



Mapping agricultural constraints: Nationwide demand-driven research, extension and policy perspectives

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ABSTRACT

Translating farmer knowledge into actionable agricultural policy remains a key challenge in agricultural governance. This study develops and operationalises a participatory diagnostic framework to generate structured policy-relevant agricultural intelligence. Using data from the Viksit Krishi Sankalp Abhiyan (VKSA) conducted during 2025 across India, a total of 11,477 Focus Group Discussions (FGDs) were held across 448 districts in 34 states and Union Territories (UTs), engaging 1,63,650 farmers including 55,250 farm women. Farmer-identified issues were grouped into 20 thematic domains and validated through severity scoring by Krishi Vigyan Kendra (KVK) scientists using a standardised 10-point scale. Comparative analysis was conducted across four state typologies- large, medium, small states/UTs and north-eastern states. Findings showed strong convergence around three foundational constraints: seed system inefficiencies, climate variability and water management challenges, alongside region-specific priorities in mechanisation, horticulture and crop-livestock integration. The proposed framework strengthens the Research-Extension-Policy (REP) interface by institutionalising farmer knowledge within scientific validation and policy translation processes, offering a scalable model for adaptive, regionally differentiated agricultural strategies aimed at enhancing resilience, productivity and sustainability.

Keywords: Agriculture & allied Sectors, Climate change, Farmer perceived constraints, Focus group discussion, Participatory mapping

Agricultural systems worldwide are under increasing stress from climate volatility, groundwater depletion, biodiversity erosion and widening productivity gaps (Sisodia and Sharma 2022, Farah *et al.* 2025). In India, despite notable gains in food grain production, continues to face with deep structural inefficiencies. The *kharif* crops cover 64.06% of cultivated area and produce 179.93 mt annually (MoA&FW 2024), yet a persistent gap remains between potential and actual farmer-level yields (Srivastava 2014, Bekele 2022). Farmer vulnerability is driven by erratic seed access, declining groundwater, soil degradation, rising input costs and climate-induced risks (Kuchimanchi *et al.* 2019, Kumar *et al.* 2020). These challenges are further compounded by limited awareness of improved practices (Muddassir and Alotaibi 2023, Justine *et al.* 2025), weak

technology delivery systems (Yigezu *et al.* 2021), and inadequate capacity building (Malik and Khan 2020). Given India's diverse agro-ecological conditions- spanning semi-arid plains, humid tropics and fragile hill ecosystems- regionally differentiated interventions are essential rather than blanket policy prescriptions.

Agricultural extension in India has largely relied on top-down dissemination models that overlook the ground-level farmer realities (Birner *et al.* 2007), creating persistent mismatches between scientific innovations and field-level adoption (Iiyama *et al.* 2018). Participatory frameworks such as Participatory Rural Appraisal (PRA) (Chambers 1994), Farmer First approach (Watkins 1990) and co-production of knowledge (Norström *et al.* 2020) offer a corrective by enabling experiential farmer knowledge into research prioritisation and policy design. However, most participatory diagnostics remain localised and lack mechanisms for scientific validation, inter-regional comparability and structural policy translation (Kerr 2025), leaving limited empirical evidence on the conversion of decentralised farmer insights into actionable priority indices at scale.

The present study addresses this gap by developing a scalable participatory diagnostic framework operationalised

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through the Viksit Krishi Sankalp Abhiyan (VKSA), a nationwide outreach campaign coordinated by the Indian Council of Agricultural Research (ICAR) and Ministry of Agriculture & Farmers Welfare (MoA&FW), conducted across 728 districts and engaging over 13.5 million farmers to revitalise the Research-Extension-Policy (REP) interface (Singh *et al.* 2025).

MATERIALS AND METHODS

Study area and coverage: The study was conducted in 2025 across 448 districts representing 34 states and UTs of India. This nationwide coverage ensured representation of diverse agro-climatic zones, production systems and socio-economic conditions, spanning the *kharif* cropping seasons.

Sampling framework: A purposive sampling design was adopted. Data were collected through 11,477 Focus Group Discussions (FGDs) facilitated by Krishi Vigyan Kendras (KVKs). Before data collection, a structured rapport-building phase was conducted to foster trust and encourage open discussion. Facilitators were trained to maintain a neutral, non-directive approach, allowing farmers to articulate and prioritise issues organically, thereby reducing hierarchical barriers. Each FGD comprised 10–20 farmers with gender representation. In total, 1,63,650 farmers participated, including 55,250 farm women, reflecting gendered perspectives in problem identification.

