Traditional crop diversity, agricultural calendar and indigenous traditional knowledge (ITK) in Spiti valley of the Indian trans-Himalaya

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ABSTRACT

The Spiti valley of Himachal Pradesh, a high-altitude cold desert of the Indian trans-Himalaya, possesses rich traditional crop diversity and indigenous agricultural knowledge. However, socio-economic changes, climate variability and shifting livelihood patterns are increasingly threatening these valuable biocultural resources. This study was conducted during 2025-26 in villages under Losar, Kibber, Kaza and Kungri Panchayats to document traditional crop diversity and indigenous farming knowledge. Data were collected from 120 households using participatory rural appraisal (PRA) tools, including transect walks, focus group discussions, seasonal calendars and farmer meetings. A total of 28 traditional crop landraces and native plant varieties were recorded, including six barley landraces, four wheat landraces and two black pea landraces, along with several indigenous vegetables, spices and medicinal plants. Barley remained the most resilient and widely cultivated crop, whereas, black pea, wheat, mustard and several indigenous vegetables showed marked decline. Farmers reported that 42.85 per cent of traditional crops were declining and 17.85 per cent had become nearly extinct over the last 20-30 years due to labour shortages, youth outmigration, changing food habits, low market demand and climate variability. The study also documented indigenous systems of land measurement, crop calendars, irrigation management, collective labour sharing and agricultural rituals. These knowledge systems contribute significantly to sustainable resource management and climate adaptation. The findings emphasize the need for community-based conservation and promotion of traditional crops to strengthen agrobiodiversity, cultural heritage and climate resilience in the Spiti valley.

Keywords: Spiti valley; Indigenous traditional knowledge; Agrobiodiversity; Traditional crop landraces; Cold desert agriculture; Participatory rural appraisal; Climate resilience; Barley landraces; Indigenous farming systems; Trans-Himalaya

INTRODUCTION

Traditional agricultural landscapes in mountain communities are vital repositories for biodiversity, biocultural heritage and agroecological resilience (Reyes-Garcia et al 2023, Ibarra et al 2023). A premier example of this dynamic is the high-altitude, trans-Himalayan region of the Spiti valley in Himachal Pradesh. Spiti offers a critical vantage point for examining indigenous food systems, traditional ecological knowledge and the compounding pressures of climate change on mountain farming. Across Spiti and the broader Asian mountain rangelands, temperatures and climatic shifts are accelerating far beyond global averages, directly threatening local economies and vulnerable agroecosystems (Chaudhary and Bawa 2011, Kohli et al 2021). Recognizing its ecological significance, the Spiti valley within the Lahaul-Spiti district was designated as India's first Cold Desert Biosphere Reserve under UNESCO's Man and the Biosphere (MAB) Programme (Anon 2025). Despite this protective status, the valley is undergoing intense socio-cultural and environmental transitions. Local farmers increasingly observe alarming ecological shifts, notably a steady decline in the availability of forest areas, wastelands, fallow lands and communal pastures (Sharma and Chauhan 2013).

Bodh community and agricultural decline: The Spiti valley is primarily inhabited by the Bodh (also referred

to as the Bhot or Chazang) community (Kumar and Manohar 2015). To survive the harsh altitudinal gradients, the Bodh historically relied on a highly diversified farming strategy. This included the polyvarietal cultivation of staple grains (specialized varieties of barley and wheat) oilseeds and tubers (mustard and potatoes) niche and ritual flora (diverse medicinal herbs, local vegetables and unique condiments such as wild onions and black Jeera). However, modern socio-economic pressures have disrupted this equilibrium. Like many mountain regions globally, Spiti faces rapid agricultural transformation, severe labour shortages and a widening generational gap where indigenous traditional knowledge (ITK) is failing to transmit to younger demographics. Consequently, the region is experiencing a stark erosion of its crop genetic resources, particularly its hardy barley landraces and specialized niche crops like the native black pea.

Knowledge gaps and research objectives: While agro-ecological studies have explored various pockets of the Indian trans-Himalaya, a systematic, structured documentation of crop diversity and associated agricultural ITK in the Spiti valley remains sparse and incomplete. Unlocking these insights is crucial for designing development strategies that are both culturally aligned and climate-resilient. To bridge these gaps, this research evaluates traditional crop diversity and indigenous farming insights within the Spiti valley. Utilizing participatory rural appraisal (PRA) tools alongside quantitative data analysis, this study maps the biocultural significance of these native crops, diagnoses the specific drivers behind their multi-decadal decline and establishes how integrating ITK can reinforce agro-ecological resilience against shifting environmental and economic realities.

