



13th Himalayan
Popular Lecture

Nature-based Solutions to Ensure Food Security and Sustainable Green Economy in the Indian Himalayan Region

Dr Harish Kumar Sharma

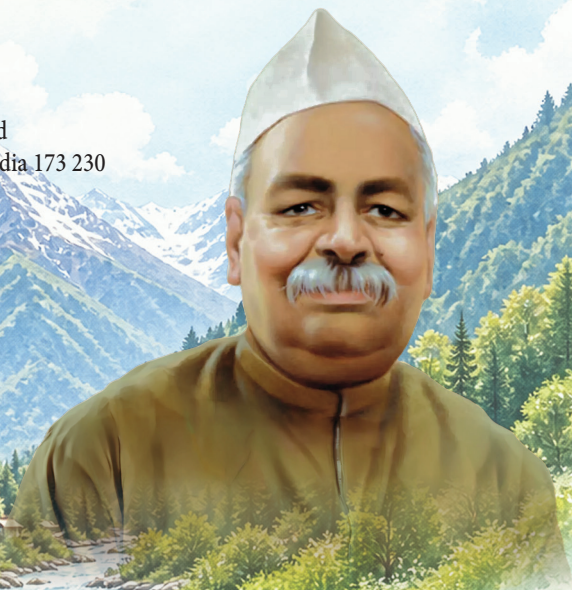
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September 10, 2026



G.B. Pant National Institute of Himalayan Environment

(An autonomous Institute of Ministry of Environment, Forest & Climate Change, Govt. of India)

Himachal Pradesh Regional Centre, Mohal, Kullu - 175 126, Himachal Pradesh, India



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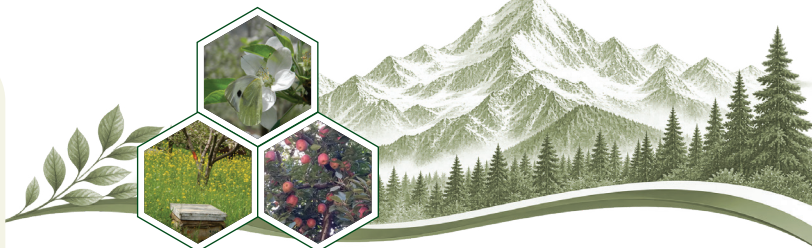
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Dr Harish Kumar Sharma, former Principal Scientist, remained actively engaged in research, teaching and extension in Apiculture. He was Scientist Incharge of apiculture section and handled 14 external funded National and International projects in various fields of apiculture financed by ICAR, New Delhi, World Bank, ICIMOD, Kathmandu, FAO, DST, CRIDA, ICAR, NBB, Misnistry of Agriculture and Farmers Welfare, many of these projects were multi institutional and also operated in different countries. Major R & D initiatives launched by him include conservation and selection of *Apis cerena*; standardization of use of pollen dispenser for ensuring pollination in apple; development of mud-hives a cost effective and eco-friendly hive for upliftment of socio-economic status of the farmers and providing eco-services through pollination; bee breeding programme for improvement of *Apis mellifera* and conservation of *Apis cerana*; commercialization of bumble bee rearing, creation of international laboratory and infrastructure facilities for bee-breeding and bumble bee rearing; development of beekeeping training manual which has been adopted by National Bee Board, Ministry of Agriculture and Farmers Welfare; and evaluating impact of neonicotinoids on pollinator populations. He established inter-institutional collaborations with National and International Institutions like ICIMOD, Kathmandu, Nepal; GBPHED, Almora, UK; National Bee Board, New Delhi. He was consultant to FAO through ICIMOD to conduct studies on importance of pollinators and pollination in vegetable seed production for cash crop farming in the Indian Himalayas and to ICIMOD for conducting study on Honey Trade Policy in India.

He has supported bee-keeping development programme under PPP mode for sustainable improvement of quality and development of productivity in the Indian Honey Sector performed by the organizations Quality Services International GmbH (QSI), Bremen, Germany and Bremer Analyse-Institute for Naturwaren GmbH (QUAIN), Bremen, Germany in cooperation with the National Bee Board of India. He has imparted training on bee keeping to Bhutanese and Nepalese and beekeepers from Himachal Pradesh, Uttarakhand, Sikkim and Meghalaya. He has guided eleven M.Sc. and 3 Ph.D. students. He has more than 100 publications as research papers, books, book chapters, monographs, manuals and policy papers.

Currently, he is actively engaged as Consultant to GIZ for conducting studies on wild pollinators, bee flora and pollination management in apple in Himachal Pradesh; Chairperson of Scientific Panel on Sweets and confectionery, FSSAI, New Delhi; Honorary Technical Advisor, Meghalaya Farmers' (Empowerment) Commission, Govt of Meghalaya to promote apiculture and its related activities in Meghalaya; and team leader and beekeeping expert, AFC India Limited, New Delhi for third party evaluation of Central Sector Scheme entitled "National Beekeeping and Honey Mission (NBHM)", Department of Agriculture & Farmers Welfare (DA&FW), Ministry of Agriculture & Farmers Welfare, GOI.





