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Popularization of Ragi millet through Frontline demonstration in district Gonda, Uttar Pradesh

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Abstract
Field-level extension trials serve as an effective vehicle for agricultural technology transfer, as demonstrated by a two-year study conducted during the *Kharif* 2022 and 2023 seasons across 5.0 hectares involving 50 growers under the guidance of Krishi Vigyan Kendra, Mankapur, Gonda (Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya). Designed to bridge the yield gap and enhance net farm income, the study evaluated finger millet (*Eleusine coracana*, locally termed *madua* or ragi) a climate-resilient staple ranking sixth in Indian cereal production behind rice, wheat, maize, sorghum, and pearl millet, with primary cultivation concentrated across Karnataka, Andhra Pradesh, Tamil Nadu, Odisha, and Maharashtra. Revered for its exceptional dietary profile, the grain provides 320 kcal, 67.0 g carbohydrates, 7.16 g protein, 1.92 g fat, 210 mg phosphorus, 146 mg magnesium, 2.50 mg zinc, and an outstanding 364 mg of calcium per 100 g, establishing it as a staple for weaning foods and therapeutic diets addressing degenerative joint conditions. While both regimes received an identical synthetic fertilizer application of 40:40:0 kg/ha N:P:K, the demonstration package introduced the high-yielding variety 'VL 376' paired with a phosphate-solubilizing bacterial (PSB) seed inoculant, contrasting with the uninoculated local landraces planted under conventional farmer practices; this intervention led to marked economic gains, delivering net returns of ₹66,683 per hectare and a benefit-cost ratio of 2.69, well above the ₹47,273 per hectare and 2.21 B:C ratio achieved through traditional management.

Keywords: Frontline demonstration (FLD), finger millet, integrated crop management (ICM), technology index, yield gap analysis

Introduction
The term "millet" designates a diverse group of small-seeded annual grasses cultivated primarily across marginal, drought-prone soils in temperate, subtropical, and tropical regions. Major millets grown throughout India include finger millet (*ragi*), sorghum (*jowar*), barnyard millet (*sawan*), pearl millet (*bajra*), kodo millet, foxtail millet (*kangni*), and little millet (*kutki*). Following India's domestic celebration of the National Year of Millets in 2018, the United Nations General Assembly, prompted by an Indian proposal to the Food and Agriculture Organization, designated 2023 as the International Year of Millets to spotlight their strategic potential for global food systems. Exceptionally nutrient-dense and inherently gluten-free, these grains offer far greater nutritional value than conventional cereals like wheat and polished rice, delivering abundant dietary fiber, plant protein, essential fatty acids, vitamins, trace minerals such as iron, magnesium, phosphorus, and potassium and potent bioactive phytochemicals. These properties promote efficient digestion, support cardiovascular health, and assist in managing metabolic disorders like diabetes, with notable compositional variation across species; pearl millet, for example, contains a relatively high lipid concentration, whereas finger millet maintains a markedly low-fat profile. Beyond their dietary merits, millets represent a cornerstone of agricultural security and rural livelihoods across Africa and Asia, serving concurrently as household staples and livestock feed. India stands as the foremost global producer—contributing roughly 15% of worldwide output and sharing more than 55% of total harvest volume alongside Niger and China with Rajasthan driving domestic yield alongside significant production hubs across Karnataka, Andhra Pradesh, Tamil Nadu, Odisha, and Maharashtra.

Material and methods

To evaluate the yield disparity in finger millet (*ragi*), frontline demonstrations (FLDs) were carried out across two consecutive cropping seasons *Kharif* 2022 and *Kharif* 2023 on selected growers' holdings under the administrative oversight of Krishi Vigyan Kendra, Mankapur, Gonda (affiliated with Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya). The field trials spanned an aggregate area of 5.0 hectares involving 50 progressive farmers who received targeted technical training prior to trial implementation. The demonstration plots implemented an integrated crop management protocol featuring the improved cultivar 'VL 376' bio-primed with a phosphate-solubilizing bacterial (PSB) seed dressing, benchmarked directly against contiguous micro-plots representing conventional farmers' practices reliant on untreated local landraces; detailed agronomic interventions are summarized in Table 1. Researchers systematically gathered empirical data on yield-contributing traits and conducted comparative economic assessments encompassing cost of cultivation, net monetized returns, and benefit-cost ratios. Furthermore, to quantify the translational efficacy of the introduced package, the technology gap, extension gap, and technology index were computed following the analytical methodology established by Samui *et al*. (2000) [7].

