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# Using Combined Nutrient Management Practices to Maximize Yields, Nutrient Uptake, and Balance for Rice-Rice Cropping Systems

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

An on-site experiment was carried out at the Bangladesh Rice Research Institute (BRRI). The objective was to assess the most appropriate blend of organic and inorganic fertilizers for the Boro-Fallow-Transplanted Aman rice cropping pattern. An experiment was carried out at the BRRI Farm in Gazipur, Bangladesh to assess rice yields, nutrient absorption, and balance. The nutrient management practices included absolute nutrient control (T1), the recommended chemical fertilizer dose by BRRI (T2), a combination of kitchen waste (3 t/ha) and 50% of the recommended BRRI fertilizer dose (T3), a combination of cow dung bio-slurry (3 t/ha) and 50% of the recommended BRRI fertilizer dose (T4), and a combination of poultry litter (3 t/ha) and 50% of the recommended BRRI fertilizer dose (T5). The practices were evaluated using a randomized complete block design with three replications conducted over two consecutive years. The performance of Poultry litter with 50% BRRI-recommended fertilizer (T5) and BRRI-recommended fertilizer dosage (T2) has been superior in all parameters. The same approaches (T5) and (T2) demonstrated the highest absorption of nutrients by rice crops. The observed N and K balance exhibited a negative trend but with a lesser degree of negativity. Additionally, a lower level of deficit was seen in the T5 treatments. The T5 treatment exhibited a surplus of P, while other treatments showed a deficit of P. This research shows that poultry litter (3 t/ha) combined with 50% of the fertilizer suggested by BRRI is enough and acceptable for a sustainable rice yield.


*Keywords: Chemical fertilizer; organic materials; rice-rice cropping pattern.*

## 1. INTRODUCTION

"Rice is the staple food for nearly half the world's population, and its continued increased production to meet the enhanced demand due to the ever-increasing population faces many challenges" [1]. "Rice–Fallow–Rice, the dominant cropping system in Bangladesh, has received little attention regarding soil organic carbon (SOC) changes through organic amendments" [2]. In Bangladesh, the agricultural sector plays a crucial role in achieving development objectives such as poverty reduction and enhanced food security. The key to achieving these goals lies in the uptake of contemporary agricultural techniques, notably the adoption of modern rice varieties (MVs). Rice serves as the staple food source for over three billion individuals across Asia, where the production and consumption of rice account for over 90% of the global total 9 [3]. In Bangladesh, loss of soil fertility is a major impediment to increased crop output. Increased land use intensity, along with the use of chemical fertilizers and little or no organic manure, has resulted in serious soil fertility loss, resulting in crop productivity stagnation or even decline. Bangladeshi farmers utilize an average of 172 kg of nutrients per hectare per year (132 kg N + 27 kg P + 17 kg K + 4 kg S, and 2 kg Zn), while crop removal is around 250 kg/ha [4]. At least 2.5 percent organic matter is required in optimal soil. However, most soils in Bangladesh have less than 1% organic matter, [5] which is increasing day by day, generating a nutritional imbalance in the soil. Soil organic matter (SOM) promotes soil fertility and productivity through improving physical, chemical, and biological qualities. SOM can help improve soil quality and crop output in a variety of ways, including nutrient cycling and provisioning during decomposition, aggregate stability and soil porosity, water-holding capacity, particularly accessible water, and cation exchange capacity [6,7]. The purpose of this experiment is to see how different organic manures and chemical fertilizers affect rice yield and soil qualities using kitchen waste, cowdung bio-slurry, and poultry manure.

## 2. MATERIALS AND METHODS

### 2.1 Study Location and Soil

The experiment was conducted from Transplanted Aman (wet season) 2017 to Boro (dry season) 2019 at the experimental field of Bangladesh Rice Research Institute, Gazipur, located at 23.58°N latitude and 90.25°E longitude at an elevation of about 8.5 m above the sea level. The average annual rainfall is 2200 mm, of which 70% occurs between mid-June and to end of September. The lowest mean temperature (12°C) prevails in January and the highest (34°C) in May. The soil of the experimental site belongs to inceptions according to the USDA soil classification system.

