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INDIGENOUS SEED CONSERVATION PRACTICES IN THE TRANS-HIMALAYA: LESSONS FROM SPITI VALLEY

Mast Ram Negi, Ashish Kumar*, Binita Shah, Gopal Singh Rawat

Integrated Mountain Initiative (IMI), Dehradun, Uttarakhand, India

***Correspondence:** akgusain95@gmail.com

ABSTRACT

PIndigenous seed systems developed over centuries have enabled farming communities to conserve locally adapted landraces, ensure food security, and sustain livelihoods. This article presents a case study of seed storage and exchange system practised by the farmers of Spiti Valley in the state of Himachal Pradesh. The farmers in Spiti follow traditional underground seed storage structures and barter-based seed exchange function as low-cost, climate-resilient alternatives to centralised seed banks. Strengthening indigenous, community-managed seed conservation practices in the Trans-Himalayan region offers effective pathways for conserving agro biodiversity, enhancing food security, and strengthening livelihood resilience, and should be formally integrated into government climate and agriculture programmes.

Key words: Agroecology; Trans-Himalayan; Indigenous seed; Seed bank; Naked Barly; Black Pea; Traditional Farming

BACKGROUND

The Trans-Himalayan region of India, located in the north of Great Himalayan range, is characterized by cold arid climate, high elevation and short growing season. This region represents a distinct socio-cultural landscape inhabited by agro-pastoral communities who have inherited tremendous knowledge on agriculture and animal husbandry since ages. Much of the land in the region is uncultivable due to nutrient poor soil, short growing season and scarcity of water for irrigation. Yet the area harbours distinct niche crops adapted for such climatic conditions and forms a unique agro ecological zone (Gupta *et al.,* 2024). Spiti Valley in the state of Himachal Pradesh represents such cold arid region, characterised by long, harsh winters, low and erratic precipitation. Here, agriculture is largely dependent on snow- or glacier-fed irrigation and limited to a single cropping season, making local communities highly vulnerable to climate variability and external shocks. Under these conditions, the farming communities of Spiti have developed several systems of conserving soil nutrients, agricultural crops and seeds of traditional crops. Some of the traditional crops conserved by the farmers in Spiti include landraces of barley, wheat, and pulses that are well adapted to cold, drought, and low-input environments. These traditional seeds are selected, stored, and exchanged using indigenous knowledge systems that prioritise yield stability, seed longevity, nutritional value, and resilience rather than short-term productivity (Montufar & Ayala, 2024; Behl *et al.,* 2025). Such practices have helped maintain crop diversity, soil health, and adaptive capacity in an otherwise marginal environment(Asiedu-Darko, 2014). This article deals with key features of seed storage and conservation as practised by the farmers in Spiti Valley, Himachal Pradesh. It is based on the observations made in the area as part of ongoing project, entitled 'Agroecology, climate resilient farming and livelihood enhancement in border village of Indian Himalayan region', being implemented by IMI (Integrated Mountain Initiative), funded by NMHS (National Mission of Himalayan Studies).

AGROECOLOGY AND TRADITIONAL FARMING SYSTEMS OF SPITI VALLEY, HIMACHAL

Spiti,a sub-division of district Lahaul & Spiti in the state of Himachal Pradesh, is located in the Trans-Himalaya. The region is characterised varying topography, including wide and extensive valleys, steep slopes with loose scree and exposed rocks, an undulating plateau and glaciers (Fig. 1). The valley aligned in north-west to south-east direction with altitude ranging between 3000 - over 6000 m asl. This region is flanked by the Great Himalayan range on the south, Barasigri group of glaciers on the west, Zanskar range in the north and Tibetan plateau on the northeast. Agriculture is practices only in the valleys and in some flat areas of the plateau. Agricultural activities are restricted to a single short growing season (May to August) and depend largely on snow- and glacier-fed irrigation systems, locally managed through traditional kuhlchannels. Despite these constraints, the farmers have

Fig. 1: Traditional agroecological landscape of Hikkim, Spiti Valley, Himachal Pradesh, showing high-altitude villages and irrigated fields sustained by snow- and glacier-fed kulh systems amid the Trans-Himalayan cold desert terrain.

evolved fairly stable agro ecological practices that emphasise stability, resource efficiency, and risk minimisation rather than high-input productivity. The traditional farming system of Spiti is deeply rooted in agro biodiversity adapted to high-altitude conditions, with traditional seed storage and conservation practices firmly embedded in the socio-cultural fabric of local communities. Non-monetary seed exchange systems based on trust and reciprocity ensure equitable access to quality seeds, particularly during crop failure, seed loss, or food scarcity. Women play a central role in seed selection, storage, and exchange, reinforcing household food security and intergenerational knowledge transfer. In the context of increasing climate uncertainty and market dependency, strengthening indigenous seed systems is essential for safeguarding agro biodiversity, enhancing food sovereignty, and supporting sustainable livelihoods in the Trans-Himalayan cold arid region.

