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Agronomic Performance and Economic Productivity of Maize as affected by Inorganic NPS and Urea Fertilizers Rates on Different Soil Types

Melkamu Hordofa Sigaye*, Ashenafi Nigussei and Abreham Yacob

Department of Natural Resource Management, Wondo Genet Agri. Research CenterP. O. Box 198, Shashemane, Ethiopia

**Corresponding author*

Abstract

The field study was conducted for two consecutive years in the Dore Bafeno and Meskan districts of the central rift valley of Ethiopia, to determine optimum rates of NPS and Urea fertilizers for better maize yield and economic profitability. The experiments were comprised the fourteen treatments: (150 kg ha^{-1} NPS + 150 kg ha^{-1} Urea), (200 kg ha^{-1} NPS + 150 kg ha^{-1} Urea), (250 kg ha^{-1} NPS + 150 kg ha^{-1} Urea), (300 kg ha^{-1} NPS + 150 kg ha^{-1} Urea), (150 kg ha^{-1} NPS + 250 kg ha^{-1} Urea), (200 kg ha^{-1} NPS + 250 kg ha^{-1} Urea), (250 kg ha^{-1} NPS + 250 kg ha^{-1} Urea), (300 kg ha^{-1} NPS + 250 kg ha^{-1} Urea), (150 kg ha^{-1} NPS + 350 kg ha^{-1} Urea), (200 kg ha^{-1} NPS + 350 kg ha^{-1} Urea), (250 kg ha^{-1} NPS + 350 kg ha^{-1} Urea), (300 kg ha^{-1} NPS + 350 kg ha^{-1} Urea), control and Recommended NP (92N 69 P_2O_5) and laid out in a randomized complete block design with three replication. At the Dore Bafeno site, the pooled mean analysis results showed that the application of 250 kg ha^{-1} NPS fertilize plus 250 kg ha^{-1}. Urea gave the maximum above-ground biomass (17259.0kg ha^{-1}) and grain yield (6738.7kg ha^{-1}). While at the Meskan site, the combined use of 200 kg ha^{-1} NPS fertilize with 250 kg ha^{-1} Urea produced the greater grain yield (6964.1 kg ha^{-1}) and above ground biomass (17053.2 kg ha^{-1}). In sites, however, the unfertilized plots gave the minimum grain and above ground biomass yields. Like agronomic performance, the application of 250 kg ha^{-1} NPS fertilize plus 250 kg ha^{-1} Urea and 200 kg ha^{-1} NPS fertilize with 250 kg ha^{-1} Urea revealed the maximum net benefit value of 84147.4 ETBha^{-1} and 88376.7 ETB ha^{-1} for Dore bafeno and Meskan sites, respectively. Therefore, the combined application of 200 kg ha^{-1} NPS with 250 kg ha^{-1} Urea fertilizers and 250 kg ha^{-1} NPS with 250 kg ha^{-1} Urea fertilizers were the best treatments for Dore bafano and Meskan sites, respectively.

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Grain yield, Maize, NPS and Urea fertilizers.

Introduction

Maize (*Zea mays* L.) is the most widely cultivated cereal crop and source of cash in Ethiopia, and with area coverage (16%) and production (26%) with about 6.5 million tons of production in (CSA, 2014). The estimated average yields of maize for smallholder farmers in Ethiopia are about 3.2 t ha^{-1} (CSA, 2014), which is much lower than the yield recorded under demonstration plots of 5 to 6 t ha^{-1} (CSA, 2014). However, low soil fertility and low levels of inputs use are some of the major crop production constraints in Ethiopia (Taffesee *et al.*, 2011 and Abreha *et al.*, 2013). Tropical smallholder farming system including Ethiopia lack of sustainability, mainly due to nutrient losses by soil erosion, lack of soil fertility restoring input and unbalanced nutrient mining (Ajaya *et* *al.*, 2007 and Hirpa *et al.*, 2009). Thus, the potential maize productivity in the country has not yet been exploited. To alleviate the soil fertility problems different research activities have been undertaken on maize production using various fertilizer sources in different parts of the country. Achieving high maize yield requires adequate and balanced supply of nutrients as declining soil fertility is prominent constraint for maize production (Barbieri *et al.*, 2012).