### 2.2 Experimental Design and Treatments

The experiment consisted of five treatments in a Randomized Complete Block Design with three replications. The treatments were different sources of soil nutrients such as absolute nutrient control ($T_1$); BRRI recommended fertilizer dose ($T_2$); Kitchen waste (3 t/ha) + 50% BRRI recommended fertilizer dose ($T_3$); Cow dung bio-slurry (3 t/ha) + 50% BRRI recommended fertilizer dose ($T_4$) and Poultry litter (3 t/ha) + 50% BRRI recommended fertilizer dose ($T_5$). Organic materials with chemical fertilizers were applied to Boro and Transplanted Aman rice separately. All organic materials were applied on a dry weight basis after calculating their moisture contents. The BRRI recommended dose of NPKS in the Transplanted Aman season was 100-10-85-5 kg $ha^{-1}$ and in the Boro season, it was 138-10-80-5 kg $ha^{-1}$. Organic manures and all the fertilizers, except urea, were applied at the time of final land preparation and incorporated into the surface soil. Urea was applied in three equal splits; the first split was applied at final land preparation, the second split at maximum tillering, and the third split at the panicle initiation stage. The unit plot size was 4m x 5m. Rice crops were grown twice (Transplanted Aman and Boro) in a year and between these two rice crops, there was a fallow period. In the Transplanted Aman season, 30- to 35-day-old seedlings of BRRI dhan49 were transplanted at 20-cm×20-cm spacing in the last week of July; paddy was harvested in the last week of November. In the Boro season, 40- to 42-day-old seedlings of BRRI dhan58 were transplanted at the same spacing in the second week of January; paddy was harvested in the first week of May [8,9].

## 2.3 Soil and Plant Samples Analysis

Soil samples at 0-15 cm were collected after the completion of two cycles of the cropping system from each treatment plot. Plant samples (straw and grain) against each treatment plot were oven-dried at 70 °C for 48 h and finely ground.

The initial and final soil samples were analyzed for soil pH and organic matter by the Nelson and Sommers [10] method; total N by the Microkjeldahl method [11] exchangeable K by 1N $NH_4OAc$ method [12] available P by Olsen and Sommers [13] method; available S by turbidity method using $BaCl_2$ [14].

Ground plant samples were digested with di-acid mixture ($HNO_3$-$HClO_4$) (5:1) as described by Piper [15] for the determination-concentration of N (Micro-Kjeldahl method), P (spectrophotometer method), and K (atomic absorption spectrophotometer method).

## 2.4 Nutrient Uptake and Apparent Balance Calculation

“Crop nutrient uptake was calculated from the nutrient (N, P, and K) concentration and the straw and grain yields” [16]. “Apparent nutrient balance for the Boro-Fallow-Transplanted Aman rice cropping system (average of two years) was computed as the difference between nutrient input and output” [17]. The inputs were supplied from fertilizer and the outputs were estimated from crop uptake in a cycle [18,19].

## 2.5 Organic Fertilizer Collection and Nutrient Content

Organic Fertilizers were collected from the Bangladesh Rice Research Institute (BRRI) residential area and nearby BRRI. The nutrient status of different sources of Organic fertilizer is in the Table 1.

## 2.6 Statistical Analysis

The data on yield and yield contributing characters were subjected to analysis of variance (ANOVA) to determine the effects of organic fertilizer treatments. The least significant difference (LSD) at a 5% level of probably was used to separate the means for organic treatments. All the analysis was carried out using a standard statistical procedure (R-software 1) [20].

