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Indigenous Agricultural Practices of the Paddari Tribe in Jammu and Kashmir: Insights for Sustainable Mountain Farming

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Abstract | Ancient Indian classical texts such as Kautilya's *Arthashastra*, Patanjali's *Mahābhāṣya*, *Krishi-Parashara*, Varahamihira's *Bṛhat Saṃhitā*, and Surapala's *Vṛkṣāyurveda* contain valuable insights into traditional agricultural practices. This study focuses on indigenous agricultural practices among the Paddari Tribe of the Union Territory of Jammu and Kashmir. Data were collected from 50 farmers (30 male and 20 female) with over 20 years of experience in indigenous farming, using in-depth interviews and purposive sampling techniques. The findings reveal that the Paddari Tribe employs various eco-friendly agricultural practices, including traditional tools, seed selection, land preparation, pest control, storage methods, soil selection, plant propagation, grafting, mixed cropping, crop rotation, intercropping, and shifting cultivation. These practices, free from chemical inputs, contribute to sustainable agriculture. In modern society, indigenous agricultural knowledge systems are increasingly recognized as vital for sustainable development, particularly in the Global South, as they promote harmony with nature. The Sustainable Development Goals (SDGs) and National Education Policy 2020 (NEP-2020) emphasize integrating indigenous agricultural knowledge with modern technology to foster sustainable farming. This research highlights how blending traditional and modern agricultural practices can lead to more sustainable and environmentally friendly farming systems.

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Introduction

Indigenous knowledge (IK) encompasses the skills, practices, and wisdom developed, sustained, and passed down through generations within a community, often forming a core part of its cultural or spiritual identity (World Intellectual Property Organization, WIPO). This knowledge system, rooted in local experiences and adaptation to the environment, strengthens cultural identity and supports sustainable development goals, including agriculture (Chakravarty *et al*., 2013). Agriculture, one of humanity's oldest activities, has evolved through scientific advancements in crop improvement, production, protection, and resource management (Bhushan *et al*., 2013; Mohammad *et al*., 2025a; Al-Adwan, 2024). However, indigenous agricultural practices accumulated over centuries remain vital for their ecological sustainability (Gadgil *et al*., 1993; Mohammad *et al*., 2025b; Al-Rahmi *et al*., 2023). Ancient Indian texts such as Kautilya's *Arthashastra*, Patanjali's *Mahābhāṣya*, *Krishi-Parashara*, Varahamihira's *Bṛhat Saṃhitā*, and Surapala's *Vṛkṣāyurveda* document traditional methods, including seed selection, land preparation, pest control, mixed cropping, crop rotation, and terrace farming (Shaila and Begum, 2021; Parmar *et al*., 2023; Mohammad *et al*., 2025c). These practices are inherently eco-friendly, avoiding chemical inputs while promoting sustainability (Rautaray, 2002; Mohammad, 2025; Hujran *et al*., 2023).

Modern scholars argue that indigenous knowledge should form the foundation of development models, particularly in the Global South, as it fosters harmony with nature (Farooquee *et al*., 2004; Inglis, 1993; Mohammad *et al*., 2025d). In India, rural and tribal communities have preserved nature-friendly farming systems through rituals like *Halabhiyoga* (plough yoking), *Sita-yajna* (furrow sacrifice), and ceremonies honoring ecological balance (Aithal, 2022; Mohammad *et al*., 2025f). These traditions reflect a deep cultural connection to agriculture, emphasizing mutual survival, social equity, and ecological stewardship.

The study focuses on Paddar, a remote sub-division of Kishtwar district in Jammu and Kashmir (UT), bordered by Himachal Pradesh's Pangi region (east), Marwah-Wadwan valley (west), Zanskar (north), and the Chenab River. Situated in the Trans-Himalayas (33°15'10"N–33°30'10"N, 76°02'10"E–76°25'15"E) at 1,500–4,500 meters above sea level, Paddar comprises 32 villages with a population of 21,548 (Census of India, 2011; Mohammad *et al*., 2025g). Its pristine environment marked by ice-capped mountains, meadows, and pollution-free air supports traditional agrarian lifestyles. Over 70% of Jammu and Kashmir's population relies on agriculture (Mehmood and Anand, 2020), while 90% of Paddar's inhabitants depend solely on farming and cattle rearing. Despite modernization, Paddari farmers predominantly use indigenous methods, which are cost-effective, eco-friendly, and health-safe (Shaila and Begum, 2021). However, these practices face extinction due to shifting priorities and government-led agricultural modernization (Camacho *et al*., 2016; Ridwan *et al*., 2023). This study documents Paddari rituals, tools, and beliefs such as seed selection, pest control, and crop rotation to preserve their cultural and ecological value. This study aims to identify and document the indigenous agricultural practices of the Paddari tribe, which have sustained their agrarian lifestyle for generations. Beyond mere identification, the research seeks to examine the uniqueness of these practices, exploring how they differ from conventional methods in terms of ecological adaptation, cultural significance, and sustainability. Furthermore, the study will assess their relevance in modern society, particularly in light of global calls for sustainable agriculture and the preservation of traditional knowledge. Finally, it will analyze the impact of modernization on these practices, investigating how technological advancements, policy shifts, and socio-economic changes have altered or eroded Paddari farming traditions over time.