G.B. Pant National Institute of Himalayan Environment (NIHE)

G.B. Pant National Institute of Himalayan Environment (formerly known as G.B. Pant National Institute of Himalayan Environment and Sustainable Development, was established in 1988-1989, during the birth centenary year of Bharat Ratna Pt. Govind Ballabh Pant, as an autonomous Institute of the Ministry of Environment, Forest and Climate Change (MoEF&CC), Govt. of India. The Institute has been identified as a focal agency to advance scientific knowledge, to evolve integrated management strategies, demonstrate their efficacy for conservation of natural resources, and to ensure environmentally sound management in the entire Indian Himalayan Region (IHR). The Institute functions under a Society, guided by a Governing Body and Science Advisory Committee. It has a decentralized set up, with its Headquarters at Kosi-Katarmal, Almora, and at present six regional centres are operational at Srinagar (Garhwal Regional Centre), Mohal-Kullu (Himachal Regional Centre), Tadong-Gangtok (Sikkim Regional Centre), Itanagar (North-East Regional Centre), Ladakh (Ladakh Regional Centre) and Mountain Division (at MoEF&CC, New Delhi). The R & D programmes of the Institute have been reoriented in to four functional Centres based of stakeholder needs, viz., Centre for Land and Water Resource Management (CLWRM), Centre for Socio-Economic Development (CSED), Centre for Biodiversity Conservation and Management (CBCM) and Centre for Environmental Assessment & Climate Change (CEA&CC). (Details: <http://gbpihed.gov.in>).

HIMACHAL PRADESH REGIONAL CENTER (HPRC)

Himachal Regional Center is located in Mohal of the Kullu district of Himachal Pradesh state. The Himachal Regional Center was established on July 01, 1992, in a rented building at Dhalpur, District Kullu, and continued up to June 1993. The foundation stone of the center's office and residential complex was laid by Shri Kamal Nath, Hon'ble Union Minister for Environment and Forests on June 2, 1993, in Mohal village of Kullu district. During the construction of the office and residential complex, the work of Himachal Regional Center was conducted from June 1993 to March 1999 at the rent building of Shamshi, Kullu. After the construction of a permanent building in Mohal in the year 1998, on April 02, 1999, the office and residential complex were duly inaugurated by Hon'ble Shri Suresh Prabhu, Environment Minister, Ministry of Environment and Forests, Government

NATURE-BASED SOLUTIONS TO ENSURE FOOD SECURITY AND SUSTAINABLE GREEN ECONOMY IN THE INDIAN HIMALAYAN REGION

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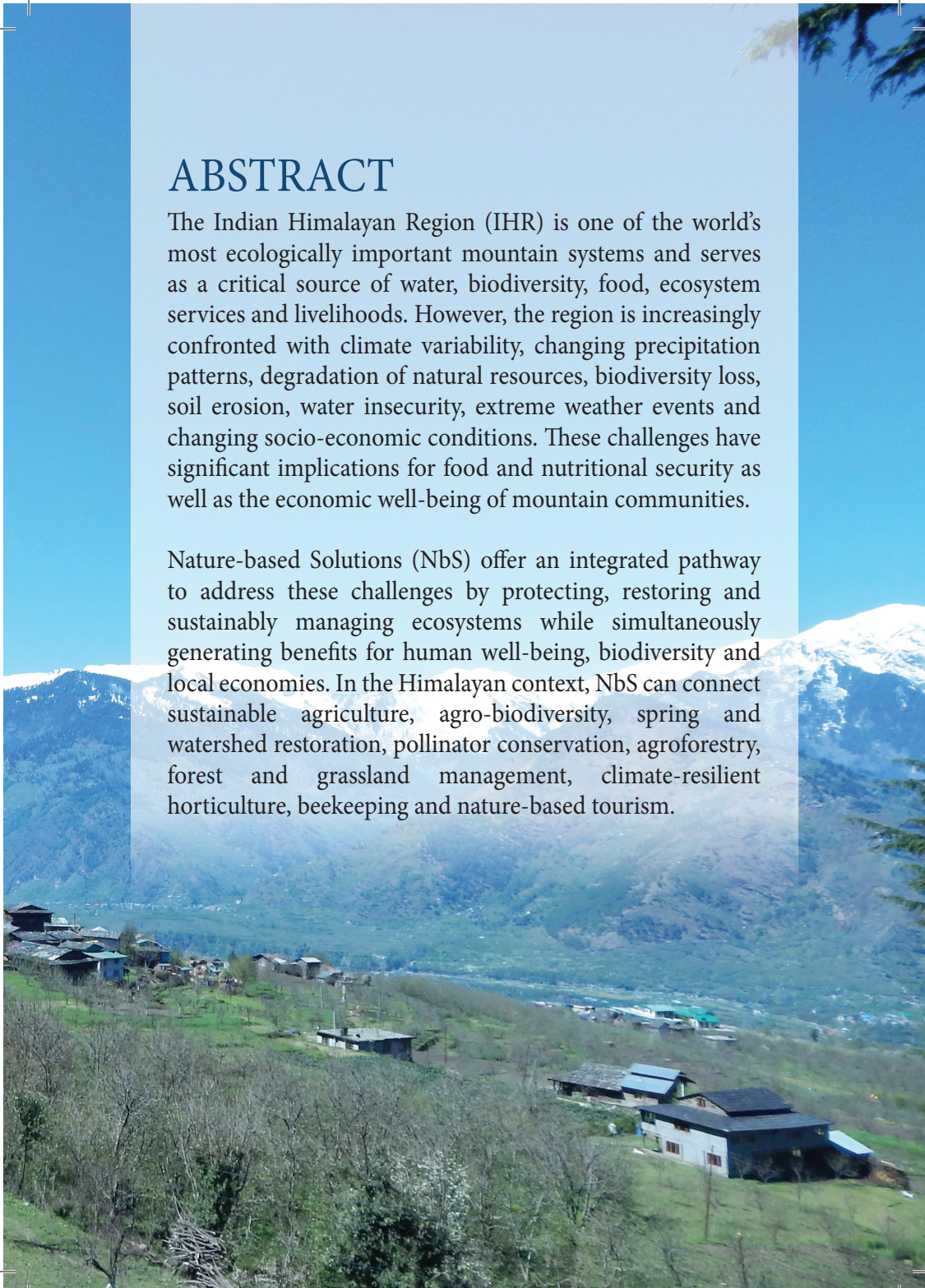
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ABSTRACT

