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Research Article

Nutrient Expert Impact on Yield and Economic In Maize and Wheat

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Abstract

The lower productivity and higher yield gaps in major cereals are the dominant problems of agriculture in eastern-terai of Nepal. Hence, field experiment was conducted to evaluate Nutrient Expert® wheat and maize model on farmer's field at two sites each for maize and wheat in Morang and Jhapa district. The experiment was conducted in Randomized Completely Block Design replicated among twenty farmers in each district. Two treatments executed were NE (Nutrient Expert Recommendation) and FFP (Farmer Fertilizer Practices).The result revealed significant difference in terms of morphology, yield attributes and yield of wheat and maize. The highest wheat yield (4.71 ton ha^{-1}) was obtained from NE followed by FFP (3.00 ton ha^{-1}) in Jhapa and in Morang, was (4.01 ton ha^{-1}) in NE followed by (2.05 ton $ha^{-1)}$ in FFP. In contrary, the higher maize yield (9.22 ton ha^{-1}) was obtained from NE followed by FFP (4.94 ton ha^{-1}) in Jhapa and (8.059 t ha^{-1})in Morang NE followed by FFP (4.52 ton ha^{-1}). The net revenue of NE wheat in Morang was found to be increased by 344.799% while in maize the increment in net revenue of NE was only by 131.158% in Jhapa than in Morang. NE based practices produced significantly higher productivity and profitability in comparison with FFP.

Keywords: Farmer's Fertilizer Practices, Nutrient Expert, Wheat, Maize, Net Revenue

Introduction

Wheat and maize are the most important cereal crops in Nepal. Due to lack of specific nutrient management of the fertilizer causes the severe loss in yield. The SSNM practice in rice increased the yield by 37.56% (Shrestha *et al.*, 2016). Site-specific nutrient management (SSNM) integrates information from different scales to make field-specific decisions on N, P, and K management. SSNM is a set of nutrient management principles, which aims to supply a crop's nutrient requirements tailored to a specific field or growing environment. It aims to account for indigenous nutrient sources, including crop residues and manures and apply fertilizer at optimal rates and at critical growth stages to meet the deficit between the nutrient needs of a high yielding crop and the indigenous nutrient supply (IRRI, 2011).

SSNM strives to enable farmers to dynamically adjust fertilizer use to optimally fill the deficit between the nutrient needs of a high yielding crop and the nutrient supply from naturally occurring indigenous sources, including soil, crop residues, manures, and irrigation water. The SSNM

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approach does not specifically aim to either reduce or increase fertilizer use. Instead, it aims to apply nutrients at optimal rates and times in order to achieve high rice yield and high efficiency of nutrient use by the rice, leading to high cash value of the harvest per unit of fertilizer invested. SSNM also provides guidance relevant to the context of farmer's fields. SSNM maintains or enhances crop yields, while providing savings for farmers through more efficient fertilizer use. By minimizing fertilizer overuse, greenhouse gas emissions can be reduced in some cases up to 50%. Nutrient Expert® an innovative, information and communication technology (ICT)-based decision support systems (DSS) tool such NE for maize, rice and wheat which uses SSNM to develop strategies to manage fertilizer N, P, and K (Gabinete and Buresh, 2009).

Government of Nepal provides region based fertilizer recommendation, single fertilizer dose recommendation for each terai, hills, and mountain but nutrient status of the field vary from farmers field to field, and government recommendation fertilizer dose is impractical to meet the demand of specific crop at specific sites. Whereas Farmers have small sized of land holding and practice intensive cropping system. They apply fertilizer as per their wish. Imbalanced use of fertilizer (use of either higher or lower dose of fertilizer) gives low economic return, low productivity and unsustainability of production. On contrary to this, hybrid maize and wheat is a high nutrient demanding crop and its sustainable production can only be achieved by site specific nutrient management practice (SSNM).

Existing fertilizer recommendations for crops often advise fixed rates and timings of N, P, and K for vast areas of cereals production. Such recommendations assume the need of crops for nutrients is constant among years and over large areas. But crop-growth and crop-need for supplemental nutrients can be strongly influenced by crop-growing conditions, crop and soil management, and climate - which can vary greatly among fields, villages, seasons, and years. Thus, this study was conducted to find out the impact of SSNM and increase the economic status of farmer by increasing the productivity of maize and wheat.

