



## Nitrogen Use Efficiency and Performance of Rice to the Application of Slow-Release Nitrogen Fertilizer Under Waterlogged Conditions in North Western Ethiopia

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### Abstract

Highly soluble N fertilizers like urea may be lost from the soil plant system through leaching, ammonia (NH<sub>3</sub>) volatilization and denitrification that reduce NUE and Yield. The study was conducted to determine the effects of UREASTabil on enhancement of nitrogen utilization efficiencies of rice crop and to evaluate the influence of UREASTabil on growth and yield of rice under waterlogged conditions of Fogera area. The treatments set up were comprised Control, recommended N from conventional urea (as basal & tillering), recommended N from UREASTabil fertilizer applied once as basal, recommended N from UREASTabil (split as basal and tillering), half below the recommended N from UREASTabil as basal, half more than the recommended N from UREASTabil (split as basal and tillering), half more than the recommended N from conventional urea (split as basal and tillering), half more than the recommended N from UREASTabil as basal. Data were collected plant height, total tiller number, panicle length, number of fertile grains, thousand seed weight, grain yield, straw yield and harvest Index. Economic analysis was performed by following CIMMYT (1988) partial budget analysis methodology. Highly significantly ( $P < 0.01$ ) affected grain yield (3.55 t ha<sup>-1</sup>) was recorded on 136.5 kg N ha<sup>-1</sup> in split application 45.5 kg N ha<sup>-1</sup> as basal and 91 kg N ha<sup>-1</sup> tillering stage from UREA Stabil source. From the conventional urea source of N, the application of 136.5 kg N ha<sup>-1</sup> in split application (45.5 kg ha<sup>-1</sup> as basal and 91 kg ha<sup>-1</sup> tillering stage was provided higher yield (3.14) which is statistically non-significant compared to slow-release fertilizer. The economic analysis has further revealed that application of 136.5 kg N ha<sup>-1</sup> from UREA Stabil in split application of 45.5 kg N ha<sup>-1</sup> as basal and 91 kg N ha<sup>-1</sup> tillering stage provided highest net benefit of Birr 47,356 ha<sup>-1</sup> was the most profitable treatment for lowland rice production. Slow release UREA Stabil nitrogen fertilizer enhances nitrogen use efficiency by reducing denitrification, leaching and ammonia volatilization. Application of 136.5 kg N ha<sup>-1</sup> rate from the source of UREA Stabil in split application of 45.5 kg ha<sup>-1</sup> as basal and 91 kg N ha<sup>-1</sup> tillering stage is the best to be recommended for lowland rice production of Fogera and similar agro-ecologies in Ethiopia.

**Keywords:** NUE; UREA stabil; Profitability; Yield

### Introduction

Nitrogen is the most limiting plant nutrients in general and in the tropics particular where the fluctuation of temperature and precipitation scorches the organic matter, which is a large reserve of organically bounded nitrogen which later converted into inorganic forms and utilized by plants with the deed of soil biota. Hence, high rate of organic matter decomposition severely depletes soil nutrients especially soil nitrogen and usually manifested in the poor performance of test crops in Ethiopia without any supply of inputs.

Different studies released recommendations since nineteen seventy especially on nitrogen and phosphorus although it is blanket recommendation. Since then, the associated yield obtained from a given pieces of land decreases without the application of chemical fertilizers witnessing that there is a need for applying sufficient amount of nitrogen in the cropping systems in Ethiopia. Therefore, the fertilizer import has been progressively increased for the last decade (Agricultural Input and Marketing Directorate, Ministry of Agriculture (MoA), Central Statistics Agency (CSA), 2010 & 2011, African Fertilizer, FAO). Parallel to this, the national fertilizer consumption started at nineteen seventy and gradually increased through nineteen eighty, nineteen ninety five and two thousand four and two thousand five which stood at 950, 43 200, 250 000, and 323 000 tons respectively.