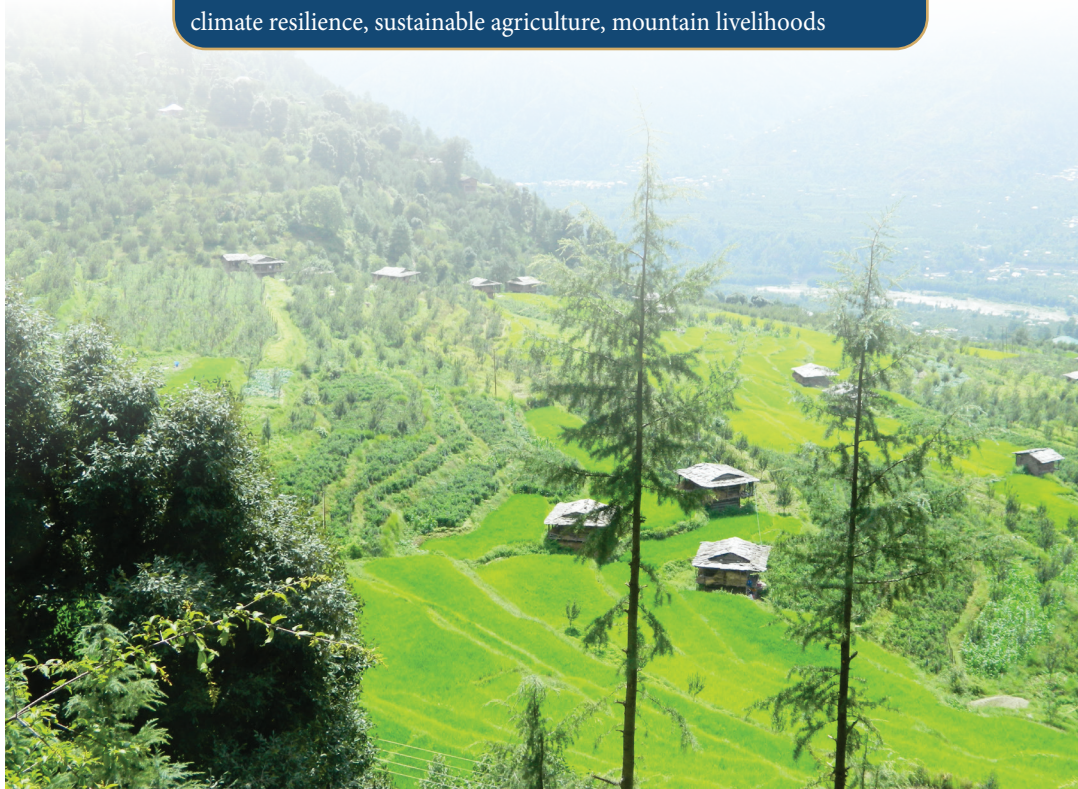
The Indian Himalayan Region (IHR) is one of the world's most ecologically important mountain systems and serves as a critical source of water, biodiversity, food, ecosystem services and livelihoods. However, the region is increasingly confronted with climate variability, changing precipitation patterns, degradation of natural resources, biodiversity loss, soil erosion, water insecurity, extreme weather events and changing socio-economic conditions. These challenges have significant implications for food and nutritional security as well as the economic well-being of mountain communities.

Nature-based Solutions (NbS) offer an integrated pathway to address these challenges by protecting, restoring and sustainably managing ecosystems while simultaneously generating benefits for human well-being, biodiversity and local economies. In the Himalayan context, NbS can connect sustainable agriculture, agro-biodiversity, spring and watershed restoration, pollinator conservation, agroforestry, forest and grassland management, climate-resilient horticulture, beekeeping and nature-based tourism.



