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Chapter 3

Yield and economic assessment of Black Wheat and Paigambari varieties of *Triticum aestivum* L. under Natural Farming in Begusarai, Bihar

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Abstract

Two Front Line Demonstrations were conducted during the Rabi season of 2024-25 in the Begusarai district of Bihar to evaluate the yield performance and economic efficiency of Black wheat and Paigambari wheat varieties under natural farming and conventional production systems across three villages. Under natural farming, Black wheat recorded a grain yield of 24.87 q ha^{-1} with a benefit cost (B:C) ratio of 7.57, compared to 25.69 q ha^{-1} and a B:C ratio of 6.32 under conventional practices. Paigambari wheat produced a grain yield of 26.13 q ha^{-1} with a B:C ratio of 5.41 under natural farming, while conventional management resulted in a grain yield of 26.73 q ha^{-1} and a B:C ratio of 4.53. However, natural farming led to a marginal reduction in grain yield for both varieties, it substantially enhanced economic efficiency due to lower input costs. Black wheat generated the highest economic returns owing to its higher market price. The demonstrations indicate that cultivation of high-value wheat varieties, particularly Black wheat, under natural farming systems can improve farm profitability while supporting sustainable, low-input wheat production in eastern India.

Keywords: Black wheat, Paigambari, *Triticum aestivum* L., Natural farming, Jeevamrit, Economics, Benefit cost ratio.

1. Introduction

Wheat (*Triticum aestivum* L.) is a principal staple crop of India and a cornerstone of national food and nutritional security. During 2024-25, the national average wheat productivity was 3595 kg ha^{-1}; however, productivity in Bihar remains comparatively lower despite its location within the fertile Indo-Gangetic Plains [1]. Wheat-based cropping systems in this region sustain millions of smallholder farmers and support diversified production systems, including hydroponic fodder cultivation [2]. Conventional wheat production in the Indo-Gangetic Plains is characterized by heavy reliance on synthetic fertilizers and pesticides. Although these inputs have enhanced productivity, their continued and excessive use has increased production costs, degraded soil health, reduced system resilience, and raised serious environmental concerns [3]. These limitations have renewed interest in alternative production strategies that are low-input, economically viable, and environmentally sustainable, particularly for resource-constrained farming systems [4].

Natural farming has emerged as a viable agroecological approach that emphasizes the use of indigenous biological inputs and on-farm resources, including microbial formulations such as *Bijamrita, Jeevamrit,* and *Ghanjeevamrit* [4]. These inputs enhance soil biological activity, improve nutrient availability, and reduce dependence on external chemical inputs. By lowering cultivation costs while improving soil health and ecological stability, natural farming is gaining relevance in eastern India, where smallholder dominance and input constraints prevail [4, 5].

Parallel to this shift, there is renewed interest in indigenous and traditional wheat varieties conserved and improved by farmers through mass selection. Many traditional wheat cultivars declined following the Green Revolution; however, their superior nutritional attributes and relevance to farmers' needs have renewed efforts for their conservation and promotion [6]. These varieties are often well adapted to local agro-climatic conditions and perform reliably under low-input environments. Recent studies have highlighted the superior nutritional and

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antioxidant properties of certain indigenous wheat types, including black wheat and Paigambari wheat, compared to conventional varieties [6]. Owing to their health benefits, these varieties command premium market prices, thereby offering opportunities for income enhancement alongside nutritional security. Despite increasing adoption of natural farming practices, systematic scientific evidence on the performance of high-value and traditional wheat varieties under chemical-free conditions in eastern Bihar is limited. Comparative evaluation of their growth, yield, and economic performance under natural and conventional farming systems is therefore essential. The present study was undertaken to assess the agronomic and economic suitability of black wheat and Paigambari wheat under natural farming in comparison with conventional practices, with the aim of generating evidence-based recommendations for sustainable wheat production and enhanced livelihoods of smallholder farmers in the region.

