

ASSESSING CAPACITY GAPS FOR ADVANCING SUSTAINABLE AGROECOSYSTEMS**Anamika Sharma¹, Kiran Rana² and Amardeep Chauhan³**

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ABSTRACT

This study examines capacity gaps among farmers in the North-Western Himalayan region of India, focusing on Jammu & Kashmir and Uttarakhand. Using a multistage sampling method, data were collected from 347 respondents engaged in rice-wheat-vegetable based production systems. Capacity need assessment (CNA) was conducted across five domains i.e., knowledge, technical skills, finance and market access, social and leadership abilities, and accessibility to resources. The results of one-sample t-tests revealed substantial and statistically significant deficits across all indicators when compared to the desired benchmark of 5. In Jammu & Kashmir, mean scores for the five domains ranged from 1.34 to 2.15, while in Uttarakhand they ranged from 1.19 to 1.79 with all gaps highly significant ($p < 0.01$). The most critical weaknesses were observed in social and leadership capacities and accessibility followed by finance and market linkages, whereas technical competence showed relatively smaller but still significant gaps. The overall CNA mean score (3.01) further confirmed systemic deficiencies across both states. These findings underscore the urgent need for targeted interventions through knowledge reinforcement, technical training, financial inclusion, leadership development and improved access to institutional and infrastructural support.

Keywords: capacity need assessment, sustainability, agroecology, farmer empowerment

INTRODUCTION

Indian agriculture is undergoing a critical transition shaped by resource-intensive practices and uneven regional development. The Green Revolution enhanced food security through high-yielding varieties, fertilizers, pesticides and irrigation technologies (Ameen and Raza, 2018; Campagnolla *et al.*, 2019; Ochieng *et al.*, 2024). However, it also led to soil degradation, groundwater depletion, ecological pollution and growing resource inequalities (John and Babu, 2021). These issues compounded by climate change, population growth, poverty and land degradation which underscore the need for sustainable agricultural systems that balance productivity, environmental health and social equity (Pratik and Vinaya, 2021; Shahlas *et al.*, 2024). Consequently, sustainable agriculture has emerged as a priority, integrating food security, rural livelihoods and ecological balance through soil and water conservation, biodiversity management and climate-resilient practices (Kaur and Pateer, 2025; Sharma and Bipana, 2024; Vinaya *et al.*, 2024). Agroecology in particular offers a transformative framework that merges ecological principles with farmers' knowledge to enhance resilience and reduce production risks (Kerr *et al.*, 2023; Gnanasanjevi *et al.*, 2025). Empirical evidence shows that conservation agriculture and integrated pest management can increase yields by 25% and

22%, respectively, while organic farming cuts chemical inputs by up to 70%, collectively improving food security by 25-40% across availability, access, utilization and stability dimensions (Paul, 2022).

Despite these opportunities, farmers remain constrained by significant gaps in knowledge, technical skills, financial literacy, market access, leadership and resource accessibility. These limitations restrict their ability to transition from conventional systems to sustainable practices and weaken their participation in agricultural operations. Identifying and addressing these capacity gaps is therefore central to advancing agroecological development and strengthening the resilience of farming communities. A systematic assessment of farmers' needs not only provides evidence-based insights into areas requiring intervention but also guides the design of extension, training and institutional support mechanisms that can accelerate sustainable agricultural transformation.

Conceptual Framework: This study is based on the premise that farmers' capacities directly shape the sustainability of agroecosystems. Capacity building is understood as a multidimensional process that includes knowledge acquisition, technical skills, financial literacy, leadership development and improved access to resources. Strengthening these dimensions

equips farmers to make informed decisions, adopt sustainable practices and engage more effectively in value chains and local institutions. Systematic capacity need assessment thus serves not only as a diagnostic exercise but also as a strategic pathway for empowering farmers, enhancing resilience and aligning agricultural systems with global sustainability goals.

OBJECTIVE

To assess the capacity need of farmers regarding sustainable agriculture system in North-Western Himalayan region.