This paper proposes a landscape-based framework in which ecological restoration becomes an investment in food security and economic development. It emphasises convergence among science, indigenous and local knowledge, government institutions, communities, markets and private enterprise. A proposed implementation framework—Restore, Produce, Process, Market and Monitor across household, village, watershed, landscape and regional value-chain scales—can help translate NbS from individual projects into a coordinated Himalayan green-economy strategy.

Keywords: Nature-based Solutions, Indian Himalayan Region, food security, green economy, agroecology, pollinators, ecosystem restoration, climate resilience, sustainable agriculture, mountain livelihoods



Nature-based Solutions to Ensure Food Security and Sustainable Green Economy in the Indian Himalayan Region

1. INTRODUCTION

The Indian Himalayan Region (IHR) is not merely a geographical entity; it is a complex ecological, social and economic system that supports millions of people and provides essential ecosystem services to much of the Indian subcontinent. Extending across approximately 2,500 km and encompassing 13 States and Union Territories, the region contains diverse forests, grasslands, wetlands, rivers, springs, agricultural landscapes and unique biodiversity.

The Himalaya provides water, fertile valleys, forest products, biodiversity, agricultural resources and cultural services. Mountain communities have historically developed production systems that are closely adapted to local ecological conditions. Mixed farming, livestock integration, traditional crop varieties, forest-based livelihoods, rainwater harvesting and community management of natural resources have contributed to resilience in difficult mountain environments.

Climate change is altering temperature and precipitation patterns. Extreme rainfall, drought-like conditions, landslides, floods, forest fires and other hazards are affecting agriculture and infrastructure. Springs and traditional water sources are becoming increasingly vulnerable in several areas. Soil erosion and declining soil health threaten agricultural productivity. Changes in land use, biodiversity loss, invasive species and inappropriate agricultural practices further increase ecological vulnerability.

At the same time, mountain communities face economic challenges, including small and fragmented landholdings, limited mechanisation,





inadequate post-harvest infrastructure, weak market linkages and, in some areas, migration of working-age populations.

Consequently, the question facing the Himalayan region is no longer simply: How can we produce more food? The more important question is: How can we create resilient food systems that provide nutritious food, sustain farmers' incomes and restore the ecological systems on which mountain agriculture depends? Nature-based Solutions provide an important answer to this challenge.

2. NATURE-BASED SOLUTIONS: FROM CONSERVATION TO DEVELOPMENT

Nature-based Solutions refer broadly to actions that protect, restore or sustainably manage ecosystems to address societal challenges while simultaneously providing benefits for biodiversity and human well-being.

In the Himalayan context, the concept is particularly relevant because the region's economic systems are fundamentally dependent on natural capital. For example:

- A spring provides water for households and agriculture.
- A healthy soil provides nutrients and stores carbon.
- A forest regulates water, protects slopes and provides biomass and biodiversity.
- A flowering landscape supports pollinators.
- Pollinators support fruit, vegetable and seed production.

Healthy ecosystems, therefore, represent an economic asset as much as an ecological asset.

The NbS approach changes the development paradigm from:



Extract → Produce → Consume

towards:

Restore → Sustainably Produce → Add Value → Prosper → Reinvest in Nature

This shift is particularly important for mountain regions where ecological carrying capacity is limited and conventional resource-intensive development can create long-term costs.



3. FOOD SECURITY IN THE HIMALAYAN CONTEXT

Food security has four interconnected dimensions:

1. Availability
2. Access



3. Utilisation and nutrition
4. Stability over time

For mountain communities, food security is closely connected with ecological security. For example:

- A decline in water availability can reduce crop production.
- Loss of crop diversity can reduce nutritional resilience.
- Pollinator decline can affect fruit and seed production.
- Soil degradation can reduce productivity.
- Extreme weather can disrupt local food supply chains.

Therefore, food security interventions in the IHR need to move beyond conventional production-focused approaches.

Diversification as a strategy

Diversified farming systems can provide greater resilience than dependence on a limited number of crops. Traditional Himalayan crops such as millets, buckwheat, amaranth and pulses, together with vegetables, fruits and locally adapted varieties, can contribute to both nutritional security and climate resilience. Crop diversity also provides genetic resources that can become increasingly important under changing climatic conditions. Thus, Agro-biodiversity is not only a conservation objective; it is an insurance policy for future food security.

4. SOIL HEALTH AND REGENERATIVE AGRICULTURE

Soil is one of the most important but frequently overlooked natural assets of mountain agriculture. Himalayan soils are vulnerable to erosion because of steep slopes, intense rainfall and land-use changes. Loss of organic matter reduces water-holding capacity, nutrient availability and biological activity.



Nature-based soil management can include:

- Compost and farmyard manure;
- Mulching;
- Biomass recycling;
- Cover crops;
- Crop rotation;
- Reduced soil disturbance;
- Biological pest management;
- Integrated crop–livestock systems; and
- Conservation of soil moisture.

