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Effect of organic and inorganic nutrient management on economics of pearl millet (*Pennisetum glaucum* L.)

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Abstract
This study was undertaken to evaluate the economics of pearl millet (*Pennisetum glaucum* L.) cultivation under various combinations of organic and inorganic nutrient management. The experiment, conducted at the Guru Kashi University Research Farm (Bathinda) during the kharif 2023 season, employed ten treatments with three replications in a Randomized Block Design. Economic indicators including cost of cultivation, gross returns, net returns, and benefit-cost ratio (B:C) were calculated for each treatment. The findings demonstrate that the treatment comprising 75% of the recommended dose of fertilizer (RDF) plus poultry manure (PM) at 1.5 t ha^{-1} (T_{10}) was most profitable, offering the highest gross and net returns, while 100% RDF treatment (T_2) delivered the best benefit-cost ratio. These results highlight integrated nutrient management strategies as both economically and agronomically viable for sustainable pearl millet cultivation in semi-arid regions.

Keywords: Pearl millet, economics, nutrient management, benefit-cost ratio, organic manure

1. Introduction
Pearl millet (*Pennisetum glaucum* L.) is a staple grain crop in semi-arid regions of India, valued for its resilience to drought and marginal soils. With increasing concerns over the sustainability of agriculture and rising input costs, there is a growing impetus to assess not only the agronomic yield but also the economic viability of integrating organic and inorganic nutrient sources (Bhatla *et al*., 2018; Divya *et al*., 2019; Pratap *et al*., 2008) [2, 3, 8]. Efficient nutrient management could reduce cultivation costs and maximize profits while preserving soil health (Gurjar *et al*., 2023; Yadav *et al*., 2019) [4, 10].

2. Materials and Methods
Site and Experimental Design
The field experiment was conducted at Guru Kashi University (Talwandi Sabo, Bathinda, Punjab; 29°57'N, 75°07'E; 208 m a.m.s.l.) during kharif 2023. The soil at the site was sandy loam, with pH 7.4 and moderate fertility levels. The climate is semi-humid with hot summers and cold winters.

- **Design:** Randomized Block Design (RBD)
- **Treatments:** 10 nutrient management strategies
- **Replications:** 3
- **Plot size:** Net plot of 1.7 m × 2.7 m
- **Variety:** PCB 165
- **Sowing:** July 29, 2023; row spacing 45 cm × 15 cm
- **Treatments:**

1. T_1: Control (No fertilizer applied)
2. T_2: RDF 100%
3. T_3: RDF 75% + Azotobacter
4. T_4: RDF 75% + Azospillium
5. T_5: FYM 10 t ha^{-1}
6. T_6: VC 5 t ha^{-1}

7. T_7: PM 3 t ha⁻¹
8. T_8: RDF 75% + FYM 5 t ha⁻¹
9. T_9: RDF 75% + VC 2.5 t ha⁻¹
10. T_{10}: RDF 75% + PM 1.5 t ha⁻¹

Economic Parameters

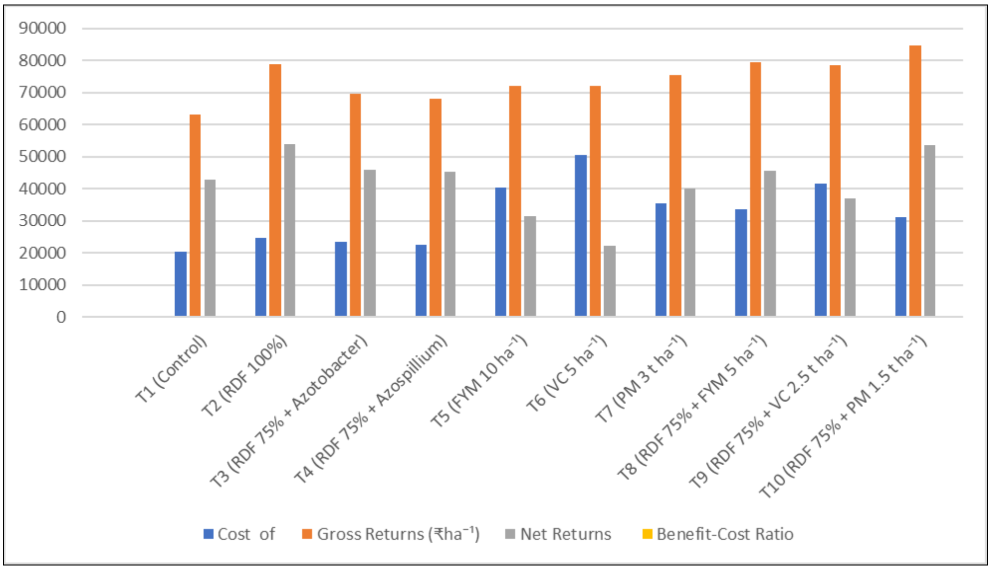
- **Cost of cultivation (₹ ha⁻¹):** Based on prevalent local charges for all activities and inputs
- **Gross returns (₹ ha⁻¹):** Calculated from market value of grain and stover yields for each treatment
- **Net returns (₹ ha⁻¹)**: Gross returns minus cost of cultivation
- **Benefit-Cost Ratio (BCR)**: Net return divided by cost of cultivation

