

Promotion of Millets under Horticultural-Based Cropping Systems and Value Addition for Livelihood Enhancement of Scheduled Caste Farmers in Parvathipuram Manyam District, Andhra Pradesh

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Abstract

Millets are important climate-resilient cereals with considerable potential for improving food and nutritional security in rainfed and resource-constrained farming systems. The present study was undertaken under the ICAR–Indian Institute of Millet Research (ICAR-IIMR) Scheduled Caste Sub Plan during 2024–25 to promote millet cultivation through horticultural-based cropping systems and to develop value-added millet products for livelihood enhancement of Scheduled Caste farmers in Parvathipuram Manyam district of Andhra Pradesh. The study was conducted in selected villages of Gummalakshimpuram and adjoining areas. A structured questionnaire was used to collect primary information from 20 farmers regarding socio-economic characteristics, perception and constraints related to millet cultivation. Descriptive statistics, including frequency and percentage, were used for interpretation. Field demonstrations of the biofortified finger millet variety Indravathi were conducted at 20 locations over two consecutive years. The pooled demonstration results showed a grain yield of 21.6 q ha⁻¹ with Indravathi compared with 18.3 q ha⁻¹ under the local variety, representing an 18.03% increase. Net returns were ₹42,584 ha⁻¹ with Indravathi compared with ₹31,170 ha⁻¹ under the local variety, while the benefit:cost ratio increased from 1.96 to 2.31. Soil testing of approximately 100 samples revealed that 85% of the samples were low in organic carbon and more than 70% were low in available zinc. Accordingly, integrated nutrient-management practices involving vermicompost, biofertilizers and micronutrient application were promoted. Four vocational training programmes were conducted, benefiting 60 participants comprising 20 men and 40 women. Training covered improved millet production, soil health, processing, value addition, packaging and labelling. Hands-on training resulted in the preparation of ragi laddus and sorghum cookies. The findings indicate that an integrated approach combining improved biofortified varieties, horticultural diversification, soil-health management, capacity building and value addition can contribute to improved productivity, nutritional security and livelihood opportunities among resource-constrained farmers.

Keywords: biofortified finger millet, Indravathi, horticultural-based cropping system, value addition, soil health, Scheduled Caste farmers, livelihood security, Parvathipuram Manyam

1. Introduction

Millets are a diverse group of small-seeded cereals that have traditionally formed an important component of dryland agriculture and food systems in India. Their adaptability to relatively harsh agro-climatic conditions, short duration and comparatively lower water requirement make them suitable for rainfed and resource-constrained farming situations. In addition to their agronomic importance, millets are recognized for their nutritional contribution, particularly their dietary fibre, minerals, proteins and bioactive compounds (Saleh et al., 2013; Kumar et al., 2021; Tomar et al., 2022).

The growing concerns associated with climate variability, declining natural resources and nutritional insecurity have renewed interest in millet-based production systems. Diversification towards climate-resilient cereals can reduce production risks while contributing to household food and nutritional security. Millets can also be incorporated into diversified farming systems involving horticultural crops, thereby providing opportunities for efficient use of land and resources.

Finger millet (*Eleusine coracana* L.), commonly known as ragi, is one of the important small millets cultivated in the upland and rainfed regions of Andhra Pradesh. It is particularly valued for its calcium content and suitability to marginal environments. Biofortified finger millet varieties offer an additional advantage by combining agronomic performance with enhanced nutritional attributes. The project under consideration promoted the biofortified variety Indravathi along with improved crop-management practices.

Parvathipuram Manyam district is predominantly agricultural and characterized by substantial dependence on rainfed farming. The project report indicates that approximately 80% of the cultivated area is under rainfed conditions and that erratic rainfall is one of the major factors affecting agricultural productivity. Paddy, ragi, bajra, pulses, maize and other crops constitute important components of the local agricultural system.

The project area also represents a farming environment in which small and marginal holdings predominate. The baseline survey reported that the average farm size among the sampled social groups was approximately two acres. Such holdings require diversified and economically viable production systems that can provide food, nutrition and income from limited land resources.

Despite the potential of millets, adoption is constrained by inadequate availability of quality seed, limited knowledge of improved production practices, inadequate processing facilities and insufficient awareness regarding value addition and market opportunities. The project was therefore designed to address these constraints through an integrated intervention involving improved millet varieties, horticultural-based cropping systems, soil-health management, farmer training, critical-input support and value addition.