Data collection

Phase I- Open-ended questionnaire were used to elicit all perceived agricultural constraints without restricting responses to predefined categories. Facilitators documented verbatim problem statements to preserve contextual nuance.

Phase II- Farmer-identified constraints were consolidated and grouped into 20 broad domains covering crop production, natural resource management, livestock systems, input supply, institutional constraints, socio-economic issues and others (Table 1). This thematic classification enabled structured comparison while retaining contextual diversity.

Phase III- The consolidated problem categories were evaluated by KVK professionals using a standardised 10-point severity scale (1, Minimal severity; 10, Extreme severity). State-level severity indices were computed as arithmetic means of district-level scores. All 20 thematic domains were initially ranked. For ease of presentation and discussion, only the 11 most prominent domains are presented in the Table 1. The rank values were assigned based on the complete set of 20 identified domains. Therefore, rank values exceeding 11 reflect the original ranking among all 20 domains and not solely the 11 domains displayed.

Analytical framework: For comparative assessment, states and UTs were grouped into four typologies based on the administrative classification adopted in the VKSA reporting framework considering geographical size and regional characteristics: Large size states; Medium size states; Small size states/UTs and North-eastern region. Within each typology, severity scores were ranked in descending order to identify priority constraints. The

ranking of agricultural constraints was carried out based on the frequency and priority scores assigned during Focus Group Discussions (FGDs). Focus Group Discussions are widely used to capture collective perceptions, identify key issues, and establish priorities among stakeholders (Krueger and Casey 2015). The prioritisation and ranking process followed participatory approaches commonly employed in agricultural and rural development research to identify and rank local constraints and problems (Narayanasamy 2009). The analysis is primarily descriptive and comparative, designed to identify convergence and divergence patterns. Given participatory and non-random nature of sampling, findings should be interpreted as research, extension and policy-guiding diagnostic insights rather than statistically generalizable estimates.

RESULTS AND DISCUSSION

Farmer perceptions across diverse agro-climatic regions showed a high degree of convergence. Across all problem thematic domains, seeds and improved varieties (constraints related to seed availability, quality and varietal suitability); climate change and its impacts (climate change and variability, including erratic rainfall, increasing temperatures, extreme weather events and their adverse effects on agricultural productivity and livelihoods) and water management (constraints in water resources management, including groundwater depletion, inadequate irrigation infrastructure, inefficient water use and limited rainwater harvesting and storage facilities) consistently emerged as the top-ranked concerns. The availability and accessibility of quality seed remain a fundamental constraint to agricultural progress in India (Aheisibwe *et al.* 2015, Jalonen *et al.* 2018). Despite release of several high-yielding and climate-resilient varieties, many farmers continue to rely on older, less productive cultivars due to restricted access to newly released seed material (Kala-Satheesh *et al.* 2024). Climate change emerged as a critical problem, substantiated by long-term studies documenting adverse effects of rising temperatures, erratic rainfall, and extreme events on crop yields (Pathak 2022). Water management concerns- particularly groundwater depletion, inefficient irrigation and inadequate rainwater harvesting- further underscores the structural fragility of farming systems (Meenu 2025, Devineni *et al.* 2022). Groundwater depletion is strongly associated with reduced crop yields, contraction in cropped area and lower production, especially during the dry winter (*rabi*) season (Bhattarai *et al.* 2021, Dangar *et al.* 2021).

Large states: In large states such as Uttar Pradesh, Madhya Pradesh, Tamil Nadu and West Bengal, seeds and improved varieties were consistently identified as a major constraint (Table 2). Farmers expressed dissatisfaction with the quality and adaptability of seeds to local agro-ecologies, along with issues of timely availability (Chauhan *et al.* 2016). In Madhya Pradesh, lack of improved soybean seed has been documented concern (Dupare *et al.* 2010), while in Jhansi (Uttar Pradesh), seed storage practices

Table 1 Major thematic domains of farmer-identified agricultural constraints identified during Focus Group Discussions (FGDs)