To achieve these goals, the study focuses on formally cataloging the current diversity of traditional crop landraces and native plant varieties cultivated across the Spiti valley. It examines the shifting socioeconomic and environmental pressures over the past few decades to pinpoint exactly what is driving the decline of these resilient crops. Alongside this biological assessment, the research systematically records indigenous agricultural practices, cultural rituals and traditional resource management strategies. Ultimately, these insights will be used to design actionable, community-driven conservation frameworks that blend indigenous knowledge with modern sustainability practices, ensuring that biodiversity protection directly supports local livelihoods and climate resilience.

METHODOLOGY

Study area

Geographically, the Spiti valley is nestled in the northeastern corner of Himachal Pradesh. It is bordered by the Kinnaur and Kullu districts to the south, the Chamba and Kangra districts to the west and shares an international border with Tibet to the east. Sitting deep within the Indian trans-Himalaya, the valley's elevation spans from roughly 3,300 meters to well over 4,800 meters above sea level. This extreme altitude shapes a cold, arid climate and a unique cold desert ecosystem. To capture a comprehensive view of this landscape, the fieldwork for this study focused on the communities and surrounding village settlements within the Lossar, Kibber, Kaza and Kibber panchayats (Fig 1).

Data collection

Between January 2025 and May 2026, data were collected from about 120 families living across different villages. The information was gathered using participatory rural appraisal (PRA) tools, including transect walks, focus group discussions, seasonal calendars and farmers' meetings.

Data analysis

The PRA tools and household-level interactions data were analyzed with blend of descriptive and ethnobotanical methods (Table 1). Traditional crop diversity was measured by species inventory and frequency count in the villages, whereas, long-term changes in crop status were assessed by farmer recall using qualitative trend analysis over the past 20-30 years. The ITK in agriculture and farming practices were explored through descriptive qualitative analysis of the PRA outputs and thematic interpretation, whereas, socio-economic data were summarized using descriptive statistics to give a background to traditional farming and knowledge systems.

RESULTS

Socio-economic characteristics of respondents

The socio-economic profile of the surveyed households (Table 2) highlights a heavy reliance on agriculture as the primary source of livelihood in the Spiti valley. Out of the 120 respondents, women constituted a marginally larger share (56.7%) compared

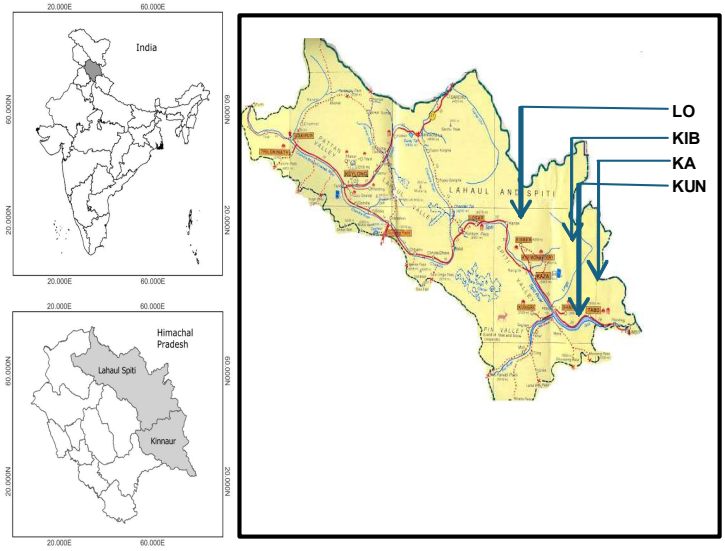

Fig 1. Map showing study sites in Spiti valley of Himachal Pradesh namely Losar, Kibber, Kaza and Kungri Panchayats and nearby village settlements under agro-ecology project