2. Materials and methods

2.1. Experimental location and design

The experiment was conducted during the Rabi season of 2024-25 in three villages of Begusarai district, Bihar, Tetrai, Bikrampur and Fafuat, under Front Line Demonstrations (FLD) programme. The study covered a total area of 1.2 ha and involved seven participating farmers. Begusarai district, located in the middle Gangetic plains, experiences a subtropical climate with hot summers, cool winters and a distinct monsoon season, receiving an average annual rainfall of 1,100-1,200 mm, supplemented by irrigation during dry periods. The soils of the experimental sites were predominantly alluvial, fertile, well-drained and moderately rich in organic carbon. No chemical fertilizers or pesticides were applied to maintain natural farming conditions. The selected locations represent the typical agro-ecological conditions and resource constraints of smallholder farmers in the region. Conducting the experiment under on-farm conditions across multiple locations enabled reliable evaluation of the performance, adaptability and economic viability of black wheat and Paigambari varieties under natural farming practices.

2.2. Natural farming practices

Bijamrita was used for seed treatment and prepared by soaking 5 kg of fresh indigenous cow dung (tied in a cloth) in 20 L of water for 12 h. Subsequently, 5 L of cow urine, 50 g of lime water, and a small quantity of soil collected from undisturbed bunds or forest areas were added. The dung bundle was gently squeezed to release nutrients and beneficial microorganisms. Seeds of Black wheat and Paigambari were treated with this solution prior to sowing to enhance microbial colonization, nutrient availability, and protection against seed-borne pathogens. *Ghanjeevamrit* was applied at 250 kg ha^{-1} to improve soil fertility. It was prepared by thoroughly mixing 100 kg of air-dried indigenous cow dung, 1 kg jaggery, 1 kg pulse flour (besan), and 250 g of soil from undisturbed forest or bund areas. The mixture was shaped into cakes and fermented under shade for 10 days before soil application. *Ghanjeevamrit* was incorporated into the soil before sowing to enrich organic matter and beneficial microbial populations. *Jeevamrit* was prepared in a 250 L plastic drum using 100 L water, 5 kg cow dung, 5 L cow urine, 1 kg jaggery, and 75 g forest soil. The mixture was fermented for 9 days under shade and stirred twice daily to ensure aeration and microbial activity. *Jeevamrit* was applied both as a soil and foliar input at 500 L ha^{-1} per irrigation, twice a month, throughout the crop growth period to supply nutrients and stimulate microbial activity. Neem leaves (12.5 kg) or crushed neem seed kernels (3–8 months old) were mixed with 250 L water in a drum, followed by 12.5 L cow urine and 2.5 kg dung from an indigenous cow. The mixture was stirred for 2–3 min, covered with a gunny bag, and incubated for 48 h with stirring thrice daily. After incubation, the mixture was filtered through a fine mesh. The filtrate (*Neemastra*) was sufficient for application over one hectare.

All conventional plots received inorganic fertilizers at the rate of 120 kg N, 60 kg P and 40 kg K per hectare at sowing. Nitrogen, phosphorus and potassium were applied in the form of urea, single super phosphate and muriate of potash, respectively.

2.3. Data recording and economic analysis

Pooled mean data of all recorded observations were used to evaluate the performance of black wheat and Paigambari varieties under natural farming as well as conventional conditions. Growth parameters, including plant height at physiological maturity, number of tillers per plant, and spike length, were recorded from ten randomly selected plants in each plot. Total above-ground biomass was measured at crop maturity by harvesting the entire plot. The harvest index was calculated as the ratio of grain yield to total above-ground biomass. Grain yield was recorded at harvest in quintals per hectare (q ha^{-1}) and adjusted to standard moisture content.

Economic analysis was carried out to assess the profitability of both wheat varieties. The cost of cultivation comprised expenditures on seed, preparation and application of natural inputs (*Bijamrita, Jeevamrit*, and *Ghanjeevamrit*), and labour costs associated with land preparation, sowing, irrigation, weeding, and other field operations. Gross return was calculated based on the prevailing market price of grain at harvest, while net return was derived by deducting the total cost of cultivation from the gross return. The benefit cost (B:C) ratio was computed to evaluate economic efficiency.