**Table 1. Nutrient status of different organic fertilizers**

| Organic Fertilizer | Nutrient content status (%) | | |
|---|---|---|---|
| | N | P | K |
| Kitchen waste | 0.65 | 0.18 | 0.45 |
| Cow dung bio-slurry | 0.67 | 0.29 | 0.60 |
| Poultry litter | 1.84 | 1.20 | 2.08 |

## 3. RESULTS AND DISCUSSION

### 3.1 Rice Yield and Agronomic Performance

The plant height, tiller production, panicle number, grain number, grain yield, and straw yields of Transplanted Aman and Boro rice were significantly impacted by various nutrient management practices in both the first and second years (Tables 2 and 3). Treatment $T_5$ produced the tallest plant, maximum number of tillers, panicle, and grains/panicle, as well as the highest grain and straw yields of Transplanted Aman and Boro rice. These were significantly higher than that of other treatments, except $T_2$ treatment in both years which were statistically identical with $T_5$ for every parameter. The treatment $T_2$ exhibited the second highest values for plant height, number of tillers, panicle, grain per panicle, grain yield, and straw yield of Transplanted Aman rice. These values were substantially higher compared to those seen in treatments $T_3$ and $T_4$. For every rice crop in both years, $T_4$'s performance was again noticeably better than $T_1$'s (Tables 2 & 3). The average plant height, tiller production, panicle number, grain number, grain yields, and straw yields in Transplanted Aman rice varied between 90.5 and 101.8 cm, 189 and 250.5 no. $m^{-2}$, 182 and 240.5 no. $m^{-2}$, 98.5 and 117 no. $panicle^{-1}$, 2.36 and 5.28 t/ha, and 2.74 and 5.80 t/ha, respectively, as a result of different nutrient management practices. However, in Boro rice, the treatments exhibited statistically significant differences from each other. The $T_5$ treatment had the greatest value, while the $T_1$ treatment had the lowest value in both years. The average plant height, tiller production, panicle number, grain number, grain yields, and straw yields in Boro rice varied between 77.57 and 91.85 cm, 182.5 and 260 no. $m^{-2}$, 160 and 239.5 no. $m^{-2}$, 94.5 and 143 no. $panicle^{-1}$, 2.46 and 6.29 t/ha, and 2.71 and 6.35 t/ha, respectively, due to different nutrient management practices (Tables 2 & 3) [21].

### 3.2 Nutrient Concentration of Rice Grain and Straw

The contents of grain N, P, and K were significantly higher in the $T_5$ treatment where 3 t/ha Poultry litter with 50% BRRI recommended chemical fertilizer was applied and which is statistically identical with $T_2$ treatment where BRRI recommended 100 % chemical fertilizer was applied. The straw N, P, and K contents were also higher with the $T_5$ treatment. On the other hand, the $T_1$ (absolute control) resulted in the lowest N, P, and K contents in the grain and straw of both rice varieties. The treatment combinations indicated that the increased N, P, and K contents in grain and straw were the effect of poultry litter application, and the decreased N, P, and K contents in grain and straw were the effect of no nutrient application (Table 4).

### 3.3 Nutrient Uptake by Rice

Different nutrient management practices demonstrated significant uptake of N, P, and K by the Boro Fallow-Transplanted Aman rice cropping system in both first and second years (Table 5). The greatest uptakes of all nutrients were estimated from $T_5$ treatment by all the rice crops which were significantly different from the other treatments. The nutrient uptake followed the order: K > N > P. The control ($T_1$) treatment showed significantly inferior nutrient uptake to the other treatment (Table 5). The total nutrient uptake by crops (BRRI dhan49+BRRI dhan58) varied from 68.18-215.97 kg N $ha^{-1}$, 13.78-45.94 kg P $ha^{-1}$ and 82.30-252.59 kg K $ha^{-1}$. Among the treatments, maximum total nutrient uptakes were recorded from 3 t/haPoultry litter with 50% BRRI recommended chemical fertilizer treatments plot ($T_5$) followed by BRRI recommended dose treatment ($T_2$), and the minimum was in control plot ($T_1$) (Table 5).