Inorganic fertilizers have been the important tools to overcome soil fertility problems and also responsible for a large part of the food production increases. The drive for higher agricultural production without balanced use of fertilizers created problems of soil fertility exhaustion and plant nutrient imbalances not only of major but also of secondary macronutrient and micronutrients. The deficiencies of secondary macronutrient and micronutrient will arise if they are not replenished timely under intensive agriculture (Fageria and Baligar, 2008 and Singh, 2011). However, the nationwide fertilizer trials with cereals have indicated that more than 50% of the soils are highly responsive to the addition of nitrogen, 25% to phosphorus and a very few to potassium.

Recently, according to the soil fertility map Ethiopia soil analysis data revealed that the deficiencies of most of nutrients such as, nitrogen (86%), phosphorus (99%), sulfur (92%), born (65%), zinc (53%), potassium (7%), copper, manganese, and iron were widespread in Ethiopian soils (Ethio-SIS, 2016). Similarly, Asgelil *et al.*, (2007) found that the soil analyses and site-specific studies also indicated that elements such as K, S, Ca, Mg, and micronutrients (Cu, Mn, B, Mo, and Zn) were becoming depleted and deficiency symptoms were observed in major crops in different parts of the country. Furthermore, the above listed nutrient deficiencies were widely spread at Dore-bafano (*Hawassa zuriya*) and Meskan (Ethio-SiS, 2016). Consequently, to overcome this problem, multi-nutrient balanced fertilizers containing N, P, K, S, B and Zn in blended form have been issued to ameliorate site-specific nutrient deficiencies and thereby increase crop production and productivity.

The office of the ministry of agricultural and natural resources introduced economical fertilizer technology to relieve the difficulties of soil fertility and crop yield in the area (NPS, NPSB, NPSZnB). Farmers in the study areas are now using an inorganic NPS fertilizer that has 19 percent nitrogen, 38 percent phosphorus, and 7 percent sulfur (EthioSIS, 2014). However, in the districts, the NPS fertilizer rate utilized by farmers is a blanket suggestion (100 kg ha-1) with 46 kg N ha-1 through Urea. This fertilizer (blended NPS) may or may not be enough to meet the crop N requirements in the area. Nevertheless, the current blended fertilizer (NPS) contains lower nitrogen as compared to the recommended nitrogen fertilizer from Urea for economical maize production. Therefore, for optimum maize yield, it is necessary to evaluate the effects of different inorganic NPS and Urea fertilizers rates. Furthermore, there is little data on the influence of a blended fertilizer application rate supplemented with nitrogen from Urea on maize yield and yield components. As a result, the purpose of this experiment was to assess the response of maize production and yield components to NPS mixed nitrogen fertilizer rates and to determine economically best and optimum rate of NPS blended and nitrogen fertilizer rates for maize production in each district.

Materials and Methods

Description of experimental sites

The study was executed on farmer field across soil types and agro-ecologies separately in two locations for two consecutive (2019-2020) cropping seasons situated at Dore Bafano and Meskan. Dore Bafano (Sidama region) is geographically located at (6^{o} 57’ N and 38^{0} 15’ E to 7^{0} 10’) with altitude ranging from 1850 to 1934 *m.a.s.l*. The mean annual rainfall ranges 800 -1100 mm; the peak rainy months are April, July, August and September. The mean annual minimum and maximum temperature are 12 and 26.7 0C, respectively. The dominant soil type of the district is Andosols. While, Meskan (Southern region) site lies at (08°05’N and 38°26.9’ E) with an altitude of 1908 *m.a.s.l.* The mean annual rainfall is 1062 mm. The mean annual minimum and maximum temperature are 10 and 24 ^{0}C, respectively. The dominant soil type of the district is vertisols. Major crops produced in the districts include maize, haricot bean, vegetables and other cereal crops.