Farmers cultivate a limited yet resilient set of indigenous crops, including multiple landraces of barley (*Hordeum vulgare*), naked barley (*Hordeum vulgare* var. *nudum*), wheat (*Triticum aestivum*), black pea (*Pisum arvense*), green pea (*Pisum sativum*) and potato (*Solanum tuberosum*) majorly, which are well suited to cold, drought-prone, and low-input environments (Fig. 2). These crops are grown under a traditional rotation system during the single Kharif growing season, in which barley and wheat are commonly rotated with black pea and green pea to maintain soil fertility and

Fig. 2: Traditional crops of Spiti Valley, Black pea (*Pisum arvense*) and naked barley (*Hordeum vulgare* var. *nudum*) grown under a high-altitude, single-season farming system in Lossar, Spiti Valley, Himachal Pradesh.

ensure stable production. This practise plays a central role in sustaining food and nutritional security in Spiti Valley. Indigenous crop varieties provide staple food, fodder, and crop residues that support integrated crop-livestock systems. The continued use of locally adapted landraces helps farming households buffer against climatic variability, crop failure, and market fluctuations. Traditional farming systems also support cultural continuity, indigenous knowledge transmission, and community-based resource management. Overall, the agro ecology and traditional farming systems of Spiti Valley represent a finely balanced interaction between climate, ecology, and human adaptation.

INDIGENOUS INFRASTRUCTURE FOR SEED STORAGE: THE KAKTI SEED CONSERVATION CAVE OF SPITI

Farmers in Spiti follow a careful approach to seed selection and storage, giving priority to grain quality, yield stability, and by-product value. Seeds are selected from solo crop fields to minimise contamination and ensure genetic purity. Exchange of seeds generally occurs when productivity begins to decline, typically after seven to eight years of continuous cultivation. During seed exchange, an additional quantity, usually around 25 per cent,is collected to compensate for storage losses and sowing wastage. Women play a central role in managing seed exchange, particularly for cereal crops, both within and across villages. A defining feature of Spiti's indigenous seed system is the use of traditional underground seed storage structures locally known as *Phanh*. Constructed entirely from mud and stone, these caves and underground bunkers provide natural insulation and protection from rodents, pests, moisture, and extreme temperature fluctuations without chemical preservatives.

One notable example of indigenous seed storage in Spiti, Kakti village of Kaza Panchayat, at an altitude of approximately 4,200 metres above sea level. This traditional seed storage cave has been carefully maintained by Mr. Chhering Namgyal, the fifth-generation custodian of the structure, reflecting an unbroken lineage of indigenous knowledge and stewardship spanning nearly four centuries. The seed storage has been practised for nearly 400 years and remains functional in villages. Originally used as a dwelling by his forefathers, the cave has gradually evolved into a dedicated space for seed storage and conservation, demonstrating adaptive reuse of traditional architecture. The cave contains two underground bunkers constructed entirely from locally available materials such as stone and mud (Fig. 3). These bunkers together have a storage capacity of approximately 400–500 kg and provide a naturally regulated microclimate that protects seeds from extreme cold, moisture fluctuations, rodents, and insect infestation. The stable underground conditions allow long-term storage without the use of chemical preservatives or modern energy-dependent technologies. The structure is used to preserve indigenous landraces of barley (*Hordeum vulgare*), including Soha barley and Kniu

Fig. 3: Custodian of a traditional seed storage cave (Phanh) at Kakti village, Spiti Valley, showing the exterior stone-built structure and the interior underground bunker used for conserving indigenous seeds.

(naked barley), as well as traditional landraces of black pea (*Pisum arvense*). The continued use of this seed storage cave illustrates the technical efficiency, durability, and ecological appropriateness of indigenous seed conservation systems. Beyond its functional role, the structure represents cultural continuity, intergenerational knowledge transmission, and community-based stewardship of agro biodiversity in the Trans-Himalayan cold arid.

INDIGENOUS SEED BANKS VS MODERN SEED BANKS: FUTURE PROSPECTS

As the farmers of Spiti are struggling to maintain age-old farming systems under changing climate and rush for cash crops, there is a need to revamp the system of conserving the quality seeds, exchange of seeds of traditional crops and establishment of modern seed banks. Modern seed banks are typically centralised and technology-driven, relying on controlled temperature and humidity for long-term conservation. While effective for genetic preservation, such systems are capital-intensive, energy-dependent, and geographically distant from farming communities, limiting their immediate usefulness in remote high-altitude regions. Indigenous seed banks, in contrast, are decentralised, community-managed systems embedded within local landscapes and livelihoods. Traditional seed storage structures, such asunder ground *Phanh* bunkers, maintain stable microclimatic conditions without external energy inputs. These systems function as dynamic, living seed systems where seeds are continuously cultivated, exchanged, renewed, and adapted, ensuring availability during climatic shocks, crop failure, or market disruptions. From a policy perspective, indigenous seed banks offer greater relevance for food security, seed sovereignty, and livelihood resilience in high-altitude regions. Integrating basic scientific documentation and quality control into indigenous systems can create hybrid models that combine conservation efficiency with local adaptability. This will enhance climate resilience, reduce dependency on external seed markets, and strengthen sustainable livelihoods. Strengthening indigenous seed banks directly contributes to India's commitments under the Sustainable Development Goals (SDGs 2, 12, 13, and 15), the National Biodiversity Action Plan (NBAP), and the National Action Plan on Climate Change (NAPCC), particularly the National Mission for Sustaining the Himalayan Ecosystem (NMSHE) and the National Mission for Sustainable Agriculture (NMSA).

CONCLUSION

Conservation and storage of quality seeds of traditional crops is an essential component of farming system in any agro-ecological zone. Indigenous and community-managed seed storage system as practised by the farmers in Spiti underlines the need for encouraging such practices with modern tools and techniques of seed preservation. Given the unique agro ecological conditions of high-altitude cold arid areas, indigenous seed conservation practices provide locally adapted solutions that are not adequately addressed by centralised systems. There is a need to strengthen the system of indigenous seed storage and exchange among the farmers under the border area development programme of the Government of India. Targeted financial and technical support should be extended for strengthening traditional seed storage infrastructure such as underground bunkers and stone–mud structures.

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