Objectives

The study was undertaken with the following objectives:

1. To introduce improved and biofortified millet varieties and scientific production technologies under horticultural-based cropping systems.
2. To assess farmers' perception and constraints related to millet cultivation.
3. To demonstrate the performance of the biofortified finger millet variety Indravathi under farmers' field conditions.
4. To identify major soil-fertility constraints and promote integrated nutrient management.

5. To impart skills to farmers, particularly women and rural youth, in millet processing and value addition.
6. To promote horticultural-fused millet products as a potential avenue for livelihood diversification and income generation.

2. Materials and Methods

2.1 Study area

The study was conducted in Parvathipuram Manyam district of Andhra Pradesh under the ICAR-IIMR Scheduled Caste Sub Plan. Project activities were concentrated in selected villages of Gummalakshmipuram and adjoining areas. The district is characterized predominantly by red soils, sandy loams and sandy clay soils, with rainfed agriculture forming an important component of the farming system.

2.2 Sampling and data collection

A baseline field survey was conducted using a structured questionnaire. Twenty farmers were selected for collection of primary information relating to socio-economic characteristics, millet cultivation, perception and constraints. Frequency and percentage were used to summarize the collected information. The project report states that simple statistical tools such as frequency, percentage and mean were adopted for interpretation.

2.3 Baseline socio-economic assessment

The baseline survey classified the sample according to village, social group and landholding size. Scheduled Caste households constituted 79% of the sample, followed by Scheduled Tribe households (15%) and Backward Caste households (6%). The average landholding among the sampled social groups was approximately two acres.

2.4 Millet demonstrations

The biofortified finger millet variety Indravathi was introduced through field demonstrations. Twenty demonstrations were conducted over two consecutive years. Improved production practices were supported through distribution of vermicompost and biofertilizers. The local variety was used as the comparison treatment under farmers' field conditions.

2.5 Soil-health assessment

Approximately 100 soil samples were collected from farmers' fields in Duddukallu, Dasupalem and Komarada villages during 2025. The samples were analyzed for major and micronutrients following standard soil-testing procedures. The results were subsequently used for planning nutrient-management interventions.

2.6 Horticultural diversification

The project promoted millets as components of horticultural-based farming systems, including their use as intercrops in orchards. Field demonstrations included ragi and sorghum intercropped with cashew. Improved fruit planting material was also distributed to farmers to encourage backyard horticulture and diversification.

A total of 1,250 improved fruit saplings comprising mango, jackfruit, acid lime, sapota and moringa were distributed to 200 Scheduled Caste farmers.

2.7 Capacity building and value addition

Four vocational training programmes were conducted during the project period. The programmes addressed millet production, soil testing, pest and disease management, processing, value addition, packaging and labelling. A total of 60 participants, comprising 20 men and 40 women, benefited from the skill-development activities.

Hands-on demonstrations were conducted on the preparation of horticultural-fused millet products, particularly ragi laddus and sorghum cookies. Exposure visits were organized to familiarize farmers with food processing, protected cultivation, mushroom cultivation, vermicomposting, beekeeping and other enterprise opportunities.

3. Results and Discussion

3.1 Socio-economic characteristics of the respondents

The baseline survey revealed that Scheduled Caste households constituted the major proportion of the sampled beneficiaries (79%). Scheduled Tribe and Backward Caste households accounted for 15% and 6%, respectively. The average farm size was approximately two acres.

The predominance of small holdings highlights the importance of production technologies that are suitable for limited land resources. Integration of millets with horticultural crops can provide an opportunity for farmers to diversify production rather than depending exclusively on a single crop.

The project approach was therefore appropriate in emphasizing both millet production and horticultural diversification. The distribution of improved fruit saplings additionally provided a long-term opportunity for nutritional and income security.

3.2 Performance of biofortified finger millet variety Indravathi

The field demonstrations indicated better performance of Indravathi compared with the local variety. The pooled grain yield under Indravathi was 21.6 q ha⁻¹, compared with 18.3 q ha⁻¹ under the local variety.

Table 1. Performance of finger millet variety Indravathi under farmers' field conditions

Parameter	Indravathi	Local variety
Grain yield (q ha ⁻¹)	21.6	18.3
Yield increase over local variety (%)	18.03	—
Net returns (₹ ha ⁻¹)	42,584	31,170
Benefit:cost ratio	2.31	1.96

The yield advantage of 18.03% indicates the potential of the improved variety under the target farming conditions. The economic advantage was also substantial, with net returns of ₹42,584 ha⁻¹ under Indravathi compared with ₹31,170 ha⁻¹ under the local variety.