S. no	Thematic domains	Farmer-identified constraints
1.	Seeds and improved varieties	Constraints related to seed availability, quality and varietal suitability
2.	Plant protection measures	Constraints related to plant protection, including pest and disease management, access to quality pesticides, diagnostic services and knowledge of integrated pest management practices
3.	Fertiliser and nutrient management	Constraints in plant nutrient management, including timely availability of fertilisers, affordability, balanced nutrient application and limited awareness of nutrient management practices
4.	Protected cultivation	Constraints faced by farmers in adoption of protected cultivation
5.	Farm machinery and implements	Constraints in the adoption of farm mechanisation
6.	Soil health management	Constraints in soil health management, including declining soil fertility, limited adoption of soil-testing recommendations and inadequate awareness of sustainable soil management practices
7.	Water management	Constraints in water resources management, including groundwater depletion, inadequate irrigation infrastructure, inefficient water use and limited rainwater harvesting and storage facilities
8.	Climate change and its impact	Constraints arising from climate change and variability, including erratic rainfall, increasing temperatures, extreme weather events and their adverse effects on agricultural productivity and livelihoods
9.	Bio-diversity erosion	Constraints related to biodiversity erosion, including declining agro-biodiversity, loss of indigenous varieties and reduced ecosystem services
10.	Energy in agriculture	Constraints related to agricultural energy access and utilisation, including unreliable power supply, high energy costs and limited access to alternative energy sources
11.	Livestock production and dairy	Constraints related to livestock and dairy production, including breed improvement, disease management, feeding practices and market access
12.	Poultry farming	Constraints related to poultry production, including disease outbreaks, input availability, housing, feeding and marketing
13.	Pig farming	Constraints related to pig production, including breed availability, disease control, feed resources and market linkages
14.	Fish farming	Constraints related to fisheries and aquaculture, including seed quality, pond management, disease incidence and input accessibility
15.	Fodder Production	Constraints related to fodder production and feed availability, including scarcity of quality fodder seed, limited cultivation area and seasonal shortages
16.	Horticulture including vegetables	Constraints related to horticultural production, including access to quality planting material, pest and disease management, post-harvest losses and market fluctuations
17.	Processing and value addition	Constraints related to processing and value addition, including inadequate infrastructure, limited technical knowledge, lack of storage facilities and weak market linkages
18.	Socio-economic issues	Socio-economic constraints affecting farming households, including labour shortages, rising input costs, limited access to credit, migration and livelihood insecurity
19.	Institutional and policy	Institutional and policy-related constraints, including limited extension support, inadequate access to government schemes, procedural barriers and weak inter-agency coordination
20.	Miscellaneous	Other context-specific constraints reported by farmers that could not be classified under the predefined thematic domains

have reduced farmer confidence in formal seed systems (Pal *et al.* 2021, Kumar *et al.* 2025). In Bihar, Karnataka, Andhra Pradesh and Gujarat reported climate change and its impacts as the highest priority, while Rajasthan also ranked climate variability among its major constraints. Water management was dominant in Maharashtra and

Rajasthan, where groundwater extraction has exceeded recharge (Devineni *et al.* 2022, Monir *et al.* 2024). Soil health and mechanisation were secondary position, while livestock, fodder and plant protection were ranked lower, confirming that crop-centric issues remain dominant in these states (Indoria *et al.* 2016).

Table 2 Diagnostic matrix of perceived agricultural constraints in large size states

States/UTs	Seeds	Climate change	Soil health	Fertiliser	Water	Farm machinery	Plant protection	Live-stock	Fodder	Horti-culture	Institu-tional
Uttar Pradesh	1	5	3	7	2	4	8	9	9	6	11
Maharashtra	4	6	2	12	1	5	13	8	11	3	10
Bihar	2	1	9	3	4	5	8	7	11	4	2
Madhya Pradesh	1	5	6	5	2	4	3	10	15	8	14
Rajasthan	3	2	9	8	1	4	8	5	6	7	12
Karnataka	4	1	2	11	3	7	9	8	10	5	13
Tamil Nadu	1	7	3	8	2	6	4	9	11	5	7
West Bengal	1	2	4	8	3	3	6	7	9	1	5
Andhra Pradesh	2	1	5	3	4	6	7	9	10	4	9
Gujarat	4	1	3	4	2	7	5	8	12	6	13