### 3.4 Total Input and Output of Nutrients

40% N from urea was effectively considered in the input estimation. Annual input of N varied from 0.00 to 158 kg $ha^{-1}$ $yr^{-1}$, P input ranged from 0.00 to 82 kg $ha^{-1}$ $yr^{-1}$ and K input was from 0.00 to 207 kg $ha^{-1}$ $yr^{-1}$. The great amounts of nutrients were measured in the $T_5$ treatment and the tine amount in the $T_1$ treatment (Table 6). The output of nutrients (mean of two years) ranged from 70.85 to 204.61 kg N $ha^{-1}$, 14.32 to 43.53 kg P $ha^{-1}$ and 86.11 to 236.86 kg K $ha^{-1}$. The highest outputs of all nutrients were found in $T_5$ and the lowest were in the control ($T_1$) treatment (Table 6).

### 3.5 Apparent Nutrient Balance

The nutrient balance did not account for the addition of N from rainfall, irrigation water, or gaseous losses, or BNF. The apparent balance of N, P, and K are shown in Fig. 1.

**Table 2. Agronomic features and yield of different nutrient management approaches during Transplanted Aman in the rice-rice cropping system**

| Treatments | Plant height (cm) | | | Number of Tiller $m^{-2}$ | | | Number of Panicle $m^{-2}$ | | | Number of Grain/ panicle | | | Grain yield (t/ ha) | | | Straw yield (t/ ha) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1st Year | 2nd Year | Mean | 1st Year | 2nd Year | Mean | 1st Year | 2nd Year | Mean | 1st Year | 2nd Year | Mean | 1st Year | 2nd Year | Mean | 1st Year | 2nd Year | Mean |
| $T_1$ | 95.23 | 85.77 | 90.5 | 194 | 184 | 189 | 187 | 177 | 182 | 98 | 99 | 98.5 | 2.6 | 2.11 | 2.36 | 2.95 | 2.53 | 2.74 |
| $T_2$ | 102.85 | 99.81 | 101.33 | 245 | 236 | 240.5 | 238 | 226 | 232 | 112 | 114 | 113 | 5.54 | 4.86 | 5.2 | 6.18 | 4.98 | 5.58 |
| $T_3$ | 101.53 | 93.67 | 97.6 | 219 | 217 | 218 | 209 | 208 | 208.5 | 107 | 108 | 107.5 | 4.71 | 4.2 | 4.46 | 5.16 | 4.43 | 4.80 |
| $T_4$ | 101.6 | 92.94 | 97.27 | 227 | 216 | 221.5 | 216 | 201 | 208.5 | 105 | 115 | 110 | 4.45 | 4.13 | 4.29 | 5.2 | 4.33 | 4.77 |
| $T_5$ | 103.35 | 100.25 | 101.8 | 251 | 250 | 250.5 | 244 | 237 | 240.5 | 115 | 119 | 117 | 5.65 | 4.9 | 5.28 | 6.48 | 5.12 | 5.8 |
| $LSD_{0.05}$ | 1.23 | 1.68 | - | 18.55 | 18.55 | - | 12.09 | 17.71 | - | 6.52 | 6.48 | - | 0.39 | 0.35 | - | 0.53 | 0.43 | - |
| CV (%) | 2.10 | 1.25 | - | 4.18 | 4.18 | - | 5.70 | 4.28 | - | 6.1 | 5.22 | - | 6.4 | 4.32 | - | 6.85 | 4.62 | - |

**Table 3. Agronomic features and yield of different nutrient management approaches during Boro in the rice-rice cropping system**

