**Comparative** **Bio-Economic Efficiencies of Different Organic Manures in Winter Rice**

**Abstract**

The experiment was conducted to analyze comparative bio-economic efficiencies of different organic manures in winter rice (locally known as *boro* rice) of Bangladesh. This study consists of 11 treatments of different combination of chemical fertilizer and organic manures. Vermicompost, Trico-compost, Cow dung, Poultry manure and Co-compost @ 2.5 t ha-1 or 5 t ha-1 were applied with recommended fertilizer dose (RDF) or 75% RDF, respectively. Only RDF was considered as control. The experiment was conducted at the Agronomy Field Laboratory of Bangladesh Agricultural University (90°25'35.2"E and 24°43'07.3"N) following a randomized complete block design with three replications. Overall, the result indicates that the combination of RDF with 2.5 t ha-1 organic manure significantly enhanced the yield attributes and yield of winter rice while 75% RDF coupled with any of the organic manures studied found less effective than RDF in terms of yield. Poultry manure and cow dung @ 2.5 t ha-1 with RDF resulted in higher benefit cost ratio (2.34 and 2.28) than single application of RDF (2.05) in winter rice which is also closely followed by co-compost application @ 2.5 t ha-1 (2.00). The BCR was determined to be less than 1 for vermicompost and trico-compost at a rate of 5 t ha⁻¹ with RDF. Considering both productivity and profitability, poultry manure appeared as the best manure to be incorporated with RDF. Based on availability and other factors cow dung and co-compost @ 2.5 t ha-1 with RDF could also be applied for sustainable and increased yield of winter rice.

**Keywords:** *Integrated nutrient management; Co-compost; Vermicompost; Cow dung; Poultry manure; Winter rice*

**Introduction**

Rice is the primary staple meal of the most malnourished and impoverished people in Asia and Africa, and it provides nearly half of the world's population with essential calories (Bin Rahman & Zhang, 2023). Bangladesh ranks the third position in rice production and fifth in terms of cultivated area (BBS, 2022). Globally 3.18 t ha-1 rice is produced on average while Bangladesh's national average is marginally higher at 3.25 t ha-1, but substantially lower than China (4.74 t ha-1) and Japan (5.00 t ha-1) (FAO, 2022). The primary causes of soil fertility depletion in Bangladesh, which lowers yield, include increased cropping intensity, the use of newer varieties (HYVs and hybrids), uneven fertilizer use, and little to no incorporation of organic manure. Because of the subtropical climate, Bangladesh's soil has an extremely low organic matter content and is still declining. A prerequisite for maintaining soil fertility and agricultural productivity is the augmentation of soil resources. Excessive use of chemical fertilizer may temporarily supply required nutrients to the crop plant but deteriorates soil health and environment. Using manure is an effective way to improve soil microbial biomass, nutrient availability, which can help reduce dependence on chemical fertilizers (Maitlo *et al*., 2022 ;Alam *et al*., 2024). Organic manures can serve as a supplement allowing more than 20% reduction in chemical fertilizer usage while maintaining crop yield and quality (Wu *et al*., 2024). Organic fertilizers enhance soil fertility by increasing nutrient levels, improving microbial diversity (especially bacteria), and altering soil physicochemical properties such as pH, EC, and NO₃-N content (Zhang *et al*., 2023) The most common organic manures are cow dung, farmyard manure, poultry manure, crop residues, vermicompost, urban waste etc. Vermicomposting is a sustainable biological treatment that converts organic solid waste into nutrient-rich fertilizer, supporting organic agriculture and environmental protection. It helps control pollutants, recover nutrients, and enhance soil health and crop production (Wang *et al*., 2024). Nitrogen nutrition provided by vermicompost helped to improve the grain quality of aromatic rice (Manir *et al*., 2025). vermicompost strengthens plants' antioxidative defensemechanisms, helping them withstand environmental stress (Manzoor *et al*., 2024). The research findings indicated that applying 20 tons per hectare of Tricho-tithonia along with 50% of therecommended NPK fertilizer dose produced the best growth response in local-Jambi red chilivarieties (Eliyanti *et al*., 2024). Another excellent source of nutrients for soil is poultry manure. The application of poultry manure enhances microbial diversity, supporting the cycling of carbon, nitrogen, and sulfur, along with key enzymes like dehydrogenases and catalase carbohydrate-active enzymes which offers a cost-effective, sustainable way to boost soil health (Minkina *et al*., 2023). Co-compost is a great way for plants to get organic matter and vital nutrients that help them withstand drought and water stress (Manga *et al*., 2022). The results of the experiment showed that applying co compost at a rate of 2 t ha-1 in addition to the recommended dosage of chemical fertilizer (RDF) increased rice grain production by 7% compared to applying RDF alone (Mahmud *et al*., 2024). Based on the explanation above, the purpose of this investigation was to ascertain the most appropriate organic manure in terms of productivity and cost-effectiveness for sustainable winter rice farming, as well as to compare the relative efficacy of various organic manures when mixed with chemical fertilizers.

**Materials and Methods**

**Experimental Site and Duration**

The experiment was carried out at Bangladesh Agricultural University's (BAU) Agronomy Field Laboratory. The site was situated at 90°25'35.2"E and 24°43'07.3"N (average height from seal level: >18 m). That medium-high land area was part of the Sonatola series, characterized by non-calcareous dark grey floodplain soils, within the Old Brahmaputra Floodplain (Agroecological Zone-9). The experiment was conducted during the winter season (November to April) of 2022-23.