The higher benefit:cost ratio of 2.31 compared with 1.96 indicates that the improved variety provided better economic efficiency under the conditions of the demonstrations.

The project report identifies Indravathi as a biofortified variety rich in iron, zinc and calcium and suitable for the local production environment. During the field day, the variety was demonstrated against the local cultivar Peddachodi.

These results are in agreement with the broader scientific understanding that improved and biofortified millet varieties can simultaneously address productivity and nutritional objectives. Kumar et al. (2021) emphasized the nutritional importance and food-processing potential of finger millet, while ICAR has highlighted biofortified millet varieties as important tools for nutritional security (Indian Council of Agricultural Research, 2022, 2023).

3.3 Soil fertility constraints and nutrient management

Soil analysis revealed substantial fertility constraints in the study area. Approximately 85% of the soil samples were low in organic carbon, while more than 70% were low in available zinc.

Table 2. Soil fertility constraints identified in the study area

Soil parameter	Reported status	Recommended intervention
Organic carbon	85% samples low	Vermicompost and organic-residue management
Available zinc	>70% samples low	Zinc sulphate application
Nutrient imbalance	Observed in farmers' fields	Integrated nutrient management

The project responded by promoting vermicompost production and application and distributing zinc sulphate and other fertilizers according to identified needs. A total of 3,500 kg of vermicompost was distributed, while zinc sulphate was supplied to 60 farmers. Urea, SSP and MOP were also distributed to selected beneficiaries.

The emphasis on soil testing is particularly important in rainfed farming because nutrient deficiencies can limit the response of crops even when other production practices are improved. Integrated nutrient management combining organic and inorganic nutrient sources can improve nutrient availability and support sustainable crop productivity (Choudhary et al., 2023; Dwivedi et al., 2023).

3.4 Horticultural-based millet production

One of the distinctive features of the project was the promotion of millets within horticultural-based farming systems. Rather than restricting millet production to sole cropping, the project promoted millets as intercrops and components of orchard-based systems.

Field visits were conducted during crop growth and maturity stages to demonstrate ragi and sorghum intercropping with cashew.

Table 3. Horticultural diversification interventions

Intervention	Scale	Purpose
Improved fruit saplings	1,250	Crop and nutritional diversification
Beneficiary farmers	200	Expansion of backyard horticulture
Cashew + ragi demonstration	Field-based	Millet–horticulture integration
Cashew + sorghum demonstration	Field-based	Diversification of orchard systems

Integration of annual millets with perennial horticultural crops can be particularly useful for smallholders because it provides food production during the establishment phase of orchards while making more efficient use of available land (Dhaka et al., 2023; Ashoka et al., 2023).

3.5 Farmer perception and major constraints

The project report indicated that 56.66% of farmers had a medium level of perception towards millet cultivation. The major constraints reported were lack of good-quality seed, inadequate processing facilities and insufficient awareness regarding millet cultivation and utilization.

These constraints indicate that productivity enhancement alone may not be sufficient to achieve sustained millet adoption. A complete intervention should address the entire production-to-consumption continuum, including:

- availability of quality seed;
- improved production technologies;
- access to farm inputs;
- primary processing;
- value addition;
- packaging and labelling;
- market linkages; and
- farmer and consumer awareness.

The findings therefore support an integrated value-chain approach rather than a production-only strategy (Sangappa et al., 2023; ICAR–Indian Institute of Millets Research, 2024).

3.6 Capacity building and participation of women

Four vocational training programmes were organized during the project period. The programmes covered crop production, soil testing, pest and disease management, processing, value addition, packaging and labelling.

A total of 60 individuals participated, comprising 20 men and 40 women.

Table 4. Capacity-building programmes conducted under the project

Sl. No.	Major theme	Date	Venue
1	Millet production and improved technologies	17.05.2025	Duddukallu
2	Processing and horti-fused millet products	17.06.2025	College of Horticulture, Parvathipuram
3	Millet and horticultural crop production, demonstrations and input distribution	01.08.2025	Duddukallu
4	Processing, value addition, packaging and labelling	31.10.2025	College of Horticulture, Parvathipuram

The relatively high participation of women is important because millet processing and value addition can be undertaken at household or community scale, potentially creating opportunities for women-led enterprises.