Based on the International Fertilizer Association's (IFA) suggestion fertilizer application rate, nutrient uptake close to 4.3 million tons of nitrogen, phosphate, and potash is required to produce this much maize, wheat, barley, and sorghum. However, CSA's farm management practice data from two thousand three/ two thousand four to two

thousand ten / two thousand eleven shows that the actual amount of fertilizer applied was 1.6 million tons, and when considering that a limited amount of nutrients from the fertilizer is actually taken up by the crops, more than 2.7 million tons of nutrients from the soil. A large portion of the uptake of nitrogen, which is the most important micronutrient for crop growth, is coming from the soil, given the fact that insufficient amounts applied.

Sieling reported that the mineral fertilizer NUE for winter wheat decreases with increasing N levels. Hatfield and Prueger (2004) also confirmed that the efficiency of N use by a crop depends upon the response of water and N availability during the growing season.

Accordingly, in Ethiopia urea as a source of nitrogen and DAP as a source of nitrogen and phosphorus applied as a high-grade fertilizer in order to obtain optimum harvest. One of the major challenging issues especially in high rainfall and waterlogged area in connection with these are the loss of nitrogen through ammonium volatilization or

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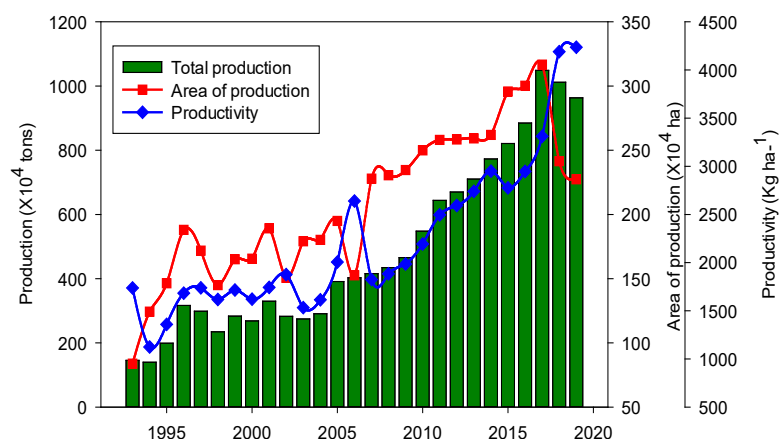


Figure 1: Maize yield (kg ha<sup>-1</sup>), total production (x10<sup>4</sup> tons), and area coverage (x10<sup>4</sup> ha) in Ethiopia from 1993-2019. Adapted from the FAOSTAT database.

fixation by clay minerals. On the other hand, in low moisture area, its low solubility and toxic effect burns the root so as to reduce its growth and the performance of the crops grown under this condition also challenges the use of these fertilizers. The national average yield of rice is about 2.8t ha<sup>-1</sup> (CSA, 2018), which is lower compared to the world average productivity of 4.6 t ha<sup>-1</sup> (FAOSTAT, 2018).

Nitrogen is the major yield-limiting plant nutrient in the rice production system of northwestern Ethiopia as stated by [1]. UREAstabil is one of the slow-releasing nitrogen fertilizers and hydrolysis of urea is reduced by the presence of N-(nbutyl) thiophosphoric-triamide (nBTPT) that slows down urease activity of urea hydrolysis thereby improve recovery of nitrogen applied. This fertilizer application believed to increase crop productivity. However, the soil, crop management practice, availability of water and climate condition affects urease inhibitor (nBTPT) [2].

UREAStabil is a concentrated nitrogen fertilizer that can be applied as a granular for field crops as well as liquid fertilizer through irrigation water for the orchard. Besides, it supposed to have basic advantage of having a combination of rapidly soluble, well absorbable nitrogen with urease inhibitor that helps to improve nitrogen penetration to plant roots by restraining the sorption and fixation of NH<sub>4</sub><sup>+</sup> in the surface soil layer, which slows the effect of this nitrogen form down. In another way it helps to reduce its losses due to ammonia volatilization into the atmosphere during surface application. However, this product has never been tested in our context [3].

Therefore, this research is proposed: - To determine the effects of UREAstabil on the enhancement of nitrogen utilization efficiencies of the rice crop. To evaluate the influence of UREAstabil on the growth and yield of rice under waterlogged conditions [4].

