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Impact assessment of hands-on trainings towards millet value addition among tribal farmers in Kerala and Odisha

¹Soumya Ranjan Behera, ²Esakkimuthu M and ³Pratheesh P Gopinath

¹Ph.D. Scholar, Kerala Agricultural University, Department of Agricultural Extension Education, College of Agriculture Vellayani, Thiruvananthapuram, Kerala, India

²Assistant Professor (Sr. Scale) in Agricultural Extension, Kerala Agricultural University, ICAR-KVK, Wayanad, Kerala, India

³Assistant Professor & Head, Kerala Agricultural University, Department of Agricultural Statistics, College of Agriculture Vellayani, Thiruvananthapuram, Kerala, India

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Corresponding Author: Esakkimuthu M

Abstract

This research study assessed the impact of hands-on training on millet value addition among tribal farmers using an action research approach in states of Kerala and Odisha in India. A total of 160 farmers (80 from each state) were selected from millet-dominant tribal regions, and the intervention focused on enhancing skills in processing, value addition, packaging, and marketing etc. The impact was measured using a ten-items adopting Likert's summated rating scale techniques and analysed through descriptive statistics, impact index and correlation analysis etc. The overall impact index was 71.40%, indicated a moderate to high-level of effectiveness of the training programme. It is evidenced that, state-wise analysis revealed slightly higher impact in Kerala (72.60%) compared to Odisha (70.20%), although the difference was statistically non-significant ($p = 0.953$), suggesting uniform effectiveness across the millets growing regions. The trainings had significantly improved farmers' confidence, processing skills, and awareness of business opportunities, while relatively lower gains were observed in institutional access and entrepreneurial development. The correlation analysis indicated that variables such as education, farming experience, decision-making ability, extension contact, and self-confidence had a strong positive influence on impact, whereas gender and family size were non-significant. The study concludes that hands-on trainings is an effective extension strategy for enhancing livelihood outcomes among tribal millet farmers, but its impact can be further strengthened through improved market linkages, institutional support, and continuous capacity-building initiatives among millets growers.

Keywords: Millet value addition, hands-on training, tribal farmers, impact assessment, action research

Introduction

Globally, the millets has re-emerged as climate-resilient and nutritionally rich-crops that are increasingly recognized for their role in ensuring food security, environmental sustainability, and livelihood resilience in marginal farming systems. These small-seeded cereals are well adapted to arid and semi-arid agro-ecological conditions, requires low-external inputs while offering high nutritional value, includes essential micronutrients and dietary fiber (Harish *et al.*, 2024) ^[12]. In the recent global and national initiatives evidenced and reinforced the importance of role and importance of millets in sustainable agriculture, key-emphasis on their potential to address the climate change challenges and nutritional insecurity etc. Despite these advantages, millets cultivation has declined in several regions due to changing food preferences, limited awareness, and weak market linkages, highlighting the need for targeted interventions to revive their production potentials and utilization (Gayathri & Manimozhi, 2024) ^[8]. Indian context, millets are predominantly cultivated by tribal farmers who solely rely on traditional farming systems

and rainfed agriculture for their livelihood security. These communities possess rich indigenous knowledge but often operate under several constraints such as marginal land-holding size, poor infrastructure, and limited access to extension services etc. In the recent research studies indicates millet-based farming systems contribute significantly to livelihood security, offers stable yields under climatic stress and enhanced the resilience among small and marginal millets growers (Kurandawad & Gowda, 2025) ^[16]. However, tribal farmers continue to face challenges related to low-productivity, inadequate value chains, and limited income opportunities, which restrict the full realization of millet-based livelihoods (Chapke *et al.*, 2025) ^[4].

The states of Kerala and Odisha provide an important context on millet-based tribal livelihoods. In Kerala, particularly in tribal dominant regions such as Attappadi, millets are integral to traditional food systems and has gained and renewed attention through community-based and institutional interventions. In Odisha, tribal communities in regions such as the Eastern Ghats have historically

depended on millet cultivation as a staple food and livelihood source. However, despite their cultural and ecological significance, millet systems in these regions face constraints including declining cultivation, limited processing infrastructure, and weak-market integration (Government of India, 2023; Food and Agriculture Organization, 2021) ^[9, 7]. Furthermore, value chain analysis indicates that strengthening processing, marketing, and value addition activities is critical for enhancing farmer income and ensuring sustainability of millet systems (Devaux *et al.*, 2021; Barrett *et al.*, 2020) ^[6, 2]. Millets value addition in millets has emerged as a key-strategy to enhance the economic viability of millet cultivation by transforming raw-grains into diversified, marketable products. Processing activities such as cleaning, dehulling, milling, and preparation of value-added products like snacks and ready-to-cook items significantly increase shelf-life, consumer acceptability, and market value etc. Since, then research highlights that value addition not only improves income opportunities, but also contributes to nutritional security and employment generation among rural and tribal communities (Nandal & Bhardwaj, 2025) ^[17]. However, lack of technical knowledge, hands on skills, and access to appropriate millets based technologies remain a major barrier, which was preventing tribal farmers from engaging effectively in value addition activities.