Materials and Methods of Maize and Wheat

This study was conducted in Eastern Nepal in Jhapa district in amalgamation with FORWARD, Nepal, NRNA-NCC Australia and IPNI, Delhi project "Transfer, Evaluation and Dissemination of an Innovative Fertilizer Management Tool (Nutrient Expert®) for Increasing Crop Yields and Farmers' Income in Eastern Nepal". Twenty farmers were selected randomly on the site of Morang(Itahara and Rajghat) for maize and Morang(Itahara and BabiyaBirta) for wheat and Jhapa(Damak and Gauradaha for maize and Jhapa(Dhukurpani and Gauradaha). The site of Jhapa is located at an elevation of 1,350 m with the latitude of 26º22'00" N and longitude of 88º12'00" E with the altitude of 70 m to 506m and the site of Morang is located at the latitude of 26.5500° N and longitude of 87.6200° E with the altitude of 80m to 169m masl. The experiments were carried out in selected Farmer's field. A preliminary survey was done in 2 VDCs for selection of farmer's field. Total of 10 farmers were chosen for the experimental trails from each VDC.

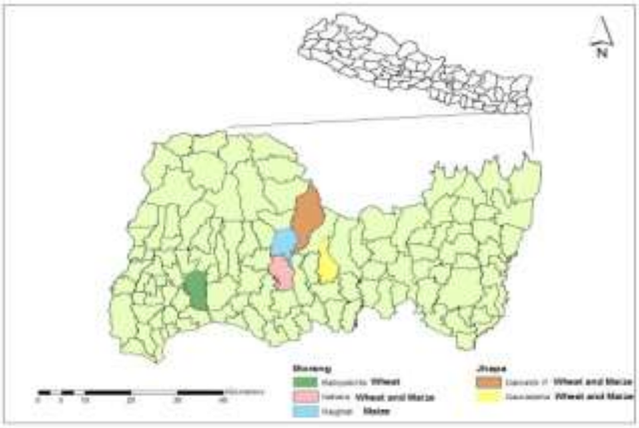

Fig. 1: Map showing the VDC of Jhapa and Morang where survey site is implemented.

Farmers of each municipality was collected, among them farmer mostly growing maize and wheat was selected. Preliminary survey was done with the Nutrient Expert questionnaire by interview with the farmer and visiting the farmers' field. The information was collected from the farmers, yield and cost of cultivation for each farmer field was obtained by using the Nutrient Expert® software Questionnaire was filled up from mid April 2016 for wheat and around mid-May for maize. 10 household of each municipality was selected to take the representative soil sample of the project side. For soil sampling Z pattern was drawn, soil from 20 cm depth was collected and representative soil sample was prepared by mixing it well and was sent to soil testing laboratory Tarhara and some of the sample was sent to IPNI lab of India to test the nutrient status of the soil.For the nutrient content of farm yard manure and poultry manure, 2-3 sample of FYM and poultry manure was collected and send to IPNI research laboratory to know about the nutrient's content. Research design Randomized Complete Block Design with 2 treatments and 20 replications was set up. Treatments were NE – Nutrient Expert® -Maize recommended spacing and fertilizer dose FP – Farmer own practice of seed rate and fertilizer dose,Nutrient recommendation. For nutrient expert field, nutrient recommendation for individual farmer field was given by nutrient expert software model Maize: 150:90:100 N, P, K (kg/ha), Wheat: 170:90:80 N, P, K (kg/ha) and In farmer field plot farmer had their own previous practice. Gross plot size: 100 m^2, Net plot size was 1 m^2 and 10 m^2 from where yield attributing data and actual yield were taken respectively.

FYM, Nitrogen, phosphorus and potash were applied in nutrient expert filed as per the recommendation from nutrient expert software. Full doses of phosphorus, potash and fym were given as basal dose while nitrogen was provided in three-split dose. Field will be prepared first by using a tractor. A deep ploughing was done on Dec. 3rd 2016. Final field preparation was completed on 7th Dec. 2016 for maize and around first week of November for wheat. Broadcasting was done in farmers' field practice while line sowing was in nutrient expert plot in both maize and wheat. Maize (Pioneer-3785) was sown on first week December and Wheat (NL-297) in first week of November. The spacing for NE maize: 60x20 cm^2, the wheat was contnously sowed with