Table 1. Analytical methods employed for agricultural and ITK assessment

Component	Type of data	Analysis method/index	Formula/approach	Purpose/interpretation
Agriculture crop resources	Traditional crop species, landraces	Species inventory and frequency count	Simple listing and occurrence across villages	To document overall agrobiodiversity and identify dominant and declining crops
Agricultural crop status assessment	Farmer perceptions (past vs present)	Trend analysis (qualitative ranking)	Categorized as stable, declining or extinct based on recall (20-30 years)	To assess temporal changes in traditional crop cultivation
Socio-economic data	Household characteristics	Descriptive statistics	Frequency and percentage distribution	To contextualize farming practices and knowledge systems
Indigenous traditional knowledge in agriculture	Traditional knowledge, agricultural practices	Descriptive qualitative analysis	PRA-based thematic interpretation through discussion with resourceful contact farmers	To understand indigenous traditional knowledge systems and farming practices of agriculture of Spiti valley

Table 2. Socio-economic characteristics of respondents (n = 120)

Category	Class	Number of households	Percentage
Gender	Male	52	43.3
	Female	68	56.7
Age (years)	18-30	18	15.0
	31-45	42	35.0
	46-60	38	31.7
	>60	22	18.3
Education level	No formal schooling	34	28.3
	Primary	46	38.3
	Secondary and above	40	33.4
Primary livelihood	Agriculture	74	61.7
	Agriculture + wage labour	28	23.3
	Service/others	18	15.0

to men (43.3%). This strong female representation underscores their essential roles in local agricultural activities, including seed management, irrigation, weeding and harvesting.

In terms of age distribution, the vast majority of respondents (66.7%) fell into the economically active age brackets of 31-45 years (35.0%) and 46-60 years (31.7%). The elderly population (above 60 years) accounted for 18.3 per cent of the total, representing a vital group as they served as the primary holders of traditional farming knowledge.

The educational background of the respondents was predominantly low to moderate; exactly two-thirds (66.6%) had either no formal schooling (28.3%) or had only completed primary education (38.3%). Correspondingly, subsistence farming systems remained the backbone of the local economy. Relying on agriculture alone (61.7%) or combining farming with wage labour (23.3%) served as the predominant livelihood strategy for 85.0 per cent of the households in the area.

Traditional crop diversity of Spiti valley

Despite its harsh cold-desert environment, the Spiti valley maintains a rich agricultural repository of 28 distinct landraces, with barley, wheat and peas serving as the primary cultivated crops (Tables 3, 4). Known locally as *Nyeh*, barley is highly resilient and grown across all altitudes, thriving even at extreme elevations of 4,600 meters above mean sea level or higher in villages like Kibber, Hikkim, Komic and Langza. Conversely, wheat, locally called *Tro*, is highly sensitive to altitude; it is grown for grain production only in lower areas below 4,200 meters, while fields above this threshold are used strictly for seasonal cattle fodder because the rapid onset of winter prevents the grains from fully maturing. This disparity is driven by their vastly different growing cycles, as barley requires only 60 to 100 days from sowing to harvest compared to the approximately 140 days needed for wheat. Consequently, farmers manage staggered schedules by sowing wheat 15 to 20 days before barley and harvesting it two to three weeks after the barley crop has already been reaped.

The local agricultural crops of the Spiti valley include wheat (*Tro*), potatoes, mustard and a native variety of pea known as black pea (*Tsanma Nakpo*). The region features a rich repository of indigenous vegetables, including local radish (*Laphuk*), local methi (*Buksuk*), a green leafy vegetable (*Chultee*), local mustards (*Teche* and *Yehr*) and varieties of wild onion and spices (*Lawat*, *Gyamin*, *Koche* and *Kala Zeru*). Traditionally, farmers practiced the polyvarietal cultivation of barley, locally called *Nyeh* or *Jau*, growing six distinct native varieties: *Soha* (a husked barley), *Langkarmoh*, *Sermoh*, *Labsel*, *Kneu* (a naked barley or *Nangajau*) and *Nenak*. The black-coloured *Nenak* variety is uniquely fermented for four to five months to achieve top quality production, while *Sermoh* and *Labsel* are primarily ground into a traditional barley flour called *Tsampa*, which serves as the foundational staple diet for the people of the valley.