Experimental Design and Treatments

The experiment was established in a randomized complete block design (RCBD) with three replications in each site. The experiments were consisting of 14 treatments in a combination of NPSB and N along with their levels is as under (Table 1). The improved maize variety (*BH-546*) was used sown in a row by 75cm interrow spacing and 30cm intra-row spacing. NPSB blended and phosphorus-containing fertilizers triple superphosphate (TSP) were basally applied once at sowing to minimize losses and increase nutrient use efficiency. However, nitrogen was applied as per the treatment in split form (1/3 at planting and the remaining 2/3 at knee-high stage). All-important field management practices were applied as per recommendations.

Crop harvest, soil sampling and analyses

At maturity, $3m^2$ of maize was manually harvested from the middle of each plot to determine the plant height, above-ground biomass, grain yield, straw yield, and 1000 kernels weight; the grain yield which was adjusted to a 12.5 % moisture content. Composite soil samples were sampled at random across all experimental at a depth of 0-20 cm before treatment application and after harvesting the crop soil samples were also collected immediately from each experimental unit to investigating the changes in soil chemical properties due to treatment application.

The soil samples were air-dried, were processed, and analyzed for soil texture, pH, organic matter, total nitrogen, available phosphorous, total sulfur, and cation exchange capacity were analyzed following the standard procedures outlines.

Economic Analysis

The marginal rate of return (MRR) was performed following the CIMMYT partial budget analysis (CIMMYT 1988). The variable costs associated with labor and fertilizer purchase were compared using partial budgeting, which included only costs that varied from the control, i.e., costs of variable inputs (fertilizer and labor). The grain yield was down adjusted by 10% with the assumption of variation in crop management, postharvest loss in farmer managed experiments compared to experiments managed by researchers.

The income from grain was calculated by multiplying the total yield per ha with the farm gate price. A price of grain 15.5 birr per kg. The net benefit was calculated as the difference between the gross benefit (ETB ha^{-1}) and the total costs (ETB ha^{-1}). Following the CIMMYT partial budget analysis method, total variable costs (TVC), gross benefits (GB), and net benefits (NB) were calculated. Then treatments were arranged in an increasing TVC order and dominance analysis was performed to exclude dominated treatments from the marginal rate of return (MRR) analysis. A treatment is dominated if it has a higher TVC than the treatment which has lower TVC next to it but having a lower net benefit. A treatment which is non-dominated and having a MRR of greater or equal to 100% and the highest net benefit is said to be economically profitable (CIMMYT 1988). Benefit cost ratio was calculated by dividing gross benefit with total cost.

Statistical Analysis

The data were analyzed by using a two-way analysis of variance (ANOVA) using statistical analysis software (SAS) version 9.4, (SAS, 2014). Whenever the treatment effects were significant, mean separations were made using the least significant difference (LSD) test at ($p \leq 0.05$) level of probability test by proc-mixed analysis (Gomez and Gomez, 1984).

Results and Discussion

Physicochemical properties of the experimental field soil

The analysis results indicated that soil particles (sand, silt and clay) distribution was 40, 34 and 26 % and 18, 34 and 48% for Dore bafano and Meskan, respectively (Table 2). According to USDA (1998) soil textural classification system, the experimental sites had silt loam and clay textural classes for Dore Bafeno and Meskan, respectively. The soil pH (H_2O) analysis shows slightly acidic and neutral for Dore bafano and Meskan sites, respectively and is suitable for maize cultivation (Table 2). Tekalign (1991) reported that when the soil pH ranges from 6.7-7.3 rates as neutral. The total nitrogen contents of the soils were 0.26 and 0.3% for Dore Bafeno and Meskan, respectively and rated as medium range according to Tekalign (1991). Soil organic carbon contents were 3.51% and 4.49% at Dore Bafeno and Meskan site, respectively, and rated as high according to Tekalign (1991). The analysis result show that available P content of Dore bafano and Meskan sites were 4.52 and 23.05 mg kg^{-1}, respectively (Table 2), which is rated as medium and high according to (Cottenie, 1980).

