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Research note 2

Intensifying Agriculture in Southern Bangladesh: Unlocking Mungbean Productivity through Innovative Management Practices



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The experimental design involved four fertilizer and management treatments, as outlined in previous studies (refer to treatments section). Each treatment was applied to approximately 10 decimals (400 m²) of land, with a minimum spacing of 50 cm between treatment plots to avoid interference between adjacent plots. Consequently, the land provided by each farmer for the trial covered a minimum of 40 decimals (1,600 m²). The treatments tested were designed to reflect common farmer practices as well as recommendations from the BARC fertilizer recommendations including with rhizobium inoculum or without inoculum.

Mungbean Variety

The BARI Mungbean-6 variety, widely cultivated in southern Bangladesh, was used in the trials. The seed rate was determined according to the recommendations provided by the Bangladesh Agricultural Research Institute (BARI) to ensure optimal growth and yield under different treatment conditions.

The improved mungbean variety, BARI Mungbean-6, was evaluated under four different fertilizer management practices:

T1: Farmers' fertilizer practice without rhizobium inoculation of mungbean seed (control).

T2: Farmers' fertilizer practice with rhizobium inoculation of mungbean seed.

T3: BARC-recommended fertilizer without rhizobium inoculation of mungbean seed.

T4: BARC-recommended fertilizer with rhizobium inoculation of mungbean seed.

Table 1: Fertilizers applied in each experimental treatment

Treatment	Nitrogen	Phosphorus	Potassium	Sulfur	Zinc	Boron	Rhizobium
	Unit (Kg/ ha)						
T1	FP ¹	0.0					
T2	FP ¹	50.0					
T3	15.0	15.0	20.0	10.0	1.5	1.0	0.0
T4	0.0	15.0	20.0	10.0	1.5	1.0	50.0

FP¹: Farmer practice

Fertilizers in T1 and T2 are applied according to farmers' standard practice for amounts and timing. These are recorded as part of experimental data collection. All fertilizers in T3 and T4 are applied basally during final land preparation.

Weed and root nodules

Information on weeds was collected from two 0.5 m × 0.5 m (0.25 m²) subplots within each treatment 35 days after sowing (Figure 2). In each treatment, the sampled weeds were categorized into grasses, sedges, and broadleaves, and their fresh biomass weight was recorded. Besides, five plants were randomly uprooted from each quadrat in each treatment between 45 to 50 days after sowing (DAS). The roots were carefully washed, the nodules on each root were counted, and the data was recorded.

Harvest and Data Analysis

Mungbean crops were harvested when pods began to darken from bright green. They are mostly handpicked at weekly intervals. Between one and three pickings are achieved, largely depending on weather conditions and, to a lesser extent, available labor. To estimate crop yield three sub-samples are collected from each treatment, from sub-sample crop cut areas of 1m². Yield samples from all

plots are collected away from treatment borders, with two samples nearer to opposite sides of the treatment plot and one from approximately the middle of the plot.

Experimental data were analyzed with the JMP (Version 14; SAS institute Cary, NC, USA; Littell et al., 2006) using ANOVA. The significance of the effect of treatment was determined by the magnitude of the F value ($P < 0.05$). If significance was detected at $\alpha = 0.05$, treatment means were separated by using the student's-t or Tukey's Honestly Significantly Different (HSD) test for non-interacting and interacting sources of variation, respectively.

Results and discussion

The results showed that Year 2 outperformed Year 1 in all yield and yield components (Table 2), assuming that the growing conditions in Year 2 were more favorable for mungbean production. Yield and yield components, such as pod number, seed size, and seed weight, are significantly influenced by a range of environmental and agronomic factors. One of the key factors that could have contributed to the improved performance in Year 2 is weather, especially the perception and content of soil moisture.

Among the fertilizer treatments, T3 and T4, which used BARC-recommended fertilizers, resulted in significantly higher yields ($P < 0.001$) compared to the farmer-based practices (T1 and T2). The addition of rhizobium inoculation in T2 and T4 further enhanced yields, indicating a synergistic effect between the fertilizers and the biofertilizer. In terms of yield components, T3 and T4 showed the highest number of pods per plant, with rhizobium inoculation (T2 and T4) contributing to a further increase. The highest seed count per pod and greater pod length were also observed in these treatments. Rhizobium inoculation slightly improved these components. Additionally, T3 and T4 exhibited a significant increase in 1000-grain weight, with rhizobium inoculation also contributing to improved grain weight.