Status and trends of traditional crop diversity

A review of long-term changes from farmers' memories over the last 20-30 years, showed that the status of agriculture crop resources has greatly changed (Table 5). Around 42.85 per cent of the crops listed were reported to be declining, while 17.85 per cent were considered almost extinct. Farmers mainly blamed these changes on labour shortages, less willingness of youth to carry on the tradition, very little market demand and unpredictability of the weather. Only 25 per cent of the crops were reported to be steady, mainly those varieties associated with cultural rituals or regular household consumption. These results warn about ongoing loss of genetic diversity and disappearance of agrobiodiversity in valley of Himachal Pradesh.

Indigenous land measurement system of Spiti valley

The land which is now-a-days measured in terms of Bigha was used to be measured in terms of *Khal* and *Nyima*. One *Khal* is the size of the field that requires one *Khal* of seed which in turn is equal to seed contained in 20 *Theh* a traditional wooden pot having approximately seed content of 12-13 kg (Plate 1A). Area-wise one *Khal* of land is roughly equal to 1/ 16^{th} of an acre. Agriculture land is also measured by *Nyima*, meaning a day-long or a field size that requires a day-long (9 AM to 6 PM) ploughing by a pair of *Dzo* (a male hybrid of yak and cow). So, one *Nyima* field is roughly equal to $3/4^{th}$ of an acre.

Most of the farmers are self-sufficient who live in small homes scattered throughout the vast geographical area. Farmers carry out a collective workforce-sharing system called *Pheh* through which all agricultural activities are completed without hiring labourers. The agriculture fields are small in size due

Table 3. Traditional crop diversity of Spiti valley

Crop	Scientific name	Local name	Number of landraces/varieties	Current status
Barley	*Hordeum vulgare*	*Nyeh*	6	Stable; some landraces/varieties extinct
Black pea	*Pisum arvense*	*Tsanpa Nakpo*	2	Highly declining
Wheat	*Triticum aestivum*	*Tro*	4	Highly Declining
Potato	*Solanum tuberosum*	*Helu*	3	Declining
Mustard	*Brassica juncea*	*Nyur* or *Teche* or *Yehr*	3	Extinct
Wild onion	*Alliumcarolianum*	*Lawat*	1	Declining in wild
Wild onion	*Allium przewalskianum*	*Koche*	2	Declining in wild
Wild cultivated radish	*Raphanus sativus*	*Liyu* or *Laphuk*	1	Declining
Wild cultivated turnip	*Brassica rapa*	*Nyungma*	1	Declining
Wild spinach or green leafy vegetables	*Spinacia oleracea*	*Nyat* or *Chultee*	1	Declining
Black quimine	*Bunium persicum*	*Zeera Nakpo*	1	Declining in wild
Seabuckthorn	*Hippophae rhamnoides*	*Chharma* or *Tirku*	3	Declining in wild
Local Methi	*Mentha citrate*	*Buksuk*	1	Declining in wild

Table 4. Crop calendar and agronomic notes for Spiti valley

Crop	Sowing time	Harvesting time	Agronomic note
Barley	April-May	August-September	Grown as main traditional crop; only farmyard manure used with no issues related to diseases and pests; five different types of barley grown; staple diet of Spiti valley folks
Wheat	April-May	August-September	Grown over less area than barley
Black pea	April-May	July-August	Main traditional crop; requires less irrigation; only farmyard manure used; no diseases and pests
Green pea	April-May	July-August	Introduced crop; now established as main cash crop; labour intensive crop; requires high dosage of chemical fertilizers, pesticides and fungicides; requires more water for irrigation
Potato	May-June	September-October	Staple diet of Spiti valley; grows in well-drained loam soils
Mustard	May-June	August-September	Grown as oilseed; also used as vegetable, green leaf
Radish	May-June	July-August	Fast growing root crop used for special local food (*Thukpa*); grows well in well-drained sandy soils
Cabbage	May-June	July-August	Good for temperate climate; grows well in well-drained loam soils; requires more irrigation
Cauliflower	May-June	August-September	Good for temperate climate; grows well in well-drained loamy soils; requires more irrigation
Broccoli	May-June	July-August	Good for temperate climate; grows well in well-drained loamy soils; requires more irrigation

to the desert conditions and mountainous terrains. All cultivable land is called *Zhing*. Fertile land that gives high yield crop is called *Zhing-Zang* while those on rocky land are called *Ri-Zhing*. The prime agriculture field of a household is called as *Ma-Zhing*. Medium fertile fields are called *Bar-Zhing* while the least fertile

fields are called *Tha-zing*. Some fields are cultivated in the alternate year due to low productivity and are called *Lok* or done so to restore the productivity. Those fields where only vegetables are cuttivated are called as *Tsera* and those left as such under grass production are called as *Riya* or *Olthang*.