**Experimental Soil and Climate**

The field soil was nearly neutral, with a pH of 6.82, and exhibited low organic matter and fertility levels. It was medium-high land with a fairly level topography, moderate drainage, and was cropped with rice, wheat, and maize. The soil had a silt loam texture containing 67% silt, 20% sand, and 13% clay having a bulk density of 1.35 g/cc, porosity of 46.67%, and particle density of 2.60 g/cc. Chemically, it had 1.77% organic carbon, 0.66% nitrogen, a C:N ratio of 11.06, and contained 15.67 ppm available phosphorus, 0.087 ppm exchangeable potassium, and 23.08 ppm available sulfur, making it fertile and suitable for diverse crop cultivation.

The experimental site experienced a subtropical climate, marked by high temperatures and heavy rainfall from March to October, while temperatures were moderately low and rainfall was scarce from November to February. Relative humidity was high from April to July and low during most of November to February. The average air temperature (°C) throughout the experimental period ranged from 19.8 to 24.4, and the total rainfall varied from 0.00 mm to 17.7 mm. The relative humidity varied from 80.2% to 84.35%. The average total sunshine (hrs.) ranged from 164.4 to 227.2.

**Experimental Treatments and Design**

Eleven different chemical fertilizer and organic manure combinations made up the experimental treatments *e.g*., (i) BRRI Recommended dose of chemical fertilizer (RDF) (T1), (ii) 100% RDF + Vermicompost @ 2.5 t ha-1 (T2), (iii) 100% RDF + Trico-compost @ 2.5 t ha-1 (T3), (iv) 100% RDF + Cow dung @ 2.5 t ha -1 (T4), (v) 100% RDF + Poultry Manure @ 2.5 t ha-1 (T5), (vi) 100% RDF + Co-compost @ 2.5 t ha-1 (T6), (vii) 75% RDF + Vermicompost@ 5 t ha-1 (T7), (viii) 75% RDF + Trico-compost @ 5 t ha-1 (T8), (ix) 75% RDF + Cow dung @ 5 t ha-1 (T9), (x) 75% RDF + Poultry Manure @ 5 t ha-1 (T10), (xi) 75% RDF + Co-compost @ 5 t ha-1 (T11).The experiment followed a randomized complete block design with three replications. The different manures used in the study were analyzed at the Plant Nutrition and Environmental Chemistry Laboratory of BAU, for their nutrient contents which has been presented in (Table 1).

**Crop Husbandry**

From BAU's Agronomy Field Laboratory, healthy seeds of BRRI dhan89 (a high yielding Bangladesh Rice Research Institute (BRRI) released winter rice variety, average yield potential 9.17 t ha-1) was collected. Prepared and ready to use organic manures were obtained from the agronomy farm at BAU and co-compost from the NGO Forum for Public Health, Mymensingh.A power tiller was used to plough and cross-plow the experimental field. The experimental field was cleared of all weeds and stubbles, and the area was then prepared treatment-wise in accordance with the layout.

Urea, triple superphosphate, muriate of potash, gypsum, and zinc sulfate were sprayed at 296, 161, 210, 124, and 12 kg ha-1, respectively, in order to meet the prescribed dose of chemical fertilizers (RDF). In accordance with the experimental requirements, chemical fertilizers and manures were applied. Three equal portions of urea were administered at 15, 45, and 60 days following transplantation (DAT). All manures were applied in compliance with treatment guidelines and thoroughly mixed with the soil before the last stage of field preparation.

In the prepared puddled field, forty-day-old, healthy seedlings of comparable size were transplanted at a rate of three seedlings per hill, with row-row and hill-hill spacing of 25 cm and 15 cm, respectively. Where required, gap filling was carried out at seven DAT. Three hand weeding were done at 15 DAT 45 DAT, and 60 DAT. To improve maturity, the field was ultimately drained out 15 days prior to harvest. Infection from any disease organism or a substantial bug infestation were not observed in the field. Therefore, no steps were done to protect the plants.

**Data Collection**

In order to document the different components of rice production, five rice hills—aside from border hills—were randomly selected from each unit plot prior to harvest. When 90% of the grains were golden yellow, it was harvested. Harvesting each plot separately allowed us to record the grain and straw yields. The crop was washed, threshed, and dried until it had a grain moisture content of 14% after harvest. The weight of the grain and straw was measured and transformed to tons per hectare. The growth, yield attributes and yield of winter rice were noted. Benefit cost ratio (BCR) of different integrated nutrient management for *winter* rice was also calculated.

**Statistical Analysis**

Compiling and tabulating the data in the appropriate format for statistical analysis was done. Analysis of variance was performed using the MSTAT-C software tool. Using Duncan's Multiple Range Test, the mean differences between treatments were examined at a 5% probability level.

**Results and Discussion**

**Effect on Growth attributes**

**Plant Height**

Chemical fertilizer and organic manure combination exerted significant influence on the plant height of BRRI dhan89 at all the sampling dates (Figure 1). The combination of 75% RDF with 5 t ha-1 vermicompost or trico-compost resulted in statistically similar plant height at all the observations (Figure 1). They showed the lowest height at different DATs. On the other hand, application of all the manures @ 2.5 t ha-1 with RDF always demonstrated higher plant height compared to sole application of RDF. At 30 DAT (30.45 cm), 50DAT (51.26 cm), 70 DAT (70.16 cm) and at harvest (99.13 cm) poultry manure @ 2.5 t ha-1 with RDF resulted in the highest height of plants and at 90 DAT (95 cm) it occurs when cow dung @ 2.5 t ha-1 was applied with RDF. The differences in plant height due to the nutrient sources were thought to be caused by the varying availability of key nutrients. Nitrogen release mostly depends on the types of manure and temperature. Poultry manure exhibits the fastest mineralization, followed by vermicompost and cow dung (Mondol *et al*., 2024).