Overall, BARC-recommended fertilizers (T3 and T4) produced the highest yields and yield components. The inclusion of rhizobium inoculation enhanced these outcomes, demonstrating its potential as a biofertilizer to optimize mungbean productivity. These findings emphasize the importance of adopting scientifically recommended agronomic practices and integrating biofertilizers for sustainable agricultural improvement.

Table 2: Mungbean yields and yield components using different fertilizer options

	Yield (t ha ⁻¹)	Pant population m ⁻²	Pods plant ⁻¹	Seeds pod ⁻¹	Pod length (cm)	1000 grain weight (g)
Year						
Y1	1.12 b	34.89 b	11.25 b	8.39 b	7.80 b	33.40 b
Y2	1.31 a	40.21 a	12.30 a	9.79 a	8.44 a	46.68 a
Treatment						
T1	1.02 c	31.99 b	10.18 c	8.49 c	7.48 c	37.74 c
T2	1.15 b	34.49 b	10.89 b	8.92 b	7.81 b	38.93 b
T3	1.38 a	42.05 a	13.00 a	9.56 a	8.60 a	42.04 a
T4	1.33 a	41.67 a	13.01 a	9.39 a	8.59 a	41.43 a
Year × Treatment						
Y1 × T1	1.05 d	27.67 f	10.04 e	8.06 e	7.31 c	29.96 f
Y1 × T2	1.07 cd	32.10 e	10.29 e	8.37 de	7.42 c	31.94 e
Y1 × T3	1.20 b	40.94 abc	12.12 cd	8.66 cd	8.19 b	36.25 d
Y1 × T4	1.17 bc	38.84 bcd	12.56 bc	8.45 cde	8.28 b	35.42 d
Y2 × T1	0.99 d	36.30 de	10.33 e	8.91 c	7.65 c	45.53 c
Y2 × T2	1.22 b	36.87 cd	11.50 d	9.47 b	8.20 b	45.93 bc
Y2 × T3	1.56 a	43.17 ab	13.90 a	10.46 a	9.02 a	47.83 a
Y2 × T4	1.49 a	44.50 a	13.47 ab	10.33 a	8.91 a	47.43 ab
F- ratio						
Year	95.03***	55.92***	38.50***	338.98***	131.69***	2285.24***
Treatment	72.34***	51.00***	74.47***	40.22***	101.85***	53.61***
Year × Treatment	23.46***	3.44*	3.40*	11.25***	3.92*	11.08***
Treatment						

The box plot reveals variability in the treatment results, particularly between T4 (BARC-recommended fertilizer with rhizobium) and T3 (BARC-recommended fertilizer without rhizobium). T4 shows high variability, with a larger spread in the box and whiskers, indicating significant differences in yield among farmers (Figure 1). This variability could be attributed to factors such as the way the treatment is applied, local soil conditions, or environmental influences affecting rhizobium effectiveness. In contrast, T3 displays more stability, with a smaller spread, suggesting more consistent yields across different farmers. This stability implies that the BARC-recommended fertilizer alone produces a more uniform outcome, possibly due to its lower reliance on variable factors like inoculation effectiveness. The implications are that while T4 provides the highest average yield, its variability means not all farmers may experience the same level of benefit, highlighting the need for tailored guidance or training.