In this context, hands-on training has been identified as an effective extension approach to bridge knowledge and skill gaps among farmers. The conventional training methods, hands-on training emphasizes experiential learning, enabling farmers to acquire practical skills through demonstrations and active participation. In case of empirical studies have showcased that trainings interventions significantly improve farmers' knowledge, skills, and attitudes toward millet cultivation and value addition. Moreover, training programmes on millet value addition have demonstrated measurable improvements in participants' knowledge and skill levels, with pre- and post-training assessments indicating significant gains (Hemamalini *et al.*, 2021) ^[13]. Similarly, intervention-based training programs have been found to enhance farmers' knowledge and attitudes, leading to increased adoption of improved practices and sustainable agricultural development (Gayathri & Manimozhi, 2024) ^[8]. In India the grassroot level, hands-on training on millet value addition typically involves participatory methods such as demonstrations of processing techniques, preparation of value-added products, training on packaging and storage, and exposure to market opportunities. These development approaches are particularly effective in tribal contexts where experiential learning and community participation played a crucial role in knowledge dissemination. The research studies focused on tribal farmers have shown strong positive perceptions toward such training programs, especially in areas related to processing techniques, product development, and quality standards, indicates their relevance and effectiveness in improving livelihood outcomes (Rani *et al.*, 2024; Gayathri & Manimozhi, 2024) ^[21, 8].

Impact assessment of such trainings interventions is essential to evaluate their effectiveness and formulation of policy and program design. Impact assessment involves measuring changes in knowledge, adoption behaviour,

income, and social empowerment resulting from the intervention. Pre- and post-trainings data collection methods are widely used to capture these changes and to establish causal relationships between interventions and outcomes. The evidences suggested that well-designed intervention programs can significantly enhance farmers' knowledge levels, attitudes, and practices, thereby contributing to sustainable agricultural development and improved livelihoods (Gayathri & Manimozhi, 2024) ^[8]. Despite growing research on millet promotion and livelihood enhancement, there exists a significant research gap in understanding the comparative impact of hands-on training on millet value addition among tribal farmers across different regions. It is observed that, from the existing studies focus either on production aspects or on single-region interventions, with limited emphasis on comparative analysis between states such as Kerala and Odisha. Moreover, there is insufficient integration of multiple impact dimensions, includes knowledge, adoption, and economic outcomes, in evaluating training effectiveness. In these circumstances, address this gap is essential for designing context-specific and scalable interventions.

The present study aims to assess the impact of hands-on trainings on millet value addition among tribal farmers in Kerala and Odisha and to compare the extent of impact between the two states. The study specifically seeks to evaluate changes in knowledge, adoption, and livelihood outcomes resulted from the intervention and to identify factors influencing the effectiveness of training programs. The findings of this study are expected to contribute to the development of effective extension strategies, promotion of millet-based enterprises, and strengthening of tribal livelihoods. Furthermore, this study provides a basis for future research focusing on long-term impact assessment, integration of value chains, gender dimensions in value addition, and the role of institutional support in scaling millet-based interventions.

Methodology

This study conducted using an action research approach with a quasi-experimental design, aimed to assess the impact of hands-on trainings on millet value addition among tribal farmers. This action research is widely recognized for its participatory and problem-solving orientation, particularly in community-based agricultural interventions where stakeholders' involvement is crucial for meaningful change (Stringer, 2020; Koshy *et al.*, 2022) ^[24, 15]. The study adopted a comparative framework, evaluating the outcomes of the intervention across two states to understand regional variations on its impact. The study was purposively carried out in the states of Odisha and Kerala due to their significant role in millets cultivation and the predominance of tribal populations dependent on millets-based farming systems. Within these states, Koraput district in Odisha and Palakkad district in Kerala were selected purposively based on their status as millet-hubs and the concentration of tribal communities engaged in traditional millet cultivation. The Koraput district has been a focal area under the Odisha Millet Mission, promoting millet-based livelihoods, while the Attapadi region of Palakkad district has gained prominence for millets revival initiatives among tribal farmers (Government of Odisha, 2023; Government of

Kerala, 2022)^[11, 10].