METHODOLOGY

An inductive research approach with a quantitative method was adopted for this study. Data were collected through a structured survey, employing a multistage sampling technique to ensure representative coverage of the study area. The study was conducted in the North-Western Himalayan region of India, which comprises the states of Jammu & Kashmir, Himachal Pradesh and Uttarakhand. Out of the three states, Jammu & Kashmir and Uttarakhand were purposively selected owing to their extensive area under the rice-wheat-horticulture (vegetable) based production system, which characterizes the region’s agroecosystem. From each state, two districts were purposively chosen based on their dominance in rice-wheat-horticulture (vegetable) production: Jammu and Kathua district from Jammu & Kashmir and Udham Singh Nagar and Nainital district from Uttarakhand. Within each district, two blocks were randomly selected. Accordingly, Marh and R.S. Pura blocks were chosen from Jammu district; Barnoti and Marheen from Kathua district; Gadarapur and Sitarganj from Udham Singh Nagar district; and Kotabag and Bhimtal block from Nainital district. At the final stage, one village was randomly selected from each block: Halqa (Marh block), Chohala (R.S. Pura block), Nanan (Marheen block), Gadiyal (Barnoti block), Dogra (Kotabag block), Govindpur (Sitarganj block), Gardarpur (Gadarapur block) and Bhimtal (Bhimtal block). A total sample size

of 347 respondents was determined using the Probability Proportionate to Size (PPS) method at a 10% precision level.

Primary data which was collected through personal interviews using a structured schedule, were first organized in Microsoft Excel and subsequently analyzed using SPSS software. Descriptive statistics were employed to summarize responses, while one-sample t-tests were applied to assess the significance of capacity need gaps. Secondary data from government reports and credible online databases were also used to supplement and validate primary findings.

RESULTS AND DISCUSSION

Capacity Gaps Across Jammu & Kashmir and Uttarakhand

The one-sample t-test results revealed substantial capacity gaps in both Jammu & Kashmir and Uttarakhand (table1) with all five assessed indicators performing significantly below the desired mean of 5. In Jammu & Kashmir, the accrued mean scores were 1.90 for knowledge, 2.15 for technical capacity, 1.66 for finance and market, 1.38 for social and leadership and 1.34 for accessibility, yielding mean differences between -2.85 and -3.66 with highly significant t-values ($p < 0.01$). Similarly, in Uttarakhand, mean scores were 1.64 for knowledge, 1.79 for technical capacity, 1.44 for finance and market, 1.25 for social and leadership and 1.19 for accessibility with mean differences ranging from -3.21 to -3.81 and strongly significant t-values ($p < 0.01$). The results indicate that farmers in both regions face severe and statistically significant deficiencies, most notably in social and leadership skills and accessibility followed by financial and market linkages. These gaps highlight the urgent need for targeted extension and advisory services, capacity-building programs and institutional support to enhance farmers’ ability to participate effectively in sustainable agroecosystem development, which aligns with earlier studies (Chandra and Uniyal, 2021; Rana, 2020; Chandra, 2024).

Table 1: Empirical evidence of capacity deficiencies in Jammu & Kashmir and Uttarakhand (n=347)

Sr. No.	Indicators	Accrued Mean	Desired Mean	Mean Difference	T-Value	Accrued Mean	Desired Mean	Mean Difference	T-Value
		Jammu and Kashmir				Uttarakhand			
1	Knowledge	1.90	5	-3.10	-21.14**	1.64	5	-3.36	-28.11**
2	Technical capacity	2.1525	5	-2.85	-29.62**	1.79	5	-3.21	-47.02**
3	Finance and Market	1.66	5	-3.34	-18.80**	1.44	5	-3.57	-25.88**
4	Social and Leadership	1.38	5	-3.62	-28.92**	1.25	5	-3.75	-37.30**
5	Accessibility	1.34	5	-3.66	-24.25**	1.19	5	-3.81	-32.54**

**Significant at $p \leq 0.01$

Domain-specific capacity gaps in North-Western Himalayan region**Table 2: Indicator-wise disparities in capacity need assessment in North-Western Himalayan region** (n=347)

Sr. No.	Indicators	Accrued Mean	Desired Mean	Mean Difference	T-Value
1	Knowledge	3.58	5	-1.42	-5.14**
2	Technical capacity	3.94	5	-1.06	-6.57**
3	Finance and Market	3.09	5	-1.91	-6.05**
4	Social and Leadership	2.63	5	-2.37	-10.56**
5	Accessibility	2.51	5	-2.49	-9.09**