## Materials and Methods

### Description of the study area

An experiment on UREAstabil and conventional urea nutrients were conducted on rain fed lowland rice in Fogera district. The study at Fogera area is situated at 11 °54.4'46.3"N to 11 °57'03.0"N latitude and 37 °41'23.9"E to 37 °42'32.2" E longitude at elevation range of 1787-1812 meter above sea level. The study site received mean annual rainfall of 1219 mm with annual average minimum and maximum temperature of 12.75°C and 27.37°C, respectively [5].

### Plant material

The rice variety X-jigna has rain fed lowland ecosystem adaptability and good characteristics of cold tolerance. The morphology of the variety is unerect leaf angle and unerect flage leaf angle. The genotype has intermediate type of panicle and purple color of the apex. The biomass response is promising and highly preferred by the producers with the right agronomic management practice. In addition to the high biomass and yield performance white color grain of X-jigna variety chosen by the rice producing farmers [6].

### Soil characteristics

The soil in Fogera immeasurably require nitrogen fertilizer and without N fertilizer yield is not expected but other macro nutrients like P & K deficiency not highly observed [7]. The experimental soil type was found to be vertisols and the textural class was clay loam. The PH (H<sub>2</sub>O) of the soil was 5.89 and soil organic carbon was 1.2% [8].

### Experimental design and treatments

The treatments were comprised UREA<sup>Stabil</sup> and conventional urea at recommended rates of nitrogen sources. Therefore, a total of eight rates were used to evaluate the efficiencies of UREA<sup>Stabil</sup> under waterlogged and high rainfall conditions. The treatments set-up was (without any external application of N (control=0N), recommended N from conventional urea 91kg ha<sup>-1</sup> (30kg ha<sup>-1</sup> at planting & 61kg ha<sup>-1</sup> tillering stage), recommended N from UREA<sup>Stabil</sup> (91kg ha<sup>-1</sup>), half of the recommended N from UREA<sup>Stabil</sup> (45.5 kg ha<sup>-1</sup>), recommended N from UREA<sup>Stabil</sup> (45.5 kg ha<sup>-1</sup> at planting & 45.5 kg ha<sup>-1</sup> tillering), half more than the recommended N from UREA<sup>Stabil</sup> (136.5kg ha<sup>-1</sup>, 45.5 kg ha<sup>-1</sup> at planting & 91 kg ha<sup>-1</sup> tillering), half more than the recommended N from conventional urea (136.5kg ha<sup>-1</sup>, 45.5 kg ha<sup>-1</sup> at planting & 91 kg ha<sup>-1</sup> tillering), half more than the recommended N from UREA<sup>Stabil</sup> 136.5 kg ha<sup>-1</sup>) once at planting. The treatments were laid out in Randomized Complete Block Design (RCBD) and replicated three times. The gross size of the experimental plots was 3m x 4m consisting of 15 rows planted at a spacing of 20 cm apart with the seeding rate of 100 kg ha<sup>-1</sup> X-jigna rice variety. The net plot area was made by excluding the left and right outer rows and a plot length of 0.5 m from the top and bottom sides of the plot. The final net plot size was thus 2.6m x 3m [9].

### Data collected

Data on plant height, panicle length, number of total tillers per m<sup>2</sup>, number of fertile panicles per m<sup>2</sup>, thousand seeds weight, grain yield, straw yield and harvest index were collected timely from the

net plot areas following their respective standard measuring methods and procedures. The rice grain yield and thousand seeds weight were adjusted at 14% standard moisture content [10].

### Data analysis

All collected data were subjected to analysis of variance (ANOVA) using SAS software version 9.0 (SAS-Institute, 2003). Mean separation was done by using Least significance difference (LSD) method at probability levels of  $P \leq 0.01$  and  $P \leq 0.05$  depending on the ANOVA results. Statistical analysis of the grain yield and NUE data were also accomplished by standard analysis of variance (ANOVA) [11].