From each selected district, one block was chosen purposively based on highest millet production. Accordingly, Nandapur block in Koraput district and Attapadi block in Palakkad district were selected. Further, two Gram Panchayats were selected from each block using purposive sampling to ensure representation of active millet-growing tribal communities. In Attapadi block, Sholayur and Pudur Gram Panchayats were selected, while in Nandapur block, Nandapur and Malibelgaon Gram Panchayats were chosen. The selection criteria included millet production intensity, accessibility, and participation in agricultural interventions, which are commonly used parameters in location-specific agricultural research (Davis *et al.*, 2020)^[5]. The respondents/millet growers for the study were drawn as part of the action research intervention conducted at the village level. A total sample size of 160 tribal farmers was selected, comprising 80 farmers from Kerala and 80 farmers from Odisha. From each Gram Panchayat, 40 farmers were selected, ensuring equal representation across villages and states. These balanced sampling enhances the validity of comparative analysis and reduces sampling bias in intervention-based approach among millet (Khandker *et al.*, 2010)^[14]. Besides, during the course of preliminary field investigation, it was observed that farmers lacked adequate knowledge and skills in millet value addition, which limited their ability to enhance income and engage in entrepreneurial activities. Henceforth, based on this need assessment, hands-on training on millet value addition was identified as the core intervention. The needs-based training is considered a critical component in improving the effectiveness of extension systems and fostering adoption of innovations among farmers (Anderson & Feder, 2021)^[1].

The training programme was conducted at the village level with the active support of local stakeholders, including agricultural officers and Gram Panchayat leaders (*Sarpanch*), to ensure community participation and contextual relevance. The trainings were delivered in the local language to facilitate better understanding among tribal farmers. Each Gram Panchayat received two structured sessions, comprising both theoretical and practical components. The first session focused on theoretical aspects, including the importance of millets, processing techniques such as cleaning, dehusking, and milling, and various value addition methods. It also included information on government schemes, subsidies, institutional support, and exposure to audio-visual materials demonstrating millet-based product preparation. The second session was interactive in nature, emphasizing product awareness, packaging, storage, and marketing aspects. Participatory and experiential learning approaches such as hands-on training have been found to significantly improve farmers' knowledge, skills, and adoption behaviour compared to conventional extension methods (Davis *et al.*, 2020)^[5]. Hence, following the training intervention, data were collected using a structured interview schedule consisting of 10 items designed to measure the impact of training. The responses were recorded using a 5-point continuum on their responses adopting Likert summated rating scale, with scores ranging from 5 (strongly agree) to 1 (strongly disagree) adopted by (Boone & Boone, 2012)^[3].

The collected data were analysed using descriptive statistical tools such as frequency, percentage analysis, and mean to understand the distribution of responses among farmers. The impact of the training programme was assessed by calculating the mean score and impact index. The mean score was computed as the sum of individual scores divided by the total number of respondents, while the impact index was calculated using the formula:

$$\text{Impact Index} = \frac{\text{Total Score Obtained}}{\text{Maximum Possible Score}} \times 100$$

The impact index was calculated at three levels, viz., overall (160 farmers), state-wise (Kerala and Odisha), and village-wise (40 farmers per village), enabling a comprehensive assessment of the intervention. The comparative analysis between the two states was performed based on mean score differences across the 10 items to identify variations in training effectiveness.

Finally, ethical considerations were strictly adhered during the study. The informed consent was obtained from all respondents prior to data collection, participation was voluntary, and confidentiality of the information provided by the respondents was maintained throughout the research process.

Results and Discussion

Impact Assessment

The Impact Index was computed from 10 items (scale 1-5) covering confidence, processing techniques, income potential recognition, business opportunities, packaging, marketing, resource management, government scheme access, entrepreneurial thinking, and capacity to guide others.

Table 1: Descriptive Statistics of Impact Assessment of Kerala and Odisha

Descriptive Statistics of Impact Assessment							
State	Items	Mean	Median	SD	Variance	Min	Max
Kerala	IMP1	3.58	4	0.88	0.78	2	5
Kerala	IMP2	3.69	4	0.88	0.77	2	5
Kerala	IMP3	3.55	4	0.86	0.73	2	5
Kerala	IMP4	3.69	4	0.95	0.9	1	5
Kerala	IMP5	3.55	4	0.9	0.81	2	5
Kerala	IMP6	3.61	4	0.75	0.57	2	5
Kerala	IMP7	3.61	3.5	0.88	0.77	2	5
Kerala	IMP8	3.5	3	0.8	0.63	2	5
Kerala	IMP9	3.7	4	0.85	0.72	2	5
Kerala	IMP10	3.41	3	0.81	0.65	2	5
Kerala	IMP TOTAL	35.89	36	5.63	31.72	22	47
Odisha	IMP1	3.62	4	0.79	0.62	2	5
Odisha	IMP2	3.62	4	0.93	0.87	1	5
Odisha	IMP3	3.55	3.5	0.84	0.71	2	5
Odisha	IMP4	3.52	4	0.87	0.76	2	5
Odisha	IMP5	3.66	4	0.84	0.71	2	5
Odisha	IMP6	3.56	4	0.81	0.65	1	5
Odisha	IMP7	3.65	4	0.87	0.76	2	5
Odisha	IMP8	3.51	3	0.91	0.84	1	5
Odisha	IMP9	3.59	4	0.74	0.55	2	5
Odisha	IMP10	3.54	4	0.78	0.61	2	5
Odisha	IMP TOTAL	35.84	36	5.11	26.06	23	50