The objective should be to develop location-specific regenerative and agroecological systems rather than impose one uniform package across the Himalayan region. Scientific research should work together with farmers' experience and traditional knowledge to identify practices suitable for different altitudes, soils, crops and climatic conditions.





5. WATER SECURITY THROUGH SPRING AND WATERSHED RESTORATION

Water is the foundation of Himalayan food security. The region's agricultural systems depend heavily on springs, streams, rainfall and snow-fed systems. Changes in rainfall patterns, land degradation and disturbances in recharge areas can affect the availability and reliability of water.

Spring restoration should therefore be treated as an agricultural and livelihood intervention, not merely as a water-sector activity.

A Nature-based watershed approach should include:

Protection of spring recharge zones | catchment restoration | contour vegetation | soil-moisture conservation | rainwater harvesting | wetland conservation | restoration of riparian vegetation and community -based water monitoring.





The guiding principle should be: Source → Catchment → Farm → Community

rather than treating individual water sources as isolated structures.

6. POLLINATORS: THE INVISIBLE INFRASTRUCTURE OF FOOD PRODUCTION

Pollinators are an essential but often under-recognised component of food security. Bees and other pollinating insects contribute to the reproduction and productivity of numerous agricultural and horticultural crops. The Himalayan region, with its rich floral diversity and extensive horticultural landscapes, has significant potential for pollinator conservation and pollination-based enterprises.

A pollinator-friendly Himalayan landscape should provide:

- diverse flowering plants;
- flowering field margins;
- forest-edge habitats;
- pesticide-risk reduction;
- nesting and shelter sites;
- integrated pest management; and
- seasonal floral continuity.

This creates an opportunity to link pollinator conservation with beekeeping, horticulture and rural enterprise. Beekeeping can generate honey, beeswax and other products while also providing pollination services.

The concept can be extended further through api-tourism, demonstration apiaries and observation hives where visitors, students and farmers can observe bee colonies and understand the relationship between pollinators, agriculture and biodiversity. This can transform the honeybee from simply



a production resource into an educational, ecological and tourism asset.

7. AGROFORESTRY: CONNECTING FARMS AND FORESTS

The traditional Himalayan landscape has never been completely divided between agriculture and forests. Farmers have historically depended on trees and forests for fodder, fuel, fruits, medicinal resources, timber and ecosystem services.

Agroforestry can strengthen this connection.

Well-designed agroforestry systems can:

reduce soil erosion | improve microclimates | provide fodder | diversify farm income | support biodiversity | provide fruits and other products and improve landscape connectivity.





However, agroforestry must be location-specific. Species selection should consider altitude, water availability, soil conditions, biodiversity and community needs. The objective should be to create multifunctional landscapes, not simply increase tree cover.

8. FORESTS, GRASSLANDS AND COMMUNITY COMMONS

Forests are central to Himalayan ecological security, but grasslands, alpine meadows and community commons are equally important.

These ecosystems support:

livestock | pollinators | wild biodiversity | water regulation | soil conservation | medicinal plants and cultural practices.

Restoration programmes should therefore adopt a broader ecosystem approach. Community participation is essential because many Himalayan landscapes are managed through customary institutions and local practices.

A successful restoration model should provide both: ecological benefits + livelihood benefits. Restoration should not be viewed merely as planting trees. It should mean restoring the functions of an ecosystem.





9. CLIMATE-RESILIENT HORTICULTURE

Horticulture provides an important economic opportunity for Himalayan farmers.

Apple, pear, stone fruits, vegetables, nuts, spices, medicinal plants and other high-value crops can generate significant income. However, climate variability is creating new production risks.

A climate-resilient horticultural strategy should integrate

climate-resilient varieties | improved soil health | water-efficient practices
integrated pest management | pollination management | weather
advisories | post-harvest management | processing | storage and market
diversification.

The focus should gradually shift from: More production → More value
to: More value → Higher and more stable farm income





10. FROM PRODUCTION TO GREEN VALUE CHAINS

Producing a mountain product is only the first step. A significant portion of economic value can be generated through:

Production → Processing → Packaging → Branding → Certification → Marketing

Himalayan products such as honey, traditional grains, fruits, herbs, spices, medicinal plants and processed foods can command greater value when linked to appropriate quality standards and market identities.

The region can develop specialised green-economy clusters around:
honey and pollination | mountain foods | fruit processing | medicinal and aromatic plants | traditional grains | organic/agroecological products





| eco-tourism | seed and nursery enterprises and ecosystem restoration services.

This approach can reduce dependence on low-value raw commodity markets.

11. NATURE-BASED TOURISM AND API-HORTI TOURISM

Tourism is already an important economic activity in the Himalayan region. The opportunity is to move towards nature-positive tourism.

The Himalayan landscape itself can become a classroom and enterprise platform.

Visitors can experience:

traditional farms | orchards | beekeeping | observation hives | traditional foods | medicinal plants | biodiversity trails | village ecosystems | spring restoration and local conservation initiatives.

A particularly promising model is api-horti tourism, where beekeeping and horticulture are integrated into an educational tourism experience.