**Tillering ability**

Number of tillers hill-1 were significantly affected by the integration of RDF and different organic manures at all the growth stage (except 30 DAT) (Figure 2). The maximum and minimum number of tillers were recorded from RDF with 2.5 t ha⁻¹ poultry manure and RDF with @ 5 t ha-1 vermicompost respectively at different DATs. At 90 DAT, 2.5 t ha-1 cow dung (14.16) or poultry manure (15.10) in combination with 100% RDF provide the highest significant response for obtaining the greater number of total tillers hill-1 which is statistically different from other treatments. This result supported the nutrient composition of poultry manure, which contains more nitrogen compared to other manures (Table 1) and was responsible for the vegetative growth of plants. Kader *et al*. (2022) also reported that the application of vermicompost, cow dung, and chemical fertilizers had a significant impact on the total number of tillers plant-1. It was also noted that the combination of 75% chemical fertilizer with different organic manures at 5 t ha⁻¹ sometimes resulted in less tillers compared to the application of the recommended dose of chemical fertilizer alone. This may have occurred because the amount of essential macro and micronutrients released from 5 tons of organic manure was lower than the nutrients available from 25% of the chemical fertilizer or because of the gradual nutrient release from organic manure.

**Effect on Yield attributes**

**Number of effective tillers hill-1**

The analysis revealed that the number of effective tillers hill-1 was notably affected by the application of both organic and inorganic fertilizers (Table 2). The highest count of effective tillers hill-1 (12.9) was achieved with the recommended dose of chemical fertilizer combined with 2.5 t ha⁻¹ poultry manure. This result is also supported by the residual impact of poultry manure and chemical fertilizers enhancing the number of effective tillers hill-1 in BR11 rice

(Pp *et al.*, 2024).

**Non effective tillers hill-1**

From this experiment we find that RDF with 2.5 t ha-1 co-compost produced the lowest number of non-effective tiller which is also statistically identical with 2.5 t ha-1 cow dung (Table 2). There were notable differences between the types of co-composed fecal sludge-based manures and chemical fertilizer combinations in the generation of the total tiller count hill-1, which was observed by (Mahmud *et al*. (2024).

**Grains panicle-1**

A notable variation in the number of grains panicle-1 was found among the different combinations of chemical fertilizers and organic manures (Table 2). The maximum number of grains panicle-1 (115.75) was observed in rice plants treated with 100% of the recommended fertilizer dose (RDF) along with 2.5 t ha⁻¹ of cow dung. Most interestingly, only 75% of chemical fertilizer with 5 ton ha-1 cow dung produced 1.67% more grains panicle-1 compared to sole application of recommended dose of fertilizer. It is also higher than other manure at 5 t ha-1 with 75% chemical fertilizer. Cow dung contains high organic matter content (Table 1) which improves soil structure, water holding capacity, aeration and creates an optimal environment for root development and nutrient uptake, which supports larger and more productive panicles. Moreover, as the nutrient release process of cow dung is slow compared to other manures and fertilizer, it may match the crops nutrient demand during flowering and grain filling (critical growth stage), leading to better panicle performance. (Atman *et al*., 2018) also observed the significant effect of cowdung on number of Grains panicle-1.

**Number of sterile spikelets panicle-1**

A notable variation in the number of sterile spikelets panicle-1 was identified among the treatments that included various combinations of chemical fertilizers and organic manures (Table 2). The highest count (16.25) of sterile spikelets panicle-1 was observed with 75% RDF combined with 5 t ha⁻¹ trico-compost. Conversely, the lowest counts were recorded with 100% RDF paired with 2.5 t ha⁻¹ trico-compost (12.14), cow dung (11.99), poultry manure (11.97), or co-compost (11.61). Combination of RDF with 2.5 t ha⁻¹ organic manures ensures sufficient water supply essential for photosynthesis and nutrient transport affecting pollen development and grain setting by increasing water holding capacity of soil. In addition, macro and micro nutrients like N, P, K, Zn, B etc. critical for grain filling, pollen formation and fertilization become more available.

**Grain yield**

Grain yield of rice by applying an integrated system where different organic manures were added with chemical fertilizers ranging between 5.35 t ha⁻¹ to 8.37 t ha⁻¹ (Table 2). It was observed that the highest grain yield (8.37 t ha⁻¹) was recorded when 2.5 t ha⁻¹ poultry manure was applied alongside of the 100% RDF. The benefits of poultry manure on yield and yield-contributing traits are clearly evident from the experiment with maize varieties grown in soil amended with 50 and 75 g/pot of poultry manure (Rasool *et al*., 2023). In treatment T1, where only recommended doses of fertilizers were applied 6.81 t ha⁻¹ grain yield was observed, which was significantly lower than the higher grain yield. Numerous studies have highlighted the benefits of using co-compost (Kumar *et al*., 2025), vermicompost (Iqbal *et al*., 2024), cowdung (Pramono *et al*., 2024), poultry manure (Ding *et al*., 2025) and trico-compost in improving soil health and boosting rice yields. The adoption of INM in cropped fields resulted in yield increases ranging from 1.3% to 66.5%, compared to conventional nutrient management, across major cropping systems (Paramesh *et al.*, 2023). In this study, grain yield was increased by 11.2%, 3.64%, 18.63%, 21.83% and 18.49% respectively as a result of the integration of vermicompost, trico-compost, cow dung, poultry manure or co-compost @ 2.5 t ha⁻¹ with RDF compared to using the recommended dose of chemical fertilizer alone. Results from different experiments also showed that the relative performances of organic manures followed the order poultry manure > cowdung > vermicompost > trico-compost (Farid *et al*., 2011; Hasan *et al.,* 2024).