(IMP- Impact items)

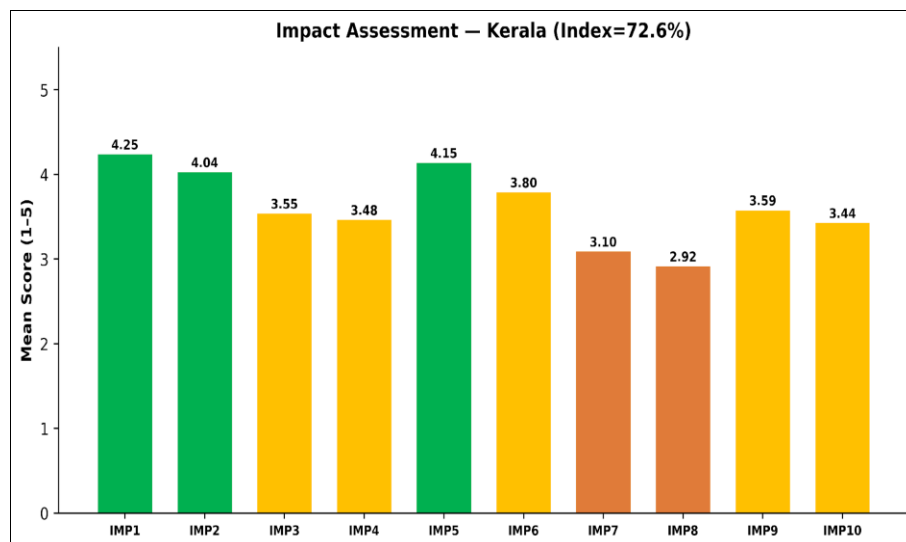


Fig 1: Impact level of Tribal Millet Farmers of Kerala (n=80)

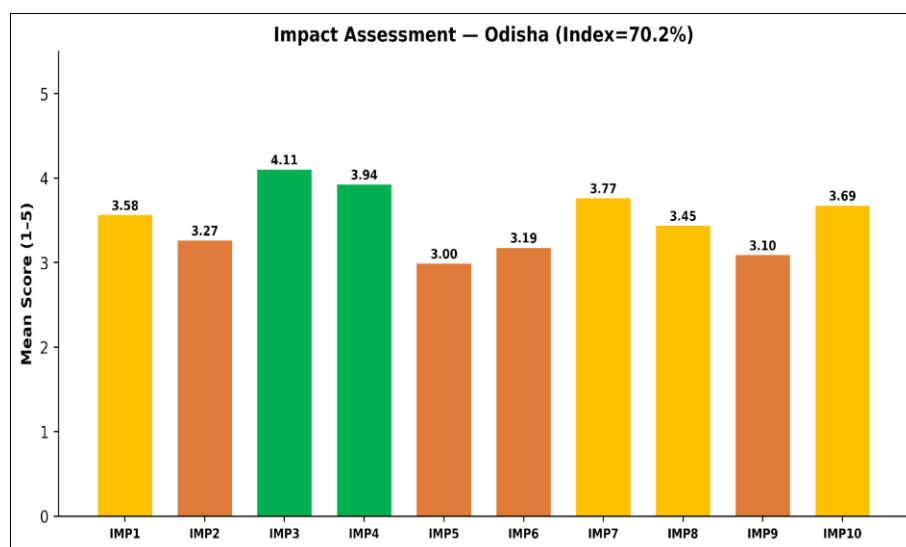


Fig 2: Impact level of Tribal Millet Farmers of Odisha (n=80)

Impact Assessment of Hands-on Training on Millet Value Addition

State-wise Impact Assessment in Kerala

In Kerala, the impact assessment revealed a relatively higher impact index of 72.6%, indicates a slightly stronger effect of the training intervention compared to the overall average. The graphical analysis shows that confidence (IMP1: 4.25) and processing knowledge (IMP2: 4.04) recorded the highest mean scores, reflecting the effectiveness of the training in enhancing both psychological and technical dimensions among farmers. Additionally, value addition awareness (IMP5: 4.15) and marketing-related understanding (IMP6: 3.80) also showed strong performance, indicating better comprehension of post-harvest and market-oriented practices. However, lower scores were observed for resource management (IMP7: 3.10) and government scheme access (IMP8: 2.92), suggesting that institutional linkage and resource utilization remain relatively weak areas. The mean scores ranging from 2.92 to 4.25 indicate that while most farmers experienced a positive impact, certain aspects require further strengthening through follow-up interventions. The higher performance in

Kerala may be attributed to better extension services, institutional support, and exposure to development programmes, particularly in tribal regions like Attappadi. These findings align with Rao *et al.* (2020), who reported that millet-based interventions in Kerala significantly improved farmers' knowledge and livelihood outcomes. Furthermore, Anderson and Feder (2021)^[1] emphasized that effective extension systems enhance the outcomes of training programmes by facilitating access to information and institutional support.

