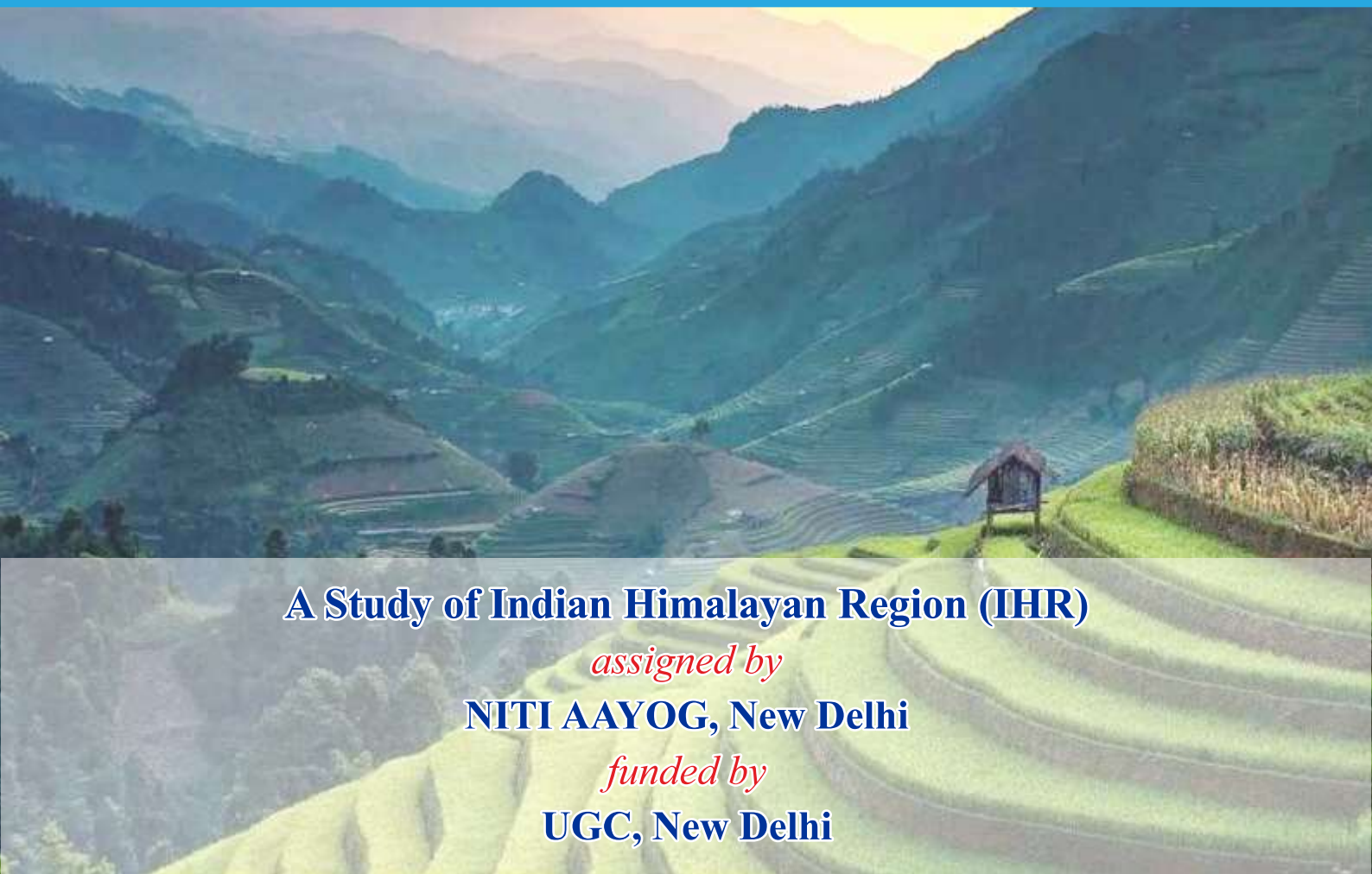




(Thematic Study-II)



Agro-Ecology in Himalayan States with special emphasis on marketing



A Study of Indian Himalayan Region (IHR)

assigned by

NITI AAYOG, New Delhi

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Submitted by

Indian Himalayan Central Universities Consortium (IHCUC)

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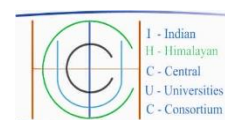
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**INDIAN HIMALAYAN
CENTRAL UNIVERSITIES CONSORTIUM**



(IHCUC)



Himalaya is the youngest and most sensitive mountain chain, having more than 15 thousand glaciers spread over 12 thousand square kilometers. Himalaya is a unique gift of nature for its freshwater, range of medicinal plants and biodiversity for humanity. Though the Himalayas are strategically important and a natural tool for climatic control, the recent rise in extreme natural events, depletion of natural resources, loss of livelihood, increasing natural disasters, and excessive migration of people to plain regions for livelihood and safety have raised an alarming concern for future generations. The Himalaya itself has been bleeding over the years due to various natural and anthropogenic factors, but the inhabitants living in this large Indian Himalayan Region (IHR) are now also paying the price of this damage. These problems are getting more complex with time. Therefore, to find a more humanistic solution, the concept of Indian Himalayan Central Universities' Consortium (IHCUC) was propagated by the HNB Garhwal University, Srinagar, Garhwal, Uttarakhand, in 2019 in the presence of India's National Security Advisor, Shri AjitDoval, Kirti Chakra, Former Union Minister of Education, Shri Ramesh Pokhriyal "Nishank" and the Chancellor of the HNB Garhwal University, Dr. YogendraNarain. The aim was to form a multi-institutional forum to develop joint multidisciplinary research and share knowledge and experiences on migration, employment, agroecology, tourism, and other common problems and resolution. In December 2019, in a meeting of four Vice-Chancellors, Professor AvinashKhare, VC Sikkim University, Professor S.K. Srivastava, VC NEHU, Professor D.C. Nath, VC, Assam (Silchar) University and Professor Annpurna Nautiyal, VC, HNB Garhwal University with the Vice Chairman of NITI Aayog Dr. Rajiv Kumar, the IHCUC formalized its aims and objectives by agreeing to work on five thematic studies on '*Enumeration and Valuation of the Economic Impact of Female Labour in the Hills*', '*Agroecology in the Himalayan States with special emphasis on Marketing*', '*Development of Eco-Friendly and Cost-Effective Tourism in Hills*', '*Opportunities of Livelihood to check Migration from Hills*', and '*Water Conservation and Harvesting Strategies*'. After a meeting with the Vice-Chancellors of 12 Central Universities of IHR and the Director of CSIR-IHBT in January 2020, under the chairmanship of Dr. Rajiv Kumar, Vice Chairman, NITI Aayog, the IHCUC was officially launched by the NITI Aayog. With the sponsorship of NITI Aayog and the Ministry of Education, Government of India a grant of Rs. 2 Cr was allocated by the University Grants Commission, New Delhi, to work on the above thematic areas under the

coordinator ship of Professor Annpurna Nautiyal, Vice-Chancellor, HNB Garhwal University, Srinagar, Garhwal, Uttarakhand. Her vision, sharing thoughts on each report with the teams, constant interest, dialogue, leadership role and a good coordination with all the Vice Chancellors as institutional partners and their team coordinators and members as well as the officials of the NITI Aayog and UGC helped immensely in the finalization of these reports. The inputs and suggestions provided from Dr. V.K. Saraswat, member NITI Aayog, CEO Shri Amitabh Kant and senior advisors Dr. Neelam Patel and Shri Avinash Mishra and others were very helpful in preparing the final report. The COVID-19 Pandemic hampered the pace of work, but now the five reports on the five thematic areas which have been consolidated and compiled by the team members of the HNB Garhwal University, are being presented to the NITI Aayog. This marathon exercise of submission of productive reports in each area became possible only with the support and inputs of the team members of the partner institutions representing their institutions and also on account of their Vice Chancellors' active interest in motivating their team members in the capacity of the main institutional Coordinator for each institution of the IHCUC.

Structure and Main Institutional Coordinators of IHCUC

Name	(IHCUC)	Designation	Institution Represented
Professor Annpurna Nautiyal	Convener & Chief Coordinator of IHCUC	Vice Chancellor	H.N.B. Garhwal University, Uttarakhand
Professor Avinash Khare	Coordinator	Vice Chancellor	Sikkim University, Sikkim
Professor V. K. Jain	Coordinator	Vice Chancellor	Tezpur University
Professor Saket Kushwaha	Coordinator	Vice Chancellor	Rajiv Gandhi University Arunachal Pradesh
Professor Pardeshi Lal	Coordinator	Vice Chancellor	Nagaland University
Professor G.P. Parasin	Coordinator	Vice Chancellor	Tripura University
Professor K.R.S. Sambasiva Rao	Coordinator	Vice Chancellor	Mizoram University
Professor S.K. Srivastava	Coordinator	Former Vice Chancellor	North-Eastern Hill University, Meghalaya
Professor Prabha Shankar Shukla		Present Vice Chancellor	
Professor Mehraj-ud-Din Mir	Coordinator	Former Vice Chancellor	Central University of Kashmir
Professor Farooq A. Shah		Present Vice Chancellor	
Professor Ashok Aima	Coordinator	Former Vice Chancellor	Central University of Jammu
Professor Sanjiv Jain		Present Vice Chancellor	
Prof. Kuldeep Agnihotri	Coordinator	Former Vice Chancellor	Central University of Himachal Pradesh, Dharmshala
Professor Sat Prakash Bansal		Present Vice Chancellor	
Professor D.C Nath	Coordinator	Former Vice Chancellor	Assam University Silchar
Professor R.M. Pant		Present Vice Chancellor	
Shri Jarnail Singh	Coordinator	Former Vice Chancellor	Manipur University
Professor N. Lokendra Singh		Present Vice Chancellor	
Dr. Sanjay Kumar	Coordinator	Director	CSIR-IHBT- Palampur, Himachal Pradesh

Foreword

Feeding an ever-increasing human population with adequate and quality food is a global challenge. In past few decades high-input based agricultural systems have seriously impacted agro-biodiversity, soil and water quality along with the environmental health. It is now increasingly being argued that the future of agriculture is not input-intensive modern agriculture, but to opt for a knowledge-intensive and sustainable agricultural production which not only fulfills the food demand but also minimizes environmental consequences. Interestingly, a large number of ethnic communities have been practicing an agriculture-based livelihood for centuries and fulfilling their food and nutritional demand. For generations, local communities have been successful in maintaining a wide variety of agroecosystems to an optimum level of production along with sustaining soil health and other ecosystem services. This has augmented a significant interest in investigating ‘agroecology’ of local food systems for building a resilient livelihoods. In recent times agroecology has emerged as an ecological concept and principle for designing and managing agricultural systems in the face of environmental degradation, climate change and other vulnerabilities.