Medium states: In Chhattisgarh and Odisha, seed systems were again highlighted as a universal concern (Table 3). In developing countries, over 80% of crops are sown from farmer-saved seeds (Hodgkin *et al.* 2005). A study in Punjab revealed that farmers preferred farm-saved seeds owing to the high cost of certified seed and generational reliance on self-retained material (Singh *et al.* 2021). Water management issues featured prominently in Telangana and Haryana, where farmers struggle with inefficient irrigation delivery. Telangana's Deccan Plateau geography with major rivers at lower elevations accessible only through dams or pumping compounds water availability challenges (Jain and Dannenberg 2018). Farmers in Jharkhand and Kerala emphasised climate change, citing increasing rainfall irregularity. Moderate concerns were recorded regarding soil health and fertiliser management, reflecting both soil degradation and limited adoption of precision nutrient practices. While horticulture, fodder production and institutional issues were generally ranked lower, these were significant within specific state contexts for instance, horticultural concerns in Kerala due to its reliance on plantation and high-value crops. Kerala's agriculture is heavily skewed toward horticultural and plantation crops: horticultural crops occupy 77% of the cropped area and contributing around 85% of the agricultural economy (Pulikkamath and Shafeek 2024),

presents distinct challenges around horticulture and fodder that were accordingly ranked higher in that state.

Small size states and UTs: In smaller states and UTs, including Himachal Pradesh, Uttarakhand, Andaman & Nicobar Islands ranked climate change and its impacts as the foremost concern, whereas Jammu & Kashmir, Goa, Ladakh, and Puducherry ranked as second most important constraints, reflecting unique ecological and geographic contexts (Table 4). Climate change was ranked among the most pressing concerns, particularly in ecologically fragile regions such as the Himalayan and island ecosystems, where agricultural systems are highly vulnerable to climatic variability and extreme weather events (Rao and Filho 2015, Raghuvansh *et al.* 2017). Horticulture (including vegetables) emerged as a high-priority area in J&K, Goa, Lakshadweep and Puducherry, reflecting the economic importance of fruit and vegetable crops. Seed accessibility was a distinctive challenge in remote territories such as Ladakh and Andaman & Nicobar Islands, stemming from logistical and infrastructural bottlenecks. Livestock and fodder were primary concerns in Lakshadweep and Ladakh, respectively.

North-eastern states: The north-eastern region presented a distinct problem profile, shaped by ecological sensitivity and socio-economic diversity (Table 5). Farmers in Manipur, Meghalaya and Tripura ranked constraints related to seeds

Table 3 Diagnostic matrix of perceived agricultural constraints in medium size states

States/UTs	Seeds	Climate change	Soil health	Fertiliser	Water	Farm machinery	Plant protection	Livestock	Fodder	Horticulture	Institutional
Punjab	3	7	1	2	2	3	4	6	9	11	10
Haryana	2	4	3	8	1	6	7	6	7	4	10
Jharkhand	2	1	4	8	3	3	6	5	7	3	8
Chhattisgarh	1	7	6	9	2	6	4	8	10	5	13
Odisha	1	4	7	9	2	10	8	5	12	6	14
Kerala	5	3	8	10	7	4	6	5	8	1	9
Telangana	2	4	3	8	1	6	9	12	14	5	7

Table 4 Diagnostic matrix of perceived agricultural constraints in small size states and UTs

States/UTs	Seeds	Climate change	Soil health	Fertiliser	Water	Farm machinery	Plant protection	Livestock	Fodder	Horticulture	Institutional
Jammu & Kashmir	3	4	7	7	3	5	6	3	2	1	9
Himachal Pradesh	4	1	5	5	4	3	3	4	5	2	8
Uttarakhand	5	1	4	10	2	6	7	9	12	3	11
Delhi	8	11	4	9	3	10	4	3	5	2	1
Goa	3	2	4	10	6	3	7	5	6	1	11
Andaman and Nicobar Islands	1	1	4	7	3	6	9	4	6	2	5
Puducherry	8	2	3	10	7	4	10	2	3	1	6
Lakshadweep	3	2	3	3	3	6	3	1	5	1	5
Ladakh	2	2	1	4	3	4	2	3	1	3	4

and improved varieties among the top concerns, underscoring seed scarcity, adaptability to short growing seasons and limited supply chains (Aheisibwe *et al.* 2015, Jalonen *et al.* 2018). Climate change impacts were highlighted in Arunachal Pradesh, Meghalaya and Nagaland, reflecting the region's vulnerability to shifting rainfall patterns and recurrent floods or droughts (Karki *et al.* 2020). Interestingly, water management was prioritised in Assam and Sikkim despite abundant rainfall illustrating the paradox of seasonal water scarcity caused by poor harvesting, storage and distribution mechanisms. Farmers gave relatively higher importance to fodder and livestock-based livelihoods, reaffirming the integrated mixed farming systems prevalent in the eastern Himalayan region, which incorporate poultry, piggery and fishery alongside agriculture (Kumar *et al.* 2018).