Two weeding were done at 30 DAS and 25 days after first weeding in NE plot while single weeding at 30 DAS was done in FFP plot in both maize and wheat and weeding was done manually in both the treatments. Loosening and earthing up was done after 45 DAS in maize. Wheat was carried to house cutting with sickle on to threshing floor in the field, beaten with wooden stick. None of them used a mechanical thresher or animal for threshing. While maize was also harvested manually. Harvesting and data collection was done from Mid May 2016 for maize and first week of April 2016 for wheat. The yield and attributes effective tillers/m2, spike length and filled grains/spike of wheat and No of ear/m2, No of kernel row/cob, No of kernel/row, No. of kernel/cob of maize were taken and similarly, Cost of cultivation, Gross return, Net revenue, B:C ratio were also calculated. Microsoft word was used for data processing. MS excel was for data input, table, charts, graphs and simple statistical analysis. IBM® SPSS Statistics® version 16.0 and GenStat® 15th edition were used for statistical analysis. ANOVA was performed at 0.05% level of significance.

Results and Discussion

Yield Attributes of Maize and Wheat

From the trail set up in the farmers field; yield, yield attributes and economics of hybrid maize and wheat was obtained. Highly significant result was found for plant no. (m^2), cob no. (m^{-2}), test wt. (g), yield at 15.5% (t ha^{-1}) , avg. no. of kernel/ear, average, biological yield and stover yield in both Jhapa and Morang maize as shown in Table 5, Table 6, Table 7 and Table 8. Significant result was found in harvest index of Morang maize while highly significant result on Jhapa maize (https:// en.m.wikipidia. Org / wiki/ Jhapa_ district). Cob length was found to be non-significant in Jhapa maize while highly significant in Morang maize (https:// en.m.wikipidia. Org / wiki/ Morang_ district). Highly significant result was found for spike length, filled grain per spike, effective tillers per metre square and biological yield in both Jhapa and Morang wheat as shown in Table 1, Table 2, Table 3 and Table 4. Significant result was found in plant height, straw yield and harvest index on Morang wheat while highly significant result in Jhapa wheat.

Highest length of cob was found in NE maize i.e (18.07 cm and 18.87 cm) followed by (17.26 cm and15.71 cm) in FFP in Jhapa and Morang respectively but result was non-sig for Jhapa maize in case of cob length. The highest kernel row per cob and seed no. per cob was found in NE maize i.e. (14.23 and 14.2) followed by (13.41 and 13.15) in FFP while (589.9 and 595.1) seed no./cob in NE followed by (502.4 and 455.6) in FFP of Jhapa and Morang respectively. Larger cob size may be the result of enhanced photosynthetic activity followed by efficient utilization of applied N, efficient transfer of metabolites and subsequent accumulation of these metabolites in the cob The cob length may be non-sig due to environmental influences. Increasing nitrogen applications increased ear length, ear diameter, kernel number per ear and single fresh ear weight (Oktem & Oktem, 2005). The number of kernels per ear is a function of ear length (kernels per row) and kernel rows per ear. Thousand grain weight, number of kernel rows ear-1, number kernels ear-1 , grain yield, stover yield as well as harvest index showed remarkable increase with increasing N rate and number of N split application (Pandey and Chaudhary, 2014). Highest kernel row per cob and highest average no. of kernel/ rows was found in NE maize in both Jhapa and Morang. So, highest kernel per ear was found in NE. Lowest kernel per row was observed in FFP which result lower yield. Although there is no difference among these two treatments in Jhapa maize in case of length of ear/ plant but significant difference in kernel no. shows that incomplete grain filling was found in case of FFP.

Table 1: Effect of improved nutrient management on plant no./m^2, cob no./m^2, cob length, kernel row/cob, seed no./cob and test weight on maize in Morang:

Treatments	Cob number/m^2	Cob length (cm)	Kernel row/cob	Seed no./cob	Test weight
NE	7.75	18.87	14.2	595.1	327.5
FFP	4.65	15.71	13.15	455.6	292.5
SEm (±)	0.153	0.221	0.12	10.33	4.34
LSD	0.453**	0.65**	0.3552**	30.56**	12.84**
CV	11	5.7	3.9	8.8	6.3

Note: NS= non-significant; Significant "*"; highly significant "**"

Table 2: Effect of improved nutrient management on plant no./m^2, cob no./m^2, cob length, kernel row/cob, seed no./cob and test weight on maize in Jhapa:

Treatments	CL(cm)	Kernel row/cob	Seed no./cob	Test weight
NE	18.07	14.23	589.9	361.4
FFP	17.26	13.41	502.4	310.4
SEm (±)	0.712	0.1277	10.58	4.15
LSD	2.107NS	0.378**	31.31**	12.27**
CV	18	4.1	8.7	5.5

Note: NS= non-significant; Significant "*"; highly significant "**"

Table 3: Effect of improved nutrient management on effective tillers /m^2, filled grains/spike, length of spike and plant height on wheat in Morang.