Indigenous agriculture calender of Spiti valley

The indigenous agricultural calendar of the Spiti valley is guided by the astrological calculations of the *Lotho* (the Tibetan almanac). Before any farming activities begin, local astrologers are consulted to select an auspicious day to commence the initial field preparations, a traditional practice known as *Saka*.

To ensure a successful season, rituals are performed to pacify the elemental spirits of the earth and water, the *Sadak* and the *Lhu,* before the soil is ploughed. These traditional farming practices are structurally organized across twelve months, with specific agricultural tasks allocated to distinct periods of the year (Table 6).

Generic agricultural activities

Traditional farming in the Spiti valley relies on historical customs and the generational wisdom of the local community. These indigenous agricultural techniques, deeply embedded in cultural traditions and ecological awareness, offer a viable, low-input alternative to modern farming methods. Today, Spiti's farmers continue to cultivate a substantial volume of their local and native crops using this ancestral knowledge. These crop varieties are uniquely adapted to the fragile local ecology, possessing highly specific moisture and nutrient requirements that allow them to survive in a harsh landscape.

Farming in this region presents unique challenges; water resources are strictly limited and the soil remains frozen and unworkable until late spring. Overcoming these constraints requires the community to rely heavily on collective wisdom to manage the short growing season. While minor procedural variations exist across different villages due to shifting altitudes and resource availability, traditional farming

Table 5. Farmers' perceptions on traditional crop landrace status (last 20-30 years)

Status	Number of crops/landraces	Percentage	Key reasons reported
Stable	7	25	Limited to household consumption and religious and cultural use
Highly declining	4	14.28	Low market value; labour shortage; diet change
Declining	12	42.85	Climate variability; youth out migration, no viable market demand
Extinct	5	17.85	Seed loss; introduction of new commercial green pea

Table 6. Indigenous agricultural calendar of Spiti valley

Name of the Month	Meaning of the month	Approximate time period of farming activities
Jama Dawa	Alpine crow pregnancy month	16 December-15 January
Jirug Dawa	Alpine crow egg month	16 January-15 February
Deya Dawa	Hot sun month	16 February-31 March
Jyingdev Dawa	Month of seed sowing	1 April -15 April
Namyong Sayong Dawa	Green earth month	16 April-15 May
Methok Dawa	Flowering month	16 May-15 June
Debu Dawa	Grain maturity month	16 June-15 July
Sem-la Dawa	Harvesting month	16 July-15 August
Khuyu Dawa	Threshing month	16 August-15 September
Nyiruk Dawa	Descending day month	16 September-15 October
Nyikhim Dawa	Sun descending month	16 October-15 November
Losar Dawa	New year month	15 November-16 December

practices remain largely uniform throughout this cold-desert ecosystem. All operations are strictly coordinated around the traditional agricultural calendar, though actual timelines shift year-to-year depending on the variable onset of the seasons.

The generic agricultural activities performed in the Spiti valley are detailed below:

Digging out manure from cow and yak sheds (*Langsa Tonche*): The first agriculture activity of Spiti valley begins soon after the crop harvesting and is the digging out of cow and yak sheds and taking out cow and yak manure. This is done after the completion of crop harvest and is called as *Langsa Tonche*. The taking out of cow and yak manure is followed by the piling of manure on the fields. The piles of manure are covered with soil so that it is not spread out and blown away by high speed winds which are common in high altitude of Spiti valley during the winter months.

Spreading of soil (*Sa Gyapche*): *Sa Gyapche* is a Bhoti term literally translating to soil spreading (*Sa* meaning soil and *Gyapche* meaning spreading), which refers to the practice of scattering soil over snow-covered fields. This ritual marks the initial stage of field preparation for the upcoming sowing season. In the Spiti valley, heavy winter snowfalls of three to four feet, which often persist into April, leave the frozen ground unready for *Jyingdev Dawa* (the seed-sowing month), which typically begins between 1 April and 15 April. To accelerate snowmelt and kickstart the agricultural season, farmers spread a layer of dark soil across the snow.