State-wise Impact Assessment in Odisha

In Odisha, the impact assessment indicated an Impact Index of 70.2%, which is slightly lower graphical representation shows that processing techniques (IMP3: 4.11) and business opportunities (IMP4: 3.94) recorded the highest mean scores, indicating that the training was particularly effective in enhancing technical skills and entrepreneurial awareness among farmers. The moderate scores were observed for confidence (IMP1: 3.58) and income perception (IMP2: 3.27), suggesting that while farmers gained knowledge, confidence-building aspects may require further

reinforcement. Lower scores were recorded for value addition (IMP5: 3.00) and marketing aspects (IMP6: 3.19), indicating relatively weaker outcomes in post-harvest and market-related dimensions compared to Kerala. Interestingly, Odisha farmers showed relatively better performance in resource management (IMP7: 3.77) and capacity to guide others (IMP10: 3.69), indicating stronger community-level learning and knowledge-sharing potential. The mean scores ranged from 3.00 to 4.11, reflecting a consistent but slightly varied impact across indicators. These findings are supported by studies under the Odisha Millet Mission, which highlight that training and capacity-building interventions significantly enhance farmers' knowledge, adoption behaviour, and livelihood outcomes, particularly in tribal regions (Government of Odisha, 2023) [11]. Similarly, Chapke *et al.* (2025) [4] emphasized that millet-based interventions in Odisha contribute to improved income and entrepreneurial opportunities, though

institutional and market constraints remain challenges.

Comparison analysis

The comparative analysis reveals that both Kerala and Odisha experienced similar overall impact levels, with Kerala showing a marginally higher impact index. Kerala performed better in confidence, knowledge, and value addition aspects, while Odisha showed relatively stronger outcomes in resource management and community-level knowledge dissemination. These differences can be attributed to variations in Extension infrastructure, Market exposure, Institutional support, socio-economic conditions. The overall, the findings confirm that hands-on training is an effective strategy for improving the capabilities of tribal millet farmers, but its impact can be further enhanced through integrated support systems, including market linkages, financial access, and policy convergence.

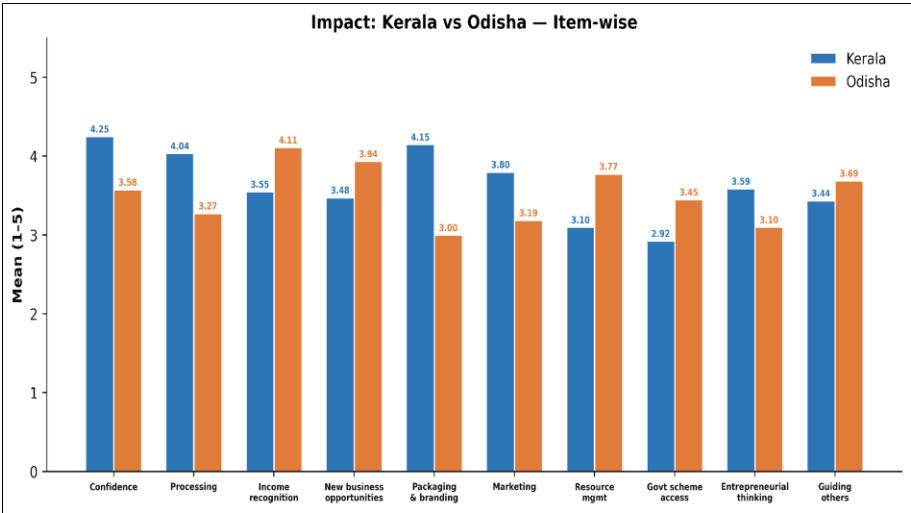


Fig 3: State-wise Item Comparison of Impact level of Farmers

Table 2: Impact of Item by State-wise Analysis

Sl.	Impact Item	Kerala	Odisha	Difference
1	Confidence in VA business	4.25	3.58	+0.67
2	Processing techniques	4.04	3.28	+0.76
3	Income potential recognition	3.55	4.11	-0.56
4	New business opportunities	3.48	3.94	-0.46
5	Packaging & branding	4.15	3.00	+1.15
6	Marketing millet products	3.80	3.19	+0.61
7	Resource management	3.10	3.78	-0.68
8	Govt scheme access	2.92	3.45	-0.53
9	Entrepreneurial thinking	3.59	3.10	+0.49
10	Guiding others in VA	3.44	3.69	-0.25

