

Productivity and Profitability Assessment of Hybrid Maize by using Nutrient Expert® Maize Model in Eastern Terai of Nepal

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Abstract— Low productivity of maize has led to low profitability of maize production in Nepal. Indiscriminate use of fertilizer and lack of site specific nutrient management technology is always been associated with low productivity of maize. Thus, field experiments on farmer's field were conducted on maize to assess the profitability at two sites of Jhapa district viz. Damak and Gauradaha using Nutrient Expert® Maize model from November 2015 to May 2016. The experiment was laid out in single factorial Randomized Completely Block Design consisting twenty replications with two treatments viz. NE (Nutrient Expert recommendation) and FFP (Farmer's Fertilizer Practice). The analyzed data revealed the significant differences in terms of grain yield, stover yield, gross return, net return and B:C ratio. NE based practices produced higher grain yield (9.22 t ha^{-1}), which was 86.6 percent higher than FFP (4.94 t ha^{-1}). Similarly, the significantly higher stover yield (12.70 t ha^{-1}), gross return (NRs. 224049 ha^{-1}), net return (NRs. 128970 ha^{-1}) and B:C ratio (2.36:1) were recorded in NE based practice. Thus, NE based practice can be adopted for obtaining higher productivity and profitability in eastern terai and similar agro-climatic regions of Nepal.

Keywords— benefit cost ratio, grain yield, gross return, net return, nutrient expert.

I. INTRODUCTION

Maize (*Zea mays* L.) is one of the most important staple crops in the world. It provides approximately 30% of the food calories to more than 4.5 billion people in 94 developing countries (Jat *et al.*, 2013). Further, it is an important crop for making edible oil and is significant source of bio-fuel production in the world (Nayava and Gurung, 2010). Maize is the second most important cereal crop after rice in Nepal. It is cultivated in 891,583 hectares of land with production and productivity of

2,231,517 tons and 2.5 t ha^{-1} , respectively (MoAD, 2017). It is the major food crop in the hills of Nepal and accounts about 71% of maize production of the country (MoAD, 2017). The demand of maize grain has increased, but the productivity in farm level is almost stagnant around $2\text{-}2.5 \text{ t ha}^{-1}$ in last decade (MoAD, 2017). The farm level yield of maize (2.5 t ha^{-1}) is not satisfactory as compared to attainable yield (5.7 t ha^{-1}) in Nepal (MoAD, 2017; KC *et al.*, 2015). This lower productivity has also led to low profitability of maize production in Nepal. Indiscriminate use of fertilizer and lack of site specific nutrient management technology is the main cause of low maize productivity in Nepal. Therefore, nutrient management is always the major concern in maize for increasing production in Nepal.

Site specific nutrient management (SSNM) is a plant based approach for supplying crops with nutrients in right amount and time. Based on SSNM principles, a dynamic nutrient management tool, Nutrient Expert® (NE), was developed that can generate farm-specific fertilizer recommendation for maize (Majumdar *et al.*, 2014).

Many researches concerning about SSNM has been carried out around the globe. Similarly, Nutrient Expert has been tested earlier in India (Majumdar *et al.*, 2014), Indonesia and Philippines (Pampolino *et al.*, 2014) and found valid. But, in Nepal, limited research has been carried out concerning about SSNM and Nutrient Expert. Therefore, the present investigation is planned, executed and accomplished with the objective of assessing the productivity and profitability of maize production using Nutrient Expert®-Maize.

II. MATERIALS AND METHODS

The study was carried out at two sites of Jhapa district viz. Damak and Gauradaha from November 2015 to May

2016. The experiment was laid out in single factorial Randomized Completely Block Design consisting two treatments viz. NE (Nutrient Expert recommendation) and FFP (Farmer's Fertilizer Practice) in twenty farmer's field, considering one farmer as one replication. The hybrid maize variety Pioneer 3785 was used for the study. The gross plot and net plot size for each treatment was maintained 100 m² and 10 m², respectively. The NE plot consist the cultivation of maize under Nutrient Expert-Maize recommended spacing, seed rate, fertilizer dose and other factors of production. FFP plot consist of maize cultivation under farmer's own practice of spacing, seed rate, fertilizer dose and other factors of production. Data of observations on yield attributing characters, grain yield and stover yield were recorded from net plot. Similarly, for profitability analysis, all the cost of cultivation was worked out on the basis of cost incurred according to the prevailing market price for different inputs, laborers, fertilizers and other factors of production. The grain yield and straw yield was converted into gross return (NRs. ha⁻¹) based on the prevailing market price of the producers. Net returns (NRs. ha⁻¹) for each plot was calculated by deducting the cost of cultivation from the gross returns obtained. Similarly, benefit cost ratio (B: C) ratio was calculated by dividing gross return with the cost of cultivation (Reddy and Reddi, 2005). All these recorded data were tabulated in MS-Excel which was subjected to