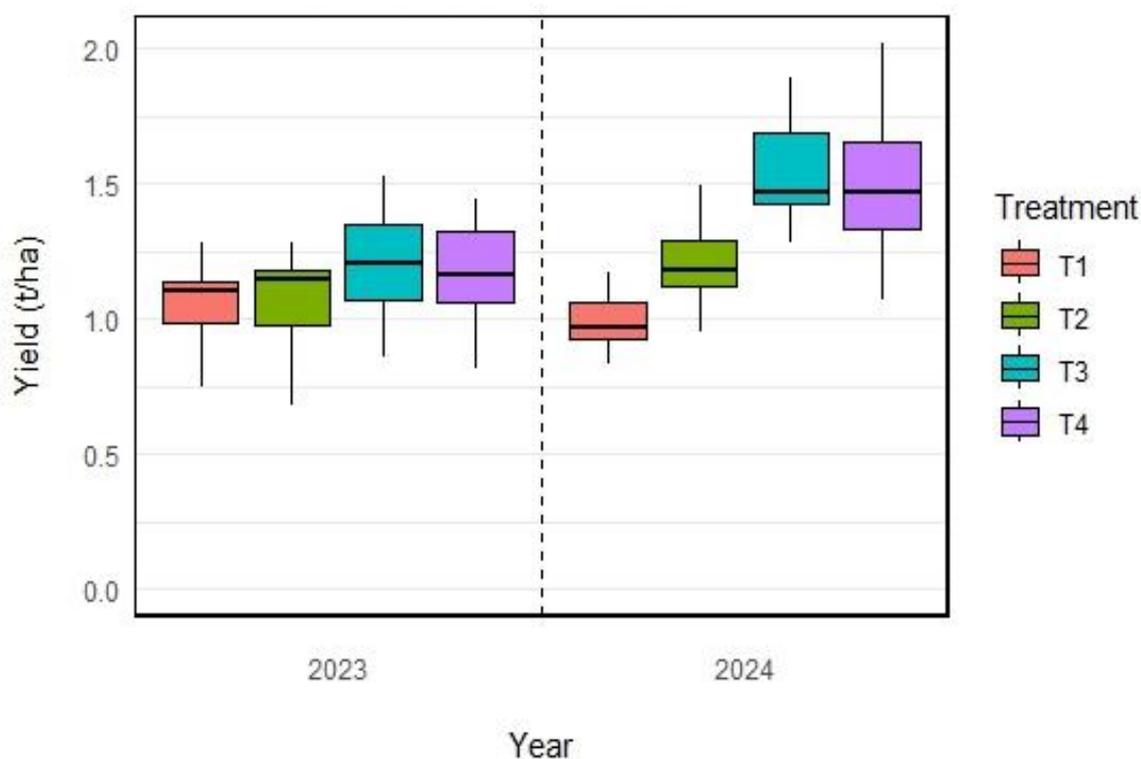


Figure 1: Variability in yield outcomes by treatments by year

In the first year, rhizobium inoculum root nodules were not observed during the data collection periods. However, in the second year, root nodules were observed, with significantly higher counts recorded in the T3 and T4 treatments compared to others (Figure 2: A). The scatter plot further indicated a positive association between the number of root nodules and higher crop yields (Figure 2: B). Rhizobium inoculum plays a crucial role in this process, as increasing root nodule counts could lead to significant productivity improvements, offering an effective pathway to sustainable agricultural development.