Extension gap =DY-LY
Technology gap =PY-DY

$$\text{Technology index (\%)} = \frac{\text{PY} - \text{DY}}{PY}$$

Where,

DY=Demonstration yield
LY=Local check yield (FP)
PY=Potential yield of variety

Result and discussion

Agronomic evaluations revealed that the improved finger millet cultivar 'VL 376', managed under an integrated crop management regime, achieved superior morpho-physiological performance, recording a plant height of 87.16 cm, 8.93 productive tillers per plant, and a 1,000-grain test weight of 3.68 g. Consequently, demonstration plots realized a mean grain yield of 23.87 q/ha representing a 29.02% yield advantage over traditional farmer practices relying on regional landraces aligning closely with trends reported by Dhaka *et al*. (2011) [2], Rai *et al*. (2015) [4], and Pandey *et al*. (2018) [5]. Benchmarking field trial outputs against the genetic potential of the cultivar highlighted an extension gap of 5.37 q/ha and an operational technology gap of 6.13 q/ha, discrepancies largely driven by heterogeneous soil fertility profiles, varying biotic pressures, and inconsistent varietal management across farm holdings. The trial established a technology index of 20.43% (Table 3), where lower percentage values signify greater regional feasibility and technological adaptability, echoing earlier assessments by Hiremath and Nagaraju (2009) [3] and Rai *et al*. (2015) [4]. Economically, the mean cost of cultivation for the improved package rose modestly to ₹39,380/ha (comprising ₹38,240/ha in 2022 and ₹40,523/ha in 2023) compared to ₹37,325/ha under conventional farmer practices, primarily due to incremental investments in certified seed stock and biofertilizer seed dressings. However, this marginal expenditure was substantially offset by enhanced economic output: demonstration plots generated an average gross return of ₹88,759/ha, net returns of ₹66,683/ha, and an elevated benefit-cost ratio of 2.69, corroborating observations documented by Hiremath and Nagaraju (2009) [3] and Sreelakshmi *et al*. (2012) [8]. Overall, the frontline trials verified that deploying improved finger millet cultivars alongside validated agronomic interventions significantly optimizes productivity and profitability under Gonda agro-climatic conditions, serving as a persuasive extension catalyst for wider agrarian adoption.

Table 1: Improved crop management practices followed in Frontline demonstrations

Sl. No	Intervention points	Recommended improved practices
1.	High yielding variety	VL376
2.	Seed treatment	Seed treatment by PSB culture @1 packet of 200 grams for 10 kg seed of Ragi was done in demonstration.
3.	Fertilizers	NPK: 40:40:0 kg/ha respectively. Half quantity of Nitrogen and full quantity of phosphorus was given before sowing of the seed rest half quantity of nitrogen was given as top dressing after hand weeding.
4.	Weeding	Hand weeding at 20 days after sowing.
5.	Irrigation	Irrigation was done at pre- flowering stage

Table 2: Yield and yield attributes influenced by improved crop management practices

Year	No of tillers/plant		Plant height (cm)		Test weight (g)		Grain yield (q/ha)		Straw yield (q/ha)	
	Demo	FP	Demo	FP	Demo	FP	Demo	FP	Demo	FP
2022	8.52	7.45	85.12	81.33	3.62	3.56	22.72	17.13	32.94	25.69
2023	9.35	8.50	89.20	85.25	3.75	3.60	25.02	19.87	36.28	29.80
Avg	8.93	7.97	87.16	83.29	3.68	3.58	23.87	18.50	34.61	27.74

Table 3: Yield and yield attributes influenced by improved crop management practices

Variables	Yield (q/ha)	Extension gap (q/ha)	Technology gap (q/ha)	Technology Index (%)
Farmer's practice	18.50			
Improved practice	23.87	5.37	6.13	20.43
Potential Yield	30.00			

Table 4: Cost of cultivation, gross return, net return and benefit cost ratio influenced by improved crop management practices

Years	Cost of cultivation (Rs/ha)		Gross return (Rs/ha)		Net return (Rs/ha)		Benefit Cost Ratio	
	Demo	FP	Demo	FP	Demo	FP	Demo	FP
2022	38240	32760	97762	74136	59522	41376	2.56	2.26
2023	40523	38150	96227	91320	73844	53170	2.82	2.39
Average	39380	37325	88759	82728	66683	47273	2.69	2.21

Conclusion

The frontline demonstrations conclusively establish that replacing local finger millet landraces with the improved cultivar 'VL 376' and adopting integrated crop management practices particularly biofertilizer seed inoculation significantly bridges existing yield gaps in Gonda district, Uttar Pradesh. Achieving a 29.02% grain yield advantage alongside a low technology index of 20.43% confirms the high agro-ecological suitability and practical feasibility of the recommended package. Despite a marginal increase in cultivation costs due to quality seed and treatment inputs, the demonstration protocol delivered superior economic gains, characterized by substantial net returns of ₹66,683/ha and an enhanced benefit-cost ratio of 2.69. Consequently, field-scale frontline demonstrations serve as an effective extension tool to overcome prevailing extension and technology gaps, offering a viable pathway to boost farm income, ensure nutritional security, and accelerate the widespread adoption of scientific millet cultivation across similar agrarian regions.

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