ANOVA (Gomez and Gomez, 1984), after analysis through GENSTAT-C, computer based program at 5% significance level. The grain yield was adjusted at 14% moisture level.

III. RESULTS AND DISCUSSION

1. Grain yield

The grain yield of maize was highly influenced by nutrient management practices (Table 1). The grain yield of maize under Nutrient Expert (NE) (9.22 t ha⁻¹) was highly significant than grain yield of maize under farmer's fertilizer practice (FFP) (4.94 t ha⁻¹). The significant increase in yield attributing characters viz. average cob number per m² (8.2), average kernel row cob⁻¹ (14.2), average kernel number row⁻¹ (42.4) and thousand grains weight (361.4 g) under NE might be mainly responsible for obtaining the higher grain yield of maize under NE. The increase in grain yield of maize under SSNM based practices and NE was also reported in previous experiments (Kumar *et al.*, 2014; Majumdar *et al.*, 2014; Pampolino *et al.*, 2014; Chauhan, 2015; Kumar *et al.*, 2015a; Vikram *et al.*, 2015; Sinha, 2016). Further, it was revealed that NE produced 86.6% more grain yield than farmer's fertilizer practice. Similar results were also reported by previous researchers in their studies (Kumar *et al.*, 2015b; Pooniya *et al.*, 2015; Sinha, 2016).

Table.1: Grain yield and stover yield of maize as affected by nutrient management practices at Damak and Gauradaha, Jhapa, Nepal, 2015/16

Treatment	Grain Yield (t ha ⁻¹)	Stover Yield (t ha ⁻¹)
NE	9.22	12.70
FFP	4.94	8.62
SEm (±)	0.14	0.24
LSD (0.05)	0.413	0.699
P-value	<.001	<.001
CV (%)	8.8	9.9
Grand Mean	7.08	10.66

The higher yields in NE may be ascribed to efficient adjustments in applying nutrients to accommodate field specific needs of the crops for supplementing plant nutrients (Pooniya *et al.*, 2015). The increased availability of nutrients at critical physiological phases results in better translocation of photosynthates from source to sink, resulting better growth and yield attributing characters,

and finally increasing the grain yield (Vikram *et al.*, 2015). Similarly, broadcasting of seed in FFP had caused patchy growth of crop, characterized by improper spacing. This led to increased incidence of insect, pest and diseases in FFP, which also led to reduced grain yield.