3.7 Millet processing and value addition

Value addition represented an important component of the project. Hands-on training was provided on preparation of ragi laddus and sorghum cookies. The processed products were subsequently demonstrated and distributed among beneficiary farmers.

Millet processing can increase the diversity and acceptability of millet foods and create opportunities for small-scale rural enterprises (Hemasankari et al., 2023; ICAR–Indian Institute of Millets Research, 2024). However, sustainable enterprise development requires attention to product standardization, food safety, shelf life, packaging, branding and market demand.

The project also developed and distributed literature on millet cultivation, nutrition, organic horticulture and vermicomposting.

Thus, the intervention combined technology transfer with knowledge dissemination and practical skill development.

3.8 Field-level technology dissemination

A field day conducted at Duddukallu village on 07 June 2025 attracted approximately 110 Scheduled Caste farmers from Komarada and Gummalakshmipuram mandals. The biofortified Indravathi variety was demonstrated against the local variety Peddachodi. Battery-operated sprayers and tarpaulins were also distributed to selected farmers.

Field demonstrations and farmer interaction are important extension approaches because they enable farmers to observe technologies under local conditions. The combination of field demonstrations, training and input support adopted in the present intervention can improve the practical understanding of improved technologies.

4. Overall Impact of the Intervention

The project adopted a multidimensional approach combining production, soil health, horticultural diversification, capacity building and value addition.

Table 5. Summary of major interventions and outcomes

Intervention	Major outcome
Indravathi demonstrations	21.6 q ha ⁻¹ compared with 18.3 q ha ⁻¹ under local variety
Yield improvement	18.03% over local variety
Net returns	₹42,584 ha ⁻¹ compared with ₹31,170 ha ⁻¹
Benefit:cost ratio	2.31 compared with 1.96
Soil testing	~100 samples analyzed
Organic carbon constraint	85% samples low
Zinc constraint	>70% samples low
Fruit sapling distribution	1,250 saplings to 200 farmers
Vocational training	60 participants
Women participation	40 women
Field day	~110 farmers participated
Value addition	Ragi laddus and sorghum cookies
Orchard-based demonstrations	Cashew + ragi and cashew + sorghum

The results indicate that the project moved beyond conventional technology dissemination and attempted to address several interconnected dimensions of rural livelihood development.

5. Conclusion

The ICAR-IIMR-SC Sub Plan intervention demonstrated the potential of an integrated millet-based approach for improving productivity, nutrition and livelihood opportunities among resource-constrained farmers of Parvathipuram Manyam district.

The biofortified finger millet variety Indravathi performed better than the local variety under the project demonstrations, recording 21.6 q ha⁻¹ grain yield compared with 18.3 q ha⁻¹ and an 18.03% yield advantage. The variety also generated higher net returns and benefit:cost ratio. These findings demonstrate the potential economic advantage of introducing improved varieties into rainfed farming systems.

Soil testing identified low organic carbon and zinc deficiency as major soil-fertility constraints. The promotion of vermicompost, biofertilizers and balanced nutrient application provided a location-specific approach to soil-health management.

The horticultural-based cropping approach, including cashew–ragi and cashew–sorghum systems and distribution of improved fruit saplings, enhanced crop diversification. The capacity-building component further strengthened the intervention by training 60 beneficiaries, including 40 women, in production, processing and value addition.

The development of ragi laddus and sorghum cookies demonstrated the feasibility of converting millet grain into diversified food products. However, the major constraints of quality-seed availability, inadequate processing facilities and limited awareness indicate the need for continued institutional support.

Overall, the study demonstrates that **integration of biofortified millet varieties with horticultural diversification, soil-health management, capacity building and decentralized value addition provides a promising framework for sustainable livelihood enhancement among small and marginal farmers in rainfed regions.**

6. Recommendations

Based on the findings, the following interventions are recommended:

1. Strengthen availability of quality seed of improved and biofortified millet varieties at village level.
2. Promote location-specific millet–horticulture intercropping models.
3. Expand soil-testing-based nutrient management, particularly for organic carbon and zinc deficiency.
4. Establish village- or FPO-level millet primary processing facilities.
5. Encourage women self-help groups to undertake millet-based value-addition enterprises.
6. Provide training in food safety, packaging, labelling, branding and marketing.
7. Strengthen linkages between farmers, FPOs, processing units and institutional markets.
8. Continue field demonstrations and farmer field days for technology dissemination.
9. Promote backyard horticulture along with millet cultivation to improve household nutritional security.
10. Undertake long-term monitoring of adoption, farm income, enterprise development and nutritional outcomes.