In Indian Himalayan region, agriculture is the primary source of economy and livelihood for over two-third of rural population. Communities maintain a wide variety of agroecosystems that are characterized by smallholdings, high crop diversity, niche-specific crops, and optimum yields along with a substantial knowledge related to manage these systems. Fortunately, there is a considerable scope to develop them as sustainable food systems, which offers sufficient opportunity to undertake investigation on diverse agroecosystems across the length and breadth of the IHR. Considering this the study on ‘Agroecology in Himalayan states with special emphasis on marketing’ has been designed to investigate selected agroecological practices that have been supporting food and nutritional requirement of local communities for generations. The focus of the study is to promote sustainable agriculture as main source of livelihood. The study provides an outline of existing agroecological scenarios and the factors affecting food production and related value chain within existing socio-cultural, economic, environmental and governance systems. It identifies main areas of intervention for creating market opportunities and enabling atmosphere for smallholders in the region. A broad framework has been provided for promoting agriculture-based livelihood through strengthening agroecological transition, agricultural diversification, value added processing, and market development.

The study is first of its own kind as till date only cursory attempts have been made in this direction. It is expected that the information would help state agencies to develop a state-specific approach for agriculture sector development and a rapid transitions to a productive and sustainable livelihood by bringing social, economic and environmental sustainability. This approach is directly linked with the Sustainable Development Goals as well.

I thank the entire team covering eight Himalayan states for contributing to this timely and relevant study. I also express a deep sense of gratitude to Dr. Rajiv Kumar, Vice Chairman, NITI Aayog for supporting this initiative whole heartedly and to all members and advisors of NITI Aayog for their observations and comments from time to time to improve the studies.



(Prof. Annpurna Nautiyal)

Coordinator, IHCUC

Vice-Chancellor, HNB Garhwal University

Acknowledgements

The Indian Himalayan Central University Consortium (IHCUC) is a national platform for generating and sharing knowledge, data, and best practices on the science, consciences, governance, and diverse on-ground facets related to foremost thrust areas pertaining to the development of Indian Himalayan region (IHR). It was jointly launched by NITI Aayog, University Grants Commission (UGC), and Ministry of Education (MoEd) in 2019 at HNB Garhwal University with a partnership of 13 central universities and 1 CSIR Institute.

Creation of IHCUC acquired significant patronage from Dr. Ramesh Pokhriyal 'Nishank', Former Union Minister of Education, Govt. of India, Sri Ajit Doval, National Security Advisor (NSA), Govt. of India, and Dr. Rajiv Kumar, Vice Chairman, Niti Aayog. We express our sincere gratitude for sponsoring and supporting the concept of IHCUC. Also, the support of NITI Aayog, UGC and MoEd is greatly acknowledged. Special thanks are due to UGC for providing funds for the five thematic studies.

Shri Amitabh Kant, Chief Executive Officer, Dr. V.K. Saraswat, Member, Niti Aayog, and other experts and advisors, such as Shri Avinash Mishra, Senior Advisor, Dr. Neelam Patel, Ms. Saloni Goel, and Dr. Ashok Jain, all senior experts from NITI Aayog extended their valuable observations and suggestions from time to time on the progress and outcome of the study. We would like to acknowledge their continued encouragement and guidance in conducting this study.

Professor Annpurna Nautiyal, Vice-Chancellor of HNB Garhwal University generously coordinated all activities of IHCUC with her able leadership. Also, the needful support and encouragement was also extended by various Vice-Chancellors and Head of the Institutions. viz. Prof. Mehrajuddin Mir, Vice-Chancellor, Kashmir University; Prof. Sanjeev Jain, Vice-chancellor Jammu University; Prof. P. Lal, Vice-Chancellor, Nagaland University; Prof. KRS Sambasiva Rao, Vice-Chancellor, Mizoram University; Prof. Saket Kushwaha, Vice-Chancellor, Rajeev Gandhi University; Prof. D.C. Nath, Vice-Chancellor, Assam University; Prof. S.P. Bansal, Vice-Chancellor, Himachal Pradesh University; Prof. S.K. Srivastava (Former) and Current Vice Chancellor Prof. Prabhakar Shukla, of North East Hill University, Meghalaya; Dr. Sanjay Kumar, Director, CSIR-IHBT- Palampur; Prof. Ashok Aima, Vice-Chancellor, Central University of Jammu; Prof. Avinash Khare, Vice-Chancellor, Sikkim University; Prof. V.K. Jain, Vice-Chancellor, Tezpur University; Prof. Jarnail Singh, (former) Vice-Chancellor, Manipur University; and Prof. G.P. Parasin, Vice-Chancellor, Tripura University. We extend our heartfelt gratitude to all of them.

During the progress of the work a series of review meetings and webinars were organized by NITI Aayog, Coordinator IHCUC, and by the universities. A large number of resource persons attended such discussions. One such webinar on 'Agroecology and Market Development in the Indian Himalayan Region' organised by NITI Aayog in association with IHCUC (25 June 2021) attracted over one hundred participants, including Vice Chairman and CEO, NITI Aayog, various secretaries to the Government of India, principal secretaries, and secretaries of the 13

Indian Himalayan States and union territories. We sincerely acknowledge their contribution and thank all of them for their valuable inputs.

Field Investigators (Shazia Bashir and Hadiya Mushtaq, Central University Kashmir; Himani Thakur and Kamini Verma, Central University of Himachal Pradesh; Akshay Saini, Tanuja, and Meenakshi Rawat, HNB Garhwal University; Rashmita Goswami, Tangem Mize, OyekTapak, Kosen Jida, Luinnom Kimsing, and Yab Rajiv Kamdir, Rajiv Gandhi University; Sucharita Roy, and Pator Singnar, Assam University; Debbie Lalnunthari, R. Vanlalmangaihi, and Lalbiakhluna, Mizoram Central University, VimetsienuoKintso, Lalen S Phom, and Keyirangdibe, Nagaland University; DaiamonlangTyngkan, Chukime R. Marak, and Adoryllene Dkhar Sawia) did a splendid work in field data collection within the limited time frame from different parts of IHR. We sincerely acknowledge their dedication and services.

The villagers, including farmers, Gram Pradhan, Gaun Bura, local leaders, and individuals across IHR extended a positive support to answer the questions / queries during field survey and greatly helped our field Investigators to fill questionnaires. We wish to extend our special thanks to all of them. Also, officials of various line departments across IHR shared departmental information and census reports. We greatly appreciate their support.

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28 February, 2022



Prof. R.C. Sundriyal
& Entire team (Theme 2)

Abbreviation

AUS	:	Assam University Silchar
BPL	:	Below Poverty Line
CAET	:	Characterization of agroecological transitions
CBBOs	:	Cluster Based Business Organizations
CPR	:	Common property resources
CUHP	:	Central University of Himachal Pradesh, Dharmshala;
CUK	:	Central University of Kashmir;
FAO	:	Food and Agriculture Organization
GDP	:	Gross Domestic Product
GO	:	Government organisation
GSDP	:	Green Skill Development Programme
HNBGU	:	Hemvati Nandan Bahuguna Garhwal University
HR	:	Human Resource Development
HYV	:	High Yielding Varieties
ICTs	:	Information and communication technologies
IHCUC	:	Indian Himalayan Central Universities Consortium
IHR	:	Indian Himalayan Region
MAPs	:	Medicinal and Aromatic Plants
MGNREGA	:	Mahatma Gandhi National Employment Guarantee Act
MIDH	:	Pradhan Mantri Fasal Bima Yojana
MoA&FW	:	Ministry of Agriculture & Farmers Welfare
MoEd	:	Ministry of Education
MoEF&CC	:	Ministry of Environment, Forest & Climate Change
MU	:	Mizoram University
NEHU	:	North-Eastern Hill University, Meghalaya
NGOs	:	Non-government Organizations
NITI AAYOG	:	National Institution for Transforming India
NTFPs	:	Non-timber Forest Products
NU	:	Nagaland University
PDS	:	Public Distribution System
PHM	:	Post Harvest Management
PKVY	:	Paramparagat Krishi Vikas Yojana
QPM	:	Quality planting material
R&D	:	Research & Development
RGUAP	:	Rajiv Gandhi University, Arunachal Pradesh;
RPVY	:	Rastriya Pashudhan Vikas Yojana
SDGs	:	Sustainable Development goals
SHGs	:	Self Help Groups
TAPE	:	Tool for Agroecology Performance Evaluation
UGC	:	University Grant Commission
VC	:	Value chain
WG	:	Working Group

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Executive Summary

1. Population growth, hunger, malnutrition, climate change, and degradation & loss of soil, water, and biodiversity are major challenges that are impacting food production systems all over the globe. There is a need to transition to sustainable food systems that produce more and strengthen rural employment, at the same time cause less harmful impact on environment. Agroecology speaks of ecology of traditional food systems that augment interaction between plants, animals, humans, landscapes and environment. Managing agroecosystems on agroecological principles ensure sustainable food & nutritional security along with continued supply of ecosystem services and biodiversity, thus helps in building resilience and adapting to climate change. It requires an enabling environment for evolving traditional food systems in environmental, economic, social and agronomic dimensions with the support of formulating appropriate policies, public investment, institutions and R&D priorities.
2. In Indian Himalayan Region (IHR) that comprises 2 UTs and 11 states (9 fully 2 partially), agriculture is the main source of livelihood. Although the contribution of agriculture to net GDP has been declining over past few decades, still agriculture is the key sector for engaging maximum workforce. This offers considerable scope to develop agriculture sector that should be planned not only to produce more food but creates wealth by generating more jobs and income for rural communities. This investigation focused on ‘Agroecology in Himalayan states with special emphasis on marketing’ with an aim to characterize selected food systems for their agroecological performance; mapping high-value agri-produce, existing value chain, and marketing; and identifying a workable marketing models for local commodities. A total of 8 states (Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Arunachal Pradesh, Assam, Meghalaya, Nagaland, Mizoram) covering 38 districts, 78 blocks, 642 villages and 9292 households were surveyed for field data collection. The methodology encompassed FAO (2019) framework ‘Tool for Agroecology Performance Evaluation’ that comprised 4 broad stages and 10 elements of agroecology. The study led to many important findings and suggestions for improvement.
3. In IHR, agriculture is the major livelihood activity that is practiced under diverse agro-climatic conditions. Over 80%percent of farmers are marginal and smallholders. Family labor is key for traditional farming systems that is characterized by small-size farms, diversified crops, and/or integration of animal husbandry, aquaculture, and forestry. In the northeast, the dominant agriculture form is shifting cultivation (Jhum) although terrace cultivation, mixed cropping and agroforestry are also practiced. In the northwest region, mixed cropping in rainfed and mono cropping in irrigated fields are practiced. Both areas have a range of subsistence (terrace farming, mixed farming, arable farming, agroforestry) to commercial (grain agriculture, plantation, agroforestry, orchards, MAPs, protected cultivation) farming systems. Of the total cropped area, 3/4 is under staple food grains, 10 to 20% under fruits and vegetable, and 5% under miscellaneous crops.
4. A key feature of IHR agricultural landscapes is that they are managed for multiple services in addition to food production. Farmers maintain high diversity of crops (cereals, millets, vegetables, pulses, fruits, oil seeds, etc.) that enhance food and nutritional security. Exclusive animals based livelihood comprising pastoral and nomadic herding is also practiced at high hills. Low production, lack of marketable surplus, limited access to market, poor-market infrastructure, feeble processing and production chains, and inadequate processing facilities were recorded as the major constraints.
5. In recent times, there is an increasing shift to grow more market demanding species, such as vegetables, fruits, pulses and medicinal plants. Although in recent years, diverse cash crops, dairy, poultry, goatery, piggyery, mushroom cultivation, floriculture, apiculture, sericulture, bamboo

cultivation, etc. have emerged as important rural enterprises. There are many such successful models developed by farmers.