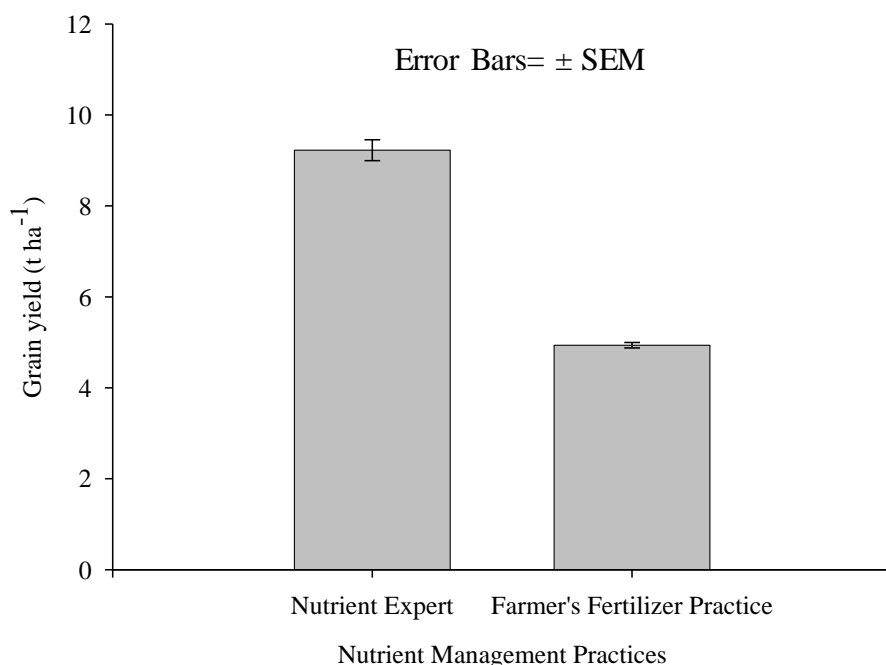


Fig.1: Comparison of grain yield of maize in two nutrient management practices

2. Stover yield

The stover yield was highly influenced by nutrient management practices (Table 1). The stover yield under NE was found to be 12.7 t ha⁻¹, which was highly significant than stover yield under farmer's practice (8.62 t ha⁻¹). Inadequate supply of nutrients in farmer's practice

might have led to reduced plant height, leaf area, etc. due to improper growth and development, which in turn results the lower stover yield of maize. Higher stover yield of maize under SSNM based practice was also agreed by earlier experiments (Kumar et al., 2015a; Kumar et al., 2015b; Vikram et al., 2015).

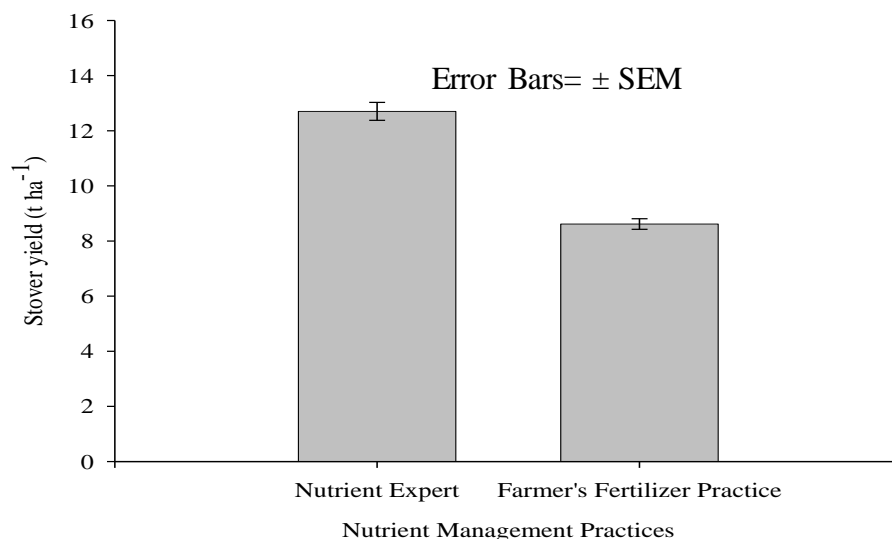


Fig.2: Comparison of stover yield of maize in two nutrient management practices

3. Economic Analysis

3.1 Cost of cultivation

The data on cost of cultivation is presented in Table 2. The data on cost of cultivation revealed that NE practice had the higher cost of production (NRs. 95079 ha⁻¹),

followed by farmer's fertilizer practice (NRs. 75470 ha⁻¹). The mean cost of cultivation was NRs. 85275 ha⁻¹.

3.2 Gross return

The total monetary value of the economic produce and the byproducts obtained from the crop is called gross return. It is calculated based on the local market price of the

products (Reddy and Reddi, 2005). The gross return was significantly influenced by nutrient management practices (Table 2). The gross return of NE practice (NRs. 224049 ha⁻¹) was significantly higher than farmer's fertilizer practice (NRs. 131264 ha⁻¹). Higher gross return under NE practice was due to higher grain yield obtained under NE practice. Similar result was also reported by Jat *et al.* (2013), Pampolino *et al.* (2014) and Satyanarayana *et al.* (2014). Further, higher gross return under SSNM based practice was also reported by Vikram *et al.* (2015).

3.3 Net return

The ultimate product remained after subtracting the cost of cultivation from the gross return is called net return (Reddy and Reddi, 2005). The net return was significantly influenced by nutrient management practices (Table 2). The net return of NE practice (NRs. 128970 ha⁻¹) was significantly higher than FFP (NRs. 55793 ha⁻¹). NE

practice produced NRs. 73177 ha⁻¹ more net return than farmer's fertilizer practice. Higher net return under SSNM based practice was also reported by Vikram *et al.* (2015).