The diagnostic mapping under Viksit Krishi Sankalp Abhiyan (VKSA) during 2025, covering 448 districts across 34 states and UTs of India, showed that seed system inefficiencies, climate change impacts and water management deficits are the most critical challenges perceived by farmers across all agro-ecological typologies. Region-specific concerns related to soil health, mechanisation, horticulture, livestock and fodder further highlight the need

for differentiated agricultural strategies. By integrating large-scale participatory diagnostics with structured scientific validation, the VKSA framework revitalises the lab-to-land continuum and demonstrates translation of decentralised farmer insights into actionable research, extension and policy guidance. The findings offer a replicable model for evidence-based, regionally adaptive agricultural planning aligned with the vision of Viksit Bharat @2047.

Research-Extension-Policy (REP) implications

The nationwide diagnostic mapping provides a structured evidence base for aligning agricultural interventions across the REP interface. ICAR institutes, KVKs, Agricultural Universities (AUs) and line departments play a critical role in translating farmer-identified constraints into actionable solutions. Key recommendations include:

Seed system strengthening: Research institutions such as ICAR institutes and AUs should prioritise the development of location-specific and climate-resilient crop varieties specifically in parts of Uttar Pradesh, Madhya Pradesh, Odisha, Chhattisgarh, Tamil Nadu, Manipur and Meghalaya. This includes establishing decentralised seed production units, farmer-led seed banks, and robust breeder,

Table 5 Diagnostic matrix of perceived agricultural constraints in north-eastern states

States	Seeds	Climate change	Soil health	Fertiliser	Water	Farm machinery	Plant protection	Livestock	Fodder	Horticulture	Institutional
Arunachal Pradesh	4	1	3	12	2	5	15	8	10	8	9
Assam	3	2	6	11	1	4	5	9	8	7	10
Manipur	1	2	5	6	7	6	8	4	5	2	4
Meghalaya	1	1	3	6	4	3	7	2	4	1	4
Mizoram	3	3	5	5	6	4	7	3	7	2	4
Nagaland	3	1	4	7	5	4	9	3	6	4	5
Tripura	1	2	2	4	4	2	7	1	2	2	2
Sikkim	5	2	2	3	1	2	4	3	2	2	6

foundation, certified seed linkages to ensure timely access to quality seeds adapted to local ecologies. KVKs can facilitate participatory varietal trials, seed villages and decentralised seed production programmes.

Climate resilient agriculture: Research institutions should intensify efforts on development and mainstreaming stress-tolerant varieties and climate-resilient production technologies particularly in rainfed regions of Rajasthan, Bihar, Jharkhand, Andaman & Nicobar Island, Meghalaya and Kerala. Disseminating crop varieties, diversified farming systems, and weather-based advisories into state action plans to reduce climate vulnerability.

Water management: Investments should be prioritising in micro-irrigation, watershed development, groundwater recharge, and rainwater harvesting infrastructure, especially in semi-arid and fragile ecosystems as Rajasthan, Gujarat, Maharashtra and parts of southern India. KVKs, in collaboration with watershed development agencies, can promote micro-irrigation systems, rainwater harvesting and efficient irrigation scheduling through demonstration and training.

Soil health and nutrient management: Scaling up Soil Health Card-based advisories, promote regenerative practices, and encourage precision nutrient application for sustainable productivity gains. Quarterly organising camps for demonstration of soil health card-based advisory services, integrated nutrient management and balanced fertiliser application in collaboration with line departments and KVKs at village-level.

Mechanisation for smallholders and farm women: Strengthening Custom Hiring Centres (CHCs) and development of low-cost implements suitable to small and marginal farmers across diverse terrains. At the same time, prioritise the promotion of women-friendly farm implement and machineries through hand-on demonstrations and skill-building programmes at KVKs farm.