6. The contribution of agriculture, livestock, wage & salary, and non-farm business in the income of smallholders was 53%, 10%, 24%, 13%, respectively, in northwestern states, and 50%, 11%, 30% and 9%, respectively in northeastern states. The income levels of farmers is low though there is high dependence on primary sector. A large number of policies and programs are existing in agriculture and allied sectors, however, they have limited impact and outcome as they are implemented independently. Also, there is a lack of awareness among local farmers on most of the policies and schemes.
7. It is argued that despite of fast urbanization still 50% of the rural population will be dependent on agriculture as the main economic activity by 2050. Agriculture, livestock, aquaculture, fisheries and forests will still be main source livelihood to them. There are abundant possibilities to develop them as a means of sustainable food and agriculture all over IHR by strengthening production, processing, and marketing. Also, an urgency of focusing on smallholders was perceived as they form the biggest farming group.
8. For IHR states, a best feasible marketing model appears to be broadening the means of livelihoods; improvising the performance of agroecosystem based on agroecological principles; supporting diversification to increase production of crop, animals, and cash crops for generating more marketable surplus; strengthening value-added processing and product development; promoting on-farm and off-farm enterprises (farming produces + animal husbandry + aquaculture + forestry); strengthening market infrastructure; and creating an enabling environment for all the above for simultaneous implementation will not only generate more employment but bring significant wealth in rural landscapes.
9. Agricultural diversification and strengthening existing food systems should be systematically approached by increasing production base and improving cropping intensity, promoting seasonal/ off-season cultivation, large scale extension, and encouraging water harvesting, mechanization, and technological support. Marketing should be promoted through aggregation, value chain development, value added processing, product development, and strengthening information, linkages and infrastructure. Also, intensifying on-farm and off-farm enterprises in rural landscapes can bring additional income opportunities for farmers. Simultaneous implementation of such activities will bring significant job and employment. Currently, there is a significant gap in relation to these aspects.
10. A cluster approach for development of agriculture and allied sector is highly desirable across IHR.
11. Implementation of such an approach requires a strong policy support and enabling environment. Connecting farmers with programs, knowledge, networks and institutions, and improving their agricultural and entrepreneurial skills will greatly advance their ability and performance for opting better farming options, improving productivity, value-added processing and product development. Promoting and strengthening farmers-producers organization and public-private linkages will greatly help in this venture. For this, all instruments, including production, extension, information, awareness & education, technology, regulation, financial, etc. should come together. Practitioners, decision-makers, development partners, local government, line departments, institutions, NGOs, private sector, management agencies, should come together to develop an enabling environment for it. Involving related to ongoing programs and policies can lead towards extending the benefit to rural people.
12. Proper nurturing of land and rural masses, adopting sustainable agriculture, and integrating activities of diverse other sectors can lead to mainstream rural areas in national planning process. It would also deliver inclusive growth across IHR, thus may drive positive changes right across the 2030 Agenda and help in achieving Sustainable Development Goals (SDGs).

Background

Agriculture and food production systems are the basis of life, and together they form the world's largest commerce sector. There are a wide variety of food production systems that play key roles in the development and sustainable living of societies. Although in recent times all food production systems are under tremendous pressure to meet the requirement of the growing population. Commercial food production is often done at a considerable environmental cost involving land conversion, intensive use of insecticides& pesticides, excessive water usage, and greenhouse gas emission. Also, there is a visible impact of climate change on food production which is also impacting our food production systems. For better living, the food needs to be sourced from healthy ecosystems. Fortunately, several native societies still meet a considerable share of their food demand and livelihoods from traditional farming practices being practiced for centuries comprising agriculture, forestry, fisheries, pastoral, and aquaculture. It is argued that the agroecology of the local production systems is a key for sustainable food supply, reducing waste, and safeguarding environmental health. The future of agriculture lies in diverse and agroecological-based farming that can meet social, economic, and environmental goals as well as maintain and increase productivity. However, the ecological integrity of most agroecosystems is threatened in recent years due to changes in socio-cultural milieu and globalization that brings negative impact on traditional food production systems. Therefore more investigation of such systems is highly desirable for a sustainable and fair food system. There is an utter need to transition for sustainable food systems that produce more with superior socio-economic benefits and fewer environmental consequences. Also, such systems should create more jobs and employment thus bringing a sustainable livelihood in rural landscapes.

Agroecology defines as the ecology of traditional food systems based on applying ecological concepts and principles. It ensures food & nutritional security along with continued supply to ecosystem services and biodiversity. Intensive and industrial agriculture brings significant costs on the environment and ecosystem services in view of the massive use of insecticides, pesticides that impact soil quality, biodiversity, and release of greenhouse gases (GHG). Agroecology optimizes interactions between plants, animals, humans, and the environment while taking into consideration the social aspects. It has been promoted to imply sustainability to agricultural systems for continued production of food and ecosystem services. The indigenous and diversified crops promoted under agroecology are typically more resilient to extreme weather and climate change conditions. It also increases the role of women and youth by creating more employment opportunities. Therefore, an enabling environment is required for promoting agroecology by devising appropriate policies, public investment, institutions, and R&D priorities to evolve traditional food systems in environmental, economic, social, and agronomic dimensions.

Agroecological characterization of any agroecosystem can be done covering varied characteristics, viz. diversity, synergies, efficiency, recycling, resilience, co-creation and sharing of knowledge, human and social values, culture and food traditions, responsible governance, and

circular and solidarity economy. Agroecosystems emphasizing these principles can be considered sustained food supply systems with multi-functional benefits within local landscapes and socioeconomic conditions. The agroecological investigation also allows comparing agroecosystems maintained in totally diverse landscapes, socio cultural, and environmental setups. The purpose is not to continue with old practices based on ideology. Reasonably, it promotes new technologies to bring sustainable improvement in agricultural productivity with a caution not to harm the environment. In recent years, agro ecology is gaining ground across all developed and developing countries, and is increasingly being supported by subject experts, the scientific community, national bodies, and international agencies and organizations, such as the United Nations Food and Agriculture Organization (FAO), UNEP and Biodiversity International as a means to improve the resilience and sustainability of food systems.

Considering that the present study on agroecology of the Himalayan region aims to collect scientific evidence on the performance of various existing agroecological systems in terms of their production, resource efficiency, resilience, social equity, and governance, and determine how these systems can be made economically, socially, environmentally viable, equitable, and sustainable. The study, on the basis of collected data has evaluated and carried the agroecological diagnostic of local food systems with regard to environmental, social, and economic dimensions in a variety of settings comprising diverse communities, territories, agro-ecological zones, production systems, etc. with a focus to attain sustainable agriculture by strengthening production base and promoting strategic marketing all over Indian Himalayan Region. A deeper understanding of the market specificities of local food systems by mapping high-value agri-produce and existing value chains has been helpful for devising a workable marketing model for various Himalayan states. It is expected that the report would be greatly useful to a wide array of stakeholders covering local and regional communities of practices on agroecology comprising producers, traders, experts, promoters, officials and extension workers, policy planners, and funding institutions. It is emphasized that developing agriculture and allied sectors on agroecological principles will not only create more food security and jobs to rural communities but also contribute immensely to state & national GDP. At the same time it would also be contributing greatly to achieve SDGs.

The Indian Himalayan region (IHR)



Figure 1. Indian Himalayan States including Central Universities and IHBT

The IHR stretches to two Union Territories (Ladakh and Jammu & Kashmir), nine states fully (viz. Arunachal Pradesh, Himachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Uttarakhand), and two states partially (viz. two districts of Assam, i.e. Karbi Anglong, and Dima Hassao; and one district of West Bengal, i.e. Darjeeling). It comprises a geographical area of 5,33,604 km². The region houses nearly 4% of the population of India with over 170 ethnic communities mainly in the northeastern states.



Figure 2. View of a Himalayan village

The region is a global asset for water, biodiversity, food, and energy. There are over 9,000 glaciers and 549 glacial lakes with 12,000 km³ of water; and supports wide diversity of plants, animals, and associated practices. It is a globally recognized Biodiversity Hotspot. The region is often epitomized as ‘climate regulator’ or ‘weather maker’ or ‘ecological buffer’ of the Indian sub-continent. IHR directly or indirectly affects nearly half of the Indian population with diverse goods and services. However, the people living in the region are poor, marginalized, and disadvantaged due to limited economic activities, small & fragmented land holdings, subsistence agriculture, jhum cultivation, and overexploitation of resources. IHR is different from other regions of the country therefore their growth trajectory is different. Also, the region is highly vulnerable to climatic, environmental, and socioeconomic changes and related risks.

There has been no focused development approach for the region. Although, time to time the Central Government has established various Task forces and working groups to look into the problems related to the hill areas of the country who suggested various approaches and recommendations to improve the status of the region, however, the situation has not changed much. For example, the Working Group for Eighth Plan highlighted the need that ‘The hill areas of the country are faced with certain peculiar problems inhibiting the process of development, and on account of the difficult terrain, variable agro-climatic conditions, distinct socio-cultural features, the hill areas have remained backward’.



Figure 3. Agricultural landscape in Himalaya (Uttarakhand)

The Task Force of the Planning Commission, Government of India for hill states and hill areas suggested that the IHR States must agree to a common essential platform for regular interaction and from therein, decide on a common essential plan for the region. However, over the years the region has been under increased pressure that greatly impacted its resources and services. To safeguard the livelihood of the people, fulfil their developmental aspirations, and maintain

environmental concerns require a paradigm shift. It desired to build a viable and sustained food production systems that also bring better income avenues to local communities. Although, it requires a thorough investigation of what needs is to be done and what developmental approach is to be undertaken. The solution drawn from such an approach may provide appropriate solutions for an improved and equitable livelihood, sustainable and resilient development, and ecological stability in the region.

Considering this the study on ‘Agroecology in Himalayan states with special emphasis on marketing’ has been designed to assess selective agroecological practices that have been supporting food and nutritional requirement of local communities for generations. The focus is to assess these food systems for their agroecological characteristics and market specificities along with their mainstreaming for improved food, nutrition, and economic security. Assessing the market value chain is given special consideration as it plays important role in the facilitation and adoption of agroecological practices by stimulating farmers’ decisions and actions. It is expected that the investigation will provide a deeper understanding of the agroecosystem with the complex interactions among resources, people, and their environment to ensure a lasting balance between food production and the sustainability of natural resources. Assessing market opportunities will also help to scale up or broaden the adoption of agroecological processes in a long-term basis and provide insights for undertaking and modifying agroecological practices for more income, agriculture policy changes, socio-economic changes, community empowerment and enhancing their adaptive capacity.