Treatments	Eff. tillers/m^2	Filled grain per spike	Spike Length(cm)	Plant Height(m)
NE	363.4	52.75	7.912	0.991
FFP	270.7	44.7	6.705	0.9297
SEm (±)	7.48	0.725	0.1087	0.01194
LSD	22.14**	2.145**	0.3217**	0.03533*
CV	10.5	6.6	6.6	5.6

Note: NS= non-significant; Significant "*"; highly significant "**"

Table 4: Effect of improved nutrient management on effective tillers /m^2, filled grains/spike, length of spike and plant height on wheat in Jhapa.

Treatments	Eff. tillers/m^2	Filled Grains per spike	Spike Length(cm)	Plant Height(m)
NE	358.3	46.7	7.283	1.155
FFP	274.9	38.85	6.040	0.947
SEm (±)	11.6	0.917	0.1162	0.0271
LSD	34.34**	2.713**	0.3439**	0.0802**
CV	16.4	9.6	7.8	11.5

Note::NS= non-significant; Significant "*"; highly significant "**"

Table 5: Effect of improved nutrient management on grain yield, biological yield, straw yield, harvest index, gross revenue, cost of cultivation, net revenue and B:C ratio on wheat in Morang.

Treatments	Grain Yield (t/ha) (t/ha)	Biological Yield (t/ha)	Straw Yield (t/ha)	Harvest Index	Gross Revenue (NRs/ha)	Cultivation Cost (NRs/ha)	Net Revenue (NRs/ha)	Benefit Cost Ratio
NE	4.018	7.565	3.547	53.27	80364	33709	47968	2.421
FFP	2.057	5.096	3.039	40.31	41132	29552	10784	1.367
SEm (±)	0.057	0.1165	0.095	0.828	1139.2	205.4	792	0.0229
LSD	0.17**	0.34**	0.28*	2.45*	3372**	639.4**	2465.3**	0.071**
CV	8.4	8.2	12.9	7.9	8.4	2.9	12.1	5.4

NS= non-significant; Significant "*"; highly significant "**"

Table 6: Effect of improved nutrient management on grain yield/ha, biological yield, harvest index, gross revenue, cost of cultivation, net revenue and B:C ratio on wheat in Jhapa.

Treatments	Grain Yield (t/ha)	Biological Yield (t/ha)	Straw Yield (t/ha)	Harvest Index	Gross Revenue	Cultivation Cost (NRs/ha)	Net Revenue (NRs/ha	Benefit Cost Ratio
NE	4.713	7.28	3.78	65.12	147979	45102	102878	3.291
FFP	2.999	6.14	3.078	49.04	102265	41703	60562	2.453
SEm (±)	0.0612	0.161	0.0638	1.323	1681.4	349.2	1750.2	0.0501
LSD	0.181**	0.476**	0.1889**	3.917**	4977**	1033.7**	5180.4**	0.1483**
CV	7.1	10.7	8.3	10.4	6	3.6	9.6	7.8

Note: NS= non-significant; Significant "*"; highly significant "**"

Table 7: Effect of improved nutrient management on biological yield, grain yield, stover yield, harvest index, gross revenue, cost of cultivation, net revenue and benefit cost ratio on maize in Morang.

Trts	Biological Yield (t/ha)	Grain Yield (t/ha)	Straw Yield (t/ha)	Harvest Index	Gross Revenue (NRs/ha)	Cultivation Cost (NRs/ha)	Net Revenue NRs/ha)	Benefit Cost Ratio
NE	21.22	8.059	13.16	38.11	151116	44125	103552	3.18
FFP	13.7	4.525	9.18	33.43	84834	39275	42578	1.995
SEm (±)	0.335	0.1007	0.335	0.892	1887.8	321.9	1873.5	0.0451
LSD	0.993*	0.298**	0.992**	2.64*	5587.8**	956.3**	5566.3**	0.1341**
CV	8.6	7.2	13.4	11.2	7.2	3.5	11.5	12.8

Note: NS= non-significant; Significant "*"; highly significant "**"

Table 8: Effect of improved nutrient management on biological yield, grain yield, stover yield, harvest index, gross revenue, cost of cultivation, net revenue and benefit cost ratio on maize in Jhapa:

Trts	Biological Yield (t/ha)	Grain Yield (t/ha)	Straw Yield (t/ha)	Harvest Index	Gross Revenue (NRs/ha)	Cultivation Cost (NRs/ha)	Net Revenue NRs/ha)	Benefit Cost Ratio
NE	21.92	9.22	12.7	42.13	224049	95079	128970	2.364
FFP	13.55	4.94	8.62	36.55	131264	75470	55793	1.738
SEm (±)	0.279	0.1395	0.236	0.598	2502.4	500	2731.9	0.0285
Lsd	0.827**	0.413**	0.699**	1.77**	7406.9**	1480**	8086.5**	0.0845**
CV	7	8.8	9.9	6.8	6.3	2.6	13.2	6.2

Note: NS= non-significant; Significant "*"; highly significant "**"

Test wt. of grain from was found highly significant. Highest test wt. was found in NE maize i.e (361.5 g and 327.5g) followed by FFP maize (310.4 g and 292.5 g) in Jhapa and Morang respectively. Higher the test wt. complements for the higher yield. The increase in test weight increase yield that increase in net revenue. The 1000-grain weight increased with N application (Scientific and technical research council). Test weight was higher due to increase in cholorophyll content in leaves, which lead to higher photosynthesis rate and ultimately plenty of photosynthesis available during grain development. (Awan et. al., 2006).

The highest spike length (7.283 cm and7.912 cm) followed by FFP wheat (6.040 cm and 6.705 cm), highest filled grains per spike in NE wheat (46.7 and 52.75) followed by FFP wheat(38.85 and 44.7), highest tillers per square metre in NE maize (358.3 and 363.4) followed by (274.9 and 270.7) in both Jhapa and Morang respectively. Plant height increased with balanced fertilizer as corroborates with the findings of MoAD (2013), due to significant absorption of nitrogen, macro and micro nutrients improving soil WHC. The probable justification may be increase might be due to balance supply of N need for vegetative growth , increase internodes length, increase the cell elongation. Increasing nitrogen supply enhanced both shoot and root growth and the positive effects of N on shoot growth were pronounced than root growth. Uddin *et al.*, 1998 reported that balanced and optimum use of fertilizer application increased the number of effective tiller. The more number of filled grain per spike in higher nitrogen rate were probably due to better nitrogen status of plant during panicle growth period that was applied during second spilt dose of urea of NE recommendation. Nitrogen application also increased plant height, grains spike-1, filled grains per spike, effective tillers, harvest index, biological yield and grain yield (Iqbal *et al.*, 2012). These results matched with those given by Bakht, *et al.*, (2010) that observed foliar as well as soil application of N significantly increased growth characteristics. Plant height, total tillers/m^2, effective tillers plant^{-1}, effective tillers plant^{-1}, grains spike^{-1}, 1000- grain weight and harvest index, was found significantly correlated with grain yield due to application of nitrogen on findings of Kader *et al.* (2013). High nitrogen availability in split doses at proper timings plays vital role in cell division or high no. of effective tiller/m^2 (Shrestha *et al.*, 2016). Significant effects of split application of N on total tillers have been reported by other researchers (Ali *et al.*, 2015). These results are in contrast with those of Sarkar and Shit (1990), who proposed that N application at different growth stages like split at sowing; tillering and flowering gave optimum grain yield. Number of tillers per/m^2, plant height, spike's length , 1000-grain weight and grain yield were significantly increased by increasing the nitrogen levels over control (Ali *et al.*, 2011). Nitrogen application displayed significant effect on plant height, total dry matter, 1000-seed weight and grain yield (Dagash *et al* 2014). Plant height, ear length, grains number per ear, biological yield and grain yield were increased with increasing N level (Soleimanzadeh *et al.*, 2013). The effect of nitrogen application timing had vigorous growth in terms of plant height and dry matter accumulation, which eventually produced significantly higher effective tillers, higher number of grains per head and higher grain weight per head and ultimately significantly higher grain and straw yields (Bhardwaj *et al.*, 2010). Plant height, number of tillers m^{-2}, spike length, 1000-grain weight, grain yield, biological yield and harvest index were highest at higher level of nitrogen (Iqbal *et al*., 2012). Increasing nitrogen fertilizer rates resulted in significant increase in plant height, number of grain/spike, number of spikes/m^2, 1000 grain weight, grain yield , straw yield , and biological yield.