**Biological yield and Harvest Index**

The study revealed that the application of 2.5 t ha⁻¹ poultry manure combined with 100% RDF resulted in the highest biological yield (17.02 t ha⁻¹) among all treatments (Table 2). It is worth noting that the combined use of organic manures and chemical fertilizers resulted in improved yield performance. Conversely, the lowest biological yield (11.32 t ha⁻¹) was observed with the combination of 75% RDF and 5 t ha⁻¹ vermicompost. A statistically significant difference in the harvest index was also observed between the chemical fertilizer and organic manure treatments. The maximum harvest index (49.15%) was recorded from 100% RDF + 2.5 t ha⁻¹ poultry manure. However, the lowest harvest index (47.19%) was obtained with 75% RDF + 5 t ha⁻¹ vermicompost.

**Economic Performance**

We observed the gross return of BRRI dhan89 varied from 185000 TK ha-1 to 285980 TK ha-1 among various combinations of chemical fertilizer and organic manure (Table 3). The fertilization of BRRI dhan89 with 2.5 t ha-1 poultry manure combined with 100% RDF yielded the best gross return, closely followed by 2.5 t ha-1 co-compost and 100% RDF combination. However, the combination of 5 t ha-1 vermicompost and 75% RDF had the lowest gross return, which was closely followed by the combination of 5 t ha-1 trico-compost and 75% RDF. The net return of BRRI dhan89 varied from -99236 TK ha-1 to 163504 TK ha-1 across various combinations of chemical fertilizer and organic manure. When BRRI dhan89 was fertilized with 2.5 t ha-1 of poultry manure combined with 100% RDF, the maximum net return was determined. This was closely followed by 2.5 t ha-1 of cow dung combined with 100% RDF. It's noteworthy to notice that the poor rice yield and high cost of vermicompost and trico-compost caused a negative net return when applied at a rate of 5 t ha-1 in conjunction with 75% RDF. Application of vermicompost or trico-compost at 5 t ha-1 in combination with 75% RDF resulted in a benefit cost ratio < 1 due to the high cost of vermicompost and trico-compost and low rice yield. The application of poultry manure at 2.5 t ha-1 with 100% RDF produced the highest benefit cost ratio (2.34), closely followed by 2.5 t ha-1 cow dung and 100% RDF combination. The benefit cost ratio of BRRI dhan89 varied between 0.66 and 2.34 among the various chemical fertilizer and organic manure combination treatments.

**Conclusion**

Based on the present findings, it was deduced that our selected winter rice BRRI dhan 89's growth and yield contributing qualities could not be stimulated by the recommended dosage of chemical fertilizer alone. In order to increase maximum growth and output, the results indicated that poultry manure at a rate of 2.5 t ha⁻¹, along with the recommended dosage of chemical fertilizers, performed better. Additionally, when treated with the necessary dosage of artificial fertilizers, the other manures performed noticeably better. In order to guarantee a better nutrient management system and the best yield of winter rice, it is therefore advised to use organic manures in conjunction with the recommended dosage of fertilizers.

**Acknowledgements**

Authors thankfully acknowledge the financial support of NGO Forum for Public Health for conducting the research and providing co-compost.