Livestock and fodder development: Integrating livestock programmes with fodder production, silage making, and community-based feed management, particularly in hilly and North-Eastern states. Relevant research institutes alongside AUs, should focus on developing superior fodder varieties and integrated livestock systems.

Reorienting research priorities towards farmer-identified constraints, building capacity of stakeholders for participatory facilitation, and ensure supportive policy reforms for last-mile technology delivery. Together, these policy actions will not only address immediate farmer constraints but also accelerate India's progress towards resilient, inclusive, and sustainable agricultural growth in line with the vision of Viksit Bharat @2047.

REFERENCES

- Aheisibwe A R, Barekye A, Namugga P and Byarugaba A A. 2015. Challenges and opportunities for quality seed potato availability and production in Uganda. *Uganda Journal of Agricultural Sciences* **16**(2): 149–59. <http://dx.doi.org/10.4314/ujas.v16i2.1>
- Bekele B G. 2022. Review on yield gap analysis: Modeling of achievable yields at farm level. *European Journal of Agriculture and Forestry Research* **10**(2): 21–27. <https://doi.org/10.37745/ejafr.2013/vol9n22127>
- Bhattarai N, Pollack A, Lobell D, Fishman R, Singh B, Dar A and Jain M. 2021. The impact of groundwater depletion on agricultural production in India. *Environmental Research Letters* **16**(8): 084030. <https://doi.org/10.1088/1748-9326/ac10de>
- Birner R, Anderson J R, Birner R and Anderson J R. 2007. How to make agricultural extension demand-driven? The case of India's Agricultural Extension Policy. IFPRI Discussion Paper. 49p. <https://doi.org/10.22004/AG.ECON.42370>
- Chambers R. 1994. The origins and practice of participatory rural appraisal. *World Development* **22**(7): 953–69. [https://doi.org/10.1016/0305-750X\(94\)90141-4](https://doi.org/10.1016/0305-750X(94)90141-4)
- Chauhan J S, Prasad S R, Pal S, Choudhury P R and Bhaskar K U. 2016. Seed production of field crops in India: Quality assurance, status, impact and way forward. *The Indian Journal of Agricultural Sciences* **86**(5): 563–79. <https://doi.org/10.56093/ijas.v86i5.58233>
- Dangar S, Asoka A and Mishra V. 2021. Causes and implications of groundwater depletion in India: A review. *Journal of Hydrology* **596**: 126103. <https://doi.org/10.1016/j.jhydrol.2021.126103>
- Devineni N, Perveen S and Lall U. 2022. Solving groundwater depletion in India while achieving food security. *Nature Communications* **13**(1): 3374. <https://doi.org/10.1038/s41467-022-31122-9>
- Dupare B, Billore S D and Joshi O. 2010. Farmers' problems associated with cultivation of soybean in Madhya Pradesh, India. *Journal of Agricultural Science and Technology* **4**: 67–74.
- Farah A A, Mohamed M A, Musse O S H and A N Bile. 2025. The multifaceted impact of climate change on agricultural productivity: A systematic literature review of SCOPUS-indexed studies (2015–2024). *Discover Sustainability* **6**: 397. <https://doi.org/10.1007/s43621-025-01229-2>
- Hodgkin T, Rana R, Tuxill J, Didier B, Subedi A, Mar I, Karamura R, Valdivia R, Colledo L, Latournerie L, Sadiki M, Sawadogo M, Brown A H D and Jarvis D. 2005. Seed systems and crop genetic diversity in agro-ecosystems. (In) *International Conference of Medicinal Plants*, Kuala Lumpur, Malaysia, 5–7 Dec 2005 -IPGRI.1p. <https://hdl.handle.net/10568/67499>
- Iiyama, M, Mukuralinda A, Ndayambaje J D, Musana B S, Ndoli A, Mowo J G, Garrity D, Ling S and Ruganzu V. 2018. Addressing the paradox-The divergence between smallholders' preference and actual adoption of agricultural innovations. *International Journal of Agricultural Sustainability* **16**(6): 472–85. <https://doi.org/10.1080/14735903.2018.1539384>
- Indoria A K, Sharma K L, Reddy K S and Rao C S. 2016. Role of soil physical properties in soil health management and crop productivity in rainfed systems–II. Management technologies and crop productivity. *Current Science* **110**(3): 320–28. DOI: 10.18520/cs/v110/i3/320-328
- Jain A and Dannenberg S. 2018. The future of water use: Scenarios for water management in Telangana–strengthening local governance in the minor irrigation sector. (In) *Envisioning Uncertain Futures*, pp. 135–50. Peperhove R, Steinmuller K and Dienel H L (Eds). Springer VS, Wiesbaden. https://doi.org/10.1007/978-3-658-25074-4_8
- Jalonon R, Valette M, Boshier D, Duminiel J and Thomas E. 2018. Forest and landscape restoration severely constrained by a lack of attention to the quantity and quality of tree seed: Insights from a global survey. *Conservation Letters* **11**(4): e12424. <https://doi.org/10.1111/conl.12424>