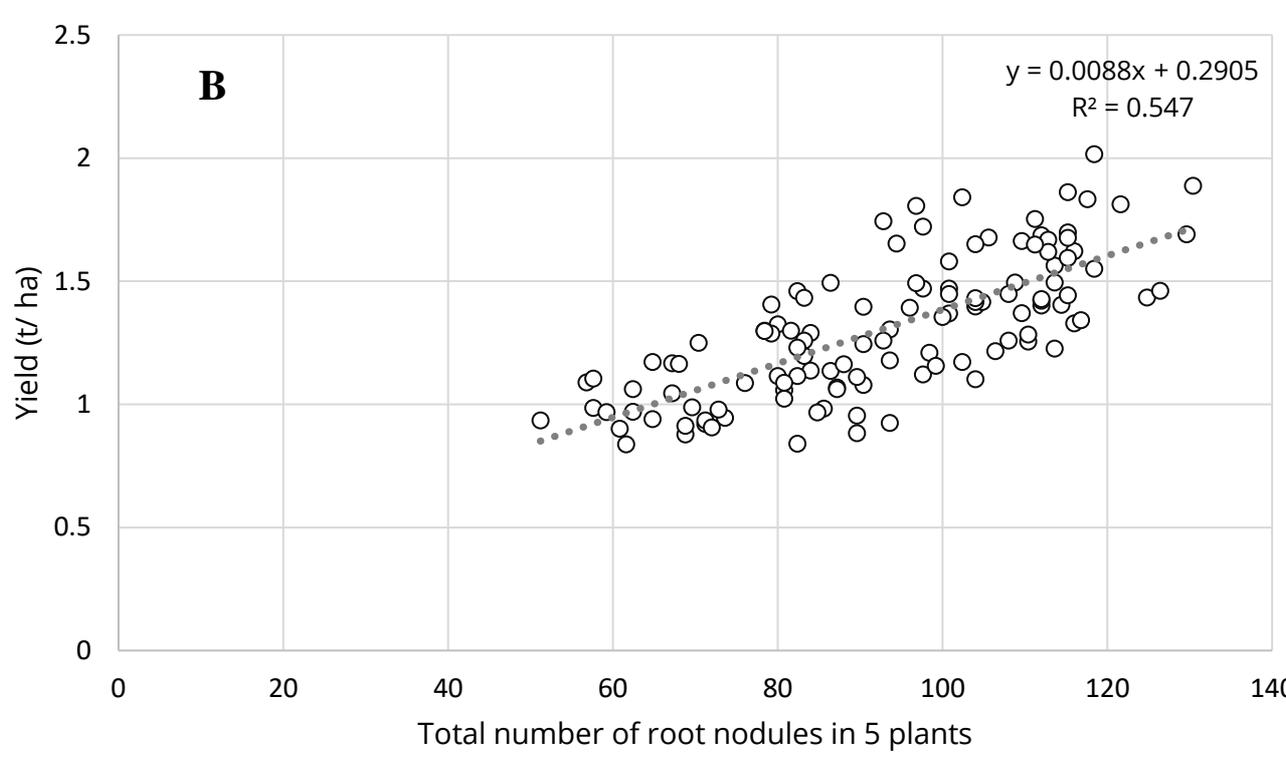
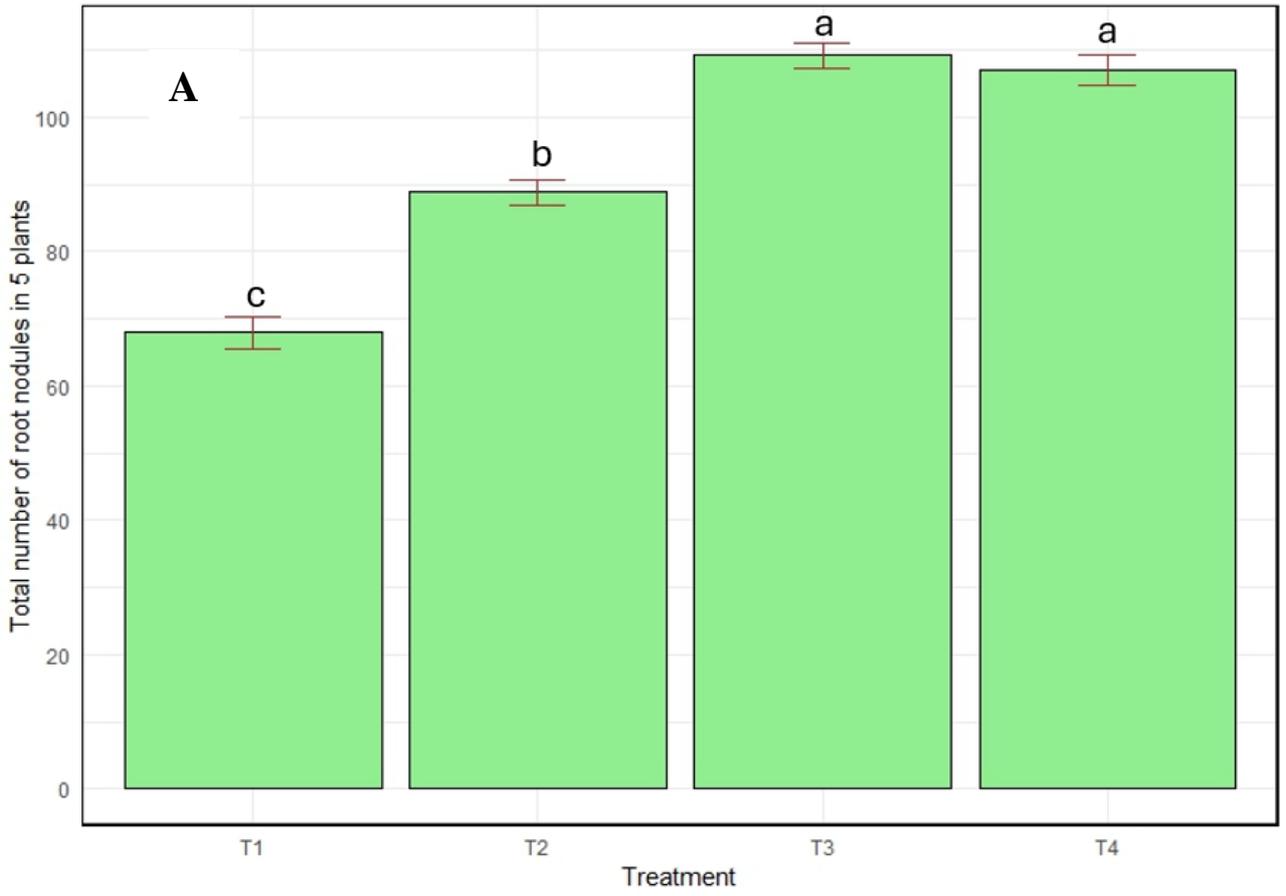