For example, a visitor could move through a complete ecological story:

Flower → Pollinator → Fruit → Farmer → Food → Enterprise





Such experiences can create income while increasing public understanding of biodiversity and sustainable agriculture.

12. INTEGRATING INDIGENOUS AND LOCAL KNOWLEDGE

The Himalayan region possesses generations of accumulated knowledge about crops, weather, water, forests, livestock and biodiversity. This knowledge should not be treated as a substitute for science, nor should science replace local knowledge. The stronger model is: Science + Indigenous and Local Knowledge + Community experimentation

Scientists can provide monitoring tools, climate analysis, ecological assessment and technological solutions. Local communities provide knowledge of landscapes, seasonal changes, traditional varieties and resource management. Together, they can create more context-specific and practical solutions.

13. WOMEN AND YOUTH AS DRIVERS OF THE GREEN ECONOMY

Women play a central role in Himalayan agriculture, livestock management, food processing, seed conservation and household-level natural-resource management. A Nature-based green economy should therefore actively support women-led enterprises. Potential areas include:

honey processing | traditional food products | seed enterprises | nursery development | medicinal and aromatic plants | food processing | eco-tourism | handicrafts linked to biodiversity and community restoration services.

Similarly, youth can become green entrepreneurs, particularly in digital marketing, eco-tourism, food processing, beekeeping, environmental monitoring and climate-smart agriculture. This can create an important



link between ecological restoration and reduction of distress migration.

14. A LANDSCAPE APPROACH

One of the major weaknesses of conventional development programmes is that different sectors often work separately.

- Agriculture may focus on production.
- Forestry may focus on forest restoration.
- Horticulture may focus on orchards.
- Water departments may focus on infrastructure.
- Tourism may focus on visitor numbers.
- A Nature-based approach requires these systems to work together.



The appropriate planning unit should increasingly be the landscape or watershed, rather than an isolated departmental project. For example, one Himalayan watershed could simultaneously implement:

Spring restoration + natural farming + pollinator habitat + agroforestry +



horticulture + beekeeping + food processing + eco-tourism.

The combined benefits can be much greater than the sum of individual interventions.

15. PROPOSED FRAMEWORK

A practical framework for the IHR can be organised around five spatial scales: Household → Village → Watershed → Landscape → Regional Value Chain and five functions: Restore → Produce → Process → Market → Monitor. This creates a simple development pathway.

- **Restore:** Restore soil, water, forests, grasslands and biodiversity.
- **Produce:** Develop diversified and climate-resilient agricultural systems.
- **Process:** Increase local value addition.
- **Market:** Connect mountain products with appropriate markets.
- **Monitor:** Measure ecological, economic and social outcomes.

This approach can convert individual projects into a coordinated regional strategy.

16. MEASURING SUCCESS

The success of Nature-based Solutions should not be measured only in terms of expenditure or infrastructure created. A Himalayan NbS programme should measure outcomes across five dimensions.

Food and Nutrition

dietary diversity | crop diversity | food availability | yield stability.

Ecology

soil organic matter | spring discharge | vegetation recovery | pollinator



abundance | habitat quality.

Economy

farmer income | value addition | enterprise creation | employment.

Climate resilience

water productivity | input dependence | resilience to extreme events | relevant emissions indicators.

Social inclusion

women's participation | youth participation | community ownership | equitable distribution of benefits.



17. POLICY AND INSTITUTIONAL CONVERGENCE

India already has several institutional building blocks relevant to this agenda.



The National Mission on Himalayan Studies emphasises sustaining and enhancing the ecological, natural, cultural and socio-economic capital of the Indian Himalayan Region and strengthening the science–policy–practice interface. National Mission on Himalayan Studies

NITI Aayog’s work on sustainable development in the IHR has identified issues including spring revival, agroecology, water conservation, market development and livelihood diversification. NITI Aayog — Sustainable Development in the Indian Himalayan Region

The opportunity is therefore not necessarily to create another isolated programme.

The greater opportunity is to converge existing programmes around landscape-level Nature-based Solutions. Agriculture, horticulture, forestry, rural development, tourism, environment, water, research institutions, universities, NGOs and local governments need to work together.

18. TEN-POINT ACTION AGENDA

A Himalayan Nature-based Solutions mission could focus on ten priorities:

1. Map natural capital and food-system vulnerabilities across Himalayan landscapes.
2. Restore springs, soils and watersheds as core investments in food security.
3. Promote diversified and regenerative agriculture based on local ecological conditions.
4. Protect pollinators and floral resources through pollinator-friendly landscapes.
5. Conserve traditional crop and livestock diversity through community-based systems.
6. Promote agroforestry and multifunctional landscapes to diversify



- livelihoods.
7. Build green value chains for mountain foods, honey, fruits, herbs and other products.
 8. Develop responsible nature-, agro- and api-tourism with community ownership.
 9. Create women- and youth-led green enterprises linked to ecological restoration.
 10. Establish a Himalayan NbS knowledge and monitoring platform connecting communities, scientists, institutions and markets.