Effects of NPS blended and Urea Fertilizers on Yield and Yield and Yield Components of maize at Dore bafano and Meskan

Dore bafano

As shown in Table (3) maize yield and yield components were significantly ($p<0.01$) influenced by application of different levels NPS blended fertilizer and nitrogen fertilizers. The pooled means analysis show that longest plant height (206.5 cm) was obtained from the application of 250 kg ha^{-1} NPS blended fertilize plus 350 kg ha^{-1} of Urea (Table 3). Whereas the shortest plant height was obtained from unfertilized or control plot. This increment in plant height might be due to increase in cell elongation and more vegetative growth attributed to different nutrient content of micronutrients. Thus, the result indicated that blended fertilizers application has enhanced the maize vegetative growth. This result is in agreement with that of Tekle and Wassie (2018), Kinfe *et al.,* (2019) and Bakala (2018) who found that application of blended fertilizers which significantly increased plant height of maize and tef as compared to the control.

The pooled mean analysis revealed that the maximum above ground biomass (17259.0kg ha^{-1}) and Straw yield (11161.0kg ha^{-1}) were obtained from application of 250 kg ha^{-1} NPS blended fertilize plus 250 kg ha^{-1} Urea and 300 kg ha^{-1} NPS blended fertilize plus 350 kg ha^{-1} Urea, respectively. Whereas the maximum grain yield (6738.7kg ha^{-1}) was obtained from 250 kg ha^{-1} NPS blended fertilize plus 250 kg ha^{-1} Urea and followed by 300 kg ha^{-1} NPS blended fertilize plus 350 kg ha^{-1} Urea which is 5578.4 kg ha^{-1}. However, the minimum values of above ground biomass, straw yield and grain yield were obtained from unfertilized plot (Table 3). The maize yield increment may be beneficial effect of yield contributing character and positive interaction of nutrients in the blended fertilizers. The present results are in agreement with Tekulu *et al.,* (2019) who obtained significantly highest biomass and grain yields of maize by the application of blended fertilizer along with Urea. Additionally, Jafer (2018) found better grain yield of maize from the application of blended fertilizer as compared to control treatment and recommended NP fertilizers. Also, Tekle and Wassie (2018) found that grain yield of tef was found highest in blended fertilizers as compared to control treatment and recommended NP fertilizers.

Meskan

Application of NPS blended fertilizer by supplementing N from urea source significantly (<0.1) influence yield and yield components of maize at Meskan site. According to two year pulled mean analysis the maximum above ground biomass (17053.2 kg ha^{-1}), Straw yield (9939.0 kg ha^{-1}) and grain yield (6964.1 kg ha^{-1}) were obtained from application of 200 kg ha^{-1} NPS blended fertilize plus 250 kg ha^{-1} Urea respectively. However, the minimum values of above ground biomass, Straw yield and grain yield were obtained from control or unfertilized plot (Table 3).

The maximum grain yield at the highest NPS rate might have resulted from improved root growth and increased uptake of nutrients and better growth due to the synergistic effect of the four nutrients which enhanced yield components and yield. Nitrogen enhances the vegetative growth as well as yield whereas phosphorus plays a fundamental role in metabolism and energy producing reaction thus resulting in enhanced grain yield (Mengel and Kirby, 2001). This result is inlined with Dassalegn *et al.,* (2018) reported that significantly higher biomass yield of maize at the rate of 46 kg N ha^{-1} under blended fertilizer of PKSZnB as compared to negative control, standard control (92 N, 69 P_2O_5) kg ha^{-1} and 222 kg N ha at N treatments under blended arranged from 0, 46, 92, 138, 176 and 222 kg N ha. Similarly, Kinfe *et al.,* (2019) blended 250 kg NPSZnB ha^{-1}fertilizer gave higher dry biomass yield of maize. Similarly, Mekuannet and Kiya (2020) reported that combined application of 150 kg NPS with 87 and 130.5 kg N $ha^{-1}$was produced significantly higher grain yield (10.7 and 10.4 t ha^{-1}) of maize. Adane *et al.,* (2020) was found that highest mean grain yield (7592 and 5329 kg ha^{-1}) during two cropping seasons by application of 350 kg ha^{-1} NPSZnB plus 200 Urea kg ha^{-1}. Tagesse and Alemayehu (2020) found that application of 200 kg blended NPS ha^{-1} with 92 kg N ha^{-1} enhanced yield of maize with acceptable economic benefit.