The impact analysis reveals a distinctive and practically meaningful state-wise pattern. Kerala respondents report significantly higher impact on processing-oriented items-confidence in VA business (4.25 vs 3.58), Processing techniques (4.04 vs 3.28), and Packaging & branding (4.15 vs 3.00). This reflects Kerala's more developed millet processing infrastructure, existing market channels, and prior exposure to value addition concepts, enabling participants to immediately relate training content to practical application. Analysis reported that, Odisha respondents show higher impact on resource and

opportunity-oriented items-Income potential recognition (4.11 vs 3.55), New business opportunities (3.94 vs 3.48), Resource management (3.78 vs 3.10), and Government scheme access (3.45 vs 2.92). For Odisha's tribal millet growers operating in a less developed value chain, the training's most impactful contribution was opening awareness of previously unknown income opportunities, resource management techniques, and government support mechanisms. The largest gap is in Packaging and branding (Kerala 4.15 vs Odisha 3.00, Δ=1.15), suggesting that Odisha needs supplementary training specifically focused on packaging, branding, and product presentation. The Government scheme access shows the reverse pattern (Odisha 3.45 vs Kerala 2.92), possibly because Odisha respondents found this information particularly novel and valuable, whereas Kerala farmers may have had prior awareness through their state's stronger extension network.

Comparative Analysis of Impact Items between Kerala and Odisha

The comparative analysis of impact indicators between Kerala and Odisha reveals significant variation in the effectiveness of hands-on training on millet value addition across different dimensions. The observed differences

reflect the influence of regional institutional support, extension systems, and socio-economic contexts on training outcomes. The results indicate that Kerala performed better in several technical and market-oriented dimensions. Notably, confidence in value addition business (+0.67) and processing techniques (+0.76) were higher in Kerala, suggesting that farmers developed stronger technical competence and self-efficacy through the training intervention. The largest difference was observed in packaging and branding (+1.15), indicating that Kerala farmers had a significantly better understanding of post-harvest value addition and product differentiation. Similarly, higher scores in marketing (+0.61) and entrepreneurial thinking (+0.49) further demonstrate the effectiveness of training in promoting market-oriented behaviour among farmers. These findings are consistent with studies emphasizing that participatory and skill-based extension approaches enhance farmers' technical knowledge and entrepreneurial capacity. For instance, Food and Agriculture Organization (FAO, 2021) [7] highlighted that value addition training improves farmers' capacity to engage in agri-enterprises and enhances market participation. Similarly, Davis *et al.* (2020) [5] in *World Development* found that hands-on extension methods significantly improve farmers' knowledge, skills, and adoption behaviour. Research by Devaux *et al.* (2021) [6] in *Agricultural Systems* also demonstrated that strengthening value chains through capacity-building interventions leads to improved income and market integration among smallholder farmers.

In contrast, Odisha exhibited relatively higher scores in income potential recognition (-0.56) and new business opportunities (-0.46), indicating that farmers were more responsive to the economic benefits of millet value addition. Additionally, Odisha farmers performed better in resource management (-0.68) and access to government schemes (-0.53), suggesting stronger awareness or utilization of institutional support systems. The higher score in guiding

others (-0.25) reflects a stronger tendency toward collective learning and knowledge dissemination, which is often characteristic of community-based tribal farming systems.

These findings are supported by recent studies on millet-based interventions in eastern India. Sibhatu and Qaim (2018) [22], extended in later works in *Food Policy* emphasized that diversification and value addition in traditional crops enhance income opportunities and resilience among smallholders. Furthermore, Pingali *et al.*, (2019) [19] noted that institutional interventions and public programmes significantly influence farmers' ability to access resources and adopt improved practices. Recent analyses of the Odisha Millet Mission have also highlighted improvements in farmers' awareness of government schemes and resource utilization through structured training and policy support (NITI Aayog, 2021) [18]. The contrasting trends observed between Kerala and Odisha suggest that while Kerala farmers demonstrated stronger technical, processing, and market-oriented competencies, Odisha farmers showed relatively higher economic awareness, institutional access, and community-level engagement. These differences underline the importance of context-specific extension strategies, as the effectiveness of training interventions is influenced by pre-existing institutional frameworks, socio-economic conditions, and exposure to development programmes.

Overall, the findings confirm that hands-on training on millet value addition has a significant positive impact across multiple dimensions, but its outcomes vary across regions. Integrating technical training (as seen in Kerala) with institutional and community-based approaches (as seen in Odisha) can enhance the overall effectiveness and sustainability of such interventions. This aligns with broader evidence suggesting that combining skill development with institutional support leads to more inclusive and sustainable agricultural development (Barrett *et al.*, 2020) [2].