19. TOWARDS A HIMALAYAN GREEN ECONOMY

The green economy of the Himalaya should not be understood simply as an economy with more renewable energy or fewer emissions. For mountain communities, a green economy should mean: an economy that generates income while maintaining the natural capital on which that income depends.

This requires a fundamental change in how economic value is understood.

- A restored spring has economic value.
- A healthy pollinator population has economic value.
- A traditional seed variety has economic value.
- A healthy forest has economic value.
- A community-managed grassland has economic value.
- A farmer maintaining a biodiversity-rich landscape is providing a public ecological service.





Future policies should therefore explore appropriate mechanisms for recognising and rewarding ecosystem stewardship.

20. MANAGED POLLINATION- A CASE STUDY

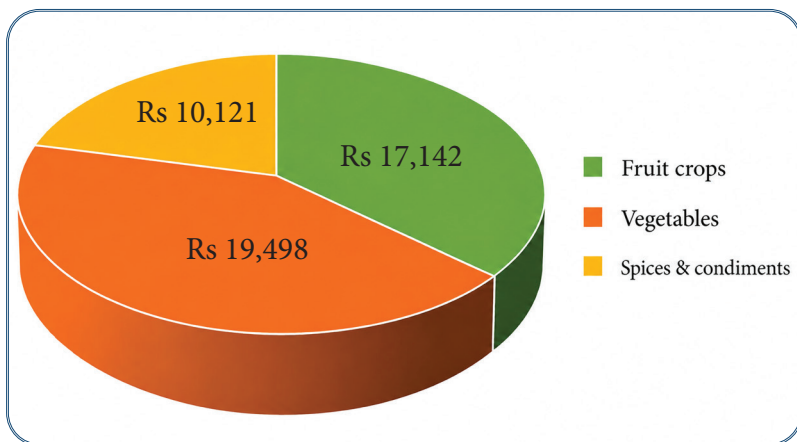
20.1 Current status of pollination and its potential in providing

Insect pollination is not only a significant ecosystem function but also an essential input in the production of a host of agricultural crops grown world-wide as three out of four crops across the globe producing fruits or seeds for human consumption depend on pollinators. Thus, pollinators play a vital role in serving a rising world population in a sustainable way and also help to maintain biodiversity and a vibrant ecosystem. A large number of honeybee subspecies have been utilized and conserved for their pollinating services in various horticultural crops of different agro-climatic conditions worldwide. These include: Rock bee (*Apis dorsata* Fab.), Indian bee (*Apis cerana indica* Fab.), European bee (*Apis mellifera* Lin.), little bee (*Apis florea* Fab.), dammer bee or stingless bee (*Tetragonula iridipennis* Lin.), alkali bees (*Nomia*), mason bees (*Osmia*), leafcutter bees (*Megachile*) and bumble bees (*Bombus*) (Richards, 1993 and Williams, 1996). At present only about 0.25 million beekeepers with 3.2-3.5 million bee boxes are providing pollination services for an area of 143 million ha of cultivated land and other forest area that actually requires at least 25 million bee colonies to meet the pollination demand of major cross-pollinated crops. Due to the presence of high temperature, low humidity and water scarcity, the availability of pollinators is critical in arid and semi-arid regions, where pollination depends on wild bees and the domestication or rearing of *A. mellifera* and *A. cerana* are not feasible.

20.2 Value of pollination provided by pollinators

IN INDIA

The Horticulture sector in India is rapidly transforming according to the change in the life style and awareness towards health and nutritional



Estimated annual economic value (in crores) of pollination through honeybees

security thus contributing more than 30 per cent to the agricultural GDP. In the last two decades, area under horticultural crops has increased from 12.77 m ha (1991-1992) to 26.22 m ha (2019-20) and production from 95.56 mt (1991-1992) to 319.57mt (2019-20). India is now the second largest producer of fruits and vegetables thus plays a significant role in the global market. As most of the horticultural crops are cross-pollinated therefore, it is the pollinizers and pollinators that play an immense role in improving their quality and production. According to (Choudhary and Chand 2017) an estimated contribution of pollinators toward Indian agriculture in 211 crops shows that the production of 108 (51.2%) crops depends on animal pollination, while 59 (28.0%) are independent to pollination. The importance of pollinators in fruit crops can be evaluated as two third fruit crops require insect pollination for their production while only 7.3% are not dependent on pollination. At present only about 0.25 million beekeepers with 3.2-3.5 million bee boxes are providing pollination services for an area of 143 million ha of cultivated land and other forest areas that requires at least 25 million bee colonies to meet the pollination demand of major cross-pollinated crops. The value of pollination in floriculture remains to be properly explored but many



of these flowers depend on insects for seed set and similar is the fate of medicinal plants.