To initiate this process, the village head (*Gatpo*) visits a Buddhist astrologer to determine an auspicious date for the soil spreading. Following local custom, the *Gatpo* greets the astrologer by presenting a *Khatak* (a traditional white Buddhist scarf) along with a bottle of wine sealed with butter at its mouth. The astrologer then consults sacred Buddhist astrological texts to identify the most favourable day to begin. If the ground is buried under too much snow to access fresh soil, farmers adapt by using household wood ash as a substitute to scatter across the fields.

Ploughing of fields (*Shing Moy*): Derived from the Bhoti language, *Shing Moy* literally translates to field ploughing (*Shing* meaning field and *Moy* meaning ploughing). To initiate this critical phase, the village head (*Gatpo*) once again consults the Buddhist astrologer to determine an auspicious day based on the *Lotho* (astrological almanac). Before the blades touch the soil, a ritual is performed at the highest point of the farm to worship the fields and surrounding mountains. This involves stacking three to five stones atop one another, burning sacred juniper leaves mixed with butter and making traditional offerings of wine in all ten directions. Only after these pacifying rituals are complete can the ploughing begin.

Depending on the altitude of the village, field ploughing commences between March and April and is carried out across two distinct seasons. Springtime ploughing is conducted in March or April using a pair of *Dzo* (a hybrid breed of yak and cow) or yaks (Plate 1B). This process carves shallow furrows four to six inches deep to prepare the beds for immediate sowing. Wintertime ploughing is executed after the autumn harvest in October and November. This crucial step ensures that moisture from winter snowmelt can deeply seep into the soil horizons, while simultaneously exposed soil helps clear the fields of leftover weed seeds and unwanted plants before the deep freeze sets in.

Sowing in the ploughed fields (*Nyoches*): Sowing of the ploughed out fields is done either in the furrows made by ploughing (done second time) or through broadcast methods.

Field leveling (*Shala*): This activity involves leveling the ploughed fields and is typically carried out roughly two to three days after the initial sowing is completed.

Canal irrigation (*Yurma Rangso*): Two to three days after the fields are levelled, experienced women from the family and village undertake the crucial task of preparing irrigation beds fed by traditional water channels, locally known as *Kuhls* or *Yuras* (Plate 1C&D). During this process, the entire field is partitioned into small, structured beds to ensure uniform, gravity-fed water distribution. Once the crop shoots emerge to about an inch long, farmers use a specialized tool fitted with the horn of an ibex or wild goat to precisely direct the flowing water within these individual beds.

Because Spiti is a cold desert, agriculture is entirely dependent on this *Kuhl* irrigation network. All cultivable lands are strategically situated along the paths of small streams and riverbanks fed by melting glaciers. Water from these smaller streams is collected in localized storage ponds called *Shings*, from which it is

Plate 1. A) *Theh* a wooden pot used for land measurement, B) Ploughing with a pair of yak, C) and (D) Kuhl irrigation (*Yurma Rangsong*)

systematically channelized to irrigate downstream fields.

To manage this scarce resource, the community relies on a centuries-old water management system that ensures water is strictly distributed among households on a rotating basis. Each year, the villagers elect or appoint a dedicated group of individuals known as waterlords or *Churpons*. The primary responsibility of the *Churpons* is to oversee the equitable distribution of the village water supply and resolve any scheduling conflicts.

***First irrigation* (*Yurma*):** The initial watering of the fields takes place 40 days after ploughing and is known as *Yurma*. Out of deep spiritual and communal respect, this first irrigation cycle follows a strict, sacred hierarchy before extending to the general community. Water is directed first to the monastery (*Gompa*), followed by the lands of the village deity, the local traditional doctor (*Amchi*) and the fields of recently deceased family members. Only after these ancestral and sacred lands are satisfied is the water distributed among the village farmers on a rotating, turn-by-turn basis.

***Second irrigation* (*Saktee*):** Second irrigation called as *Saktee* is done after the 15 days of first irrigation and it is done when the small plants are in need of irrigation and due to the lack of water and moisture small plants are undergoing wilting.

***Third irrigation* (*Sumtee*):** The third irrigation cycle is called *Sumtee* and is carried out 15 days after the second watering. By this stage, the availability of *kuhl* canal water is generally abundant, aligning perfectly with the crop's peak growth phase as the plants enter their critical flowering and development stage.

