

# TECHNICAL BULLETIN

No. 32, 2021

## Integrated Nutrient Management for Sustaining Soil Fertility and Productivity in Intensive Cropping Systems

Low and decreasing soil organic matter content, higher cropping intensity, improper cropping sequences and faulty management practices are the major causes of soil fertility decline in Bangladesh. Intensive use of high-yielding varieties has led to a sharp increase in nutrient depletion from soil. Farmers usually apply fertilizers on a crop to crop basis instead of considering the cropping pattern, and also, there is hardly any organic matter application or recycling. Lately, in many parts of the country, farmers have recently switched from two-crop or three-crop patterns to four crop based cropping patterns to increase land productivity and profits, which obviously would require improved soil and crop management practices to sustain soil fertility and productivity over the long run. To maintain and improve soil fertility and organic matter content of the soil it is necessary to apply organic manure along with inorganic fertilizers in an integrated manner. Nutrients present in soil, added as inorganic and organic sources and the nutrient harvested by crops should be considered to develop cropping pattern-based fertilizer recommendations for different agro-ecological conditions of country. This research project was aimed at improving system productivity and sustaining soil fertility through integrated nutrient management in selected areas of six upazilas of five districts of Bangladesh.

### Methodology

Field trails were conducted in selected areas of six upazilas viz., Gabtali (Bogura), Lahirirhat (Rangpur), Mohanpur (Rajshahi) Godagari (Rajshahi), Melandah (Jamalpur) and Sherpur Sadar (Sherpur) on integrated nutrient management for cropping with three/four component crops during November 2015 to April 2019. The trials were designed and set based on information collected through focus group discussions (FGD) on major cropping patterns and suitable crop varieties (short-duration HYV). Soil samples were collected from each participating farmer's field before setting



An experimental field with a standing Potato crop at Lahirirhat, Rangpur



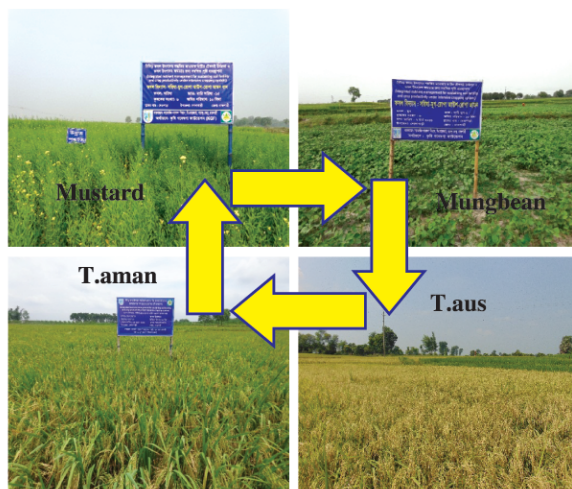
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up a trial. Fertilizer doses used for the test cropping patterns were based on initial soil analysis. After completion of the three years' trials, soil samples from the same fields were collected again and analyzed. The experiment consisted of two management packages - trial plots received integrated plant nutrition system (IPNS) based fertilizer doses for high yield goal (HYG) and farmers' practices (FP) that comprised average fertilizer doses applied by 10-15 farmers of the locality concerned.

## Results and Outputs

Irrespective of location, after completion of three crop cycles, the rice equivalent yield (REY) in trial plots (IPNS-HYG) was found to be higher than that in FP plots (Table 1). Similarly, gross margin was also higher for the trial plots than FP plots. The cropping pattern Mustard-Boro-T. Aus- T. Aman using IPNS-HYG fertilizer doses fetched 58.67% higher REY compared with FP in Gabtali, Bogura. This pattern needed almost 340 d (excluding seedling age of rice) with 25 d turn-around time to complete the whole cycle. At Lahirirhat, Rangpur, 29.94% higher REY was obtained by the four-crop pattern, Potato-Boro-T. Aus-T. Aman with IPNS-HYG fertilizer doses than FP. This



**Experiment on integrated nutrient management for a cropping pattern with four component crops**

Table 1. Average rice equivalent yield (REY) and gross margin (GM) for trial plots (TP) and farmers' practice (FP) plots at different locations of Bangladesh

Treatment/Location	REY	REY increase over FP (%)	GM (Tk/ha)	GM increased over FP (%)
<b>i. Gabtali, Bogura</b>				
TP (IPNS)	17.01	58.67	200910	99.5
FP	10.72	-	100695	
<b>ii. Lahirirhat, Rangpur</b>				
TP (IPNS)	29.47	29.90	290417	60.87
FP	22.68	-	180522	-
<b>iii. Barind, Rajshahi</b>				
TP (IPNS)	15.00	46.05	152392	50.27
FP	10.27		101410	
<b>iv. Mohanpur, Rajshahi</b>				
TP (IPNS)	32.21	9.48	308027	17.43
FP	29.42		262309	-
<b>v. Melandah, Jamalpur</b>				
TP (IPNS)	14.16	48.69	145397	58.45
FP	9.51	-	91758	
<b>vi. Sherpursadar, Sherpur</b>				
TP (IPNS)	14.69	43.04	1771212	35.83
FP	10.27		130403	