**References**

1. Alam, Md. M., Hossain, A. M., Hakim, A., Islam, Md. R., Soufan, W., El Sabagh, A., Adnan, M. and Sohidul Islam, M. 2024. Application of vermicompost to boro rice (BRRI dhan 28) can save phosphate fertilizer with sustaining productivity and soil fertility. *Pak. J. Bot.*, **56**(1). <https://doi.org/10.30848/PJB2024-1(18)>
2. Atman, A., Bakri, B. and Indrasti, R. 2018. Effect of cow manure dosages as organic fertilizer on the productivity of organic rice in West Sumatra, Indonesia. *Int. J. Environ. Agric. Biotechnol.*, **3**(2): 506–511. <https://doi.org/10.22161/ijeab/3.2.25>
3. BBS (Bangladesh Bureau of Statistics). 2022. *Yearbook of Agricultural Statistics- 2021 (33rd Series)*. Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka. pp. 1-685.
4. Bin Rahman, A. N. M. R. and Zhang, J. 2023. Trends in rice research: 2030 and beyond. *Food Energy Sec.*, **12**(2): e390. <https://doi.org/10.1002/fes3.390>
5. Ding, S., Tu, X. and Wei, J. 2025. Effects of different types of manure application on rice yield and improving soil effect. *E3S Web Conf.*, **615**: 01003. <https://doi.org/10.1051/e3sconf/202561501003>
6. Eliyanti, E., Zulkarnain, Z., Budiyati, I. and Mairizal, M. 2024. Application of Tricho-Tithonia as compost and organic ameliorant in inducing growth and yield of local-Jambi varieties of red chili. *Russ. J. Agric. Socio-Econ. Sci.*, **145**(1): Article 1.
7. FAO. 2022. *FAO Statistical Yearbook – World Food and Agriculture 2022.* FAO, Rome, Italy. pp. 1-382. <https://doi.org/10.4060/CC2211EN>
8. Farid, M. S., Mamun, M. A. A., Matin, M. A. and Jahiruddin, M. 2011. Combined effect of cowdung, poultry manure, dhaincha and fertilizers on the growth and yield of rice. *J. Agrofor. Environ.*, **5**(1): 51-54.
9. Hasan, Md. T., Rahman, Md. M., Saiful Alam, M. S. A., Kamal, M. Z. U., Miah, Md. G., Kabir, Md. H. and Rahman, G. M. 2024. Effects of organic matter amendments on physicochemical properties of soil and yield of rainfed rice. *Ecol. J.*, **6**(1): 1–8. <https://doi.org/10.59619/ej.6.1.1>
10. Iqbal, A., Hussain, Q., Mo, Z., Hua, T., Mustafa, A. E.-Z. M. A. and Tang, X. 2024. Vermicompost supply enhances fragrant-rice yield by improving soil fertility and eukaryotic microbial community composition under environmental stress conditions. *Microorganisms*, **12**(6): Article 6. <https://doi.org/10.3390/microorganisms12061252>
11. Kader, M. A., Bhuyan, M. A. H. and Hasan, K. 2022. Impact of vermicompost and cow dung along with chemical fertilizers on yield of rice. *Bangladesh Rural Dev. Stud.*, **25**: 73-81.
12. Kumar, M. G. A., Thiruppathi, M., Stalin, P. and Dinakar, S. 2025. Effect of different levels of recommended dose of fertilizer and co-compost on yield and economics of rice VAR. ADT 43. *J. Adv. Biol. Biotechnol.*, **28**(3): 88–96. <https://doi.org/10.9734/jabb/2025/v28i32072>
13. Mahmud, N. B., Anwar, M. P., Yeasmin, S., Sultana, N., Ghosh, S., Islam, A. K. M. M. and Jaman, M. S. B. 2024. Co-composted fecal sludge-based integrated nutrient management for sustainable Aman rice production. *J. Sci. Technol. Res.*, **6**(1): Article 1. <https://doi.org/10.3329/jscitr.v6i1.77386>
14. Maitlo, A. A., Zhang, S., Ahmed, W., Jangid, K., Ali, S., Yang, H., Bhatti, S. M., Duan, Y. and Xu, M. 2022. Potential nitrogen mineralization and its availability in response to long-term fertilization in a Chinese fluvo-aquic soil. *Agron.*, **12**(6): Article 6. <https://doi.org/10.3390/agronomy12061260>
15. Manga, M., Evans, B. E., Ngasala, T. M. and Camargo-Valero, M. A. 2022. Recycling of faecal sludge: Nitrogen, carbon and organic matter transformation during co-composting of faecal sludge with different bulking agents. *Int. J. Environ. Res. Public Health.*, **19**(17): 10592. <https://doi.org/10.3390/ijerph191710592>
16. Manir, M. R., Sarker, U. K., Kheya, S. A., Ahmed, M. T., Ferdous, N., Kaysar, M. S., Salam, M. A., Anwar, M. P., Somaddar, U., Hashem, A., Alfagham, A., Allah, E. F. A. and Uddin, M. R. 2025. Integrated nitrogen nutrition with vermicompost and storage duration affect grain quality characters of aromatic rice under subtropical condition. *Cogent Food Agric.*, **11**(1): 1-15. <https://doi.org/10.1080/23311932.2024.2448598>
17. Manzoor, A., Naveed, M. S., Ali, R. M. A., Naseer, M. A., UL-Hussan, M., Saqib, M., Hussain, S. and Farooq, M. 2024. Vermicompost: A potential organic fertilizer for sustainable vegetable cultivation. *Sci. Hortic.*, **336**: 113443. <https://doi.org/10.1016/j.scienta.2024.113443>
18. Minkina, T., Sushkova, S., Delegan, Y., Bren, A., Mazanko, M., Kocharovskaya, Y., Filonov, A., Rajput, V. D., Mandzhieva, S., Rudoy, D., Prazdnova, E. V., Elena, V., Zelenkova, G. and Ranjan, A. 2023. Effect of chicken manure on soil microbial community diversity in poultry keeping areas. *Environ. Geochem. Health.*, **45**(12): 9303–9319. <https://doi.org/10.1007/s10653-022-01447-x>
19. Mondol, A. T. M. A. I., Chowdhury, M. A. H., Ahmed, S. and Alam, M. K. 2024. Nitrogen dynamics from conventional organic manures as influenced by different temperature regimes in subtropical conditions. *Nitrogen*, **5**(3): Article 3. <https://doi.org/10.3390/nitrogen5030049>
20. Paramesh, V., Mohan Kumar, R., Rajanna, G. A., Gowda, S., Nath, A. J., Madival, Y., Jinger, D., Bhat, S. and Toraskar, S. 2023. Integrated nutrient management for improving crop yields, soil properties, and reducing greenhouse gas emissions. *Front. Sustain. Food Syst.*, **7**: Article 1173258. <https://doi.org/10.3389/fsufs.2023.1173258>
21. Pp, D., Rahman, K. M. M., M, M. and Bp, R. 2024. Effect of poultry manure and mineral concentration on grain yield and straw of BR11 rice genotypes in Bangladesh. *Mathews J. Nutr. Diet*., **7**(1): Article 10029. <https://doi.org/10.30654/MJND.10029>
22. Pramono, A., Adriany, T. A., Viandari, N. A., Susilawati, H. L., Wihardjaka, A., Sutriadi, M. T., Yusuf, W. A., Ariani, M., Wagai, R., Tokida, T. and Minamikawa, K. 2024. Higher rice yield and lower greenhouse gas emissions with cattle manure amendment is achieved by alternate wetting and drying. *Soil Sci. Plant Nutr*., **70**(2): 129-138. <https://doi.org/10.1080/00380768.2023.2298775>
23. Rasool, A., Ghani, A., Nawaz, R., Ahmad, S., Shahzad, K., Rebi, A., Ali, B., Zhou, J., Ahmad, M. I., Tahir, M. F., Alwahibi, M. S., Elshikh, M. S. and Ercisli, S. 2023. Effects of poultry manure on the growth, physiology, yield, and yield-related traits of maize varieties. *ACS Omega*, **8**(29): 25766–25779. <https://doi.org/10.1021/acsomega.3c00880>
24. Wang, F., Zhang, Y., Su, Y., Wu, D. and Xie, B. 2024. Pollutant control and nutrient recovery of organic solid waste by earthworms: Mechanism and agricultural benefits of vermicomposting. *J. Environ. Chem. Eng*., **12**(3): 112610. <https://doi.org/10.1016/j.jece.2024.112610>
25. Wu, S., Li, Z., Yang, Y., Sun, J., Lian, D., Lai, Z. and Hong, J. 2024. Reduction in chemical fertilizer rates by applying bio-organic fertilizer for optimization yield and quality of Hemerocallis citrina Baroni. *Agron*., **14**(8): Article 8. <https://doi.org/10.3390/agronomy14081627>
26. Zhang, X., Li, J., Shao, L., Qin, F., Yang, J., Gu, H., Zhai, P. and Pan, X. 2023. Effects of organic fertilizers on yield, soil physico-chemical property, soil microbial community diversity and structure of Brassica rapa var. *Chinensis. Front. Microbiol*., **14**: Article 1132853. <https://doi.org/10.3389/fmicb.2023.1132853>