Materials and Methods

Research design

This study adopts a qualitative research design, utilizing primary data collected through in-depth engagement with the farming community of the Paddari Tribe in Kishtwar district, Jammu and Kashmir (UT).

Study population and sampling

The target population comprised experienced farmers with extensive knowledge of indigenous agricultural practices. A purposive sampling technique was employed to select 30 participants (19 male and 11 female), each with over 20 years of experience in

traditional farming methods. To ensure regional representation, at least one male and one female farmer were selected from each panchayat in Paddar.

Data collection and analysis

Data were gathered through structured in-depth interviews, focusing on capturing detailed insights into traditional practices, challenges, and adaptations. Thematic analysis was conducted to identify recurring patterns, key themes, and significant findings, ensuring a systematic and rigorous examination of the qualitative data.

Results

Demographic profile of participating farmers

The study revealed key socioeconomic characteristics of the Paddari farming community (Table 1). The gender distribution showed male predominance (63.33%) with substantial female participation (36.67%). Educational attainment levels were notably low, with 56.67% illiteracy and only 10% reaching secondary education. Farming experience data demonstrated deep traditional knowledge, as 63.33% of respondents had 30-40 years of practice, while 16.67% possessed over four decades of indigenous agricultural expertise.

Table 1: *Demographic profile of the respondents.*

Variables	Components	Frequency	Percentage
Gender	Male	19	63.33
	Female	11	36.67
Educational qualifications	Illiterate	17	56.67
	Elementary	10	33.33
	< Secondary	3	10
Farming experience	20-30 years	6	20
	30-40 years	19	63.33
	< 40 years	5	16.67
Land holding	Upto 10 Kanals	24	80
	10-20 Kanals	5	16.67
	< 20 Kanals	1	3.33
Monthly income	Upto 10000	15	50
	10000-25000	11	36.67
	< 250000	4	13.33
Type of family	Joint	17	56.67
	Nuclear	13	43.33
Sources of income	Agriculture only	7	23.33
	Cattle rearing only	0	0
	Both	16	53.34
	Agriculture and other	7	23.33

Landholding patterns reflected the challenging mountainous terrain, with 80% of farmers cultivating less than 20 kanals. Income levels were modest, with half earning below ₹10,000 monthly and only 13.33% exceeding ₹25,000. Family structures showed 56.67% in joint family systems, while livelihood data confirmed heavy reliance on agriculture (75% exclusively dependent) with supplementary forest-based activities. These demographic factors collectively shape the community's agricultural practices and economic constraints.

Indigenous agricultural tools

The present study examines six key aspects of indigenous agricultural practices among the Paddari Tribe: the tools used in farming, seed selection and land preparation techniques, pest control methods, nutrients for crop enhancement, disease management and plant protection, and traditional practices like mixed cropping, crop rotation, and shifting cultivation. Choosing the right tool for each task is crucial for conserving farmers' energy and time. The Paddari farmers utilize various indigenous tools in their agricultural work. For land preparation, they use the plough (*Lath*) and wooden beam (*Zuin*), while the hoe (*Kudali*) and pickaxe (*Gante*) are employed for digging and leveling the soil. The sickle (*Drat*) is used for cutting crops and grass, and the weeding tool (*Kurush/Asarol*) helps remove unwanted plants (see Figure 1). Farmers mentioned that all iron tools are crafted by local blacksmiths, while the others are made by themselves. This highlights their self-sufficiency and skill in tool construction. The findings reveal that Paddari farmers possess deep knowledge of indigenous agricultural practices, including the engineering of traditional tools. Their expertise is passed down through generations, with the head of each family typically holding the most extensive understanding of these methods. This traditional wisdom ensures efficient and sustainable farming practices within the community.