Use of NE increased Yield and economics of hybrid Maize and hybrid wheat

Relative performance of NE hybrid maize was found better than FP. Significant result was obtained in grain yield, biological yield, stover yield ,harvest index, gross revenue,cost of cultivation, net revenue and benefit cost ratio of hybrid maize and hybrid wheat. Highest grain yield was observed in NE maize i.e. (9.22 t/ha and 8.059 t/ha) followed by FFP maize (4.94 t/ha and 4.525 t/ha). Highest biological yield in NE maize (21.92 t/ha and 21.22 t/ha) followed by FFP maize (13.55 t/ha and 13.7 t/ha). Highest stover yield in NE maize (12.7 t/ha and 13.16 t/ha) & followed by FFP(8.62 t/ha and 9.18 t/ha), highest harvest index in NE maize (42.13 and 38.11) followed by FFP(36.55 and 33.43), highest gross revenue in NE maize (224049 Rs/ha and 15116 Rs/ha) followed by FFP (131264 Rs/ha and 84834 Rs/ha), highest cost of cultivation in NE maize(95079 t/ha and 44125 t/ha) followed by FFP(75470 Rs/ha and 39275 t/ha), highest net revenue in NE maize (128970 Rs/ha and 103552 Rs/ha) followed by FFP(55793 Rs/ha and 42578 Rs/ha) and highest benefit cost ratio in NE maize (2.364 and 3.18) followed by FFP(1.738 and 1.995) in Jhapa and Morang respectively. Highest grain yield was observed in NE wheat i.e. (4.713 t/ha and 4.018 t/ha) followed by FFP wheat (2.99 t/ha and 2.057 t/ha), highest biological yield in NE wheat (7.28 t/ha and 7.565 t/ha) followed by FFP wheat (6.14 t/ha and 5.096 t/ha), highest stover yield in NE wheat (3.78 t/ha and 3.547 t/ha) followed by FFP(3.07 t/ha and 3.039 t/ha), highest harvest index in NE wheat (65.12 and 53.27) followed by FFP(49.04 and 40.31), highest gross revenue in NE wheat(147979 Rs/ha and 80364 Rs/ha) followed by FFP(102265 Rs/ha and 41132 Rs/ha),highest cost of cultivation in NE wheat (45102 t/ha and 33709 t/ha) followed by FFP(41703 Rs/ha and 29552 t/ha), highest net revenue in NE wheat (102878 Rs/ha and 47968 Rs/ha) followed by FFP(60562 Rs/ha and 10784 Rs/ha) and highest benefit cost ratio in NE wheat (3.29 and 2.42) followed by FFP (2.45 and 1.36) in Jhapa and Morang respectively due to higher Plant population, higher cob no per m ^{2}, higher kernel row/ear, kernel no./ear and higher test wt. which ultimately results in higher yield. Increased in yield and economics was obtained in NE based practice. Under both low and high N supply, the grain demand for N could not be met solely by soil N uptake during grain-filling, and there was significant mobilisation of vegetative N to grain N. Consequently, leaf N and RUE declined during grain-filling in all situations (Muchow, 1994).

Improved maize and wheat yields with the use of NE-based fertilizer recommendations could be attributed to the 4R complaint scientific nutrient prescription generated by NE, which primarily suggests application of major NPK nutrients using the right fertilizer sources, applied at the right rate and at the right time. Higher N from NE cause lower competition for nutrient that allow the plant to accumulate more biomass with higher capacity to convert more photosynthesis into sink resulting in more yield. Increase in gross revenue in case of NE lead to higher profitability than FFP. Although there is no difference among these two treatments in Jhapa maize in case of length of ear/ plant but significant difference in kernel no. shows that incomplete grain filling was found in case of FFP. Increase in plant height may be due to balance supply of N need for vegetative growth , increase internodes length, increase the cell elongation. Increasing nitrogen supply enhanced both shoot and root growth and the positive effects of N on shoot growth were pronounced than root growth. Fertilizer management in dose, space and time can significantly increase grain yield (He *et al*., 2009). Fertilizer recommendation and nutrient management based on NE fits in with the 4R nutrient stewardship strategy to optimize the supply and crop demand for nutrients and achieve balanced plant nutrition (Buresh, 2010). Compared to FP, NE increased grain yield and gross return above fertilizer cost, and decreased total fertilizer cost. The low yield difference between NE and FP in summer maize was related to high soil indigenous nutrient supply due to excessive fertilizer application in the previous crops in FP and thus led to the lower yield response (Cui *et al*., 2008a). NE also suggested application of secondary and micronutrients wherever they were deficient and helped in promoting balanced use of all the essential nutrients in addition to improving yields and optimizing nutrient use (Satyanarayana, 2014).