Effects of NPS Blended and Urea fertilizer rate on Economic Feasibility of Maize Production

The result of the partial budget analysis is given in (Table 4). The economic analysis revealed that the highest net benefit of 84147.4 ETB $ha^{-1}$with (75.7%) marginal rate of return was obtained from the application of 250 kg ha^{-1} NPS blended fertilizer by supplementing 250 kg ha^{-1} Urea at Dore bafano. While, the control or unfertilized treatment gives the lowest net benefit (45005.5 ETB ha^{-1}). However, at Meskan site the maximum net benefit of (88376.7 ETB ha^{-1}) with (46.0%) marginal rate of return was obtained from the application of 200 kg ha^{-1} NPS blended fertilizer by supplementing 250 kg ha^{-1} Urea. Therefore, the application of 200 kg ha^{-1} NPS blended fertilizer by supplementing 250 kg ha^{-1}Urea would be economical to be recommended on vertisols of Meskan, Southern Ethiopia.

Table.1 Details of treatment combination and set-up

Treat	Urea (kg ha^{-1})	NPS (kg ha^{-1})	N from urea	N from NPS	Total N	P_2O_5	S
1	Control						
2	RNP		200	150	92	69	0
3	150	150	69	28.50	97.50	57.00	10.50
4	150	200	69	38.00	107.00	76.00	14.00
5	150	250	69	47.50	116.50	95.00	17.50
6	150	300	69	57.00	126.00	114.00	21.00
7	250	150	115	28.50	143.50	57.00	10.50
8	250	200	115	38.00	153.00	76.00	14.00
9	250	250	115	47.50	162.50	95.00	17.50
10	250	300	115	57.00	172.00	114.00	21.00
11	350	150	161	28.50	189.50	57.00	10.50
12	350	200	161	38.00	199.00	76.00	14.00
13	350	250	161	47.50	208.50	95.00	17.50
14	350	300	161	57.00	218.00	114.00	21.00

Note: the nutrient amounts in 100 kg of NPS: 18.9% N, 38.1% P_2O_5, 7.6 % S,

Table.2 Some physic-chemical properties of the experiment fields

Parameters	Location	
	Dore Bafano	Meskan
Texture		
Sand	42	21
Silt	31	32
Clay	27	47
Textural Class	Silt loam	loam
pH H_2O (1:2.5)	6.45	7.30
% Total Nitrogen	0.26	0.30
Organic Carbon %	3.51	4.49
Available P (mg kg^{-1})	4.52	23.05

Table.3 Pooled Mean values of yield and yield components of Maize as affected by different rates of NPS and Urea at Dore and Meskan