Selection of seeds

Seeds are the foundation of agriculture and a vital source of energy for all living beings (Joshi, 2021). Farmers cultivate and preserve thousands of native seed varieties across different crop species (Dwivedi *et al.*, 2016). Among the Paddar tribe, women play a crucial role in seed selection during harvest. They carefully identify the healthiest seeds, separate them, and store them separately to avoid mixing with regular crop yields. The Paddar farmers believe that

seeds selected by hand particularly by women have higher germination success than those chosen by men. They attribute this to women's dexterity and expertise in identifying seeds that remain viable longer and maintain genetic purity. These selected seeds are stored in cool, dry conditions to preserve their quality. Unlike commercially supplied seeds from private companies or government seed corporations, Paddar farmers strongly prefer their own locally managed seeds. They argue that farmer-to-farmer seed exchange ensures reliable seed quality, especially in high-risk environments and socioeconomically disadvantaged areas. They distrust the authenticity and performance of externally supplied seeds, relying instead on traditional knowledge and community-based preservation to sustain their agricultural heritage.

Figure 1: *Indigenous agricultural tool used in farming among Paddari Tribe people (a) Sickle (Drat) (b) Asarol (Kurush) (c) Wooden Plough (d) Hoe (Kudali).*

Process of land preparation

Land preparation involves tillage to create optimal soil conditions for plant growth. This process, which includes ploughing, harrowing, and levelling, ensures proper seedbed conditions, supports plant establishment, and aids in weed control. It creates a favorable environment for both transplanting and direct sowing, ultimately enhancing crop productivity (NCERT). The Paddar farmers prepare their land using traditional methods, relying on *Chour* (hybrid bovines, a cross between cows and yaks) for traction. A plough (*Lath*), attached to a wooden beam (*Zuin*), is harnessed to the *Chour*, while a farmer guides the plough from behind to control its direction (See Figure 2). The field is ploughed twice before sowing to optimize soil conditions for seed germination. After sowing, women manually level the land. Notably, Paddar farmers prefer this indigenous approach over mechanized tractors. They argue that traditional tillage is better suited to their needs and point to the risks of tractor use in mountainous terrain, where the machinery is prone to damage during ploughing, harrowing, and levelling. Consequently, they avoid tractors altogether, relying instead on time-tested, animal-drawn methods that align with their ecological and practical constraints.

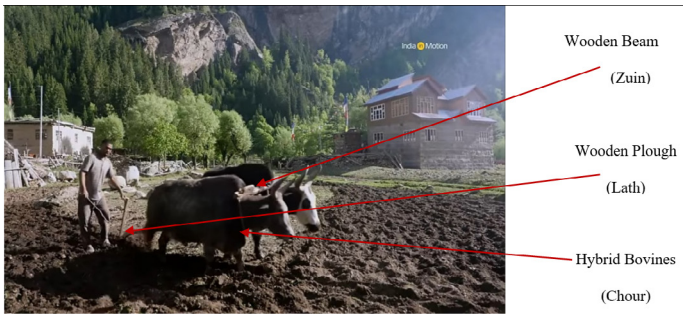

Figure 2: *Process of land preparation in indigenous way.*

Seasonal nutrient management in Paddar agriculture

In Paddar's traditional agricultural system, seasonal nutrient management follows distinct patterns for Rabi (winter) and Kharif (monsoon) crops. Farmers apply nutrients during early growth stages for Rabi crops, while Kharif cultivation involves pre-sowing manual distribution across fields, followed by double plowing to enhance soil aeration and nutrient integration. The entirely organic system primarily utilizes cow dung manure, universally employed by all farmers, along with carefully prepared farmyard manure composed of decomposed fodder, dung, and straw as mentioned in Figure 3. An innovative practice involves using coniferous needles from Deodar (*Cedrus deodara*), Pine (*Pinus* spp.), and Kail (*Pinus wallichiana*) trees as cattle bedding to absorb urine and dung, which is later composted into rich organic fertilizer. During fallow periods, the field-penning technique confines cattle to agricultural plots, allowing direct nutrient deposition that enhances soil fertility for subsequent crops. These integrated practices demonstrate a sophisticated, ecologically balanced approach to nutrient cycling that maximizes local resources while maintaining soil health. Developed through generations of agroecological knowledge, this system effectively sustains productivity without synthetic inputs by optimizing natural processes adapted to local environmental conditions and available biomass.

