2).

Table 3: Effects of NPS rates on mean grain yield of maize conducted on farmers' field around Bako-Tibe district, Western Ethiopia

| NPS level (kg ha$^{-1}$) | Grain yield (t ha$^{-1}$) 2016 Farm-1 | Farm-2 | Farm-3 | Mean | 2017 Farm-1 | Farm-2 | Farm-3 | Mean |
|---|---|---|---|---|---|---|---|---|
| 0 | 4.3 | 4.7 | 5.2 | 4.7 | 4.2 | 1.8 | 2.7 | 2.9 |
| 25 | 5.6 | 5.2 | 6.3 | 5.7 | 5.0 | 5.0 | 4.8 | 4.9 |
| 50 | 6.5 | 7.3 | 5.9 | 6.6 | 7.1 | 4.3 | 6.1 | 5.8 |
| 75 | 7.7 | 8.6 | 7.4 | 7.9 | 7.3 | 5.4 | 7.1 | 6.6 |
| 100 | 8.8 | 8.4 | 7.4 | 8.2 | 8.7 | 5.2 | 6.6 | 6.8 |
| 125 | 9.2 | 8.2 | 6.8 | 8.1 | 7.6 | 5.7 | 8.0 | 7.1 |
| PR | 8.6 | 7.8 | 7.2 | 7.8 | 7.4 | 4.8 | 6.6 | 6.2 |
| Mean | 7.2 | 7.2 | 6.6 | 7.0 | 6.8 | 4.6 | 6.0 | 5.8 |

Table 4: Partial budget analysis as affected by the application of NPS rates on maize in the 2016 and 2017 cropping season

| | 2016 | | | | | | | 2017 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NPS level | GY | Ady | TC | GB | NB | DA | MRR | GY | Ady | TC | GB | NB | DA | MRR |
| 0 | 4.7 | 4.2 | 141.0 | 21150.0 | 19740.0 | _ | _ | 2.9 | 2.6 | 870.0 | 13050 | 12180.0 | _ | _ |
| 25 | 5.7 | 5.1 | 1867.6 | 25650.0 | 23782.4 | _ | 880 | 4.9 | 4.4 | 1627.6 | 22050 | 20422.4 | _ | 1090 |
| 50 | 6.6 | 5.9 | 2292.8 | 29700.0 | 27407.3 | _ | 850 | 5.8 | 5.2 | 2032.8 | 26100 | 24067.3 | _ | 900 |
| 75 | 7.9 | 7.1 | 2795.4 | 35550.0 | 32754.6 | _ | 1060 | 6.6 | 5.9 | 2405.4 | 29700 | 27294.6 | _ | 870 |
| PR | 7.8 | 7.0 | 2957.5 | 35100.0 | 32142.5 | D | | 6.2 | 5.6 | 2477.5 | 27900 | 25422.5 | D | |
| 100 | 8.2 | 7.4 | 3018.0 | 36900.0 | 33882.0 | _ | 510 | 6.8 | 6.1 | 2598.0 | 30600 | 28002.0 | _ | 370 |
| 125 | 8.1 | 7.3 | 3100.6 | 36450.0 | 33349.4 | D | | 7.1 | 6.4 | 2820.6 | 31950 | 29129.4 | _ | 510 |

GY = Grain yield of maize (t ha$^{-1}$), Adj.GY = Adjusted yield (t ha$^{-1}$), TC = Total cost that varied among treatments (ETB ha$^{-1}$), GB = Gross benefit (ETB ha$^{-1}$), NB = Net benefit (ETB ha$^{-1}$), DA = Dominance analysis, MRR = Marginal rate of return (%), D = Dominated, PR = Previously recommended N and $P_2O_5$ and 1 USD = 22.8 ETB

The yield of maize response to NPS rates was showed variation among farms field (Table 3). For instance, higher grain yield was attained between 75-125 kg NPS ha$^{-1}$ in 2016. In 2017, however, maximum grain yield was attained between 100-125 kg NPS ha$^{-1}$cropping season (Table 3). This might be due to variability among farmers' field in soil fertility status and the different levels of land-use intensity and the ability of farmers' to apply inputs (crop residues, or manure, fertilizer) to some fields over time [24, 25]. An author, Tolera *et al.* [26] reported the heterogeneity of farmers fields were contributed to a great extent in yield variations of quality protein maize with similar nutrient rate applications in the soil during planting. Another author, Schmid *et al*. [27] indicated that a highly variable amount of nutrient was required to bring any given subplot of maize within a farmer's field to the highest yield. This indicates the call for site based fertilizer management for maize production.

Partial budget analysis for means of treatment was also carried out. The result of the partial analysis showed that variations in each season as the responses of grain yield to the treatments were varied across the seasons. In 2016, the highest net benefit ETB 33,882.00 ha$^{-1}$, was obtained when 100 kg NPS ha$^{-1}$ was used followed by 125 kg NPS ha$^{-1}$ which gave the next maximum net benefit (ETB 33,349.40). However, the acceptable marginal rate of return (510%) with maximum net benefit was achieved when 100 kg NPS ha$^{-1}$ used and it is an economically feasible fertilizer application rate that could give the maximum net benefit with acceptable MRR during uniform distribution and moderate rainy season for maize production. In 2017, however, maximum net benefit (ETB 29,129.40 ha$^{-1}$) followed by ETB 28,002.00 ha$^{-1}$ was recorded when 125 and 100 kg NPS ha$^{-1}$ was used, respectively. Thus, 125 kg NPS ha$^{-1}$ is economically feasible rate for maize production in erratic and heavy rainfall season in the study area.

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when 100 kg NPS $ha^{-1}$ was used and it is an economically feasible fertilizer application rate that could give the maximum net benefit with acceptable MRR during uniform distribution and moderate rainy season for maize production. In 2017, however, maximum net benefit (ETB 29,129.40 $ha^{-1}$) followed by ETB 28,002.00 $ha^{-1}$ was recorded when 125 and 100 kg NPS $ha^{-1}$ was used, respectively. Thus, 125 kg NPS $ha^{-1}$ is an economically feasible rate for maize production in erratic and heavy rainfall season in the study area.

## CONCLUSION AND RECOMMENDATION

Despite the huge yield potential and area under maize production in western Ethiopia, its current productivity is by far below the yield of the research field and its yield potential. Declining soil fertility and poor nutrient management are the foremost factors contributed to low productivity in the country. Also, rainfall amount and distribution across the seasons highly influenced the responses of maize to NPS fertilizer rates. In a good or uniform distribution of rainy season like in 2016, the application of 100 kg NPS $ha^{-1}$ gave the maximum grain yield and the best rate to use in maize production. While, in a heavy and uneven distribution of rainfall similar to the 2017 season, application of 125 kg NPS $ha^{-1}$ was the optimum rate for maize producers in western Ethiopia. In conclusion, the application rate at 100 kg NPS $ha^{-1}$ is the best rate and economically feasible to get the maximum net benefit ETB 33882.00 $ha^{-1}$ with an acceptable MRR in good rainy seasons for maize production and hence recommended for the users. However, during heave and erratic seasons that may results in applied fertilizer losses through runoff and leaching application rate at 125 kg NPS $ha^{-1}$ is the optimum rate and should be used to get maximum return form maize production in the study area and similar agro-ecologies in general.

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