Treatments NPS + Urea (kg ha^{-1})	Dore						Meskan					
	PH (cm)	AGBM (kg ha^{-1})	SY (kg ha^{-1})	GY (kg ha^{-1})	1000 KW (gm)	HI (%)	PH (cm)	AGBM (kg ha^{-1})	SY (kg ha^{-1})	GY (kg ha^{-1})	1000 KW (gm)	HI (%)
Control	168.4^{b}	7610.0^{f}	4512.9^{f}	3226.2^{e}	205.6^{c}	42.4^{a}	173.5^{a}	6838.0^{f}	3329.0^{e}	3358.9^{e}	199.8^{e}	52.1^{b}
R-NP	196.0^{a}	14569.0^{bc}	8999.1^{cd}	5532.5^{b}	234.1^{bc}	39.1^{ab}	206.6^{a}	14968.3^{b}	9127.0^{abc}	5691.0^{b}	272.6^{abcd}	38.2^{b}
150 NPS +150 Urea	187.6^{ab}	11328.0^{e}	7420.8^{de}	3870.2^{de}	238.4^{bc}	34.4^{abc}	185.9^{a}	10863.9^{e}	6616.0^{d}	4097.7^{de}	202.4^{e}	41.8^{ab}
200 NPS +150 Urea	187.5^{ab}	12014.0^{de}	7131.1^{e}	4511.7^{cd}	251.4^{b}	38.0^{abc}	195.8^{a}	11253.1^{e}	6825.0^{d}	4278.2^{cde}	216.9^{cde}	38.6^{b}
250 NPS +150 Urea	196.7^{a}	13402.0^{cde}	8350.3^{cde}	4514.7^{cd}	228.8^{bc}	33.8^{abc}	199.5^{a}	11358.5^{e}	6828.0^{d}	4380.9^{cde}	231.4^{abcde}	38.8^{b}
300 NPS +150 Urea	193.3^{ab}	14173.0^{bcd}	9044.2^{bcde}	5091.2^{bc}	249.1^{b}	36.0^{abc}	202.6^{a}	13062.6^{cd}	8532.0^{abcd}	4381.1^{cde}	217.3^{cde}	33.7^{b}
150 NPS +250 Urea	200.1^{a}	14847.0^{bc}	9225.6^{abcd}	5250.5^{bc}	242.9^{b}	35.8^{abc}	198.8^{a}	11980.0^{de}	7568.0^{bcd}	4262.4^{cde}	220.0^{cde}	36.0^{b}
200 NPS +250 Urea	197.9^{a}	15363.0^{abc}	10080.1^{abc}	5578.4^{b}	240.6^{b}	37.1^{abc}	205.1^{a}	17053.2^{a}	9939.0^{a}	6964.1^{a}	272.1^{abcd}	41.0^{ab}
250 NPS +250 Urea	201.6^{a}	17259.0^{a}	10482.8^{ab}	6738.7^{a}	297.7^{a}	39.6^{ab}	173.1^{a}	14092.1^{bc}	8977.0^{abc}	4964.9^{bcd}	324.2^{a}	35.2^{b}
300 NPS +250 Urea	199.2^{a}	15588.0^{abc}	10316.1^{abc}	5234.1^{bc}	248.3^{b}	35.0^{abc}	201.6^{a}	15568.7^{ab}	9637.0^{ab}	5448.8^{bc}	289.1^{ab}	35.5^{b}
150 NPS+350 Urea	203.3^{a}	15791.0^{ab}	10570.5^{ab}	5183.4^{bc}	234.5^{bc}	33.7^{abc}	197.2^{a}	12029.2^{de}	7460.0^{cd}	4419.6^{cde}	232.7^{bcde}	37.4^{b}
200 NPS +350 Urea	201.3^{a}	15328.0^{abc}	9990.0^{abc}	5300.9^{bc}	248.6^{b}	35.1^{abc}	201.3^{a}	14559.6^{bc}	9245.0^{abc}	5165.1^{bcd}	279.8^{abc}	35.5^{b}
250 NPS+350 Urea	203.3^{a}	15643.0^{abc}	10521.7^{ab}	5084.1^{bc}	250.0^{b}	33.0^{bc}	201.4^{a}	14324.4^{bc}	9624.0^{ab}	4550.2^{bcde}	256.6^{abcde}	31.9^{b}
300 NPS+300 Urea	206.5^{a}	16032.0^{ab}	11161.0^{a}	4833.7^{bc}	244.6^{b}	30.6^{c}	211.0^{a}	14855.8^{b}	10433.0^{a}	4606.1^{bcd}	206.3^{de}	30.9^{b}
CV	12.1	14.1	19.1	16.0	12.5	22.0	20.9	11.0	23.1	23.1	24.6	26.2
LSD≤0.05	27.1*	2263.5**	1981.2**	922.3**	33.8*	8.7*	ns	1601.9**	2123.2*	1235.9**	68.3*	13.2*
Year*Treatment	ns	ns	Ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Mean values followed by same letter in the same column are not significantly different at 5% probability level; Where-Plant height, AGBM- above ground biomass, SY-straw yield, GY-grain yield, KW-kernels weight and HI-harvest index.