Similar result was found in Indonesia, Philippines, Karnataka and Tamil Nadu of India by providing a nutrient management strategy tailored to field specific condition. NE increased grain yield and gross return above fertilizer cost, and decreased total fertilizer cost (Cui *et al*., 2008a). Application of nitrogen brings Plant height, total tillers/m^2, effective tillers plant/m^2, effective tillers/m^2, grains spike^{-1}, 1000- grain weight and harvest index corelation with grain yield Kader *et al* (2013). Nitrogen application increased plant height, grains spike-1, filled grains per spike, effective tillers, harvest index, biological yield and grain yield ((Ali *et al*., 2015). Studies using NE for other crops like maize and wheat also showed significant yield advantage from the NE-based fertilizer recommendation as compared to existing practices (Pampolino *et al*., 2012; Sapkota *et al*., 2014). Dobermann *et al*. (2004) also reported similar results that the SSNM practice in rice and maize across Asia resulted in higher yields than the FFP. Enhanced nitrogen availability enhanced leaf area, high photo assimilates more dry matter accumulation promoting growth and yield attributes. Reducing N and P use on most farms, and increasing K use improvement in yields, as well as nutrient use efficiency (Pampolino *et al.*, 2012). Higher yield gap can be closed improved nutrient management and agronomic practices (IPNI unpublished data).Nitrogen significantly increased the grain yield. The tasseling period was reduced as the nitrogen level.

Conclusion

Highly significant result was obtained for Comparison of Nutrient Expert® (NE) actual maize yield and gross revenue in farmer field trail and NE-based fertilizer recommendations proved to be successful while comparison. The actual maize yields recorded in farmer fields were higher by the NE management. The highest wheat yield was obtained in Jhapa NE (4.71 ton ha^{-1}) followed by FFP (3.00 ton ha^{-1}) and in Morang, NE wheat yield was (4.01 ton ha^{-1}) followed by FFP (2.05 ton ha^{-1}). In contrary, the higher maize yield was obtained in Jhapa NE (9.22 ton ha^{-1}), followed by FFP (4.94 ton ha^{-1}) and in Morang, NE maize yield was (8.059 t ha^{-1}) followed by FFP (4.52 ton ha^{-1}). The net revenue of NE wheat in Morang was found to be increased by 344.8%.The net revenue of NE maize in Jhapa was found to be increased only by 131.2%.

Thus, NE recommendation was found better over FFP. Higher yield and profitability from hybrid maize was obtained from NE based recommendation as it make use of the right source of fertilizer ,at right time, in right amount and in right place and fulfilled the growing demand for maize for food and feed. A good fertilizer recommendation method should focus on notonly maintaining high crop yield, but also reducing environmental risks so as to maintain sustainable development of agriculture. Compared with FP, proper fertilization dosage and fertilizer application time based on NE increased fertilizer K rate, and reduced N and P fertilizer rates, which significantly increased grain yield, plant nutrient uptake, nutrient use efficiency, economic benefits, and reduced apparent N loss. The NE method is a dynamic fertilization model, which adjusts fertilizer rates based on yield response, agronomic efficiency and nutrient balance for every year or season rather than using a constant fertilizer rate. The difference in climate conditions suggested that different nutrient management strategies were required for managing maize and wheat in each domain, which is one of the main considerations of the NE method. The NE method provides a scientific and reasonable guidance for fertilizer recommendation and nutrient management, enabling farmers to dynamically adjust fertilizer application rates based on crop requirements.

References

Ali A and Mubeen M (2011) Effects of nitrogen on growth and yield components of wheat Debnath, M. A. Kader and N. 2014. Effect of Nitrogen and Boron on the Performance of Wheat. *J. Environ. Sci. & Natural Resources* **7**(1): 1999-7361.

Ali NA, Sarkar MA and Paul SK. (2015) Effect of Number of Seedlings Hill-1 and Rate and Time of Nitrogen Application on the Yield of Late Transplant Aman Rice (cv. Br23). *International Journal of Applied Sciences and Biotechnology* **3**(4): 692-698. DOI: 10.3126/ijasbt.v3i4.13978

Awan TH, Manzoor Z, Safdar ME and Ahmad M (2006) Studies on the influence of primary, secondary and tertiary tillers on yield and yield related traits in basmati-2000. *Pakistan J Sci* **59**(1-2): 43-46.