- Justine P, Csorba Á, Ocansey, C M Rotich B, Maket I, Lameck A S, Abdulkadir M, Mohammed Zein M A, Michéli E and Gelsleichter Y A. 2025. Awareness and adoption strategies for improved agricultural practices (IAPs) by smallholder farmers in the Mbeya Region, Tanzania. *Discover Sustainability* **6**: 198. <https://doi.org/10.1007/s43621-025-00970-y>
- Kala-Satheesh H, Kuriyedath D, Jaleel J, Rahman E, Sathyan A, Khed V, Cariappa A and Krishna V. 2024. Seed market dynamics and diffusion of new wheat varieties in Bihar, India: A supply-side perspective. *Agricultural and Food Economics* **12**: 1–19. <https://doi.org/10.1186/s40100-024-00330-w>
- Karki S, Burton P and Mackey B. 2020. The experiences and perceptions of farmers about the impacts of climate change and variability on crop production: A review. *Climate and Development* **12**(1): 80–95. <https://doi.org/10.1080/1756552.2019.1603096>
- Kerr R. 2025. Amplifying insights: How Logarithmic Bayesianism can validate causation in participatory policymaking methods. *International Journal of Qualitative Methods* **24**. <https://doi.org/10.1177/16094069251394109>
- Krueger R A and Casey M A. 2015. *Focus Groups: A Practical Guide for Applied Research*, 5th edn. Sage Publications.
- Kuchimanchi B R, Nazareth D, Bendapudi R, Awasthi S and D Souza M. 2019. Assessing differential vulnerability of communities in the agrarian context in two districts of Maharashtra, India. *Climate and Development* **11**(10): 918–29. <https://doi.org/10.1080/17565529.2019.1593815>
- Kumar M, Panwar S G, Kushwaha R S and Dwivedi V K. 2025. Field survey on evaluation of seed quality traits and storage methods used in the legume crops by the household farmers in Jhansi district of Uttar Pradesh, India. *Legume Research-An International Journal* **38**(2): 194–201. <https://doi.org/10.5958/0976-0571.2015.00080.6>
- Kumar R, Patra M K, Thirugnanavel A, Deka B C, Chatterjee D, Borah T R, G Rajesha, S K Ray, Kumar M and Upadhyay P K. 2018. Comparative evaluation of different integrated farming system models for small and marginal farmers under the Eastern Himalayas. *The Indian Journal of Agricultural Sciences* **88**(11): 1722–29. <https://doi.org/10.56093/ijas.v88i11.84913>
- Kumar S, Mishra A K, Pramanik S, Mamidanna S and Whitbread A. 2020. Climate risk, vulnerability and resilience: Supporting livelihood of smallholders in semiarid India. *Land Use Policy* **97**: 104729. <https://doi.org/10.1016/j.landusepol.2020.104729>
- Malik S and Khan A. 2020. Gap analysis of farmers' capacity building by public and private agriculture extension sectors in central plain valley of Khyber Pakhtunkhwa. *Sarhad Journal of Agriculture* **36**(3): 992–1000. <http://dx.doi.org/10.17582/journal.sja/2020/36.3.992.1000>
- Meenu. 2025. Declining underground water levels in India: Causes, impacts, and sustainable management. *Journal of Sustainable Solutions* **2**(2): 26–29. <https://doi.org/10.36676/j.sust.sol.v2.i2.67>
- Ministry of Agriculture and Farmers Welfare. 2024. *Agricultural Statistics at a Glance 2024*. Directorate of Economics and Statistics, Government of India. <https://agricoop.nic.in> (Accessed on Dec, 2025)
- Monir M M and Sarker S C. 2024. Analysing post-2000 groundwater level and rainfall changes in Rajasthan, India, using well observations and GRACE data. *Heliyon* **10**(2): e24481. <https://doi.org/10.1016/j.heliyon.2024.e24481>