| Treatments | Plant height (cm) | | | Number of Tiller $m^{-2}$ | | | Number of Panicle $m^{-2}$ | | | Number of Grain/ panicle | | | Grain yield (t/ ha) | | | Straw yield (t/ ha) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1st Year | 2nd Year | Mean | 1st Year | 2nd Year | Mean | 1st Year | 2nd Year | Mean | 1st Year | 2nd Year | Mean | 1st Year | 2nd Year | Mean | 1st Year | 2nd Year | Mean |
| $T_1$ | 80.87 | 74.27 | 77.57 | 159 | 206 | 182.5 | 136 | 184 | 160 | 95 | 94 | 94.5 | 2.4 | 2.53 | 2.465 | 2.75 | 2.68 | 2.71 |
| $T_2$ | 85.1 | 96.83 | 90.965 | 228 | 270 | 249 | 203 | 256 | 229.5 | 144 | 135 | 139.5 | 6.2 | 5.95 | 6.075 | 6.17 | 5.83 | 6.00 |
| $T_3$ | 83.83 | 90.5 | 87.165 | 207 | 253 | 230 | 176 | 223 | 199.5 | 140 | 113 | 126.5 | 5.07 | 5.2 | 5.135 | 4.93 | 5.11 | 5.02 |
| $T_4$ | 82.94 | 91.61 | 87.275 | 190 | 245 | 217.5 | 162 | 218 | 190 | 142 | 107 | 124.5 | 4.9 | 5.33 | 5.115 | 4.73 | 5.27 | 5.00 |
| $T_5$ | 86.36 | 97.35 | 91.855 | 244 | 276 | 260 | 219 | 260 | 239.5 | 145 | 141 | 143 | 6.49 | 6.1 | 6.295 | 6.51 | 6.2 | 6.35 |
| $LSD_{0.05}$ | 1.35 | 1.41 | - | 17.11 | 14.11 | - | 18.09 | 17.77 | - | 5.36 | 7.43 | - | 0.43 | 0.41 | - | 0.55 | 0.51 | - |
| CV (%) | 2.3 | 2.35 | - | 6.3 | 7.21 | - | 6.45 | 6.48 | - | 5.92 | 6.42 | - | 3.6 | 5.05 | - | 5.98 | 8.76 | - |

**Table 4. Effect of different nutrient management on N, P, and K concentrations in BRRI dhan49 and BRRI dhan58**

| **Treatment** | | **Grain** | | | **Straw** | |
|---|---|---|---|---|---|---|
| **BRRI dhan49** | **N%** | **P%** | **K%** | **N%** | **P%** | **K%** |
| $T_1$ | 0.99 | 0.23 | 0.24 | 0.51 | 0.10 | 1.78 |
| $T_2$ | 1.13 | 0.26 | 0.28 | 0.60 | 0.12 | 1.96 |
| $T_3$ | 1.07 | 0.24 | 0.28 | 0.54 | 0.09 | 1.87 |
| $T_4$ | 1.00 | 0.25 | 0.27 | 0.55 | 0.11 | 1.90 |
| $T_5$ | 1.17 | 0.28 | 0.30 | 0.65 | 0.13 | 2.05 |
| BRRI dhan58 | N% | P% | K% | N% | P% | K% |
| $T_1$ | 1.12 | 0.25 | 0.23 | 0.62 | 0.10 | 1.75 |
| $T_2$ | 1.32 | 0.28 | 0.27 | 0.70 | 0.14 | 2.10 |
| $T_3$ | 1.21 | 0.27 | 0.25 | 0.63 | 0.12 | 1.81 |
| $T_4$ | 1.13 | 0.26 | 0.26 | 0.62 | 0.12 | 1.85 |
| $T_5$ | 1.38 | 0.30 | 0.28 | 0.79 | 0.15 | 2.14 |
| CV (%) | 5.17 | 7.95 | 9.68 | 8.15 | 11.25 | 9.10 |