**Significant at $p \leq 0.01$

Table 2 highlights pronounced disparities across all capacity domains when compared with the desired benchmark. The knowledge domain shows a significant shortfall with a gap of 1.42 points, underscoring the urgent need to strengthen knowledge resources and promote systematic capacity-building among respondents. Technical capacity, while also below the expected level, records a relatively smaller gap of 1.06, suggesting that some level of competence exists but that continued training and skill enhancement remain essential. Finance and market access present a substantial and statistically significant deficiency, reflecting critical challenges in financial literacy, access to credit and effective integration into market linkages factors that restrict farmers' participation in agricultural sustainable practices. Social and leadership skills exhibit one of the most severe gaps, pointing to limited organizational capacity, inadequate leadership development and weak collective action, which collectively represent a critical barrier to farmer empowerment. The largest deficit is observed in accessibility with a gap of 2.49, indicating serious barriers in physical, institutional and informational access that hinder the development of farmers' overall capacity. These findings are consistent with the observations of Kachali *et al.* (2024) and Chaudhary *et al.* (2024), while Shukla *et al.* (2024) specifically emphasized the critical need for improved access to marketing-related information.

Overall statistical evident Capacity Need Assessment**Table 3: Statistical evidence of capacity need assessment**

(n=347)

Test Value = 5						
CNA	t	df	Sig	Mean Difference	95% Confidence interval of the difference	
					Lower	Upper
	-13.88	37	.000	-1.99	-2.28	-1.70

The results of the one-sample t-test for the overall Capacity Need Assessment (CNA) as shown in table 3,

revealed a pronounced and statistically significant disparity between the respondents' accrued mean capacity and the desired benchmark of 5. The analysis showed an average CNA score of 3.01, which is nearly two points below the expected level with a mean difference of -1.99. This gap was highly significant ($t = -13.88, p < 0.001$) and further validated by the 95% confidence interval (-2.28 to -1.70), confirming that the true population mean falls substantially short of the benchmark. These findings indicate that respondents' overall capacity is considerably inadequate, reflecting systemic shortcomings across multiple domains including knowledge, technical expertise, financial and market access, social and leadership competencies, and accessibility to essential services and resources. The magnitude of this deficit highlights the urgent need for well-structured, targeted capacity-building programs to close the gap and strengthen farmers' ability to participate effectively in agricultural sustainable practices. These results align with earlier observations by Chandra (2024). Similarly, Kavadi *et al.* (2014) emphasized that consistent efforts by extension institutions to strengthen people's institutions enhance the efficiency, effectiveness and equity of developmental activities, thereby contributing to the sustainable development of rural agriculture.

CONCLUSION

This study reveals significant systemic weaknesses in farmers' capacities across the North-Western Himalayan region, emphasizing the challenges of transitioning from conventional to sustainable agriculture. Despite some existing knowledge and technical competence, farmers face major deficits in leadership, collective organization, finance, market access and institutional support. These are not just statistical gaps but structural barriers that constrain farmers' agency, reduce their bargaining power and hinder the adoption of sustainable practices. In ecologically fragile regions like Jammu & Kashmir and Uttarakhand, such limitations heighten vulnerability to climate shocks, resource degradation and livelihood insecurity. The findings call for comprehensive capacity-building strategies that extend beyond technical training to include leadership development, financial literacy

and equitable access to credit and markets. Strengthening farmer cooperatives, improving extension systems and fostering institutional innovations such as localized food hubs and participatory governance are essential to create enabling conditions for agroecological adoption. Addressing these multidimensional capacity gaps can transform farmers from passive beneficiaries into active agents of change. So, the study underscores that farmer capacity is a decisive factor for achieving resilience, productivity and equity in Himalayan farming systems. Bridging these gaps is not only a developmental necessity but also a strategic pathway toward national food security and global sustainability goals.

The study's findings are based on data from selected regions and may not fully represent the entire Himalayan context. Additionally, reliance on self-reported information may introduce bias and dynamic socio-economic variables could influence outcomes over time.

ACKNOWLEDGEMENT

The author sincerely express gratitude to the farmers and extension personnel of Jammu & Kashmir and Uttarakhand for their valuable cooperation and insights that greatly contributed to this study. They also extend their appreciation to the faculty and staff of G.B. Pant University of Agriculture and Technology, Pantnagar, for their continuous guidance and support throughout the research. Their encouragement and assistance were vital to the successful completion of this work on assessing capacity needs for sustainable agriculture.

CONFLICT OF INTEREST

The authors declare no conflicts of interest regarding the publication of this article and confirm that no financial support was received from any institution or organization.