- Muddassir M and Alotaibi B A. 2023. Farmers' awareness of improved maize cropping practices in Punjab, Pakistan. *International Journal of Agriculture and Biosciences* **12**(1): 8–17. <https://doi.org/10.47278/journal.ijab/2022.039>
- Narayanasamy N. 2009. Participatory rural appraisal: Principles, methods and application. (In) *Principles for Knowledge Co-production in Sustainability Research*. Sage Publications India Ltd.
- Norstrom A V, Cvitanovic C, Lof M.F, West S, Wyborn C, Balvanera P, Bednarek T A, Bennett E M, Biggs R, Bremond de A, Campbell M B, Canadell G J, Carpenter R S, Folke C, Fulton A E, Gaffney O, Gelcich S, Jouffray B J, Leach M, Tissier Le M, Lopez M B, Louder E, Loutre F M, Meadow M A, Nagendra H, Payne D, Peterson D G, Reyers B, Scholes R, Speranza I C, Spierenburg M, Smith S M, Tengo M, Hel van der S, Putten van I and Osterblom H. 2020. Principles for knowledge co-production in sustainability research. *Nature Sustainability* **3**: 182–90. <https://doi.org/10.1038/s41893-019-0448-2>
- Pal G, Sripathy K V, Kumari K, Tyagi V and Kumar S. 2021. Study on production and supply of quality seed in Eastern Uttar Pradesh. *International Journal of Social Science* **10**(3): 231–40. <https://doi.org/10.46852/2249-6637.03.2021.5>
- Pathak H. 2022. Impact, adaptation, and mitigation of climate change in Indian agriculture. *Environmental Monitoring and Assessment* **195**(1): 46. <https://doi.org/10.1007/s10661-022-10537-3>
- Pulikkamath A and Shafeek A. 2024. A preliminary analysis and estimation of the status of feed and fodder in Kerala. *Heliyon* **10**: e31200. <https://doi.org/10.1016/j.heliyon.2024.e31200>
- Raghuvanshi R, Ansari M A and Amardeep. 2017. A study of farmers' awareness about climate change and adaptation practices in India. *International Journal of Applied Agricultural Sciences* **3**(6): 154–60. DOI: 10.11648/j.ijaas.20170306.13
- Rao P and Filho W L. 2015. Local community perception of climate change and scientific validation: A review of initiatives and perspectives in the Indian region. (In) *Climate Change in the Asia-Pacific Region*, pp. 89–101. Springer Cham, Switzerland. <https://doi.org/10.1007/978-3-319-14938-7>
- Singh I, Kaur L, Kamboj V, Astha and Singh A. 2021. Seed replacement rate and management of wheat seed in Amritsar district of Punjab. *Agricultural Reviews* **44**(4): 563–67. DOI: 10.18805/ag.R-2228
- Singh R, Kumar A, Burman R R, Singh R K and Keshava. 2025. Viksit Krishi Sankalp Abhiyan: Insights and Outcomes. Indian Council of Agricultural Research, New Delhi. 108p.
- Sisodia R and Sharma R. 2022. Bibliometric analysis of peer-reviewed literature on stress factors affecting agricultural productivity. *Current Agriculture Research Journal* **10**(3). <http://dx.doi.org/10.12944/CARJ.10.3.02>
- Srivastava S K. 2014. Yield gap analysis and the determinants of yield gap in major crops in eastern region of Uttar Pradesh. *Economic Affairs* **59**(4): 653. <https://doi.org/10.5958/0976-4666.2014.00039.4>
- Watkins G. 1990. Participatory research: A farmer's perspective. *American Journal of Alternative Agriculture* **5**(4): 161–62. <https://doi.org/10.1017/S0889189300003593>
- Yigezu Y A, Bishaw Z, Niane A A, Alwang J, Shater El T, Boughlala M, Hassan A A, Tadesse W, Bassi F M, Amri A and Baum M. 2021. Institutional and farm-level challenges limiting the diffusion of new varieties from public and CGIAR centers: The case of wheat in Morocco. *Food Security* **13**: 1359–77. <https://doi.org/10.1007/s12571-021-01191-7>