Diseases and crop protection in Paddari agriculture

The Paddari Tribe employs a sophisticated array of indigenous plant protection strategies that utilize

ecological methods to manage pests and diseases in cereal and legume crops. These sustainable approaches emphasize cultural practices, mechanical controls, and resource optimization rather than complete pest elimination, maintaining balanced ecosystems while preventing environmental contamination. A major agricultural challenge involves bird management, particularly sparrows that threaten millet and rice crops during maturation. Farmers have developed multiple deterrent systems including strategically placed fires, bell-ringing mechanisms, and traditional scarecrows all designed to minimize yield loss while preserving ecological harmony. For smaller-scale protection, farmers apply kitchen ash as a dual-purpose solution that both deters pests and enriches soil nutrients. In lower elevations, monkey infestations require constant vigilance and adapted scarecrow systems to prevent crop damage. The high-altitude environment presents unique winter challenges, where heavy snowfall (10-15 feet) endangers Rabi crops like wheat, barley, and mustard. Farmers accelerate snowmelt through strategic application of kitchen ash or lamb manure, which darkens the surface to absorb solar radiation a practice that simultaneously protects crops and fertilizes the soil. These integrated protection methods demonstrate generations of accumulated ecological wisdom, showcasing adaptive solutions perfectly attuned to local conditions. The system's emphasis on minimal external inputs and harmonious coexistence with natural processes offers valuable insights for developing sustainable agricultural models in mountainous regions. Such traditional knowledge systems, when properly documented and studied, could significantly inform modern integrated pest management approaches seeking to reduce chemical dependency while maintaining crop productivity.

Figure 3: *Indigenous source for plant nutrients. A: Farmyard Manure; B: Cow dung manure.*

Mixed cropping and crop rotation in Paddar agriculture

The farmers of Paddar have developed highly effective mixed cropping and crop rotation systems that showcase their deep understanding of agroecology. These traditional practices involve growing multiple complementary crops together in the same field, creating a diversified agricultural system that reduces the risk of total crop failure while maintaining soil fertility. By carefully selecting crop combinations, farmers achieve multiple benefits including natural weed suppression, increased overall productivity, and balanced nutritional outputs through strategic pairings of legumes, cereals, and tuber crops.

Several well-established crop combinations have been perfected over generations to suit local growing conditions. Common mixed cropping patterns include red millet (Koda) grown with Bajarbhang and potatoes (Aloo), maize (Makki) interplanted with potatoes and kidney beans (Rajma), and various millet combinations with potatoes (see Figure 4). These specific arrangements demonstrate the farmers' sophisticated knowledge of plant interactions and microclimate optimization.

Figure 4: *Mixed crop fields.(A) Mix crop field (Brown Millet, Finger Millet, Golden Millet, and Potato plants). (B) Mix crop field (Maize, Potato, and Kidney Beans plants).*

Scientific research confirms the effectiveness of these traditional practices. Studies have shown that such mixed cropping systems enhance productivity through several mechanisms: Beneficial plant-to-plant interactions, more efficient use of sunlight, improved soil conditions, better water utilization, and natural weed control through canopy coverage. The system is further strengthened by seasonal crop rotations between winter crops (wheat, barley, mustard) and monsoon crops (maize, millets, buckwheat, vegetables), creating a sustainable annual cycle that maintains soil health. What makes these systems particularly valuable is their ecological approach. Rather than fighting against natural processes, the farmers work with them, creating resilient agricultural ecosystems that require minimal external inputs while producing diverse yields. This traditional knowledge, refined through generations of observation and adaptation, offers important lessons for developing sustainable

farming methods, especially in mountainous regions facing similar environmental challenges. The Paddar systems demonstrate how indigenous agricultural wisdom can contribute to solving modern farming challenges while maintaining ecological balance.

Discussion

The philosophical foundations of Indian culture have historically emphasized a harmonious relationship between humanity and nature, prioritizing environmental stewardship and sustainable resource management for future generations (Kala and Sharma, 2010). This worldview finds practical expression in the indigenous agricultural systems of communities like the Paddari Tribe, where traditional practices demonstrate profound ecological wisdom. Our research reveals that these time-honored techniques including sophisticated seed preservation methods, organic pest control, and diversified cropping systems not only maintain environmental equilibrium but also preserve vital agricultural biodiversity. Significantly, these systems align with both global sustainability objectives and India's National Education Policy 2020, highlighting their contemporary relevance despite their ancient origins.