**Table 5. Effect of different nutrient managements on nutrient uptake by BRRI dhan49 and BRRI dhan58**

| **Treatment** | **N** | | **P** | | **K** | |
|---|---|---|---|---|---|---|
| **BRRI dhan49** | **1st year** | **2nd year** | **1st year** | **2nd year** | **1st year** | **2nd year** |
| $T_1$ | 36.77 | 30.51 | 7.50 | 6.20 | 46.67 | 39.78 |
| $T_2$ | 88.45 | 75.12 | 19.31 | 16.44 | 117.16 | 95.37 |
| $T_3$ | 69.35 | 60.98 | 14.68 | 12.92 | 86.06 | 74.26 |
| $T_4$ | 64.06 | 56.99 | 14.56 | 13.04 | 87.29 | 73.67 |
| $T_5$ | 97.80 | 81.66 | 21.38 | 17.94 | 125.51 | 100.30 |
| $LSD_{0.05}$ | 13.10 | 13.25 | 5.02 | 5.15 | 6.46 | 6.50 |
| BRRI dhan58 | 1st year | 2nd year | 1st year | 2nd year | 1st year | 2nd year |
| $T_1$ | 36.76 | 37.66 | 7.36 | 7.58 | 43.25 | 42.52 |
| $T_2$ | 104.93 | 100.19 | 21.84 | 20.86 | 118.05 | 111.76 |
| $T_3$ | 77.61 | 79.87 | 16.51 | 16.98 | 82.29 | 85.17 |
| $T_4$ | 71.08 | 77.94 | 15.50 | 16.98 | 80.96 | 89.91 |
| $T_5$ | 118.17 | 111.58 | 24.56 | 23.18 | 127.08 | 120.83 |
| $LSD_{0.05}$ | 5.65 | 5.50 | 4.98 | 4.85 | 6.98 | 7.48 |
| BRRI dhan49+BRRI dhan58 | 1st year | 2nd year | 1st year | 2nd year | 1st year | 2nd year |
| $T_1$ | 73.53 | 68.18 | 14.86 | 13.78 | 89.91 | 82.30 |
| $T_2$ | 193.38 | 175.31 | 41.15 | 37.30 | 235.22 | 207.13 |
| $T_3$ | 146.95 | 140.84 | 31.18 | 29.90 | 168.35 | 159.43 |
| $T_4$ | 135.14 | 134.93 | 30.06 | 30.01 | 168.25 | 163.59 |
| $T_5$ | 215.97 | 193.24 | 45.94 | 41.12 | 252.59 | 221.13 |

Results revealed that N balance was negative in all the treatments and the depletion ranged from -46.60 to -89.14 kg N $ha^{-1}$ $yr^{-1}$. In the case of P balance, the value was negative in all treatments (ranging from -2.63 to -19.22 kg P $ha^{-1}$ $yr^{-1}$) except treatment $T_5$ where the P magnitude was greater in soil receiving from poultry manure. The soils of all treatments showed negative K balance where the K mining ranged from -29.56 to -86.10 kg K $ha^{-1}$ $yr^{-1}$. The greatest K mining was measured from control ($T_1$) followed by BRRI recommended dose ($T_2$) and the lowest K mining was calculated in Poultry litter use treatment ($T_5$).

## 3.6 Soil Properties after Two Years

After two years of experiment, soil pH in the tested treatments varied from 6.10 to 7.25 and organic matter varied from 1.33 to 1.41, respectively (Table 7). The differences in pH, OM, P, and K among the treatments were not significant. Yadvinder Singh et al. (2000) found only a little improvement in soil organic matter, P and K due to green manuring, while application of crop residues raised their levels significantly. Farmyard manure application increased P and K in their long-term experiment. Chettri et al. [22] found "an increase in organic carbon from 1.4 to 1.6% for eight years due to the application of seven tones of farm yard manure in rice and wheat cropping". Mandal et al. [23] also reported that "the organic matter and total N concentration in the soil were found to be higher in green manuring treated plots" [24-26].

**Table 6. Effect of different nutrient management practices on nutrients input (added from fertilizer and manure) and output (crops uptake) of rice- rice cropping system**

| Treatment | N | P | K |
|---|---|---|---|
| Input | kg $ha^{-1}yr^{-1}$ | | |
| $T_1$ | 0 | 0 | 0 |
| $T_2$ | 95.2 | 20 | 165 |
| $T_3$ | 86.6 | 20.8 | 109.5 |
| $T_4$ | 87.8 | 27.4 | 118.5 |
| $T_5$ | 158 | 82 | 207.3 |
| Output | kg $ha^{-1}yr^{-1}$ | | |
| $T_1$ | 70.85 | 14.32 | 86.11 |
| $T_2$ | 184.35 | 39.23 | 221.17 |
| $T_3$ | 143.90 | 30.54 | 163.89 |
| $T_4$ | 135.04 | 30.04 | 165.92 |
| $T_5$ | 204.61 | 43.53 | 236.86 |