\*REY=Rice Equivalent Yield, GM=Gross Margin, TP=Trials Plot, FP=Farmers' Practice, IPNS=Integrated Plant Nutrient System

pattern roughly needed 344 d to complete the cycle with about 21 d turn-around time in a year. At Godagari, Rajshahi, the IPNS-HYG treatment for the four-crop pattern, Mustard-Mungbean-T. Aus-T. Aman, with IPNS-HYG brought about a 50.27% increase in REY over FP. On the average, 330 d was needed to complete this pattern (excluding seedling age of rice) to complete the cycle with about 35 d turn-around time in a year. The three-crop Potato-Mungbean-T. Aus-T. Aman pattern gave a 9.48 % higher REY than FP at Mohanpur, Rajshahi. It needed 327 d (excluding seedling age of rice) to complete the cycle with about 38 d turn-around time in a year.

Calculations of nutrient balances in soil after the completion of the three-year experiment indicated that four-crop patterns absorbed much higher quantities of nutrients from soil than double or triple crop-based FP patterns at each location. The cropping pattern, Mustard-Boro-T. Aus-T. Aman rice, introduced in Bogura removed 414.03 kg/ha N annually. The values were 451.04, 377.65 and 456.41 kg/ha for the Potato-Boro-T. Aus-T. Aman (Rangpur), Mustard-Mungbean- T. Aus - T. Aman (Godagari) and Potato - Mungbean-T. Aus - T. Aman (Mohanpur), respectively. All the trial plots showed negative N balance ranging from -10 to -115 kg/ha N with the most in Mohonpur. Phosphorus uptake by plants was small compared to N and K, the P uptake from the trial plot soil being 70 to 105 kg/ha. Huge amounts of K were removed by crops in the various cropping patterns, about 80% of this being retained in straw/stover. Around 400 kg/ha K was removed by crops in the four crop-based cropping pattern. The K balance was consistently negative in all cropping patterns ranging from -100 to -295 kg/ha. These results indicated that K mining from soils has reached alarming proportions.

## **Benefits and Outcomes**

Irrespective of location, higher REY viz., 58.67%, 29.90%, 46.05%, 9.48%, 48.69% and 43.04% and higher gross margins viz. 99.50%, 60.87%, 50.27%, 17.43%, 58.45% and 35.83% were obtained in trial plots in comparison with those with farmers' practice in Bogura, Rangpur, Barind, Rajshahi, Jamalpur and Sherpur, respectively. The field trials demonstrated that integrated nutrient management considering a cropping pattern as a whole should be a better agronomic practice in increasing and maintaining system productivity. This higher yield was achieved due to inclusion of new crops and varieties as well as use of soil test based IPNS fertilizer doses with improved crop production packages for the respective cropping patterns. Soil fertility could also be preserved, except in case of potassium which needs further studies.

## **Expected Impacts**

With improved integrated nutrient management, REY as well as GM increased substantially, which was visible to the local farmers and other stake holders through training programs, field days, electronic and print media, etc. which motivated farmers to practice balance integrated nutrient management including crop residue recycling for their cropping patterns. In the experiments the modern HYV rice variety BRRI dhan48 performed very well and was well accepted by the farmers for the ausseason. Likewise, the mustard varieties BARI Sarisha-14 and BARI Sarisha-15 were found to fit well into traditional rice-rice (T. Aman-Boro) pattern performing well in a new T. Aman-Mustard-Boro increasing cropping intensity, system productivity and farmers' profits. Overall, the field trials demonstrated the possibility of increasing the production of Oilseed and Pulses which could contribute to the national economy through reduced imports of Oilseeds and Pulses.

## Recommendations

- ❖ Fertilizer packages for different crops in given cropping patterns have been recommended.
- ❖ Four crop-based cropping patterns can be practiced if short-duration crop varieties are included in the farmers' existing cropping patterns.
- ❖ Potassium fertilizer could be top dressed like N fertilizer for rice crop as well as mungbean and rice residue should be recycled for sustaining soil fertility.
- ❖ Establishment of four crops based cropping patterns needs continuous attention to the field which is sometimes difficult for the farmers. So, mechanization should be adopted for planting/sowing, harvesting and post-harvest operations to reduce production costs and ensure timely intercultural operations.
- ❖ Community-based IPM methods should be used for the control of pests to reduce risks for newly introduced unconventional crops.

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This technical bulletin has been prepared on the basis of technical information available from a completed CGP project of KGF, the details of which are given below:

**Project Code and Title:** TF 35-SF/15. Integrated nutrient management for sustaining soil fertility and crop productivity under intensive cropping system

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**Published by :**

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