### Partial budget analysis

A method of organizing experimental data and information about the costs and benefits of various alternative treatments. A partial budget analysis methodology is a way of computing the total costs that vary and the net benefits of each treatment in an on-farm experiment. Includes the average yields for each treatment, adjusted yields and gross benefit (based on the field price of the crop). It also incorporates all the costs that vary for each treatment (CIMYYT (1988) [12-15].

The N use efficiency of mineral N fertilization was calculated by equation:

$$\text{Agronomic N use efficiency (NUE)} = \frac{(\text{Grain Yield F} - \text{Grain yield C})}{\text{Fertilizer N applied kg per kg N}}$$

Where F and C represent Fertilized and Control plots respectively. NUE can be calculated as the ratio between the amount of fertilizer N removed with the crop and the amount of fertilizer N applied. It can be expressed in %.

### Results and Discussion

The Analysis of variance indicated that plant height was significantly ( $P < 0.05$ ) affected by UREA<sup>Stabil</sup> and Conventional urea. The highest plant height (83.6cm) was recorded from the split application of 136.5kg N ha<sup>-1</sup> from UREA<sup>Stabil</sup> split at planting (45.5 kg N ha<sup>-1</sup>) and tillering stage (91 kg N ha<sup>-1</sup>) while the lowest plant height (70.7cm) was recorded from the control without the application of nitrogen fertilizer (Table 1). However, from the conventional urea fertilizer the plant height was recorded 80.8cm from the application of 136.5 kg N ha<sup>-1</sup> and split at planting (45.5 kg N ha<sup>-1</sup>) and 91kg N ha<sup>-1</sup> tillering stage [16-19].

Panicle length was not significantly affected by conventional urea

and UREA<sup>Stabil</sup> fertilizer application where as the number of total tillers were highly significantly ( $P < 0.01$ ) affected. The highest number of tiller (260.7 per m<sup>2</sup>) was found from the application of UREA<sup>Stabil</sup> (136.5kg ha<sup>-1</sup>) at planting and tillering stage where as the lowest number of tiller (154.7 per m<sup>2</sup>) was found from the control without application of nitrogen fertilizer. Similar results reported as rice is a unique crop with an indeterminate tillering potential, and the actual tillering number is easily influenced by nutrients availability, planting density and variety. Split application of conventional urea fertilizer (136.5 kg ha<sup>-1</sup> at planting (45.5 kg ha<sup>-1</sup> and 91 kg ha<sup>-1</sup> at tillering stage) had resulted 245.7 tiller number per m<sup>2</sup> [20].

The analysis of variance for the number of fertile grains showed that significantly ( $P < 0.05$ ) affected by UREA<sup>Stabil</sup> and conventional urea fertilizer. The highest number of fertile grains (248.0 per m<sup>2</sup>) was found from 136.5 kg N ha<sup>-1</sup> of UREA<sup>Stabil</sup> in split application 45.5kg ha<sup>-1</sup> at planting and 91kg N ha<sup>-1</sup> at tillering stage where as the lowest number of fertile grain (147.3) was attained from the control without the application of nitrogen fertilizer. However, from conventional urea through the application of 136.5 kg N ha<sup>-1</sup>, 45.5 kg N ha<sup>-1</sup> planting and 91kg N ha<sup>-1</sup> at tillering stage 226.0 fertile grains per m<sup>2</sup> were produced. The disadvantage of urea fertilizer is that considerable amounts of N can be lost from through volatilization which may result in very low N fertilizer use efficiency [21-22].

The grain yield was highly significantly ( $P < 0.01$ ) affected by both UREA<sup>Sabil</sup> and conventional urea fertilizer N source applications. However, Concerning UREA<sup>Stabil</sup> fertilizer application the highest grain yield (3.55 t ha<sup>-1</sup>) was found from the application of 136.5 kg N ha<sup>-1</sup> from the split application while from the conventional urea fertilizer application 3.14 t ha<sup>-1</sup> grain yield was produced at 136.5 kg N ha<sup>-1</sup> split application at planting (45.5 kg ha<sup>-1</sup>) and tillering stage (91kg ha<sup>-1</sup>). Improved grain and straw yields at the higher rates of N nutrient may be attributed to the fact that application of fertilizer for crop uptake and translocation to sink thereby expressing superior crop growth and development [23-25].