Objectives

The broad objectives of the study were as follows:

- (i) **Characterizing the diversity of existing agroecosystem /food systems at the state level** and their structural characteristics; prioritize a few systems for detailed investigation (covering traditional, niche-based, and well-developed agroecosystem) from the perspective of marginal/smallholder farmers under the changing scenario;
- (ii) **Mapping high-value agri-produce in IHR**, and to identify and assess specificities of markets for products from agroecological systems;
- (iii) **Assessing existing value chain in the agri-ecology sector** in the region and identifying major opportunities and challenges to strengthen local livelihoods and income;
- (iv) **Identification of workable marketing models** for some prominent agroecosystems and farm produces

Methods

The major focus of the study was promoting sustainable agriculture as main source of livelihood. Therefore, to accomplish the identified objectives, both primary and secondary methods of data collection were applied. State-specific data related to population, demographic trend, rural-urban population, population density, and literacy rate were gathered from census (2011) records. Information on forest area, land use-land cover, net arable area, cropping intensity, net area sown, gross cultivated area, and operational holdings were gathered from the respective state governments' records. Dependence on agriculture, per capita income, contribution of agriculture in GDP and other related information were also collected from respective departments in each state.

For primary survey, we used stratified multi-stage sampling along with proportional, quota and purposive sampling methods. The 12 Himalayan states/UTs comprised a total of 152 districts (including 100 hill districts), however, the present study was undertaken in 8 states with the help of different project partners. The sampling criteria within a state comprised selection of **districts** (covering 50% of total hill districts or 2 district, whichever is more), **blocks** (20% of total development blocks or 2 blocks, whichever is more) representing different geographical regions and socioeconomic classes, **villages** (9 villages from each selected block) representing all caste/religion/income groups, and **households** (minimum 15 households of in a village covering all categories of households- landless, marginal, small, and large holdings). Thus, a total 38 districts, 78 blocks, 642 villages and 9292 households were covered from eight targeted states for primary survey.

Box 1. Targeted states, districts, blocks and villages covered for primary survey in IHR

	State/ut/ region	No. of districts covered	No. of blocks covered	No. of villages targeted	No. of households surveyed	Lead institution for data collection
1	Jammu& Kashmir	5	10	90	1350	CUK
2	Himachal Pradesh	6	12	108	1620	CUHP
3	Uttarakhand	5	11	99	1440	HNBGU
4	Assam	2	3	23	212	AUS
5	Arunachal Pradesh	8	16	88	800	RGUAP
6	Nagaland	5	10	90	1350	NU
7	Meghalaya	4	8	72	1440	NEHU
8	Mizoram	3	8	72	1080	MU
	Total	38	78	642	9292	

(CUK- Central University of Kashmir; CUHP- Central University of Himachal Pradesh, Dharmshala; HNBGU-Hemvati Nandan Bahuguna Garhwal University, Srinagar, Uttarakhand; AUS Assam University Silchar; RGUAP-Rajiv Gandhi University, Arunachal Pradesh; NU- Nagaland University; NEHU- North-Eastern Hill University, Meghalaya; MU-Mizoram University)

For investigating agroecology of traditional food ecosystems, we used recently developed FAO (2019) framework '***TAPE Tool for Agroecology Performance Evaluation 2019 – Process of development and guidelines for application***' for this study. The framework comprises 4 broad stages and 10 elements of agroecology. The study steps comprised: i) description of systems and context; ii) Characterization of agroecological parameters and transitions; iii) Criteria of performance, and iv) Analysis and participatory interpretation.

Description of agroecosystems and context comprised gathering basic information related to location, household size, productive assets, agro-ecological zone, landforms, forests, access to land, commodities produced, production systems, type of household, existing policies (incl. climate change), and enabling environment. As such, it provides details of the target area, production system, area in production, main agricultural outputs, state/centre sector schemes/programs, govt. policies, market context, various actors/groups /networks in the area.

Characterization of agroecological transitions (CAET) comprised on farm/household survey by describing current status based on 10 elements of agroecology with descriptive scales (Diversity, Synergies, Efficiency, Recycling, Resilience, Co-creation and sharing of knowledge, Human and social values, Culture and food traditions, Circular and solidarity economy, Responsible governance). Such characterization of local food systems is key for assessing and designing their sustainable development.

Criteria of performance of agroecosystems comprised on farm/household survey related to measuring progress and quantifying impact by addressing 5 key dimensions for policy makers along with time/cost constraints. The key consideration was status of land tenure, agricultural biodiversity, income and productivity, output and earnings, plants and animal's products, other activities and services, expenditures, use of chemicals and pesticides, employment, gender issues and decision making, other information.

And finally, Analysis and participatory interpretation of agroecosystems was undertaken at territory/community scale by reviewing all the results, explaining context, enabling environment, and review performance results. It comprises of a detailed data analysis, review and performance, suggestions for improving status of agroecosystems, status of enabling environment and recommendations for policy and programme and future potential.

The survey was undertaken with the help of a detailed questionnaire (FAO 2019). For each state at least 2 to 4 agroecosystems were targeted for detailed investigation (i.e. traditional, niche-based, and well developed agro ecosystem). The data is presented in the form of major agroecosystems types, important food crops, crops and cropping pattern, production systems, market practices, source of livelihoods, policies related to agriculture sector development, mapping of high-value crops. A detailed SWOT analysis of IHR agroecosystems was undertaken for their strengths, weaknesses, opportunities, and threats. Besides, an analysis with relation to participation of farmers in markets and role of middlemen, market structure, and value additions (if any) on this was also undertaken. It was also assessed as how the specific business practices facilitate smallholder producer development and empowerment in fair trade supply chains.

Based on a thorough assessment of existing value chains and using participatory approach, a viable marketing model along with the opportunities and challenges for local agro-products, and to strengthen sale and market through appropriate value chain was devised for the benefit of smallholders and marginal farmers.

Agriculture Indicators: Indian Himalayan Region

The Indian Himalayan region houses a population of 486 lakh with nearly 16.2% land area of the country. The area consists of 36% forest cover, 30% ethnic diversity, 4.4% net sown area, and 7-8% of total rural households of the country (Fig. 1). The forest area varies from state to state with a maximum in Arunachal Pradesh (80% of total area), followed by Manipur (75%), Mizoram (75%), and Uttarakhand (71%) (Fig. 2). Forests, other than supporting diverse requirements of people, have a direct bearing on agriculture in IHR. Agriculture is practiced between 4 and 48% of land area as the major livelihood activity for over 70% of the people in IHR. However, the agriculture sector GDP, which is 10-20% across the IHR states, is decreasing over the years.

Majority of farming systems in IHR are characterized by small and scattered land holdings. Communities exhibit an agro-pastoral economy having a wide variety of farm enterprises such as crop, livestock, agroforestry, horticulture, aquaculture, and orchards often with a mix of annuals and perennials and generous use of natural resources within the surrounding environment. Also, farming practices exhibit a substantial dependence on forests. Farmers maintain a high diversity of crops that enhance food and nutritional security. The family labor is key for traditional farming systems. Nearly 86% of farmers in the IHR are marginal and smallholders (Fig. 3). For centuries the local farmers have been meeting the food, nutrition, and medicinal requirements from local plants and animals. Sikkim, Tripura, Uttarakhand, and Jammu & Kashmir exhibit higher cropping intensity, although it is low for Manipur, Ladakh, Meghalaya, and Mizoram. Generally the agricultural productivity is low in view of limited access to use of modern technologies and inputs.

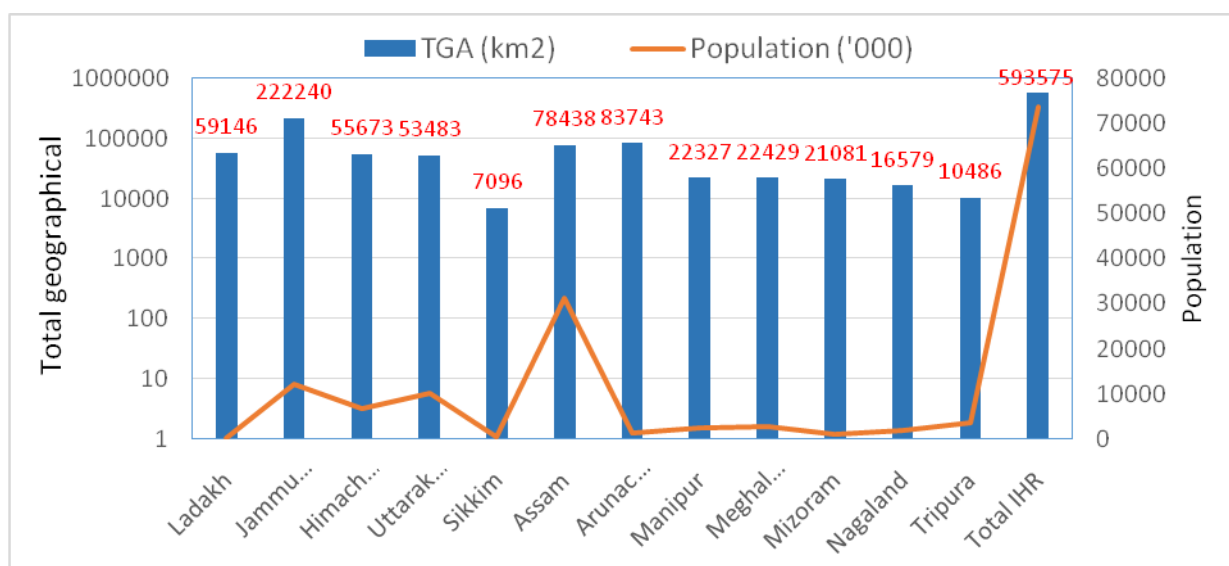


Figure 4. Area, population, and agriculture indicators of the Indian Himalayan Region

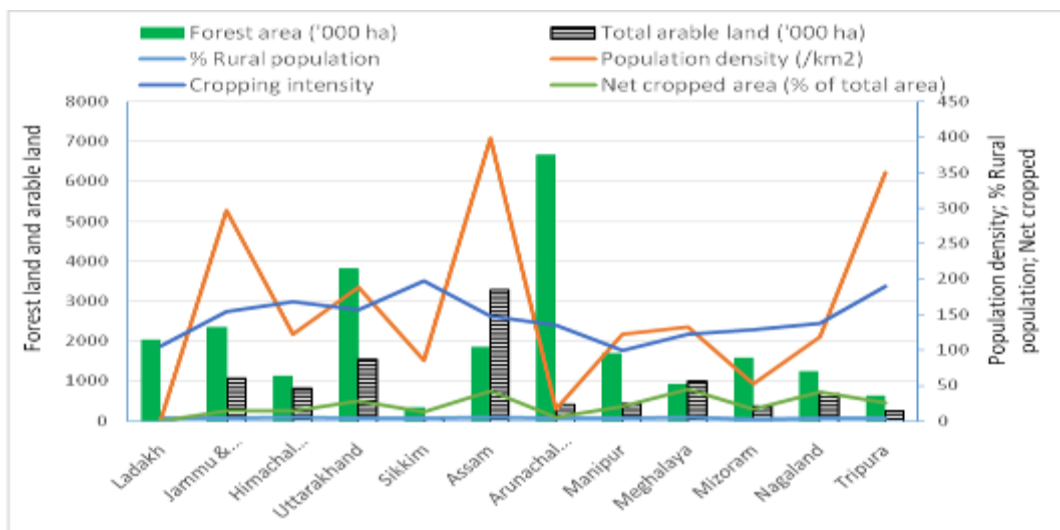


Figure 5. Forest area, total arable land, rural population (%), population density (%), and net cropped area and cropping intensity (%) in IHR states