3.4 Benefit cost (B: C) ratio

Benefit cost (B: C) ratio is defined as the ratio of the gross returns to the cost of cultivation which can also be expressed as return per rupee invested. For any enterprise relating with agriculture sector to be economically viable, a minimum B: C ratio of 1.5 is fixed. Therefore for any agriculture enterprise to be sustainable, it should maintain a B: C ratio of 1.5 (Reddy and Reddi, 2005). The benefit cost ratio was significantly influenced by nutrient management practices (Table 2). The benefit cost ratio under NE practice (2.36:1) was significantly higher than FFP (1.74:1). The higher B: C ratio under NE practice was also reported by Vikram *et al.* (2015).

Table.2: Cost of cultivation (NRs. '000 ha⁻¹), gross return (NRs. '000 ha⁻¹), net return (NRs. '000 ha⁻¹) and B:C ratio of maize as affected by nutrient management practices at Damak and Gauradaha, Jhapa, Nepal, 2015/16

Treatment	Cost of cultivation (NRs. '000 ha ⁻¹)	Gross return (NRs. '000 ha ⁻¹)	Net return (NRs. '000 ha ⁻¹)	B:C ratio
NE	95.08	224.0	129.0	2.36
FFP	75.47	131.3	55.8	1.74
SEm (±)		2.50	2.73	0.03
LSD (0.05)		7.41	8.09	0.085
P-value		<.001	<.001	<.001
CV (%)		6.3	13.2	6.2
Grand Mean	85.27	177.70	92.40	2.05