IN HIMACHAL PRADESH

Himachal Pradesh is a mountainous state with an area of nearly 55,000 km² in the northwestern Himalayas. Over six million people inhabit different areas like valleys, marginal sloping lands on hills, mountains and highlands with an altitudinal range from 350 m to 6,975 m with climate varying from hot to severely cold. Most of the population is agriculture dependent and therefore is the major source of income and employment for the rural population of the state. Agriculture contributes about 45% of the net state domestic product where, the average landholdings less than 1.62 ha (Partap and Partap, 2002). The major agricultural crops are wheat, rice and maize while crops such as potatoes, buckwheat, barley and pulses like rajma, mash and kulthi are also grown in few areas. The mountain farmers of this state have been benefitted immensely from the cultivation of cash crops. Himachal Pradesh is known as the 'Fruit State' of India as out of 614,000 ha arable land, 32% is under cultivation of horticultural crops with 196,000 ha under fruit cultivation. Apples are the main cash crop, accounting 42% of the total area under fruit cultivation and about 90% of total fruit production. About 113,154 ha are planted with apples; there are about 170,000 apple growers and annual production is about 368,603 tonnes (Department of Horticulture, 2018-19). Apple orchards dominates the agricultural economy in the districts of Kinnaur, Kullu, Shimla, parts of Chamba, Lahaul and Spiti, Mandi, Sirmaur and Solan. The vegetables grown here include potatoes, cabbage, cauliflower, tomato, pulses and beans. Besides apples, several other fruits like: almonds, peaches, plums, pears,





cherries, and pine nuts are grown in the mountains and citrus fruit, mangoes, litchis, guavas, and loquat in the foothills and valleys near the plains. Apple farming plays a major role in the economy of Himachal Pradesh contributing about USD 1.7 billion per year, with about USD 150 million to USD 170 million directly, and about USD 1.5 billion indirectly by providing jobs to thousands of people, not only in Himachal Pradesh, but also in Asia's biggest fruit market in Delhi during apple-selling season. Most of the crops and fruit varieties cultivated in Himachal Pradesh are mainly cross-pollinated or either dependent on pollination for quality produce. Among these, fruit crops are highly vulnerable to pollinator loss, resulting in a two-thirds reduction in fruit production. Next to these are oilseed crops and other lesser degree of crops like pulses, spices, and vegetables.

20.3 Pollination as an enterprise

Pollination is currently playing important role as an enterprise resulted from targeted research in the increasing use of managed honeybees in pollination. Some of the new techniques like the use of pollen dispenser had shown a great efficiency for increasing fruit set in apple orchards especially under pollinizer deficient conditions e.g. Mr. Suraj Chauhan from the Rohru, Shimla who took up the use of pollen dispenser as an entrepreneur activity which resulted into 73.33 percent increase in fruit set even in orchard with low pollinizers in 2019 as compared to the previous year. Similarly, utilizing indigenous bee *Apis cerana F.* and its conservation will result in improving ecosystem services of pollination.

Promotion of beekeeping will ensure pollination services and also provide livelihood opportunities to rural, unemployed, and landless people. The estimated population of India will be about 140 crores by 2030 AD thus India will face challenges like unemployment in youth and lack of nutritive food for which beekeeping industry could play humble role in addressing these challenges. An estimated 200 million honey bee colonies will be required then to increase productivity of 12 major crops.



Beekeeping has great potential in generating an estimated 3, 00,000 man-days for maintaining 10,000 bee colonies which will provide an estimated income of Rs. 2.00 lakhs annually. For example Mr. Din Dayal, a resident of Kullu, Himachal Pradesh, choose beekeeping as a means to generate income for his family by starting his venture with 60 colonies of *A. cerana* and now owns over 200 *A. cerana* boxes and 32 log hives and earns his livelihood by renting colonies for pollination in apple orchardist.





21. CONCLUSION

Despite much of the world's agriculture depends on pollination through honeybees, their numbers have declined worldwide. In the USA, Mexico, and Canada, both feral and managed honeybees declined by 25% between 1990 and 1998. Pollinator decline has impacted not only ecosystem functioning but it also disturbs the livelihood of many generations. It is, therefore, essential to recognize that pollination is not a free service and both conservation and stewardship are required to protect and sustain it. Thus promotion of beekeeping and managed pollination will be effective in increasing productivity of cross pollinated crops as well as means of livelihood.

The Indian Himalayan Region stands at an important crossroads. One pathway is based on increasing pressure on natural resources, fragmented development and short-term economic returns. The alternative is a nature-positive development pathway in which ecological restoration, food security, climate resilience and rural prosperity reinforce one another.

Nature-based Solutions provide the conceptual and practical framework for this transition. The Himalayan food system of the future should not be built by separating agriculture from forests, farmers from biodiversity, or economic development from ecological conservation. Instead, we need to recognise the deep connections among:

Soil → Water → Biodiversity → Pollinators → Food → Livelihoods → Green Economy.

The ultimate objective should be to create Himalayan landscapes where healthy ecosystems support healthy farms, healthy farms support healthy communities, and healthy communities become custodians of healthy ecosystems. The message is therefore simple: The green economy of the



Himalaya should not be built by consuming its natural capital. It should be built by restoring that capital—and creating value from keeping it alive. That is the promise of Nature-based Solutions for food security and sustainable development in the Indian Himalayan Region.





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