3. Results

3.1. Growth parameters

The growth parameters of Black wheat under conventional and natural farming systems are presented in Table 1. Plant height, measured at physiological maturity, was marginally higher under the conventional system (98.5 cm) compared to natural farming (96.7 cm), indicating slightly greater vegetative growth with conventional practices. A similar trend was observed for tillers per plant, with values of 5.6 under conventional farming and 5.5 under natural farming, suggesting comparable tillering capacity under both systems. Spike length followed the same pattern, recording 9.8 cm under conventional farming and 9.6 cm under natural farming, reflecting only minor differences in reproductive growth. Total above-ground biomass was also slightly higher under conventional management (43.2 t ha^{-1}) than under natural farming (42.8 t ha^{-1}), indicating a small reduction in biomass accumulation under natural farming conditions. Overall, the differences in growth parameters between the two systems were minimal, demonstrating that natural farming practices were able to sustain growth and vegetative development of Black wheat at levels comparable to conventional farming, despite the absence of chemical inputs. This indicates the suitability of natural farming practices for maintaining adequate crop growth while reducing dependence on external inputs.

Table 1: Growth, yield, and economic performance of Black wheat under different farming practices

Farming practices	Plant height (cm)	Tillers /Plant	Spike length (cm)	Biomass (t ha^{-1})	HI	Grain yield q ha^{-1}	Gross Cost (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net Return (Rs. ha^{-1})	B:C ratio
Conventional	98.5	5.6	9.8	43.2	0.60	25.69	30,456	1,92,675	1,62,219	6.32
Natural	96.7	5.5	9.6	42.8	0.50	24.87	24,630	1,86,525	1,61,895	7.57

HI = Harvest Index; Plant height measured at physiological maturity from 10 randomly selected plants per plot.
B:C ratio: benefit cost ratio
Price of Black wheat: Rs. 7,500 q^{-1}.

The growth performance of the Paigambari variety under conventional and natural farming systems is presented in Table 2. Plant height at physiological maturity was comparable under both management practices, recording 92.3 cm under conventional farming and 91.9 cm under natural farming, indicating minimal influence of production system on plant stature. The number of tillers per plant was slightly higher under conventional farming (5.1) compared to natural farming (4.8), suggesting a marginal reduction in tillering under natural farming conditions. Spike length also showed a small decline under natural farming (8.9 cm) relative to conventional management (9.2 cm), reflecting minor differences in reproductive growth. Total above-ground biomass was noticeably higher under conventional farming (38.5 t ha^{-1}) than under natural farming (36.9 t ha^{-1}), indicating reduced biomass accumulation in the absence of chemical inputs. Harvest index followed a similar trend, with higher values under conventional farming (0.58) compared to natural farming (0.53), suggesting slightly lowers efficiency of biomass partitioning into grain under natural farming. Overall, although natural farming resulted in marginal reductions in key growth parameters of Paigambari, the variety maintained comparable growth and productivity to conventional farming. These results demonstrate that Paigambari can perform satisfactorily under natural farming systems while benefiting from reduced cultivation costs and improved economic efficiency.

Table 2: Growth, yield, and economic performance of Paigambari wheat under different farming practices

Farming practices	Plant height (cm)	Tillers /Plant	Spike length (cm)	Biomass (t ha^{-1})	HI	Grain yield q ha^{-1}	Gross Cost (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net Return (Rs. ha^{-1})	B:C ratio
Conventional	92.3	5.1	9.2	38.5	0.58	26.73	29,489	1,33,650	1,04,161	4.53
Natural	91.9	4.8	8.9	36.9	0.53	26.13	24,123	1,30,650	1,06,527	5.41

HI = Harvest Index; Plant height measured at physiological maturity from 10 randomly selected plants per plot.
B:C ratio: benefit cost ratio
Price of Paigambari wheat: Rs. 5,000 q^{-1}.