REFERENCES

- Ameen, A. and Raza, S.M. (2018). Green revolution: A review. *International Journal of Advances in Scientific Research* 3: 129-137.
- Campagnolla, C., Rametsteiner, E. and Gutierrez, D. (2019). Sustainable agriculture and food systems: Towards a third agricultural revolution. *From Fome Zero to Zero Hunger* 140-157. <https://doi.org/10.18356/d3dc1fean>.
- Chandra, R. (2024). Environmental effects in the changing mountain farming system: A case study from Uttarakhand. In Proceeding, Conference Paper, International Association of Agricultural Economists (IAAE), New Delhi, India. <https://doi.org/10.22004/ag.econ.344308>.
- Chandra, R. and Uniyal, V.P. (2021). Assessment of local adaptive capacity of mountain farmers: a way forward for sustainable livelihood development. *Asia-Pacific Journal of Rural Development* 31(2): 172-194.
- Chaudhary, P. B., Patel, G. R. and Chaudhari, H. A. (2024). Adoption of good agriculture practices. *Gujarat Journal of Extension Education* 38(2): 221-224. <https://doi.org/10.56572/gjoe.2024.38.2.0036>
- Gnanasanjevi, G., Balasubramaniam, P. and Gopishankar, S. (2025). Building resilient food systems through agroecology: strategies and impacts. *Ecology, Environment and Conservation* 31(2): 803-806.
- John, D. A. and Babu, G. R. (2021). Lessons from the aftermaths of green revolution on food system and health. *Frontiers of Sustainable Food System* 22(5): 644559.
- Kachali, R., Kaula, N., Chavula, G. and Chimonyo, V.G. (2024). Stakeholder capacity needs assessment and needs matrix validation: Case study of Mzimba, Kasungu, Balaka, Zomba, and Mangochi districts. CGIAR research initiative on Mixed Farming Systems (MFS). International Maize and Wheat Improvement Center. Lilongwe, Malawi.
- Kaur, D.H. and Pateer, S. (2025). A conceptual review of sustainable agriculture approaches and practices: Toward sustainable agricultural transitions. *Economic Sciences* 21 (1): 903-913.
- Kavad, S. D., Patel, R.B. and Patel, G.R. (2014). Peoples institution for resource poor village development. *Gujarat Journal of Extension Education* 25(1).
- Kerr, R.B., Postigo, J.C., Smith, P., Cowie, A., Singh, P.K., Rivera-Ferre, M., Tirado-von der Pahlen, M.C., Campbell, D. and Neufeldt, H. (2023). Agroecology as a transformative approach to tackle climatic, food, and ecosystemic crises. *Current Opinion in Environmental Sustainability* 62: 101275.
- Ochieng, L.A., Thakker, R. and Solanki, H. (2024). Green revolution and its impacts on the environment: a review. *Towards Excellence* 16: 4.
- Paul, S. (2022). Sustainable agriculture practices for food security and environmental protection. *RESEARCH HUB International Multidisciplinary Research Journal* 9(4): 34-42.

- Pratik Kiritkumar Patel and Vinaya Kumar, H. M. (2021). Farmers socio- economic status and constraints using social media for sustainable agriculture development. *Gujarat Journal of Extension Education* 32 (1): 34-39.
- Sharma, S. and Bipana, K.C. (2024). Sustainable agriculture and it's practices: A review. *Turkish Journal of Agriculture-Food Science and Technology* 12(12): 2631-2639.
- Shukla G., Ansari M.N. and Lal S.P. (2024). Assessment of agricultural information needs of farmers: Triangulating reliability of standardized information need index. *Gujarat Journal of Extension Education* 37(2). <https://doi.org/10.56572/gjoee.2024.37.2.0005>
- Shahlas, B. T., Kumar, A. A. and Smitha, K. P (2024) Relationship between profile characteristics and attitudes of tribal and non-tribal rice farmers toward sustainable rice farming. *Gujarat Journal of Extension Education*, 38(1):213-218. <https://doi.org/10.56572/gjoee.2024.38.1.0034>.
- Vinaya Kumar H. M., Aishwarya, P. & Patel, J. B. (2024). Carbon farming in India: Issues, opportunities and challenges. Paper presented at the conference Agricultural Extension for Viksit Bharat: Innovations and Strategies for Sustainable Development, Navsari Agricultural University, Navsari, Gujarat, India.

Received : September 2025 : Accepted : November 2025