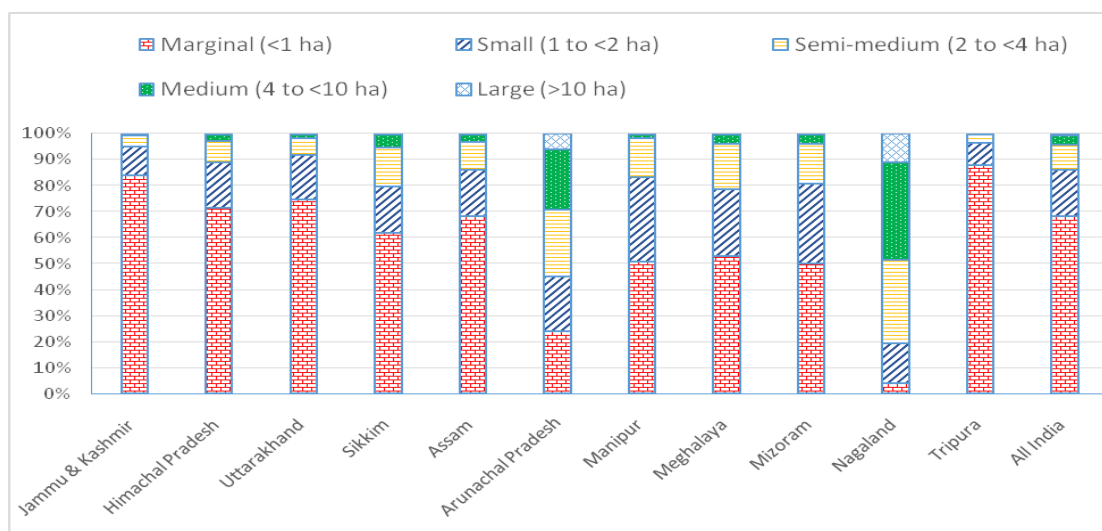


Figure 6. State-wise percentage distribution of number of operational holdings for all social groups

Across the length and breadth of the IHR a large variety of agroecosystems are maintained to support local livelihoods. Communities possess significant indigenous knowledge to maintaining agriculture, crops, plants, livestock, and other resources with relation to environmental settings, altitude, topography, climate, and local socio-cultural and economic context. In the northwestern states settled agriculture is practiced with mixed cropping in rainfed and mono-cropping in irrigated fields are practiced. In the northeastern states, 85% of the cultivated area is under shifting cultivation (locally called as jhum) that engage over 1.6 million population, particularly tribal communities.



Figure 7. Traditional crops in Western Himalaya

Although at some places terrace cultivation, mixed cropping, and agroforestry are also practiced. In Nagaland, community farming is also practiced. Interesting in both areas, paddy, wheat, maize, millets, and pulses comprise major crops. Allover, diverse practices are followed for raising crops and cropping patterns, field management, soil fertility enhancement, moisture conservation and water resource use that have evolved over the years based on trial and error. Another key feature of IHR agricultural landscapes is that they are managed for multiple services rather than just for grain production. In both, northeast and northwest regions, a considerable area is under subsistence agriculture and only a small area is under commercial farming (Box 1).

Box 2. Key agroecosystem based livelihoods in IHR

Traditional farming	Commercial farming
Subsistence Terrace farming	Grain Agriculture
Shifting Cultivation	Plantations
Mixed Farming	Commercial agroforestry
Arable Farming	Orchards
Agroforestry	MAPs
Pastoral and Nomadic Herding	Protected Cultivation
Heritage farming	High-value farming
Baranaja, rice+fish, Zabo system, Alder-based agroforestry, bamboo-drip irrigation, saffron, temperate fruit gardens, etc.	Dairy, Poultry, Goatery, Piggery, Mushroom Floriculture, Apiculture, Sericulture, Bamboo Cultivation, etc.

Traditional subsistence agriculture comprises growing crops and rearing animals for the sole purpose of feeding farm families. It is practiced in terraced farms. Sometimes it is in the form of intensive subsistence farming (such as rice as dominant/ non-dominant crop). **Shifting cultivation** involves clearing the forest and using the ground for cultivation of crops. **Mixed farming** comprises cultivation crop with raising of livestock and vegetables.

Arable farming comprises cultivation of crops without the use of animals, e.g. annual crops such as cereals, vegetables, cassava, potatoes, legumes, etc. **Traditional agroforestry** encompasses crops with livestock and trees (fodder, fruit, fibre). **Pastoral farming** comprises animal rearing, while in **nomadic herding** animals are grazed on natural pastures while transhumance shift from place to place in search of pasture.



Figure 8. Variation in selected crops landraces and Jhangora pounding

Commercial farming systems comprise **grain agriculture** where mechanized cultivation is undertaken (e.g. wheat or rice monoculture) although it is limited to low hills/plain areas. **Commercial agroforestry** comprises the cultivation of fruits (apple, orange, mango, litchi, avocado, papaya, etc.), large cardamom, grapes, spices, etc. **Agro-plantations** contain commercial plantations of tea, rubber, coffee, coconut, social forestry, etc. In recent years, intensive cultivation of vegetables, fruits and other commercial crops including medicinal and aromatic plants have taken by all the states.

Major crops (food grains and other crops)

Food grains (cereals and millets) encompass the maximum area in all states. Besides, there are fruits, vegetables, and other crop species that vary with state.

Box 3. Important crops species of different states in IHR

State/UTs	Major food grains (cereals and millets)	Vegetables	Other imp. species
Ladakh	Wheat, barley	Potato, peas, onion	Fruits, MAPs
Jammu & Kashmir	Wheat, rice, maize, rice, barley, ragi, bajra	Potato, peas	Fruits, Pulses, MAPs, gram, rapeseed, mustered,kesar

Himachal Pradesh	Wheat, maize, rice, barley	Potato, peas, off-season vegetables	Fruits, Pulses, kesar, heeng
Uttarakhand	Wheat, rice, maize, ragi, barley	potato, tomato, peas, cabbage, other vegetables	Fruits, Pulses, sugarcane, soybean
Sikkim	Maize, rice, wheat, ragi, barley	Potato, onion, temperate veg.	Fruits, Ginger, turmeric
Assam	Rice, maize wheat,	Chilies, sweet potato, other veg.	Fruits, Pulses, ginger, turmeric, black pepper, oilseeds,
Arunachal Pradesh	Rice, maize, ragi, minor millets	Potato, cabbage, tomato, leafy vegetables, Seasonal veg.	Fruits, Chilies, ginger, turmeric, Pulses, pepper, large cardamom, gram
Manipur	Rice, maize, wheat	Seasonal veg., potato, onion	Fruits, Chilies, ginger, turmeric
Meghalaya	Rice, maize	Seasonal veg., potato,	Fruits, turmeric, bay leaf, black pepper, chilies, ginger, sweet potato,
Mizoram	Rice, maize	Seasonal veg.	Fruits, Pulses, Chilies, ginger, turmeric
Nagaland	Rice, maize, wheat	Seasonal veg., tapioca, potato	Fruits, Arhar, gram, Chilies, ginger, turmeric, pineapple, passion fruit, King Chilli, dragon fruit, coffee, rubber and tea plantation
Tripura	Rice, maize	Potato, Seasonal veg.	Fruits, Pulses, Chilies, ginger, turmeric

Of the total cropped area, 3/4 is under staple food grain and remaining under other crops. In northwestern states, rice, wheat, and maize are the main crops along with millets, barley, buckwheat, pulses, and oilseeds. Uttarakhand exhibits a significant area under millets and pulses. In the northeastern states, rice is a major food crop that comprises 4/5 of total cropped areas. It is also interesting to note that the production of food grain has not maintained the status quo over the years, although there was a significant difference in crop yields in the irrigated and rainfed

areas. In recent times, however, there is an increasing trend to opt for cash crops, especially vegetables and fruit cultivation that may impact overall food grain production in near future. The cultivation of off-season vegetables, fruits, and medicinal plants has become popular in recent years. As a result, though production of rice and maize is declining, interestingly, the area under wheat production is nearly the same because of its preference in the northwestern region. In shifting cultivation (jhum) areas on average 8-35 crops are grown together that include cereals and grains, leafy vegetables, tubers, and rhizomatous crops. The crop combinations vary with the site and fallow-length of the jhum fields. Grain- and seed-yielding crops give high yield after a longer jhum cycle (60 years), although leafy vegetables, tubers, and rhizomatous crops perform better in areas with shorter jhum cycles (5-10 years). In recent times, however, the jhum cycle has been shortened to 5-10 years due to growing population and food demand. Other than jhum cultivation, the region also supports wet rice cultivation in the valleys. An excellent innovation in wet rice cultivation is the introduction of fish that maximize crop output (Apatani community). In the northeast region, home gardens are also maintained to meet diverse household needs. Most of the Himalayan communities had food self-sufficiency in the past, however, in view of small, fragmented and largely unirrigated fields most of them perform as subsistence types.



Figure 9. Traditional maize drying method

Nearly 10 to 20% of the total cropped area is under fruits and vegetable cultivation. Apples, walnuts, apricot, peaches, plums, mangoes, litchi, etc. are major fruits of northwestern states, while citrus; banana, orange, betel nut, and pineapple form the main fruits of northeastern states. Jammu & Kashmir alone produces 60% of apples in the country. In all states, fruits, vegetables and spices are now being produced as major cash crops. These comprise of potato, cabbage, broccoli, cauliflower, tomato, capsicum, brinjal, radish, chilies, ginger, turmeric, kalajeera, etc.

Apricot in Ladakh, Saffron in Jammu and Kashmir, large cardamom in Sikkim, tea (Assam, West Bengal hills, Himachal Pradesh, Uttarakhand, Sikkim, Meghalaya), and turmeric and ginger in all northeastern states form main niche crops. Such crops have specific advantages that can be harnessed for good market gains and livelihood promotion. Various states in IHR have also successfully introduced floriculture, apiculture, mushroom cultivation, pisciculture, sericulture, and dairy. All these sectors comprise the significant scope of diversification and agro-processing. As such, the expansion and diversification of horticulture is taking place at a higher pace in all IHR states, although it is much faster pace in northwestern states than the northeastern states. Such change is bringing positive impact on the income of farmers thus has significant implications for food and economic security in all IHR states.



Figure 10. Animal husbandry related activities

Livestock rearing has been an integral part of mountain farming that are used for dairy, meat, draught power, wool, manure, and farming purposes. IHR states maintain over 55 million animals of which nearly 50% are cattle, 17% goats, 12% buffaloes, and 9% sheep. At mid-hills animals are integral to mixed cropping while at high altitudes, and the economy is largely livestock-based. Since there are pastures and meadows to maintain animals, and communities possess significant knowledge regarding livestock rearing and breeding, therefore, it becomes easier for the communities to rear animals. Certain animals, e.g., pashmina goats in the highlands of Ladakh, yak in all high altitude areas, cow and buffalo in central Himalaya, and *Mithun* in Arunachal Pradesh and Nagaland are unique to the region. For smallholders, animals supplement household income. In recent times there is increasing focus to opt for hybrid animals. At places, there is an inclination for poultry and goateries in some areas. Piggery is also being promoted in some northeastern states. A large share of animal feed is collected from wild areas. Fodder availability during the lean period (winters) is a major challenge in the northwestern states. Therefore, various state governments are taking up fodder development programs as an integral part of agriculture development. There is significant scope to uplift livestock status that can provide many avenues for the development of animal products and farm incomes.