**Table 1. Comparative nutrient compositions of the manures used**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Manures | OC (%) | | N (%) | | P (%) | | K (%) | | S (%) | | Ca (%) | | Mg (%) | |
| Vermicompost | 9-18 | 1-2 | | 0.4-0.8 | | 0.5-1.2 | | 0.2-0.3 | | 1-3 | | 0.2-0.5 | |
| Trico-compost | 12-25 | 1.2-2.5 | | 0.6-1.2 | | 1.5-2.5 | | 0.2-0.5 | | 0.5-1.5 | | 0.3-0.8 | |
| Cow dung | 20-40 | 0.4-1 | | 0.2-0.4 | | 0.4-0.6 | | 0.1-0.2 | | 0.4-1 | | 0.1-0.3 | |
| Poultry Manure | 15-30 | 1.5-3.5 | | 1.3-2.5 | | 1.5-3 | | 0.5-1 | | 2-4 | | 0.3-0.8 | |
| Co-compost | 15-30 | 0.8-2 | | 0.4-1.5 | | 0.5-1.5 | | 0.2-0.5 | | 1-3 | | 0.3-0.8 | |

Source: Plant Nutrition and Environmental Chemistry Laboratory of Bangladesh Agricultural University

**Table 2.** Effect of treatment on yield contributing characters and yield of winter rice variety BRRI dhan89

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Treatments | Effective tillers hill⁻¹ (no.) | Non -effective tillers hill⁻¹ (no.) | Grains panicle-1 (no.) | Sterile spikelets panicle-1 (no.) | Grain yield  (t ha-1) | Straw yield  (t ha-1) | Biological yield (t ha-1) | Harvest index (%) |
| T1 | 9.30 def | 1.63ab | 104.27bcd | 13.22bcd | 6.87bc | 7.26bcde | 14.14 cd | 48.62ab |
| T2 | 10.6bcd | 1.33 bc | 109.04abc | 12.86 cd | 7.64ab | 8.08abc | 15.72abc | 48.60ab |
| T3 | 10.2bcd | 1.33 bc | 106.64bcd | 12.14 d | 7.12ab | 7.56abc | 14.69abc | 48.48abc |
| T4 | 11.4abc | 1.10 c | 115.75a | 11.99 d | 8.15ab | 8.52abc | 16.68abc | 48.88ab |
| T5 | 12.9a | 1.26 bc | 111.15ab | 11.97 d | 8.37a | 8.65ab | 17.02a | 49.15a |
| T6 | 11.8ab | 1.06 c | 111.02ab | 11.61 d | 8.14ab | 8.80a | 16.94ab | 48.04bcd |
| T7 | 8.21 f | 1.93ab | 99.68d | 15.60ab | 5.35d | 5.97 e | 11.32 e | 47.19 d |
| T8 | 8.30 ef | 2.33a | 100.51cd | 16.25a | 5.47cd | 6.03 de | 11.50 de | 47.50 cd |
| T9 | 10.0 cd | 1.60 bc | 106.01bcd | 13.86abcd | 6.88bc | 7.30bcde | 14.18 bcd | 48.51abc |
| T10 | 10.0 cd | 1.40 bc | 104.01bcd | 14.90abc | 6.90 b | 7.37bcd | 14.27abcd | 48.32abc |
| T11 | 9.90 cde | 1.50 bc | 102.80bcd | 14.73abc | 6.73bcd | 7.23 cde | 13.97 cde | 48.18abcd |
| Sx | 0.80 | 0.34 | 4.36 | 1.23 | 0.68 | 0.67 | 1.34 | 0.49 |
| Level of significance | \*\* | \* | \* | \*\* | \*\* | \*\* | \*\* | \* |
| CV (%) | 9.49 | 28.07 | 5.02 | 11.13 | 11.79 | 10.88 | 11.27 | 1.24 |

In a column, figure having similar letter(s) do not differ significantly at p ≤ 0.05, whereas figures with dissimilar letter(s) differed significantly as per DMRT. \*\*=significant at 1% (p≤0.01) level of probability, CV = Co-efficient of variation, NS = Not significant