***Intermediate and last irrigation* (*Nyekhor*):** In general, barley and black peas, the two most vital traditional crops of the Spiti valley, require roughly eight to ten irrigations throughout their lifecycle. In contrast, commercial green peas demand more moisture and must be irrigated ten to twelve times. The final irrigation cycle of the season, known as *Nyekhor*, is performed exactly one week before the crops are harvested.

Weeding (*Purloh*): This activity involves removing invasive weeds that compete with the primary crops for vital moisture and soil nutrients. Weeding is generally

carried out approximately two to three weeks after the fields have been sown.

Barley crop maturity and *Namgan* festival: The barley crop generally reaches maturity in the month of August. To mark the eve of this ripening season, farmers celebrate the traditional *Namgan* festival, gathering to offer prayers and express hope for a bountiful harvest.

Harvesting of barley and *Sey* festival: The harvesting of barley (*Nyeh*) takes place a few weeks after the *Namgan* festival, typically falling in the month of September. Before the reaping begins, Buddhist astrologers are consulted once again to select an auspicious day for the harvest. For optimal yield and flavour, the barley crop is ideally harvested after a maturation period of 100 to 110 days. This period of intense field labour is accompanied by great communal festivity, with locals celebrating the *Sey* festival to mark the occasion.

Threshing of barley (*Khuyu*): In the Spiti valley, barley threshing is performed using domesticated animals like cows, horses, donkeys and *Churus* (a yak-cow hybrid). After harvest, the crops are piled into heaps in a flat, 30-foot circular yard and left to dry for two weeks. On threshing day, seven to nine heaps are spread out and a line of animals is tied to a central pole to trample the grains out as they walk in circles. The animals are arranged strategically by their speed: the slow cow is placed closest to the pole, donkeys and *Dzos* take the middle and the fast horse is placed on the outermost edge. To protect the animals from exhaustion, farmers only run two threshing cycles a day. Afterward, the clean grains are stored for food, while the remaining stalks are saved as vital winter feed for the livestock.

Winnowing (*Hongs Charches*): This process is performed in a steady rhythm by two people standing opposite one another, using traditional wooden forks called *Zar*. They scoop the threshed mixture and toss it into the air, allowing the wind to blow away the light chaff while the heavier grains fall back to the ground. Any unthreshed crop ears that remain intact, known as *Achik*, are separated and set aside to be threshed a second time ten to fifteen days later. The final yield is measured using local units called *Theh* or *Khal*. Depending on soil fertility, a typical harvest yields a five- to ten-fold return on the initial seeds sown, with farmers generally averaging an eightfold return for barley and a six-fold return for wheat.

CONCLUSION

The present study demonstrates that the Spiti valley possesses a remarkable wealth of traditional crop diversity and indigenous agricultural knowledge that has enabled local communities to sustain agriculture under one of the most challenging environmental conditions of the Indian Himalaya. A total of 28 traditional crop landraces and native plant varieties were documented, reflecting the rich agrobiodiversity maintained by the Bodh community over generations. However, the study reveals a substantial decline in several traditional crops, particularly black pea, wheat landraces, mustard and indigenous vegetables, indicating an ongoing erosion of valuable genetic resources.

The decline of traditional crops is driven by multiple interacting factors including labour shortages, youth outmigration, changing dietary preferences, limited market opportunities and increasing climatic uncertainty. Simultaneously, the gradual loss of indigenous traditional knowledge associated with crop cultivation, irrigation management, collective labour systems and cultural rituals poses an additional threat to the sustainability of mountain agriculture.

Despite these challenges, the indigenous farming systems of Spiti continue to offer important lessons for sustainable agriculture. Traditional practices such as community-based irrigation management, use of farmyard manure, collective labour-sharing arrangements, locally adapted crop landraces and culturally embedded agricultural calendars contribute significantly to ecological sustainability and climate adaptation. Strengthening these systems through documentation, conservation and policy support can enhance the resilience of local livelihoods while safeguarding the valley's unique biocultural heritage.

Therefore, targeted interventions focusing on in situ conservation of traditional landraces, establishment of community seed banks, value addition and market development for traditional crops, youth engagement in agriculture and integration of indigenous knowledge into agricultural planning are urgently

required. Such measures will not only conserve the agrobiodiversity of the Spiti valley but also support sustainable mountain development and long-term climate resilience in the trans-Himalayan region.

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