Bakht J, Shafi M and Shah R (2010) Effect of various priming sources on yield and yield components of maize cultivars. *Pak J Bot* **42**(6): 4123-4131.

Bhardwaj V, Yadav V and Chauhan S (2010) Effect of nitrogen application timings and varieties on growth and yield of wheat grown on raised beds. 56(2): *Archives of Agronomy and Soil Science* **56**(2): 211-22. DOI: 10.1080/03650340903092218

Buresh RJ (2010) Nutrient best management practices for rice, maize, and wheat in Asia. In: World Congress of Soil Science Vol. 16.

Gabinete G and Buresh RJ (2009) Site-specific nutrient management (SSNM): profitability to farmers, current level of adoption, and constraints to wider adoption in Iloilo province. In: The Philippines. Paper presented at IFA Crossroads Asia-Pacific Conference, Kota Kinabalu, Malaysia

He P, Pampolino MF, Chuana L, Johnston AM, Qiu S, Zhao S, Zhou W and Xua X (2013) Nutrient requirements for maize in China based on QUEFTS. *Field Crops Research* **150**:115–125. DOI: 10.1016/j.fcr.2013.06.006

Iqbal J, Hayat K, Hussain S, Ali A and Alias MA and Bakhsh HA (2012) Effect of Seeding Rates and Nitrogen Levels on Yield and Yield Components of Wheat (*Triticum aestivum* L.) *Pakistan Journal of Nutrition* **11**(7): 53. DOI: 10.3923/pjn.2012.629.634

Kader MA, Sleutel S, Begum SA, Moslehuddin AZM and Neve SD (2013) Nitrogen mineralization in subtropical paddy soils in relation to soil mineralogy, management, pH, carbon, nitrogen and iron contents. *Eur J Soil Sci* **64**: 47–57. DOI: 10.1111/ejss.12005

MoAD (2013) Statistical information on Nepalese agriculture 2012/2013. Agribusiness Promotion and Statistical Division. Singhadurbar, Kathmandu.

Muchow RC (1994) Effect of nitrogen on yield determination in irrigated maize in tropical and subtropical environments. *Field crops research* 38(1): 1-13. DOI: 10.1016/0378-4290(94)90027-2

Oktem AG and Oktem A (2005) Effect of nitrogen and intra row spaces on sweet corn (Zea mays saccharata Sturt) ear characteristics. *Asian Journal of Plant Sciences* **4**(4): 361-364. DOI: 10.3923/ajps.2005.361.364

Pampolino MF, Witt C, Pasuquin JM, Johnston A and fisher MJ (2012) Development approach and evaluation of the Nutrient Expert software for nutrient management in cereal crops. *Karnataka J Agric Sci* **24**: 86-90. DOI: 10.1016/j.compag.2012.07.007

Pandey B and Chaudhary NK (2014) Response of tillage system, nitrogen level and split application of nitrogen on spring maize in Chitwan, Nepal. *Int J Appl Sci Biotechnol* **2**(3): 298-301. DOI: 10.3126/ijasbt.v2i3.11007

Sapkotaa TB, Majumdarb K, Jata ML, Kumara A, Bishnoia DK, McDonaldd AJ, Pampolinoe M (2014) Precision nutrient management in conservation agriculture based wheat production of Northwest India: Profitability, nutrient use efficiency and environmental footprint. *Field Crops Research* **155**: 233–244. DOI: 10.1016/j.fcr.2013.09.001

Sarkar RK and Shit D (1990) Effect of intercropping cereals, pulses and oilseeds with maize on production, competition and advantage. *Indian Agriculturist* **34**(2): 89-98.

Satyanarayana T, Majumdar K, Dutta S, Jat ML, Pattanayak SK, Biradar DP, Aladakatti YR, Pampolino M and Johnston A (2014) Nutrient Expert®–Maize: A Tool for Increasing Crop Yields and Farm Profit. Better Crops South Asia.

Shrestha A, Gupta G, Shrestha A and Subedi R (2016) Effect of different nutrient management practices in Rice in Jhapa district, *Impact journal*.

Soleimanzadeh H and Gooshchi F (2013) Effects of *Azotobacter* and Nitrogen Chemical Fertilizer on Yield and Yield Components of Wheat (*Triticum aestivum* L.). *World Applied Sciences* **21**(8): 1176-1180.

Uddin MS, Sattarand MA and Salam MA (1998) Effect of organophosphorus pesticides on ecology of Rice production in soils. *Bangladesh J Environ Sci* **4**: 169-178.