Figure 11. Pastoral lifestyle in Himalaya

Some success stories

Jammu & Kashmir comprises many success stories related to cereals, vegetables and fruits (Apple, walnut) that are performing very well within the state. Farmers grow Saffron in Pampore as a major cash crop and it is spreading fast to other states as well. Many other farmers are also cultivating Basmati rice and rajmah (pulses) as cash crops in Jammu region and earning good income. Apples, barley, cherries, oranges, peaches, pears, saffron, sorghum, and vegetables, rapeseed, mustered, kaljeera, kuth, and many medicinal plants are exported from the state and provide livelihood to numerous households.

In **Himachal Pradesh** farmers earn good cash by selling fruits and vegetables. The state has adopted a diversification approach and focuses on the production of seasonal and off-season vegetables including potato, ginger, soybean, oilseeds, and pulses. Many farmers own commercial orchards of apple, peach, pear, almond, etc. Tea is also successfully grown,

Uttarakhand is also performing well in agriculture sector and there are many success stories within the state. Several farmers have adopted vegetable and fruit cultivation. Cultivation of seasonal vegetable comprising tomato, peas, cabbage, beans, cucurbits, etc. is getting more local attention. In pockets cultivation of kidney beans, malta-orange, apple, peach, pears have successfully adopted by farmers and earning good income. Also, medicinal and aromatic plant cultivation has been introduced in many parts.

In **Arunachal Pradesh**, at places vegetable cultivation has been adopted by entire village. Cultivation of fruits (pineapple, banana, oranges, kiwi), and spices (large cardamom, ginger, turmeric) have got fair beginning. The state also has a Kiwi Growers Cooperative Society, and in Ziro valley kiwi wine brewery has been established by some progressive farmers, which is first of its own kind in the country, and rewarded by United Nations office and NITI Aayog. Green tea production and rubber plantation are also popular.

In **Assam**, the communities in Karbi-Anglong and Dima Hasao districts have started extensive cultivation of ginger and producing 30% of the total state's production, which is significant. In

2015 Karbi- Anglong has been accorded GI tag for organic ginger, which is now being exported to European countries. People are now shifting to high-value crops even in shifting cultivation areas. Piper betel is also being cultivated.



Figure 12. Some products of jhum fields in Assam

Meghalaya has many success stories in agriculture sector particularly for turmeric (lakadong variety), strawberry, and pineapple farming. Besides, cashew nuts, ginger, oranges, and betel nut are also being cultivated on commercial scale. Turmeric is cultivated in a substantial area and also being exported. Strawberry and pineapple cultivation is also being practiced in many parts. The state promotes organic cultivation; therefore good market is available for them.



Figure 13. Subsistence market Assam

In **Nagaland**, some successful example of high value crops is adoption of kidney bean (kholar), large cardamom, king chilli, banana, orange, passion fruit, ginger, potato, kiwi, sugarcane, tomato, tea, coffee, rubber etc. Farmers have been opting for such options that comprised significant market prospects.

In **Mizoram**, the crops that are successfully cultivated and showing good income to the farmers, comprised bird's eye chili, turmeric, ginger, tomato, cabbage, passion fruit, grape, kiwi, orange,

lemon, dragon fruit, and tea, rubber, and areca nut. There are also similar positive stories from other IHR states as well.

Source of Income and livelihoods

In the primary sector the agriculture and livestock support nearly 48% and 10% of the total regional income of the small and medium landholders in IHR, respectively. The wage & salary and non-farm business contribute 27% and 9%, respectively. The smallholders meet their income from agriculture, livestock wage & salary, and non-farm business as 53%, 10%, 24%, 13%, respectively, in northwestern states, and 50%, 11%, 30% and 9%, respectively, in northeastern states. The data clearly shows that Himalayan states still exhibit high dependence on agriculture and livestock, which needs to be improvised further for higher income. Therefore, various agroecosystems and food production systems need to be strengthened further through crop diversification, value added processing, and product development that can create considerable livelihood and employment opportunities in the region. Currently, there is a significant knowledge gap in relation to these aspects. The field-based evidences have made it possible to evaluate and assess each agroecosystem for its transition to sustainability by ensuring appropriate planning.

Policies and programs related to agriculture and allied sectors

The central government and various state governments are implementing diverse programs and policies to support the development of agriculture, animal husbandry, and allied sectors. These programs are implemented in the form of central sector, and state and district sectors schemes as per state govt. directives.

Box 4. Profile of major ongoing and new schemes in agriculture and allied sectors

Name of scheme	Major focus
National Mission on Horticulture (since 2005-06)	Promotes holistic growth of Horticulture sector duly ensuring backward and forward linkage.
Rashtriya Krishi Vikas Yojana (since 2009-10)	Promotes innovation and agri-enterprises and entrepreneurship development
National Project on Organic Farming (since 2004)	Promotes production and use of organic and biological sources of nutrients like bio-fertilizers, organic manure, compost for sustained soil health and fertility
National Food Security Mission (since 2007)	To enhance the production of Rice, Wheat, Pulses, coarse cereals and commercial crops
Sub-Mission on Agriculture Mechanization (since 2014-15)	Financial assistance for Farm Machinery Training and Testing Institutes to train farmers, technicians, officials, and engineering entrepreneurs with a focus to demonstrate newly developed equipment and post-harvest technology and management.
Rainfed Area Development and Climate (since 2014-15)	Promotes integrated farming system activities to enhance farm returns and to mitigate the impacts of drought, flood or other extreme weather events through conservation technologies
Dairy Entrepreneurship Development	Supports farmers, entrepreneurs, NGOs, companies, groups

(since 2010)	of organised and unorganised sectors
Agricultural Extension (since 2010)	Aims to reach out to farmers to disseminate/ refine frontline agricultural technologies through access to local technologies, distribution of seeds, etc.
Sub-Mission on Agriculture Extension (since 2014)	Improves income and livelihoods of small and marginal farmers and contribute to the achievement of faster, sustainable and more inclusive growth.
Agriculture Census and Statistics	Agricultural census including agricultural economy policy and development & improvement in agricultural statistics etc.
Soil Health Card Scheme (SHC) (since 2015)	To measure soil quality
<i>Pradhan Mantri Fasal Bima Yojana</i> (since 2016)	Covers the entire agriculture cycle for losses arising out of prevented sowing and mid-season adversities.
Mission for Integrated Development of Horticulture (MIDH) (since 2014)	Aims for holistic growth of the horticulture sector covering fruits, vegetables, root & tuber, mushrooms, spices, flowers, aromatic plants, coconut, cashew, cocoa and bamboo.
Sub-Mission on Plant Protection and Plant Quarantine (since 2014)	To minimize loss to quality and yield of agricultural crops from insect pests, diseases, weeds, nematodes, rodents, etc.
Sub-Mission on Seed and Planting (since 2014)	To strengthen seed sector and to enhance production and multiplication of high yielding certified/ quality seeds of all agricultural crops
National Project on Agro-Forestry (since 2014)	National Agro-Forestry Policy was brought out in 2014 and the scheme focuses on development of agroforestry.
Rashtriya Pashudhan Vikas Yojana (since 2014)	Promoting various component of White Revolution.
<i>Pradhan Mantri Krishi Sinchayi Yojana</i> (PMKSY) (since 2015)	Provides end-to-end solutions in irrigation supply chain (Per drop more agri.)
Mission Organic Value Chain Development for North Eastern Region (MOVCDNER) (since 2015)	Developing certified organic production, link growers with consumers and to support the development of entire value chain starting from inputs, seeds, certification and creation of facilities, etc.
<i>Paramparagat Krishi Vikas Yojana</i> (since 2015)	Soil Health Management by promoting organic farming / organic village by cluster approach and Participatory Guarantee System of certification.
<i>PM Kisan SAMPADA Yojana</i> (since 2017)	For the creation of modern infrastructure to power growth in the food processing sector.
Farmer Producer Organisations (FPOs) since 2020)	To create 10,000 new FPOs by 2024.

The important schemes are related to promoting agriculture production, organic cultivation, horticulture development, soil health management, extension, plant protection, seed production, credit, insurance, minimum support prices, marketing assistance, marketing, entrepreneurship development, infrastructure development, use of information-technology, mechanization, irrigation, and other related areas. Also, there are programs related to promoting traditional agriculture, agroforestry, pulses, organic value chain, natural resource management, and farmers'

cooperatives. The animal sector also comprises of many schemes related to dairy development, improvising animal breeds, promotion of fisheries, poultry, piggery, etc. Financial support is also provided by different ministries/ departments for setting up infrastructure for new units and modernization of value addition, human resource development, R&D works, etc. some schemes have been just initiated and yet to be reached to the people.



Figure 14. Rice and fish cultivation

The major drawbacks of policy and programs are that they are implemented independently thus largely remain unsuccessful in bringing out an impressive change and impact. A lack of community awareness on most of the policies and schemes was also found to be a major hindrance. This calls for policy planners and implementers to properly disseminate information regarding governmental programs and implement them in an integrated way to support farmers. The programs to be focused on long-term strategy to develop food and agriculture sector by increasing farm productivity, resilience and sustainability. For smallholders, a comprehensive and coherent policy package needs to be developed that can address diverse challenges of the sector and integrate many opportunities at one place. It would greatly benefit them. To realize this, all instruments like extension, information, awareness & education, technology, regulation, financial, etc. need to be brought together in pursuit of local socio economic and environmental goals.

SWOT analysis and strategy for development

For undertaking a comprehensive development of agriculture, a SWOT analysis was undertaken by assessing positive traits and future opportunities along with limitation and possible vulnerability the sector faces. Such an analysis is important for future development of the sector.