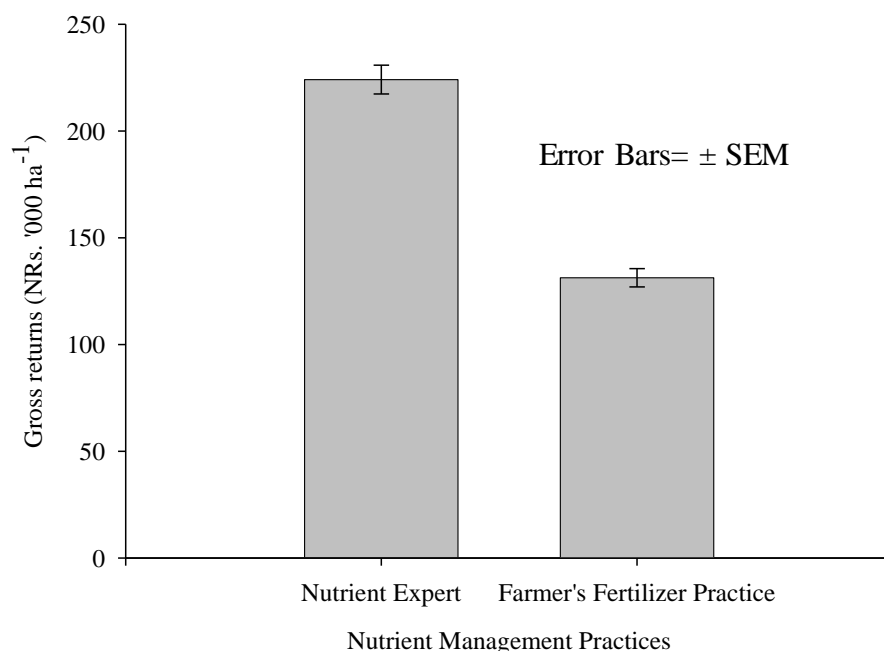


Fig.3: Comparison of gross return of maize in two nutrient management practices

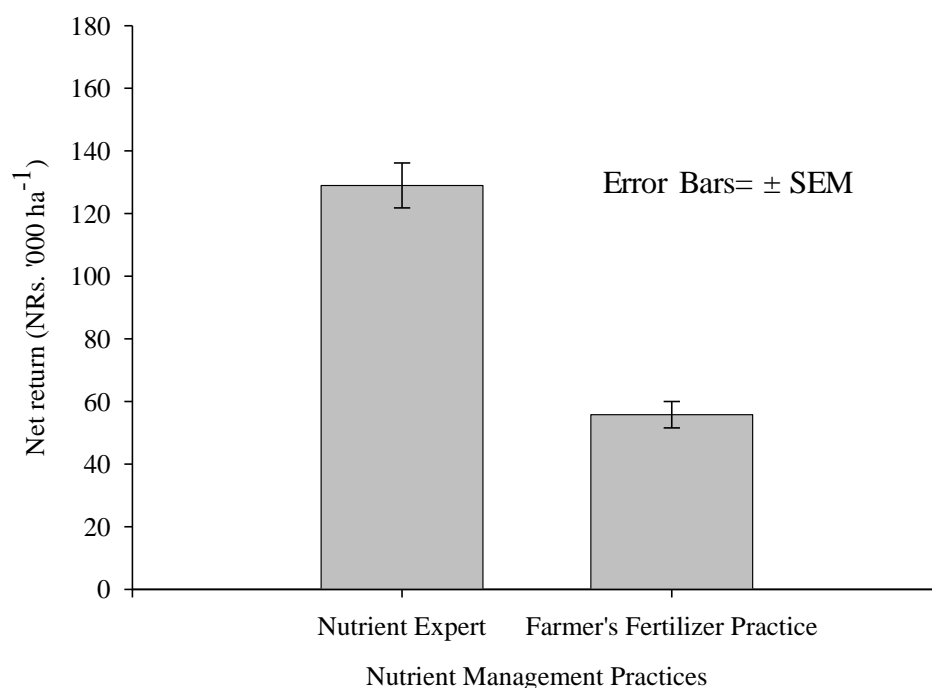


Fig.4: Comparison of net return of maize in two nutrient management practices

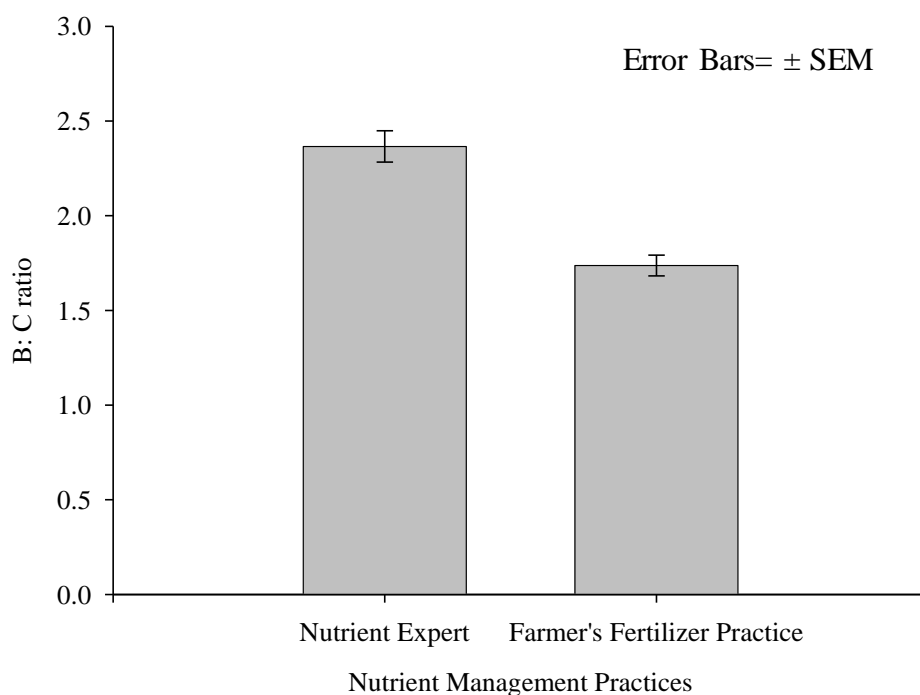


Fig.5: Comparison of benefit cost (B: C) ratio of maize in two nutrient management practices

IV. CONCLUSION

Since indiscriminate use of fertilizer and lack of site specific nutrient management technology is mainly responsible for low maize productivity and profitability in Nepal, these can be increased under NE based nutrient management practice. Thus, NE based practice can be adopted for obtaining higher productivity and profitability

for maize production in eastern terai region and similar agro-climatic condition of Nepal.

ACKNOWLEDGEMENTS

The authors are thankful to FORWARD, Nepal and farmers of research sites for providing research field and supports in the field works.

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