Straw yield was highly significantly ( $P < 0.01$ ) affected by UREA<sup>Stabil</sup> and conventional urea N sources. The straw yield was affected both by sources and rates of N fertilizer. However, the highest straw yield (5.79 t ha<sup>-1</sup>) was recorded from 136.5 kg N ha<sup>-1</sup> from UREA<sup>Stabil</sup> and from the conventional urea fertilizer 5.67 t ha<sup>-1</sup> was recorded as split application of 136.3 kg N ha<sup>-1</sup> (45.5 kg ha<sup>-1</sup> planting and 91 kg N ha<sup>-1</sup> at tillering stage) of rice (Table 1).

**Table 1:** Combined mean effects of UREA<sup>Stabil</sup> and conventional urea fertilizer sources and rates on growth and yield of rice for two consecutive years (2015-2016) in Fogera districts, northwest Ethiopia.

Nitrogen levels kg ha <sup>-1</sup>	PH							HI%
		TC	PL	Nfg	GY	Tsw	Sy	
0 N	70.7c	154.7c	16.3a	147.3c	1.0c	26.0a	2.51b	28.9de
91N (Conventional urea 30/61)	75.7bc	223.3abc	16.3a	213.3abc	3.26ab	20.0b	3.76b	41.3abc
91 N (UREA <sup>Stabil</sup> )	75.0bc	213.3abc	16.9a	206.7abc	3.02ab	25.0a	3.60b	36.6bcde
91N (UREA <sup>Stabil</sup> 45.5/45.5)	75.4bc	228.7ab	16.3a	213.3ab	3.38ab	23.7ab	3.64b	39.4abcd
45.5 N (UREA <sup>Stabil</sup> )	71.5c	177.3bc	16.3a	165.3bc	2.41b	22.3ab	2.92b	26.0e
136.5N (UREA <sup>Stabil</sup> 45.5/91)	83.6a	260.7a	17.0a	248.0a	3.55a	23.7ab	5.79a	31.0cde
136.5N(Conventional urea 45.5/91)	80.8ab	245.7ab	17.0a	226.0ab	3.14ab	24.7a	5.67a	27.8e
136.5N (UREA <sup>Stabil</sup> )	75.4bc	218.7abc	16.6a	230.7a	3.16ab	21.7a	3.84b	44.6ab
P-value	*	*	Ns	*	**	ns	**	**
CV (%)	5.71	18.86	6.6	19	12.29	11.09	27.8	16.48

PH= Plant height (cm), TC=Tiller count per m2, PL=Panicle length (cm), NFP= Number of fertile panicles per m2, DB=Dry bio-mass (tha-1), Gy= Grain yield (tha-1), Sy= Straw yield (tha-1), HI%=harvest index. \*\*= highly significant at  $P < 0.01$ , \*= significant at  $P < 0.05$ , ns= non-significant at  $P > 0.05$ .

Thousand seed weight was not significantly ( $P < 0.05$ ) affected by UREA<sup>Stabil</sup> and conventional urea treatments even if the grain yield is significantly different between treatments [26].

The rice harvest index was highly significantly ( $P < 0.001$ ) affected by the UREA<sup>Stabil</sup>. The highest HI (44.6) was shown from 136.5 kg N ha<sup>-1</sup> from UREA<sup>Stabil</sup> source of nitrogen applied once at planting and the lowest (26.0) from 45.5 N as the source of UREA<sup>Stabil</sup> followed by 91 kg N ha<sup>-1</sup> (41.7 HI) from conventional urea split application among nitrogen source of fertilizers. Similar results observed at the highest harvest index from the report of. Higher grain yields in the fertilizer treatments were associated with higher harvest index [27].