Box 5. SWOT analysis and strategy for development

Strengths	<ul style="list-style-type: none"> • Diverse agroecosystems suiting to the different local environment • Century-old traditions & IKS on the farming system and NRM • Family farming & with integral livestock • High diversity of crops and cropping patterns • Combination of economic activities for meeting livelihoods • Women- an important part of farming system • Efficient use of irrigated and rainfed areas • Efficient soil and natural resource management • Niche products- High demand for local produce • Good practices emerged in recent years (dairy, poultry, horticulture, etc.) • Model/ heritage farming • Good policy environment & institutional networks
Weaknesses	<ul style="list-style-type: none"> • Small and decreasing landholdings, and marginal communities • Tough terrain: scattered & fragile lands, women as unpaid labour force • Labour intensive & rainfed conditions (60-80% area rainfed) • Low returns (significant difference in production in rainfed and irrigated lands), • Poor and insufficient forage for animals • Weak market linkages- single entry and exit from states, middle man domination, problem of aggregation • Low awareness on government schemes and policies
Opportunities	<ul style="list-style-type: none"> • High marketing potential of local produce outside the region • High scope of mechanization • Scope of livestock farming • Water harvesting for better irrigation • Replicating successful crops, High yielding varieties (HYV), trials in field areas • Emerging agro-entrepreneurship • Development of marketing infrastructure • Scope for market expansion and value chain development • Expand technology improvement and quality inputs • Smallholder focus in development approach- new job opportunities • Large scale aggregation and processing • Food processing and value addition to local products • Establishing agro-based industries • Scope to intensify farm-based livelihood (dairy, mushroom cultivation, floriculture, apiculture, poultry, sericulture, piggy, MAP cultivation) • Agricultural education & entrepreneurial skills of rural communities
Threats	<ul style="list-style-type: none"> • Youth opting for white-collar jobs- less interest to agri. and allied activities • Migration to urban areas, women headed households • Significant difference in regional development (hills and plains) • Limited R&D on most local crops (high altitude) • Wild animal menace • Disease and insect-pest • Land abandonment, and degradation of soil quality and NRs • Attitude towards traditional agriculture- backward, low-profit • Climate change

An analysis of SWOT clearly revealed that there are more strengths and opportunities than the weakness and threats. Therefore, the agriculture and allied sectors can be targeted simultaneously for bringing a better livelihood and income to rural landscapes all over IHR.

A sustainable approach for rural livelihoods in IHR

The agriculture sector engages 60-85% workforce in IHR and it would remain so for the next many decades. Therefore, sustainable development of the region needs to build on the strengths and opportunities of the agriculture and allied sectors along with tackling its weaknesses and threats. Diverse agro-pastoral practices are undertaken to sustain livelihood at varied agro-climatic conditions and elevations that possess a significant challenge to address all of them. Over the years the growth in agriculture sector has been slow. As a result the contribution of agriculture to net GDP decreased substantially over the past few decades. The region also observed a significant demographic change in recent times. There are challenges to get proper employment within the region, therefore, younger population are migrating outside for education and jobs. Considering that farming systems have access to maximum population the sector needs to be developed for better livelihoods and retention of population in villages. It is more important because despite all odds still 50% of the rural population will be dependent on agriculture as the main economic activity even by 2050. Therefore, farming systems should be developed not only for mere productivity enhancement but for employment, jobs and cash needs. For this all food productions systems need to be strengthened for three important aspects of the agricultural economy (i.e. production, processing, and marketing). Also, proper synergy need to be developed between agriculture and allied sectors, viz., crops, horticulture, livestock, fisheries, forestry and the associated natural resources.

Box 6. Consideration for agriculture development in IHR

Mountain specificities: inaccessibility, marginality, fragility, diversity or heterogeneity, natural suitability (niche), human adaptation mechanism

Physical factors: Terrain, topography, Slope, altitude, climate (harsh winters), length of growing season, soil, conditions, moisture availability,

Socio economic factors: Land tenure, land tenancy, size of the landholdings, size of fields, and land reforms, small landholdings, rainfed agriculture, low productivity, poor production management, labour shortages, poor post-harvest management, high wages of labour, weak market networks (lack of market development) and lack of entrepreneurship skills, Migration in search of employment

Institutional factors: The smallholder farmers are constrained by many problems including those of poor access to modern inputs and credit, poor infrastructure, inadequate access to markets, market information, land and environmental degradation, inadequate research and extension services, etc.

Infrastructural factors: Irrigation, credit and marketing, storage, facilities, crop insurance, electricity, roads & transportation system, storage facility, training, skill and upskilling, linkages with markets

Technological factors: Availability of high-yielding varieties (new seeds), chemical fertilizers, insecticides, pesticides, farm machinery & mechanization, research & technological backups

Other factors: wild animals, preference for white-collar jobs, change in attitude, globalization leading to depletion of local products and processes, lack of certifying agencies body for high value produce.

In the Himalayan region, all developmental activities are greatly influenced by mountain specificities that are not only interrelated but also show considerable variability even within a state. A better understanding of mountain perspective-based development strategies are essential for formulating farmer's responsive plans, giving due consideration to marginality, fragility, diversity and niches of each area. In addition to different factors that influence agriculture like topography, soil, climate, monsoon, length of the growing season, irrigation, types and quantity of inputs, availability or adoption of different technology and local landscapes.



Figure 15. Alder based agroforestry, Nagaland

To devise future actions, assessing performance of local agroecosystems is a prerequisite along with mapping high-value agri-produces. Also, a better understanding of local physical, socioeconomic, and institutional factors is highly desirable. The smallholders are constrained by many problems including those of poor access to modern inputs and credit, facilities, market information, etc. Farmers' capacity and support system need to be rejuvenated along with requisite infrastructure and technological backups. Their access to technical know-how, credits, and policies need to be augmented. Diversification and intensification of agriculture, access to quality inputs, increasing water use efficiency are some other areas to work into. Increasing cropping intensity and off-seasons cultivation through protected cultivation (vegetables, backyard gardening), developing proper linkages between agriculture and allied sectors as well as with rural enterprises can bring desired results. A strong approach for marketing to earn cash and better livelihood will strengthen market based infrastructure. This requires proper strategy along with an enabling environment and policy support to make agroecosystems and food production systems sustainable both economically and ecologically.

Also, undertaking R&D on traditional crops to produce HYVs of potential local crops and animals, natural fertilizers, integrated pest management, and market-oriented production are highly desired. Such locally developed high yielding varieties (HYV) of rice, wheat, maize, millets, oilseeds, pulses, spices, fruits, vegetables, medicinal plants, spices, etc. adapting to the local environment with resistance to diseases and pests will go a long way for developing local farming section across the length and breadth of the IHR. All these requires appropriate policy reforms along with the effective implementation of Govt. schemes.

Based on the FAO framework, the agroecological performance evaluation of agroecosystems was undertaken by characterizing them on a 10-point scale for assessing **diversity, synergies, efficiency, recycling, resilience, human and social values, co-creation and sharing of knowledge, culture and food traditions, circular and solidarity economy, and responsible governance**. These points are important to make all food systems sustainable. A total of **25 agroecosystems** across eight IHR states were assessed for agroecological transition that are managed under different socio-cultural and territorial landscapes with varied governance arrangements. Different agroecosystems exhibited a varied pattern of the current state of transition to agroecology in different states.

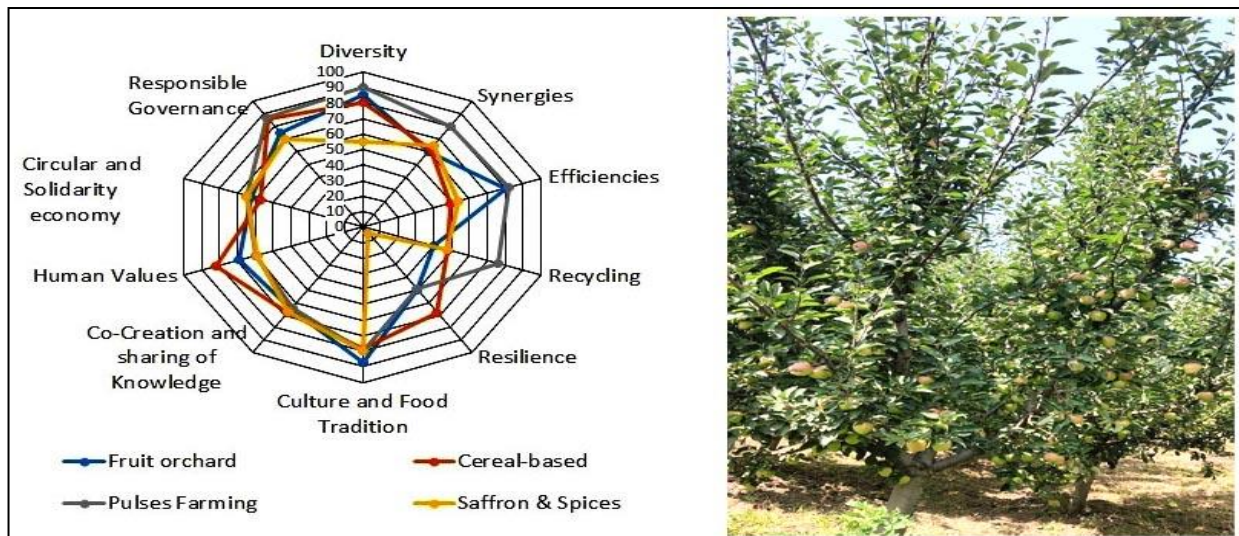


Figure 16. Visualization of the result of characterization of agroecological transition of four agroecosystems in the state of Jammu & Kashmir

In **Jammu & Kashmir**, a total of four agroecosystems were evaluated comprising cereals-based (paddy, maize), pulses-based, fruits-based, and saffron & spices-based. In terms of 10-point characterization the mean calculated scores for different agroecosystem ranged between 57 to 73% in the state. Individually, these agroecosystems scored 48 to 82%, 49 to 90%, 40 to 87%, and 5 to 80% for cereals-based, pulses-based, fruits-based, and saffron & spices-based agroecosystems, respectively. The data revealed that there is enough enabling environment in the state for managing agroecosystems. However, in the case of saffron & spices-based agroecosystem proper resilience need to be built for its sustainability. In **Himachal Pradesh**, three agroecosystems, viz., cereal-based, agroforestry (cereal + fodder), and fruit farming were investigated and the mean calculated scores ranged between 29 to 44%. Independently, the scores for three agroecosystems ranged between 25 to 62%, 10 to 49%, and 16 to 52%,

respectively. The data reveals that there is a strong need to activate policies and interventions for strengthening various characteristics of agroecology to make these systems sustainable.

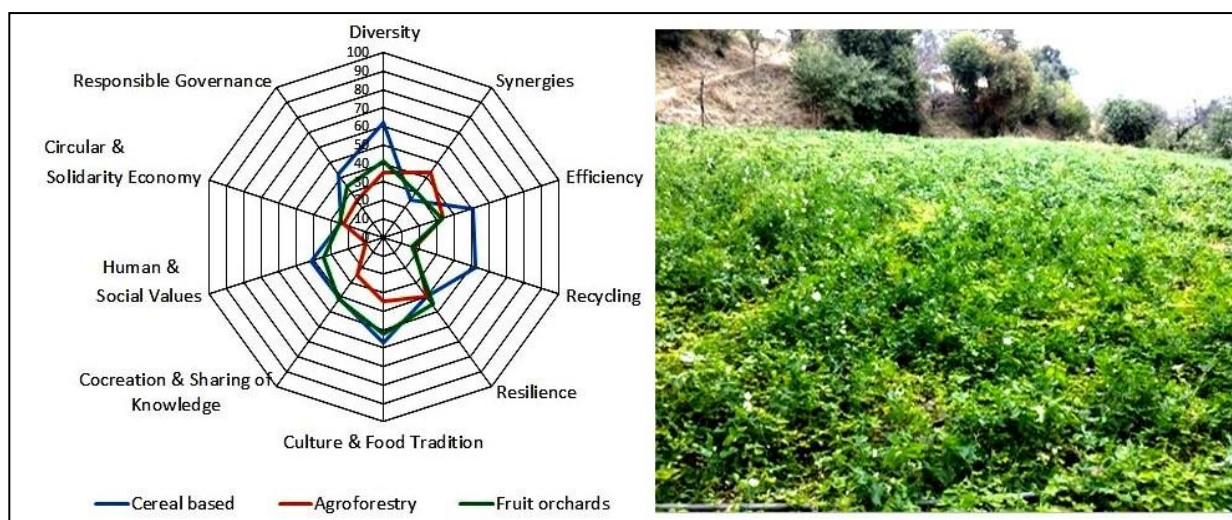


Figure 17. Representation of the result of characterization of agroecological transition of three agroecosystems in the state of Himachal Pradesh

In **Uttarakhand** state, a total of four agroecosystems, viz. Cereal-based (rainfed), rice-based (irrigated), orchard-based (apple and malta), and vegetable-based were assessed for their agroecological transition. The average calculated scores for these agroecosystems ranged between 57 to 67% (Fig. 6). The individual score for these four agroecosystems recorded as 42 to 83%, 42 to 83%, 38 to 81%, and 50 to 83%, respectively. The data revealed that responsible governance and the circular economy of cereal-based systems need to be improvised.