3.2. Yield and economics

The yield and economic performance of Black wheat and Paigambari under conventional and natural farming systems are presented in Tables 1 and 2. Grain yield of Black wheat was slightly higher under conventional farming (25.69 q ha^{-1}) compared to natural farming (24.87 q ha^{-1}). Similarly, Paigambari recorded marginally higher grain yield under conventional management (26.73 q ha^{-1}) than under natural farming (26.13 q ha^{-1}). These results indicate that the adoption of natural farming practices led to only a minor reduction in grain yield for both varieties. Despite the slight yield reduction, natural farming significantly lowered the cost of cultivation in both wheat varieties. In black wheat, the cost of cultivation decreased from Rs. 30,456 ha^{-1} under conventional farming to Rs. 24,630 ha^{-1} under natural farming. Likewise, in Paigambari, cultivation cost declined from Rs. 29,489 ha^{-1} to Rs. 24,123 ha^{-1} under natural farming. The reduction in input costs compensated for the marginal yield loss. Black wheat generated substantially higher gross returns than Paigambari due to its premium market price. Under natural farming, Black wheat recorded a gross return of Rs. 1, 86, 525 ha^{-1} and a net return of Rs. 1,61,895 ha^{-1}, resulting in a high B:C ratio of 7.57.

In contrast, Paigambari under natural farming produced a gross return of Rs. 1, 30,650 ha^{-1} with a net return of Rs. 1,06,527 ha^{-1} and a B:C ratio of 5.41. Overall, Black wheat proved to be economically superior to Paigambari under both farming systems, particularly under natural farming, where reduced input costs and higher market value enhanced profitability. The results highlight that adoption of natural farming practices, combined with high-value wheat varieties such as black wheat, can improve farm income while maintaining sustainable and low-input production systems for smallholder farmers.

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Black Wheat **Paigambari Wheat**

Figure 1: Black Wheat and Paigambari Wheat grains.

4. Discussion

The present study demonstrates that both black wheat and Paigambari can be successfully cultivated under natural farming (NF) conditions with only marginal reductions in growth and yield compared to conventional farming. Slight declines in plant height, tiller number, spike length, biomass and grain yield under NF were observed in both varieties, primarily due to the absence of readily available nutrients from chemical fertilizers. However, the use of indigenous inputs such as *Bijamrita, Jeevamrit* and *Ghanjeevamrit* likely sustained soil microbial activity and gradual nutrient release, resulting in near-comparable crop performance under chemical-free management.

Black wheat exhibited greater vegetative growth and biomass accumulation across farming systems, indicating superior vigor and adaptability to low-input conditions. Although Paigambari produced marginally higher grain yield, black wheat generated higher economic returns owing to its premium market price. This highlights that profitability under alternative farming systems is influenced not only by yield but also by input costs and market value. The better performance of indigenous varieties under NF can be attributed to their local adaptation, higher nutrient-use efficiency and greater stress tolerance compared to hybrids, which are typically optimized for high-input systems.

Natural farming significantly reduced the cost of cultivation by eliminating synthetic fertilizers and pesticides, which compensated for the slight yield reduction and resulted in higher net returns and benefit–cost ratios than conventional farming. Similar observations of lower yield but higher profitability under NF were reported by [7] emphasizing the economic viability of NF for smallholder farmers.

The present findings are consistent with earlier studies reporting yield reductions under natural or organic farming systems. Substantial yield penalties under NF were reported by [8–10]. Although the magnitude varied across cultivars and environments. Comparable trends were also observed under biofarming systems, where [11] reported an 8.15% reduction in wheat grain-equivalent yield. These yield reductions have been largely attributed to limited and slow nutrient availability from natural inputs such as *jeevamrit* and *ghanjeevamrit*, which may not adequately meet crop nutrient, demand during critical growth stages [12, 13].

Despite these limitations, the relatively smaller yield reduction observed in the present study suggests that certain genotypes, particularly black wheat, are better suited to low-input natural farming systems. Overall, the results indicate that natural farming can maintain acceptable wheat productivity while improving profitability and sustainability, especially through the adoption of indigenous and high-value crop varieties. Further research should focus on enhancing nutrient management under NF and identifying varieties with greater nutrient-use efficiency and adaptability.

5. Conclusions

The study demonstrates that natural farming can be effectively adopted for the cultivation of black wheat and Paigambari varieties under the agro-climatic conditions of eastern Bihar. Although natural farming resulted in marginal reductions in growth and grain yield compared to conventional practices, overall crop performance remained stable due to the use of indigenous inputs such as *Bijamrita, Jeevamrit*, and *Ghanjeevamrit*. Natural farming substantially reduced cultivation costs, leading to higher net returns and benefit cost ratios for both varieties. Black wheat emerged as the most economically superior option under natural farming owing to its higher market price, while Paigambari showed stable yields with lower input requirements. Future research should focus on nutritional quality, antioxidant potential, water use efficiency, soil health, and carbon footprint to comprehensively assess the sustainability and profitability of wheat varieties under natural farming systems and to support policy and extension efforts aimed at enhancing farmer livelihoods in eastern India.