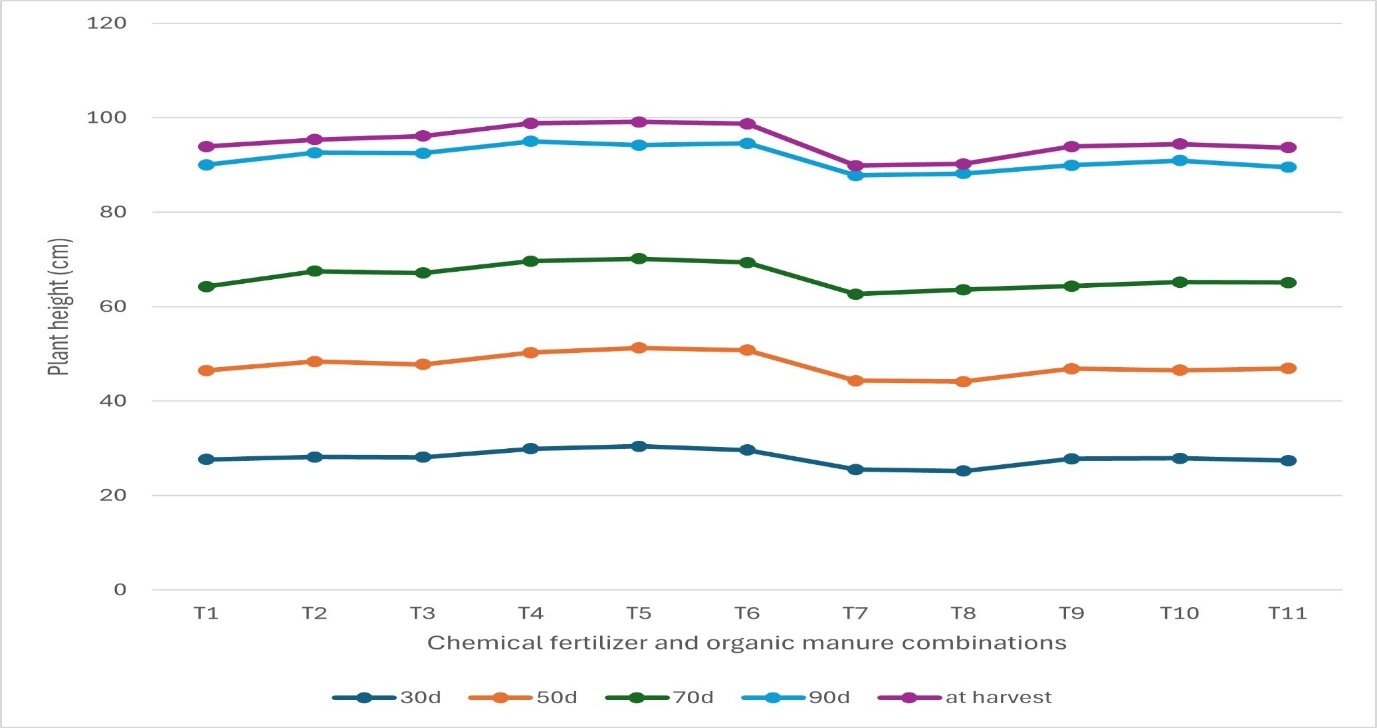
T1= Recommended dose of fertilizer (RDF), T2= RDF + [Vermicompost](mailto:Vermicompost@2.5) @2.5 t ha-1, T3 = RDF + Trico-compost @2.5 t ha-1, T4 =RDF + Cow dung @2.5 t ha-1, T5 = RDF + Poultry manure @2.5 t ha-1, T6 = RDF + Co-compost @2.5 t ha-1, T7 = 75% RDF + Vermicompost @5 t ha-1, T8 =75% RDF + Trico-compost @5 t ha-1, T9 = 75% RDF + Cow dung @5 t ha-1, T10 = 75% RDF + Poultry manure @5 t ha-1, T11 =75% RDF + Co-compost @5 t ha-1

**Table 3.** Economic efficiency of application of different chemical fertilizer and organic manure combinations in winter rice variety BRRI dhan89

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Chemical fertilizer and compost combinations | Variable cost (TK ha-1) | | | | Gross return (TK ha1) | Net return (TK ha1) | Benefit cost Ratio |
| Variable cost (Except fertilizer and manures) | Fertilizer cost | Manure cost | Total variable cost |
| T1 | 107000 | 7976 | - | 114976 | 235530 | 120554 | 2.05 |
| T2 | 107000 | 7976 | 62500 | 177476 | 261960 | 84484 | 1.48 |
| T3 | 107000 | 7976 | 87500 | 202476 | 244280 | 41804 | 1.20 |
| T4 | 107000 | 7976 | 7500 | 122476 | 278950 | 156474 | 2.28 |
| T5 | 107000 | 7976 | 7500 | 122476 | 285980 | 163504 | 2.34 |
| T6 | 107000 | 7976 | 25000 | 139976 | 280060 | 140084 | 2.00 |
| T7 | 107000 | 6016 | 125000 | 238016 | 185000 | -53016 | 0.77 |
| T8 | 107000 | 6016 | 175000 | 288016 | 188780 | -99236 | 0.66 |
| T9 | 107000 | 6016 | 15000 | 128016 | 236020 | 108004 | 1.85 |
| T10 | 107000 | 6016 | 15000 | 128016 | 236950 | 108934 | 1.85 |
| T11 | 107000 | 6016 | 50000 | 163016 | 231320 | 68304 | 1.42 |