7. Limitations of the Study

The present article is based on the project-level information available in the submitted ICAR-IIMR-SC Sub Plan report. The report provides pooled demonstration results and descriptive information but does not provide farmer-wise raw yield observations, replication-level observations or sufficient experimental details for independent statistical testing.

Therefore, the reported yield, economic and percentage differences are presented as **project-level field-demonstration outcomes** and not as results of a newly conducted replicated experiment. Future studies should incorporate larger sample sizes, control treatments, farmer-wise observations, statistical analysis and multi-season evaluation to establish the robustness of the technology under different agro-ecological conditions.

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9. References

1. Ashoka, P., Raut, D., Sudeepthi, B., Gawande, K. N., Reddy, G. S. V., Padhan, S. R., & Panigrahi, C. K. (2023). Millet's role as a climate resilient staple for future food security: A review. *International Journal of Environment and Climate Change*, 13(11), 4542–4552.
2. Choudhary, P., Shukla, P., & Muthamilarasan, M. (2023). Genetic enhancement of climate-resilient traits in small millets: A review. *Heliyon*, 9, e14502.
3. Choudhary, S., Boruah, A., Ram, N., Gulaiya, S., Choudhary, C. S., Vidhya, C. S., & Verma, L. K. (2023). Millet's role in sustainable agriculture: A comprehensive review. *International Journal of Plant & Soil Science*, 35(22), 556–568.
4. Dhaka, B. K., Dhaka, P., Singh, B., Kamal, A., Anisha, & Dhaka, A. K. (2023). Intercropping options for sustainable minor millet production: A review. *International Journal of Environment and Climate Change*, 13(12), 89–100.
5. Dwivedi, N., Rathore, V., & Sharma, K. (2023). A review of millet crops for agricultural sustainability in India. *Asian Journal of Agricultural Extension, Economics & Sociology*, 41(10), 216–224.
6. Hemasankari, P., Rao, B. D., Malathi, V. M., Kiranmai, E., & Rathnavathi, C. V. (2023). Value addition in millets through agricultural processing techniques. *Indian Farming*, 73(1), 107–109.
7. Indian Council of Agricultural Research. (2022). *Biofortified varieties: Fourth edition*. Directorate of Knowledge Management in Agriculture, ICAR, New Delhi.
8. Indian Council of Agricultural Research. (2023). *Biofortified varieties of small millets*. Indian Council of Agricultural Research, New Delhi.
9. Indian Council of Agricultural Research–Indian Institute of Millets Research. (2024). *Technologies and value-added products for millet-based enterprises*. ICAR-IIMR, Hyderabad.
10. Kumar, A., Metwal, M., Kaur, S., Gupta, A. K., Puranik, S., Singh, S., Chandra, A., & Yadav, R. (2021). Nutritional, polyphenolic composition and in vitro digestibility of finger millet (*Eleusine coracana* L.) with its potential food applications: A review. *Food Bioscience*, 44, 101382.

11. Saleh, A. S. M., Zhang, Q., Chen, J., & Shen, Q. (2013). Millet grains: Nutritional quality, processing, and potential health benefits. *Comprehensive Reviews in Food Science and Food Safety*, 12(3), 281–295.
12. Sangappa, R., Rafi Dudekula, Laxmi, B., Charishma, E., & Srinivasa Babu, K. (2023). Strengthening millet value chain through farmer producer organizations. *Indian Journal of Extension Education*.
13. Tomar, M., Bhardwaj, R., Verma, R., Singh, S. P., Dahuja, A., Krishnan, V., Kansal, R., Yadav, V. K., Praveen, S., & Sachdev, A. (2022). Interactome of millet-based food matrices: A review. *Food Chemistry*, 385, 132636.
14. College of Horticulture, Parvathipuram, Dr. Y.S.R. Horticultural University. (2025). *Project Report of ICAR-IIMR-SC Sub Plan 2024–25: Promotion of millets under horticultural based cropping system and preparation of horti-fused millet products to enhance livelihood of Scheduled Caste farmers of Parvathipuram Manyam District, Andhra Pradesh*.

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