Article Information

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References

[1] Department of Agriculture. *Farmers Welfare, Economics and Statistics. (2024–2025). Agricultural statistics at a glance 2024–25*. Ministry of Agriculture and Farmers Welfare, Government of India.

[2] N. N. Patil Vipin, R. Pal, and P. Bhoudaria. Comparative Production and Nutritional Evaluation of Hydroponically Grown Wheat and Maize Fodder with Conventional Fodder. In A. Matsoukis, editor, *Studies on Agriculture*, pages 78–81. ZenToks Books, India, 2025. ISBN: 978-81-958975-7-5.

[3] S. Verma, R. S. Chandel, R. Kaushal, P. Yankit, and S. Sharma. Soil quality management through zero budget natural farming. *ICAR news: A Science and Technology Newsletter*, 24(3):8–9, 2018.

[4] P. Dev, S. S. Paliyal, and N. Rana. Subhash palekar natural farming-scope, efficacy and critics. *Environment Conservation Journal*, 23 (1 and 2):99–106, 2022.

[5] G. Vinay, B. Padmaja, M. Malla Reddy, G. Jayasree, and S. Triveni. Evaluation of natural farming practices on the performance of maize. *Int J Ecol Environ Sci*, 2:224–230, 2020.

[6] N. Parvez, H. Choudhary, S. Parihar, K. Gandhi, S. Singh, R. Rathore, others, and A. Verma. Profiling of nutritional traits in indigenous wheat cultivars. *Journal of Experimental Biology and Agricultural Sciences*, 7(1):1–11, 2019.

[7] A. K. Behera and C. P. Chandrashekara. Effect of natural farming, organic farming, and recommended package of practices on yield and economics of irrigated wheat (Triticum aestivum). *The Indian Journal of Agricultural Sciences*, 93(1):102–105, 2023.

[8] A. Saini, S. Manuja, R. G. Upadhyay, S. Manhas, C. Sahoo, G. Singh, others, and M. R. Fayezizadeh. Assessing the effect of soil cultivation methods and genotypes on crop yield components, yield and soil properties in wheat (Triticum aestivum L.) and Rice (Oryza sativa L.) cropping system. *BMC Plant Biology*, 24(1):349, 2024.

[9] A. S. Sidhu, D. Shard, C. S. Aulakh, S. S. Bhullar, and S. Singh. Evaluating the sustainability of natural, organic and conventional farming practices: a comparative study in maize-wheat cropping system in North-west India. *Environment, Development and Sustainability*, pages 1–28, 2025.

[10] S. Darjee, R. Singh, S. Dhar, R. Pandey, N. Dwivedi, P. K. Sahu, others, and M. Shrivastava. Empirical observation of natural farming inputs on nitrogen uptake, soil health, and crop yield of rice-wheat cropping system in the organically managed Inceptisol of Trans Gangetic plain. *Frontiers in Sustainable Food Systems*, 8, 2024. Article 1324798.

[11] P. Thakur, S. S. Paliyal, A. Gill, P. Thakur, N. P. Butail, P. Dev, others, and P. Kumar. Assessing soil quality and wheat productivity under manure augmented natural farming. *International Journal of Plant Production*, 18(4):601–621, 2024.

[12] P. Thakur, S. S. Paliyal, P. Kumar, Y. Raj, P. Thakur, P. Dev, A. Thakur, N. P. Butail, and A. Gill. Natural farming needs manure augmentation to optimize soil quality and crop productivity. *Soil Use and Management*, 41(1):e70005, 2025.

[13] S. K. Sharma, N. Ravisankar, N. K. Jain, and S. K. Sarangi. Natural farming: current status, research and case studies. *Indian Council of Agricultural Research, New Delhi*, 110:12–25, 2023.