Figure 2: (A) Total number of root nodules observed in a total of five plants (B) Garin yield and total number of root nodules relationship.

The analysis reveals that adopting BARC-recommended fertilizer rates and rhizobium seed inoculation significantly increases mungbean yields and profitability compared to current farmer practices. Treatments T3 and T4, which likely include these recommendations, achieved the highest profits (BDT 45,706 and BDT 42,334) despite higher input costs (BDT 40,647 and BDT 40,828) (Table 3). In contrast, current practices (T1) had the lowest returns (BDT 23,810). Yearly comparisons show that Y1 had lower input costs with higher net returns, emphasizing the importance of optimizing practices over time. Statistical analysis confirms that both treatment and year significantly affect input costs and profits, with interaction effects highlighting performance variations across years. While both BARC-recommended practices (with or without rhizobium) are profitable and practical, broader adoption in southern Bangladesh may be limited by high input costs, access to resources, and knowledge gaps among farmers.

Table 3: Total Input Costs and Net Profit (BDT ha⁻¹) in Mungbean Cultivation Under Different Fertilizer Treatments

	Input cost (tk ha ⁻¹)	Net Return (tk ha ⁻¹)
Year		
Y1	34,675 b	37,884 a
Y2	38,887 a	33,530 b
Treatment		
T1	32,266 c	23,810 c
T2	33,382 b	30,979 b
T3	40,647 a	45,706 a
T4	40,828 a	42,334 a
Year× Treatment		
Y1× T1	30,638 d	31,213 b
Y1× T2	31,589 d	31,852 b
Y1× T3	38,146 b	45,235 a
Y1× T4	38,327 b	43,237 a
Y2× T1	33,895 c	16,407 c
Y2× T2	35,175 c	30,106 b
Y3× T3	43,148 a	46,177 a
Y4× T4	43,329 a	41,431 a
F-values		
Year	357.10***	12.36**
Treatment	424.46***	66.89***
Year× Treatment	4.28**	8.18***

Southern farmers perceive that weed infestation increases significantly after using fertilizer, especially nitrogenous fertilizers, on mungbean, leading to higher weeding costs. As a result, they are sometimes reluctant to apply fertilizer to their fields. The study showed that in Year 1, grass infestation was significantly higher, while broadleaf infestation was lower. In contrast, the results for Year 2 were the complete opposite of those in the first year. The results also indicated that there was no significant difference among treatments for grasses and sedges. Furthermore, the interaction between year and treatment was not significant either (Table 4).