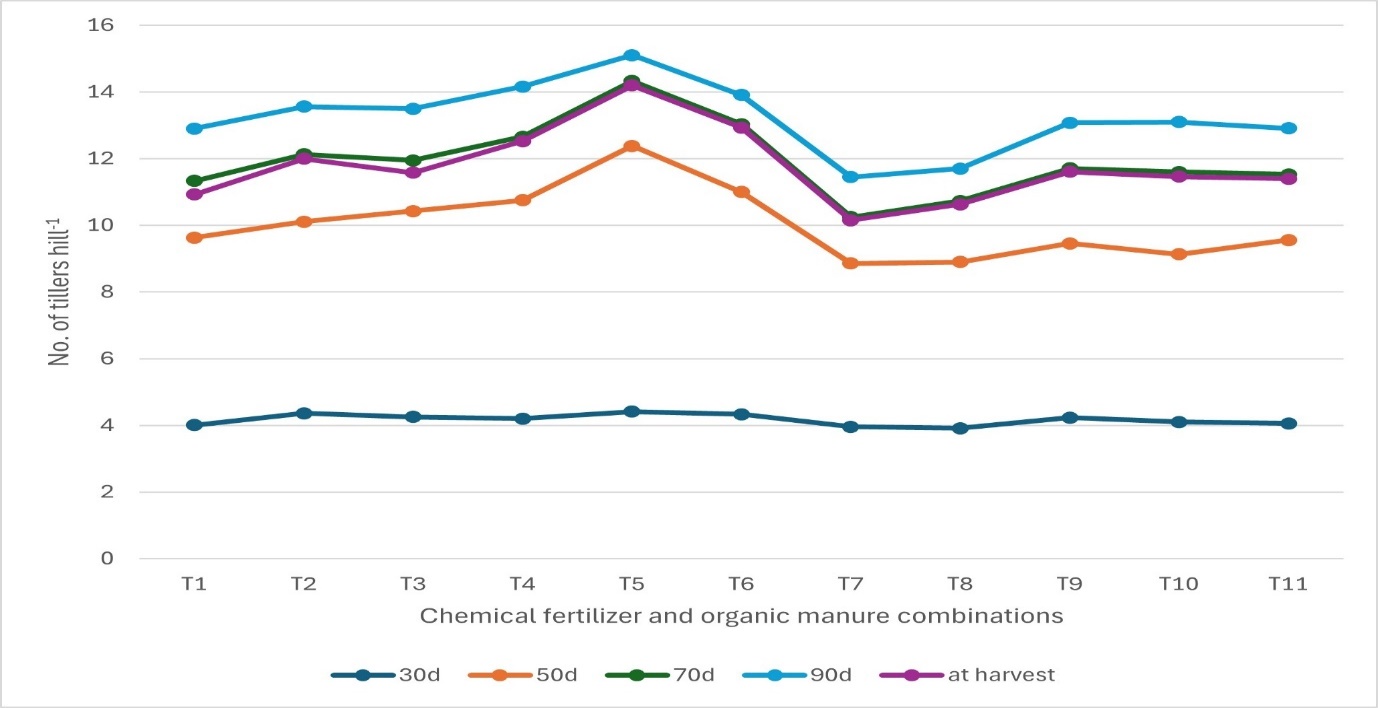
T1= Recommended dose of fertilizer (RDF), T2= RDF + [Vermicompost](mailto:Vermicompost@2.5) @2.5 t ha-1, T3 = RDF + Trico-compost @2.5 t ha-1, T4 =RDF + Cow dung @2.5 t ha-1, T5 = RDF + Poultry manure @2.5 t ha-1, T6 = RDF + Co-compost @2.5 t ha-1, T7 = 75% RDF + Vermicompost @5 t ha-1, T8 =75% RDF + Trico-compost @5 t ha-1, T9 = 75% RDF + Cow dung @5 t ha-1, T10 = 75% RDF + Poultry manure @5 t ha-1, T11 =75% RDF + Co-compost @5 t ha-1

Labor wage =500 Tk head-1 day-1; Urea=28 Tk kg-1; TSP= 28 Tk kg-1; MoP= 30 Tk kg-1; Gypsum= 14 Tk kg-1; Zinc sulphate= 240 Tk kg-1; Vermicompost = 25 Tk kg-1; Trico-compost = 35 Tk kg-1; Poultry manure = 3 Tk kg-1; Co-compost = 10 Tk kg-1; Cow dung = 3 Tk kg-1; Rice grain= 29 Tk kg-1



**Figure 1.** Effect of chemical fertilizer and various organic manure combinations on plant height at different days after transplanting of winter rice variety BRRI dhan89

T1= Recommended dose of fertilizer (RDF), T2= RDF + [Vermicompost](mailto:Vermicompost@2.5) @2.5 t ha-1, T3 = RDF + Trico-compost @2.5 t ha-1, T4 =RDF + Cow dung @2.5 t ha-1, T5 = RDF + Poultry manure @2.5 t ha-1, T6 = RDF + Co-compost @2.5 t ha-1, T7 = 75% RDF + Vermicompost @5 t ha-1, T8 =75% RDF + Trico-compost @5 t ha-1, T9 = 75% RDF + Cow dung @5 t ha-1, T10 = 75% RDF + Poultry manure @5 t ha-1, T11 =75% RDF + Co-compost @5 t ha-1



**Figure 2**. Effect of chemical fertilizer and various organic manure combinations on tillers number hill-1 at various days after transplanting of winter rice variety - BRRI dhan89

T1= Recommended dose of fertilizer (RDF), T2= RDF + [Vermicompost](mailto:Vermicompost@2.5) @2.5 t ha-1, T3 = RDF + Trico-compost @2.5 t ha-1, T4 =RDF + Cow dung @2.5 t ha-1, T5 = RDF + Poultry manure @2.5 t ha-1, T6 = RDF + Co-compost @2.5 t ha-1, T7 = 75% RDF + Vermicompost @5 t ha-1, T8 =75% RDF + Trico-compost @5 t ha-1, T9 = 75% RDF + Cow dung @5 t ha-1, T10 = 75% RDF + Poultry manure @5 t ha-1, T11 =75% RDF + Co-compost @5 t ha-1