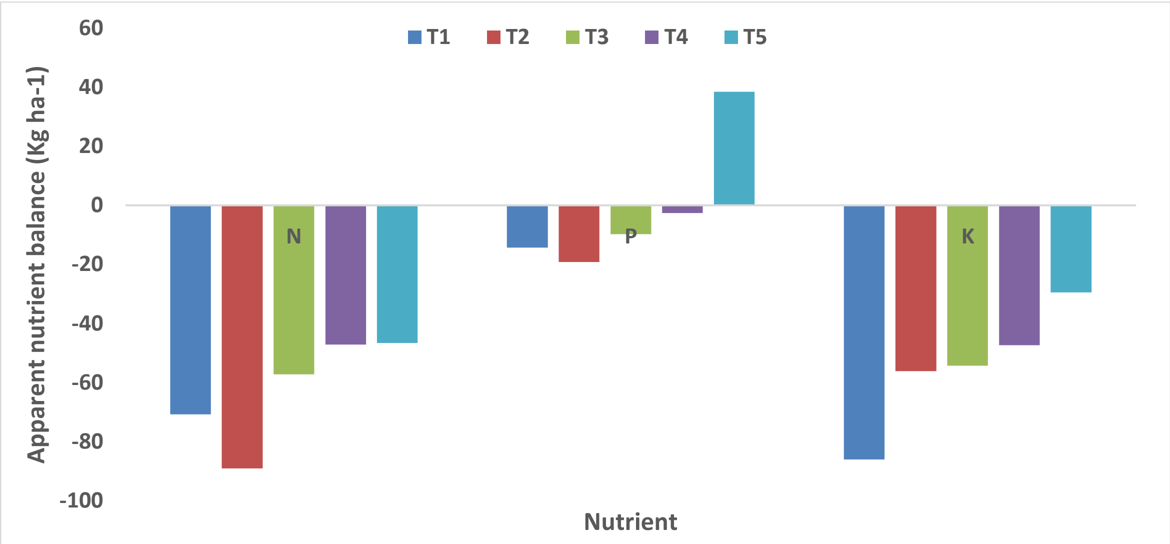


**Fig. 1. Effect of nutrient management practices on apparent nutrient balance of rice-rice cropping system**

**Table 7. Characteristics of soil of the experimental plots after two years**

| Treatments | pH | OM (%) | Total N (%) | P (ppm) | K (meq/100g soil) | S (ppm) |
|---|---|---|---|---|---|---|
| $T_1$ | 6.90 | 1.35 | 0.16 | 9.50 | 0.17 | 20 |
| $T_2$ | 7.05 | 1.33 | 0.18 | 10.0 | 0.18 | 21 |
| $T_3$ | 7.14 | 1.40 | 0.18 | 10.7 | 0.20 | 22 |
| $T_4$ | 7.25 | 1.40 | 0.18 | 10.7 | 0.21 | 22 |
| $T_5$ | 7.18 | 1.41 | 0.19 | 10.9 | 0.22 | 23 |
| Initial Soil | 7.10 | 1.38 | 0.19 | 9.70 | 0.24 | 21 |

## 4. CONCLUSION

It is concluded from the two years of experiment, that the combined application of organic and inorganic fertilizers increased the rice yield and yield contributing characters over native soil in both seasons. The application of poultry manure (3 t/ha) with 50% BRRI recommended fertilizer dose (T5) has performed significantly higher and statistically similar with 100% chemical fertilizer like BRRI dose. There was a slightly increasing trend in soil chemical properties after two years of continuous rice cultivation. Long-term use of organic materials like poultry manure would improve the organic matter and other nutrient content of soil for better productivity.

## DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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