However, this study uncovers a fundamental tension between ecological sustainability and economic viability within traditional farming systems. While Paddari agricultural methods offer clear environmental advantages through their chemical-free, low-input approach, they simultaneously constrain productivity and consequently limit farmers' economic prospects. This paradox becomes particularly acute in Paddar's challenging mountainous terrain, where additional factors such as poor infrastructure, limited market access, and climate vulnerability compound existing socioeconomic pressures. As modernization accelerates the erosion of these traditional systems, there is growing urgency to develop solutions that preserve their ecological benefits while addressing productivity limitations.

A viable path forward involves creating integrated agricultural models that strategically combine traditional ecological knowledge with appropriate modern technologies. Such hybrid systems could potentially reconcile competing priorities by maintaining genetic diversity for climate resilience (Singh and Sureja, 2008), continuing environmentally friendly organic practices, while selectively incorporating yield-enhancing technologies. Realizing this potential requires coordinated policy interventions, beginning with comprehensive documentation of indigenous knowledge systems (Sarkar *et al.*, 2015), followed by targeted investments in rural infrastructure and the development of context-specific agricultural technologies that respect local ecological constraints (Haq *et al.*, 2022).

Ultimately, the case of Paddari agriculture underscores a critical paradigm shift needed in agricultural development - one that views progress not as complete replacement of traditional systems, but as their careful evolution. By creating frameworks for the selective integration of modern innovations into indigenous practices, we can develop agricultural systems that are simultaneously productive, sustainable, and culturally appropriate. This approach holds special significance for mountain communities worldwide, where conventional agricultural modernization has often proven ecologically and socially disruptive. Future research should focus on developing practical methodologies for such knowledge integration while ensuring the preservation of the ecological integrity that makes these traditional systems so valuable in our era of climate change and environmental degradation.

Conclusions

This study underscores the vital role of traditional agricultural practices in environmental conservation and sustainable development. Among the Paddari Tribe, researchers documented a comprehensive system of indigenous knowledge, including specialized tools, seed selection protocols, land preparation techniques, organic pest management, soil conservation methods, and diverse cropping systems such as mixed cropping, crop rotation, and intercropping. These time-tested practices demonstrate significant ecological benefits, particularly through their chemical-free approach, which preserves soil health and biodiversity. However, the research reveals a concerning decline in these sustainable methods due to rapid modernization. Two key factors drive this erosion: Shifting priorities among younger generations and the widespread adoption of government-sponsored agricultural modernization programs. The findings highlight an urgent need to systematically document and preserve these indigenous knowledge systems. Such efforts would serve multiple purposes protecting cultural heritage,

maintaining agroecological balance, and offering sustainable solutions for future generations grappling with climate challenges. The study recommends immediate action, including ethnographic research to record these practices and the development of hybrid models that integrate traditional wisdom with appropriate modern technologies.

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Novelty Statement

This study breaks new ground by meticulously documenting the indigenous agricultural practices of the Paddari Tribe in Jammu and Kashmir's remote Paddar sub-division a region rarely covered in academic research. While ancient Indian farming methods have been broadly discussed, what sets this work apart is its in-depth, first-hand exploration of how a specific mountain community continues to adapt and sustain centuries-old ecological wisdom in the face of modern pressures. By highlighting unique tools, seed preservation techniques, organic nutrient management, and resilient mixed cropping systems, the paper shows how traditional practices can inform sustainable agriculture models for fragile mountain ecosystems. This fresh perspective not only preserves disappearing knowledge but also aligns with global sustainability goals and India's NEP 2020 vision an intersection that hasn't been practically showcased for this community before.

Author's Contribution

Anber Abraheem Mohammad: Conceptualized the research idea and guided the overall study design.
S.K. Panda and Niharika Panda: Contributed to developing the qualitative interview framework and engaging with the local farming communities during fieldwork.
Suleiman Ibrahim Mohammad: Coordinated data collection logistics and conducted in-depth interviews alongside.
Ravail Singh: Ensuring comprehensive regional representation.
N. Raja and Asokan Vasudevan: Helped with data organization and thematic analysis, providing critical insights during interpretation.
Mohammad Faleh Ahmmad Hunitie: Supported the literature review and contextual framing, aligning the findings with broader sustainability discourses.
All authors contributed to writing and refining the manuscript, approved the final version, and agreed to be accountable for the work's integrity.

Generative AI and AI-assisted technology statement

The authors declare that no generative AI or AI-assisted technologies were used in the preparation, analysis, writing, or editing of this manuscript. All research design, data collection, analysis, and interpretation were conducted solely by the authors.

Conflict of interest

The authors have declared no conflict of interest.

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