The analysis of Agronomic Efficiency (AE) for the nitrogen sources and rates indicates that the maximum AE 30.55 was exhibited at 136.5 kg N ha<sup>-1</sup> from UREA<sup>Stabil</sup> source of nitrogen split application (45.5kg ha<sup>-1</sup> basal and 91kg ha<sup>-1</sup> tillering stage), then the AE reduce to 15.53 at 136.5 kg N ha<sup>-1</sup> from conventional urea N source split application (45.5 kg ha<sup>-1</sup> at planting and 91 kg ha<sup>-1</sup> at tillering stage) and 15.68 AE at 136.5 kg N ha<sup>-1</sup> from UREA<sup>Stabil</sup> source once application. The AE becomes high 30.55, 25.93, 24.62 at 45.5 kg N ha<sup>-1</sup> from UREA<sup>Stabil</sup>, 91kg N ha<sup>-1</sup> from UREA<sup>Stabil</sup> (45.5/45.5), 91 kg N ha<sup>-1</sup> from conventional urea (30/90) respectively (Table 2).

Table 2: Agronomic Efficiency (AE) of Nitrogen.

N (kg ha <sup>-1</sup> )	Grain Yield (kg ha <sup>-1</sup> )	AE
0	1020	
91 Conventional Urea (30/61)	3260.01	24.62
91 UREA <sup>Stabil</sup>	3020.11	21.98
91 UREA <sup>Stabil</sup> (45.5/45.5)	3380.21	25.93
45.5 UREA <sup>Stabil</sup>	2410	30.55
136.5 UREA <sup>Stabil</sup> (45.5/91)	3550.01	18.53
136.5 Conventional Urea (45.5/91)	3140.1	15.53
136.5 UREA <sup>Stabil</sup>	3160	15.68

Table 3: Results of grain yield and straw yield adjustments, total variable cost, gross and net benefits analysis.

Nitrogen levels kg ha <sup>-1</sup>	TVC (Birr ha <sup>-1</sup> )	GY (tha <sup>-1</sup> )	SY (tha <sup>-1</sup> )	AGY (tha <sup>-1</sup> )	ASY (tha <sup>-1</sup> )	GB (Birr ha <sup>-1</sup> )	NB
							(Birr ha <sup>-1</sup> )
0 N	0	1	2.51	0.92	2.26	17040	17040
91N (Conventional urea 30/61)	3180	3.26	3.76	2.93	3.38	44232	41052
91 N (UREA <sup>Stabil</sup> )	3120	3.02	3.6	2.72	3.24	41256	38136
91N (UREA <sup>Stabil</sup> 45.5/45.5)	3210	3.38	3.64	3.04	3.28	45240	42030
45.5 N (UREA <sup>Stabil</sup> )	1560	2.41	2.92	2.17	2.63	33036	31476
136.5N (UREA <sup>Stabil</sup> 45.5/91)	4880	3.55	5.79	3.2	5.21	52236	47356
136.5N (Conventional urea 45.5/91)	4700	3.14	5.67	2.83	5.1	47520	42820
136.5N (UREA <sup>Stabil</sup> )	4600	3.16	3.84	2.84	3.46	43344	38744

Table 4: Results of dominance analysis.

Nitrogen levels (kg ha <sup>-1</sup> )	TVC (Birr ha <sup>-1</sup> )	NB (Birr ha <sup>-1</sup> )	Dominance
0 N	0	17040	
45.5 N (UREA <sup>Stabil</sup> )	1560	31476	
91 N (UREA <sup>Stabil</sup> )	3120	38136	
91N (Conventional urea 30/61)	3180	41052	
91N (UREA <sup>Stabil</sup> 45.5/45.5)	3210	42030	
136.5N (UREA <sup>Stabil</sup> )	4600	36344	D
136.5N (Conventional urea 45.5/91)	4700	42820	D
136.5N (UREA <sup>Stabil</sup> 45.5/91)	4880	47356	

D= Dominated

Table 5: Results of Marginal Rate of Return (MRR) analysis.