Table.4 Effects of NPS blended and urea fertilizer rates on economic feasibility of maize production Dore bafano

Treat	Urea (kg ha^{-1})	NPS (kg ha^{-1})	GY (kg ha^{-1})	GB (EHB ha^{-1})	TVC (EHB ha^{-1})	NB (EHB ha^{-1})	MRR%
1	Control		2903.6	45005.5	0.0	45005.5	
3	150	150	3483.2	53989.3	5914.5	48074.8	0.5
2	RNP 200	150	4979.3	77178.4	6829.5	70348.9	24.3
4	150	200	4060.5	62938.2	6971.0	55967.2	d
7	250	150	4725.5	73244.5	7744.5	65500.0	12.3
5	150	250	4063.2	62980.1	8027.5	54952.6	d
8	250	200	5020.6	77818.7	8801.0	69017.7	18.2
6	150	300	4582.1	71022.2	9084.0	61938.2	d
11	350	150	4665.1	72308.4	9574.5	62733.9	1.6
9	250	250	6064.8	94004.9	9857.5	84147.4	75.7
12	350	200	4770.8	73947.6	10631.0	63316.6	d
10	250	300	4710.7	73015.7	10914.0	62101.7	d
13	350	250	4575.7	70923.2	11687.5	59235.7	d
14	350	300	4350.3	67430.1	12744.0	54686.1	d

Where: ETB = Ethiopian Birr (currency); TCV = Total cost that vary; NB = Net benefit; MRR = GB=Growth benefit, Marginal rate of return; Price for Urea, NPS, TSP and Maize grain; 18.30, 21.0, 21.0, 15.5 Eth- birr kg^{-1} respectively.

Table.5 Effects of NPS blended and urea fertilizer rates on economic feasibility of maize production Dore bafano

Treat	Urea (kg ha^{-1})	NPS (kg ha^{-1})	GY (kg ha^{-1})	GB (EHB ha^{-1})	TVC (EHB ha^{-1})	NB (EHB ha^{-1})	MRR%
1	Control		3023.0	46856.7	0.0	46856.7	
3	150	150	3836.2	57162.9	5896.5	51266.4	0.7
2	RNP 200	150	3687.9	79389.5	6807.0	72582.5	23.4
4	150	200	3850.4	59680.9	6951.5	52729.4	d
7	250	150	6267.7	59460.5	7717.5	51743.0	d
5	150	250	3977.6	61113.6	8006.5	53107.1	4.7
8	250	200	3942.8	97149.2	8772.5	88376.7	46.0
6	150	300	5121.9	61116.3	9061.5	52054.8	d
11	350	150	3943.0	61653.4	9538.5	52114.9	0.1
9	250	250	4648.6	69260.4	9827.5	59432.9	25.3
12	350	200	4095.2	72053.1	10593.5	61459.6	2.6
10	250	300	4468.4	76010.8	10882.5	65128.3	12.7
13	350	250	4903.9	63475.3	11648.5	51826.8	d
14	350	300	4145.5	64255.1	12703.5	51551.6	d

Where: ETB = Ethiopian Birr (currency); TCV = Total cost that vary; NB = Net benefit; MRR = GB=Growth benefit, Marginal rate of return; Price for Urea, NPS, TSP and Maize grain; 18.5, 21.1, 21.1, 15.5 Eth- birr kg^{-1} respectively.

Besides, at Dore bafano, site application of 250 kg ha^{-1} NPS blended fertilizer by supplementing 250 kg ha^{-1} Urea would be economical to be recommended on Andisol of Dore bafanoSidama, Ethiopia. The study found that application of 200 NPS kg ha^{-1}along with 250 kg ha^{-1} of Urea and 250 kg ha^{-1} NPS blended fertilizer plus 250 kg ha^{-1} Urea were the best fertilizer treatments for Dore Bafeno and Meskan sites, respectively. When compared with the unfertilized (control) plot, grain yield increased by 72.9 and 107.3% at Dore Bafeno and

Meskan sites, respectively. Like agronomic performance, the application of 250 kg ha^{-1} NPS blended fertilize plus 250 kg ha^{-1} Urea and 200 kg ha^{-1} NPS blended fertilize with 250 kg ha^{-1} Urea revealed the maximum net benefit value of 84147.4 ETBha^{-1} and 88376.7 ETB ha^{-1} for Dore bafeno and Meskan sites, respectively. Therefore, the application of 200 kg ha^{-1} NPS blended with 250 kg ha^{-1} Urea fertilizers and 250 kg ha^{-1} NPS blended with 250 kg ha^{-1} Urea fertilizers could be recommended for Dore bafano and Meskan sites, respectively.

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