Table 4: Weed biomass collected from different treatments

	Fresh weight of grasses at 45 DAS (kg ha ⁻¹)	Fresh weight of broadleaf (kg ha ⁻¹)
Year		
Y1	1682 a	368 b
Y2	1422 b	1430 a
Treatment		
T1	1511	922
T2	1556	855
T3	1613	953
T4	1528	868
Year× Treatment		
Y1× T1	1700	400
Y1× T2	1720	293
Y1× T3	1765	365
Y1× T4	1544	416
Y2× T1	1322	1445
Y2× T2	1392	1416
Y2× T3	1462	1541
Y2× T4	1513	1319
F-values		
Year	11.68**	203***
Treatment	ns	ns
Year× Treatment	ns	ns

The major weeds were recorded Knotgrass (*Paspalum spp.*), Foshka Begun (*Physalis minima*), Dubia sag (*Polygonum spp.*), Durba (*Cynodon dactylon*), Bonmula (*Raphanus spp.*) and Kata Notey (*Amaranthus spp.*).



Figure 3: Major weeds found in different plots in the mungbean fields.

CONCLUSION AND RECOMMENDATION

The study demonstrates that adopting BARC-recommended fertilizer rates, combined with rhizobium seed inoculation, significantly increases mungbean yields and profitability compared to current farmer practices. Treatments T3 (BARC-recommended fertilizer) and T4 (BARC-recommended fertilizer with rhizobium inoculation) produced the highest yields and gross margins, with T4 showing a synergistic effect between fertilizer and rhizobium inoculation. While rhizobium inoculation was effective in enhancing productivity, variability in its performance among farmers suggests the need for consistent application methods and training. Despite the profitability of these practices, broader adoption is limited by factors such as resource availability, and farmers' limited knowledge about the benefits and application of these improved practices.

To enhance the adoption of rhizobium seed inoculation, it is crucial to educate farmers on its benefits and proper application through targeted training programs and demonstration plots. Establishing reliable distribution networks in rural areas to improve access to high-quality rhizobium inoculants can help bridge the gap between awareness and practical implementation. Public-private partnerships should be explored to subsidize the cost of rhizobium inoculants, making them more affordable for smallholder farmers. Additionally, advocating for supportive government policies, such as subsidies or low-interest loans, can incentivize farmers to adopt rhizobium inoculation, fostering sustainable agricultural intensification and improved mungbean productivity.

REFERENCES

- Ahmed, M., et al. (2018). *Fertilizer Recommendation Guide-2018*. Bangladesh Agricultural Research Council (BARC), Farmgate, Dhaka 1215. 223 pages. Retrieved from <https://barc.portal.gov.bd/sites/default/files/files/barc.portal.gov.bd>
- Bangladesh Bureau of Statistics (BBS). (2023). *Statistical Yearbook of Bangladesh 2023*. Dhaka: BBS. Retrieved from <http://nsds.bbs.gov.bd/en/posts/111/Statistical%20Yearbook%202023>
- Bangladesh Bureau of Statistics (BBS). (2022). *Statistical Yearbook of Bangladesh 2022*. Dhaka: BBS. Retrieved from <http://nsds.bbs.gov.bd/en/posts/111/Statistical%20Yearbook%202023>
- Humphreys, E., Tuong, T. P., Buisson, M. C., Pukinskis, I., & Phillips, M. (2015). *Revitalizing the Ganges Coastal Zone: Turning Science into Policy and Practices Conference Proceedings*. CGIAR Challenge Program on Water and Food (CPWF), Colombo, Sri Lanka. Retrieved from <https://cgspace.cgiar.org/items/2c26b35b-b3ff-419b-8dd7-f7a070bd5c6e>
- Islam, Q. S., Miah, M. M., Rahman, M. S., & Hossain, M. S. (2013). Adoption of BARI mung varieties and its constraints to higher production in the southern region of Bangladesh. *Bangladesh Journal of Agricultural Research*, 38(1), 85–96. Retrieved from <https://www.banglajol.info/index.php/BJAR/article/view/15193>
- Littell, R. C., Milliken, G. A., Stroup, W. W., Wolfinger, R. D., & Schabenberger, O. (2006). *SAS for Mixed Models* (2nd ed.). Cary, NC: SAS Institute.