Nitrogen levels (kg ha <sup>-1</sup> )	TVC (Birr ha <sup>-1</sup> )	NB (Birr ha <sup>-1</sup> )	MRR (%)
0 N	0	17040	
91N (Conventional urea 30/61)	3180	41052	718.1
91 N (UREA <sup>Stabil</sup> )	3120	38136	4860
91N (UREA <sup>Stabil</sup> 45.5/45.5)	3210	42030	4326.7
45.5 N (UREA <sup>Stabil</sup> )	1560	31476	639.6
136.5N (UREA <sup>Stabil</sup> 45.5/91)	4880	47356	478.3
136.5N (Conventional urea 45.5/91)	4700	42820	2520
136.5N (UREA <sup>Stabil</sup> )	4600	38744	4076

The lower agronomic efficiency at the highest N rates in the current experiment indicates that emphasis should be given to efficient nitrogen application methods. The split application method even for slow release N fertilizer is highly essential for water logged areas like Fogera because that from the current experiment the AE is higher at split application of slow release N source than from conventional urea N sources and real time of N management to reduce denitrification and loss of nitrogen fertilizer to efficiently use by the plant. AE N is usually higher at low N rate than at high N rate [28-30].

Following the CIMYYT (1988) partial budget analysis method, grain and straw yield adjustments, computations of total variable costs (TVC), gross benefits (GB) and net benefits (NB) were accomplished (Table 3) [31-33]. Dominance analysis was conducted after arranging the treatments in their order of TVC. A treatment will be contended as dominated if it has higher TVC but lower NB than a previous treatment with lower TVC and higher NB (Table 4). Non-dominated treatments were taken out and marginal rate of return (MRR) was computed (Table 5). According to the CIMYYT (1988) partial budget analysis, treatments revealing the minimum or more MRR (>100%) will be considered for the comparison of their NB. Highest NB (Birr 47,356 ha<sup>-1</sup>) with acceptable level of MRR (478.3%) was observed at 136.5kg N ha<sup>-1</sup> split application of UREA<sup>Stabil</sup> (45.5/91). Split application of 136.5 kg N ha<sup>-1</sup> from UREA<sup>Stabil</sup> source 45.5 kg N ha<sup>-1</sup> as basal and 91kg N ha<sup>-1</sup> tillering stage is the most profitable rate and source to be recommended for low land rice production of Fogera area [34, 35].

## Conclusion

Application of different rates of slow release UREA<sup>Stabil</sup> and conventional urea fertilizer strongly affected the grain yield of rice. Parallel to the grain yield, the straw yield is highly necessary for cattle feed in Fogera area. Slow release UREA<sup>Stabil</sup> nitrogen fertilizer sturdily influenced the straw yield. In waterlogged areas, the application of highly mobile nitrogen fertilizer beyond the optimum increase the lose

and decrease the final out put yield. From the study split application of 136.5 kg ha<sup>-1</sup> conventional nitrogen (as basal 45.5 kg ha<sup>-1</sup> & 91 kg ha<sup>-1</sup> tillering stage) reduce net benefit by increasing the total variable cost. The split application method even for slow release N fertilizer is highly essential for water logged areas like Fogera because that from the current experiment the AE is higher at split application of slow release N source than from conventional urea N sources and real time of N management and to efficiently use by the plant. This further revealed slow release UREA<sup>Stabil</sup> nitrogen fertilizer enables to enhance the nitrogen utilization efficiency by reducing denitrification, leaching and ammonia volatilization. In waterlogged conditions of rice production, slow release UREA<sup>Stabil</sup> nitrogen source of fertilizer has strong and promising effect on the growth and yield and yield components rice.

Based on the results of the present study both biological and partial budget analysis revealed that the highest grain yield and economic profitability was exhibited from 136.5 kg N ha<sup>-1</sup> applied in the form of UREA<sup>Stabil</sup> in split application 45.5 kg N ha<sup>-1</sup> as basal and 91 kg N ha<sup>-1</sup> tillering stage for water logged areas of Fogera and similar agro-ecologies in Ethiopia.

Further research work for the improved of nitrogen use efficiency of rice on slow release UREA<sup>Stabil</sup> nitrogen sources of fertilizer in combination with micro nutrients also recommended.

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