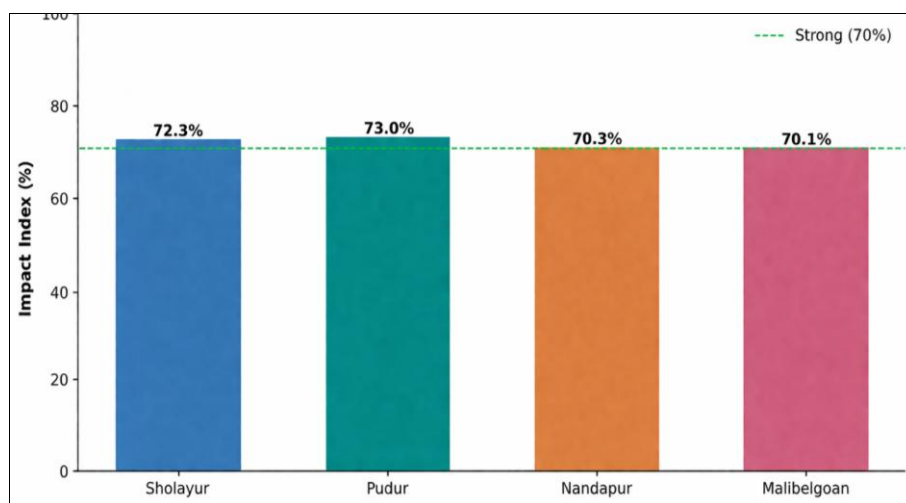


Fig 4: Village wise impact index analysis

The Village-wise impact index of hands-on trainings on millet value addition reveals a consistently strong and positive impact across all selected Gram Panchayats, with values exceeding the benchmark level of 70 percent. Among the four locations, Pudur (73.0%) and Sholayur (72.3%) in

Kerala exhibited slightly higher impact levels, indicating relatively better outcomes in terms of knowledge gain, skill development, and entrepreneurial orientation. In contrast, Nandapur (70.3%) and Malibelgaon (70.1%) in Odisha also demonstrated strong impact, though marginally lower than

Kerala, suggesting effective but comparatively moderate improvements. The narrow variation in impact scores across all villages indicates that the training programme was uniformly effective and well-received across regions, highlighting the robustness of the intervention design. The slightly higher performance in Kerala may be attributed to better extension support and institutional exposure, whereas the consistent results in Odisha reflect strong community participation and adaptability among tribal farmers. These findings are in line with studies showing that hands-on, participatory training approaches lead to significant and uniform improvements in farmers' skills and adoption behaviour across diverse contexts (Davis *et al.*, 2020; Devaux *et al.*, 2021)^[5, 6].

Table 3: Correlation between socio economic communication variable with overall impact level of Kerala and Odisha Farmers

Variable	Kerala (n=80)	Odisha (n=80)
Age	0.7636**	0.7703**
Gender	0.1031	0.0608
Education	0.7268**	0.5738**
Family Size	-0.0234	-0.1665
Land Holding	0.4828**	0.4890**
Farming Experience	0.7286**	0.7469**
Annual Income	0.4193**	0.5666**
Training Attended	0.5151**	0.2409*
Extension Contact	0.5289**	0.4893**
Mass Media Exposure	0.5784**	0.4630**
Decision Making	0.7162**	0.7772**
Info Seeking Behaviour	0.6592**	0.3788**
Self Confidence	0.6035**	0.6512**

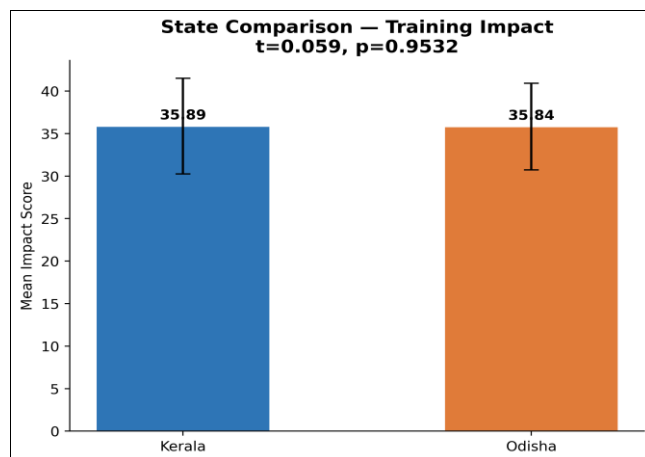
(**, Correlation is significant at the 0.01 level, *, correlation is significant at the 0.05 level)

In the case of Kerala (n = 80), a similar pattern was observed, with most variables showing strong and significant positive correlations with impact. Notably, education (r = 0.7268), farming experience (r = 0.7286), age (r = 0.7636), and decision-making ability (r = 0.7162) emerged as key determinants, indicating that more educated and experienced farmers with higher decision-making capacity derived greater benefits from the training. Communication-related variables such as mass media exposure (r = 0.5784), extension agency contact (r = 0.5289), and information-seeking behaviour (r = 0.6592) also showed strong associations, reflecting the effectiveness of extension systems. Additionally, training attended (r = 0.5151) had a significant influence, suggesting that repeated exposure to training enhances learning outcomes. However, gender and family size remained non-significant, indicating limited influence on training effectiveness. These findings are in agreement with studies highlighting that strong extension systems, farmer education, and access to information significantly enhance the effectiveness of agricultural training programmes and technology adoption (Devaux *et al.*, 2021; Ragasa *et al.*, 2016)^[6, 20].