Economic analysis followed methodologies outlined by Amarghade *et al*. (2021) [1] and Togas *et al*. (2017).

3. Results and Discussion

Table 1: Economics of Different Nutrient Management Treatments

Treatment	Cost of Cultivation (₹ha⁻¹)	Gross Returns (₹ha⁻¹)	Net Returns (₹ ha⁻¹)	Benefit-Cost Ratio
T1 (Control)	20500	63345	42845	2.09
T2 (RDF 100%)	24694	78773.86	54079.86	2.19
T3 (RDF 75% + Azotobacter)	23645	69516.3	45871.3	1.94
T4 (RDF 75% + Azospillium)	22597	68016.97	45419.97	2.01
T5 (FYM 10 ha⁻¹)	40500	72090	31590	0.78
T6 (VC 5 ha⁻¹)	50500	72215	22215	0.44
T7 (PM 3 t ha⁻¹)	35500	75615	40115	1.13
T8 (RDF 75% + FYM 5 ha⁻¹)	33645	79402.2	45757.2	1.36
T9 (RDF 75% + VC 2.5 t ha⁻¹)	41645	78709.05	37064.05	0.89
T10 (RDF 75% + PM 1.5 t ha⁻¹)	31145	84714.4	53569.4	1.72



Graph 1: Graph shows the Economics of Different Nutrient Management Treatments

Highest Net and Gross Returns

Highest gross returns (₹ 84,714.4 ha⁻¹) and net returns (₹ 53,569.4 ha⁻¹) were attained by T_{10} (RDF 75% + PM 1.5 t ha⁻¹).

The control (T_1) yielded the lowest gross (₹ 63,345 ha⁻¹) and net returns (₹ 42,845 ha⁻¹).

Treatments integrating organic manures with RDF (T8, T9) closely followed T10, reflecting the benefit of combining nutrient sources (Khadadiya *et al*., 2019; Gurjar *et al*., 2023) [5, 4].

Best Benefit-Cost Ratio

The optimal B:C ratio (2.19) was recorded for T_2 (RDF 100%), suggesting that full inorganic fertilization, despite higher input costs than untreated control, returns maximal profit per investment.

Both T_1 (control) and integrated treatments such as T_{10} and T_8 displayed competitive B:C ratios (2.09 and 1.72 respectively), supporting the adoption of integrated nutrient approaches for profitability and sustainability.

High Cultivation Cost with VC

Vermicompost-intensive treatments (T_6, T_9) had notably higher input costs, reducing net returns and BCR, emphasizing the need for careful cost management in organic amendments.

Moderate Results with FYM

FYM treatments, whether standalone (T_5) or integrated (T_8), produced moderate net returns and BCRs compared to T_{10} but were economically viable compared to high-cost VC.

Interpretations and Recommendations

The superior economics of T_{10} is attributed to moderate input costs but maximized outputs, validating integrated management involving both organic (poultry manure) and inorganic sources.

Although 100% RDF (T_2) showed the highest B:C, sustainability and potential long-term soil benefits argue for promoting strategies like T10 (RDF 75% + PM 1.5 t ha^{-1}) and T8 (RDF 75% + FYM 5 t ha^{-1}), as also supported by Amarghade and Singh (2021) [1], and Mahmood *et al*. (2017) [7].

Vermicompost-based treatments (T_6, T_9) incurred highest input costs with modest incremental returns, suggesting site-specific adaptation of nutrient sources may be required.

4. Conclusion

The economic evaluation demonstrates that integrating 75% RDF with poultry manure at 1.5 t ha^{-1} (T_{10}) provides the highest profitability among all tested treatments for pearl millet cultivation. This integrated approach is nearly as lucrative as full RDF treatment and offers additional agronomic and possible environmental advantages. For sustainable and profitable farming, integrated nutrient strategies—especially those combining poultry manure with reduced inorganic fertilization—should be prioritized and further verified with on-farm testing [Gurjar *et al*., 2023] [4] [Khadadiya *et al*., 2019] [5] [Mahmood *et al*., 2017] [7] [Singh and Chauhan, 2014] [9].

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