In Odisha (n = 80), the correlation analysis also indicated significant positive relationships for most variables, though with slightly different patterns. Decision-making ability (r = 0.7772), age (r = 0.7703), and farming experience (r = 0.7469) showed the strongest correlations, suggesting that experiential and behavioural factors played a major role in determining impact. Economic variables such as annual

income (r = 0.5666) and landholding (r = 0.4890) were also significant, indicating the importance of resource availability. Communication variables, including extension contact (r = 0.4893), mass media exposure (r = 0.4630), and information-seeking behaviour (r = 0.3788), showed moderate but significant relationships. Interestingly, training attended (r = 0.2409) was significant at a lower level (*), indicating that while training exposure contributed to impact, its influence was comparatively weaker than in Kerala. Similar to the overall findings, gender and family size were non-significant, suggesting that these variables do not play a major role in influencing impact. These results are supported by studies indicating that in resource-constrained and smallholder systems, experiential knowledge, decision-making ability, and access to extension services play a more critical role than demographic factors in influencing adoption and impact (Wossen *et al.*, 2017; Barrett *et al.*, 2020)^[26, 2].

Overall, the correlation analysis clearly demonstrates that human capital (education, experience), communication factors (extension contact, media exposure), and psychological attributes (decision-making ability, self-confidence) are key drivers of impact, while demographic variables such as gender and family size have limited influence. This underscores the need for strengthening extension systems, enhancing farmer capacity, and promoting information access to maximize the effectiveness of training interventions.



Kerala Mean: 35.89 | Odisha Mean: 35.84 | t=0.0588 | p=0.95316

Fig 5: State Comparison of the Impact of Training

The state-wise comparison of impact scores between Kerala (Mean = 35.89) and Odisha (Mean = 35.84) reveals no statistically significant difference in the effectiveness of the hands-on training programme. The calculated t-value (0.0588) is very small, and the p-value (0.95316) is much higher than the standard significance level (0.05), indicating that the observed difference in mean scores is negligible and occurred by chance. This implies that the training intervention had a uniform and comparable impact across both states, regardless of regional differences. In practical terms, farmers in Kerala and Odisha benefited equally in terms of knowledge, skills, and entrepreneurial orientation from the millet value addition training. These findings suggest that the training module was robust, well-designed, and adaptable across different socio-economic and cultural

contexts, reinforcing the effectiveness of participatory, hands-on extension approaches in diverse tribal settings. The findings of the present study indicate several important directions for future research and intervention design. Although the hands-on training on millet value addition demonstrated a substantial and uniform impact across regions, there is a clear need to strengthen institutional linkages, market integration, and entrepreneurship development components. Future interventions should focus on advanced and continuous training modules, particularly in areas such as packaging, branding, and market access, where gaps were identified, especially in Odisha. Additionally, integrating digital extension tools, mobile-based advisory services, and ICT platforms can enhance information dissemination and improve farmers' access to real-time market and technical knowledge. Longitudinal studies are also required to assess the sustainability of training impact over time, including changes in income, enterprise establishment, and livelihood security. Further research may explore gender dimensions, youth participation, and value chain integration, as well as the role of Farmer Producer Organizations (FPOs) and cooperatives in scaling millet-based enterprises. Strengthening convergence between government schemes, NGOs, and extension agencies will be critical for enhancing the overall effectiveness and scalability of such training interventions.

Conclusion

The study conclusively demonstrates that hands-on training on millet value addition had a significant, positive, and consistent impact on tribal farmers in both Kerala and Odisha. The overall impact index (71.4%) and high mean scores across indicators confirm that the training effectively enhanced farmers' knowledge, technical skills, confidence, and entrepreneurial orientation. The absence of a significant difference between states ($p = 0.95316$) indicates that the intervention was equally effective and adaptable across different socio-economic and regional contexts, highlighting the robustness of the training design. The correlation analysis further revealed that human capital factors (education, experience), communication variables (extension contact, media exposure), and psychological traits (decision-making ability, self-confidence) are key drivers of impact, while demographic variables such as gender and family size had minimal influence.

The State-wise analysis showed that Kerala farmers performed better in technical and market-oriented aspects, whereas Odisha farmers demonstrated stronger outcomes in resource utilization and institutional awareness, indicating complementary strengths across regions. Overall, the study underscores that participatory, hands-on training approaches are highly effective tools for capacity building among tribal farmers, but their impact can be further enhanced through integrated support systems involving market linkages, financial access, policy support, and continuous extension services. The results provide strong empirical evidence for scaling such interventions to promote sustainable livelihoods, value addition, and entrepreneurship in millet-based farming systems.

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