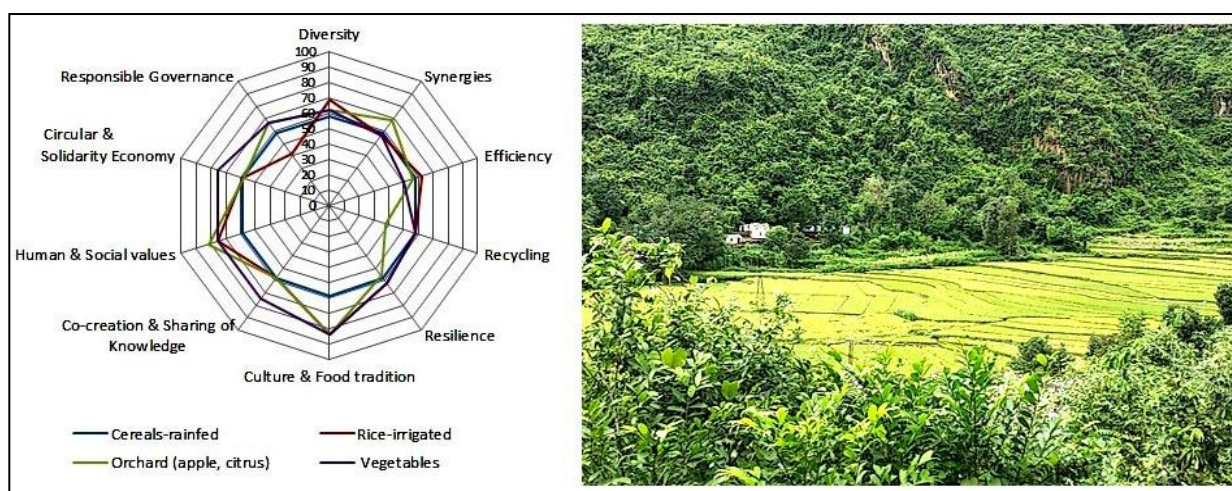


Figure 18. Visualization of the result of characterization of agroecological transition of four agroecosystems in the state of Uttarakhand

For **Assam**, two hill districts were targeted to assess the agroecological transition, both comprised shifting cultivation-based agroecosystems. The mean calculated scores ranged between as 38 to 38%. Individually these agroecosystems scored 20 to 65% and 15 to 65%. The

low score could be because of continued deterrence by all agencies for shifting cultivation practice.

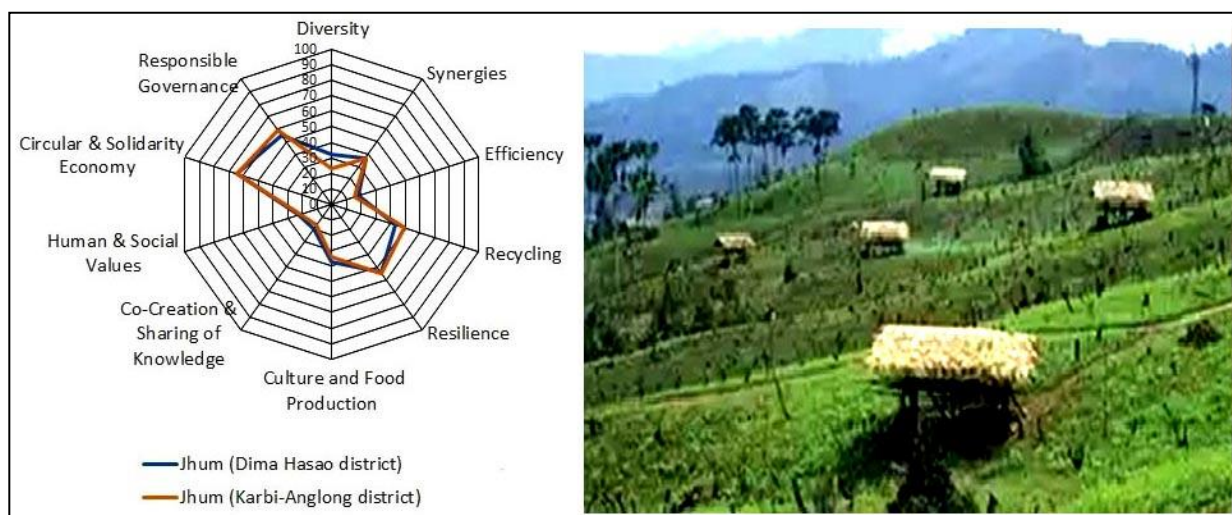


Figure 19. Visualization of the result of characterization of agroecological transition of two shifting cultivation based agroecosystems in the state of Assam

In **Meghalaya**, a total of four agroecosystems were investigated that comprised mixed-farming, agroforestry, terrace cultivation, and shifting cultivation. The mean scores ranged between 50 to 56% for various agroecosystems. Individually, these food systems scored 40 to 65 for mixed-farming, 32 to 62% for agroforestry, 40 to 62% for terrace cultivation, and 42.64% for shifting cultivation. The data reveals that terrace cultivation is performing better than the other systems.

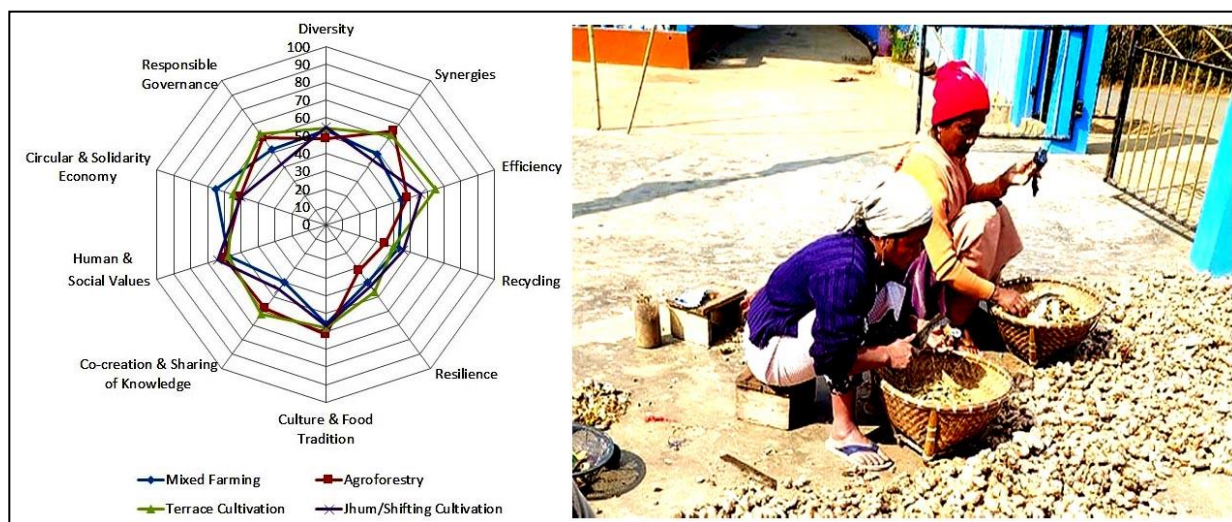


Figure 20. Visualization of the result of characterization of agroecological transition of four agroecosystems in the state of Meghalaya

In **Nagaland**, the four agroecosystems, viz. mixed farming, agro forestry, terrace cultivation, and shifting cultivation were investigated and collectively the score ranged between 54 to 62%. Individually, these agroecosystem exhibited a score 40 to 79% for mixed farming 26 to 81% for agro forestry, 30 to 69% for terrace cultivation, and 19 to 79% for shifting cultivation.

In **Mizoram**, a total of four agroecosystems were evaluated that comprised shifting cultivation, agro forestry, mixed farming, and terraced cultivation. The mean calculated scores for these

agroecosystem ranged between 47 to 55%. Distinctly, the shifting cultivation scored 42 to 68%, agro forestry 38 to 84%, mixed farming 39 to 64%, and terraced cultivation 38 to 62%.

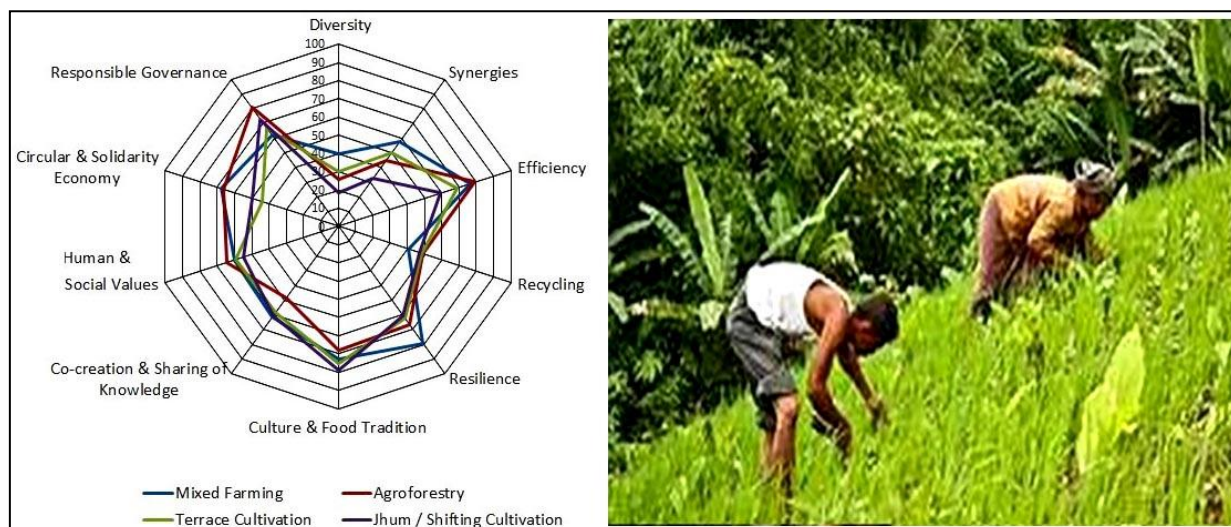


Figure 21. Visualization of the result of characterization of agroecological transition of four agroecosystems in the state of Nagaland

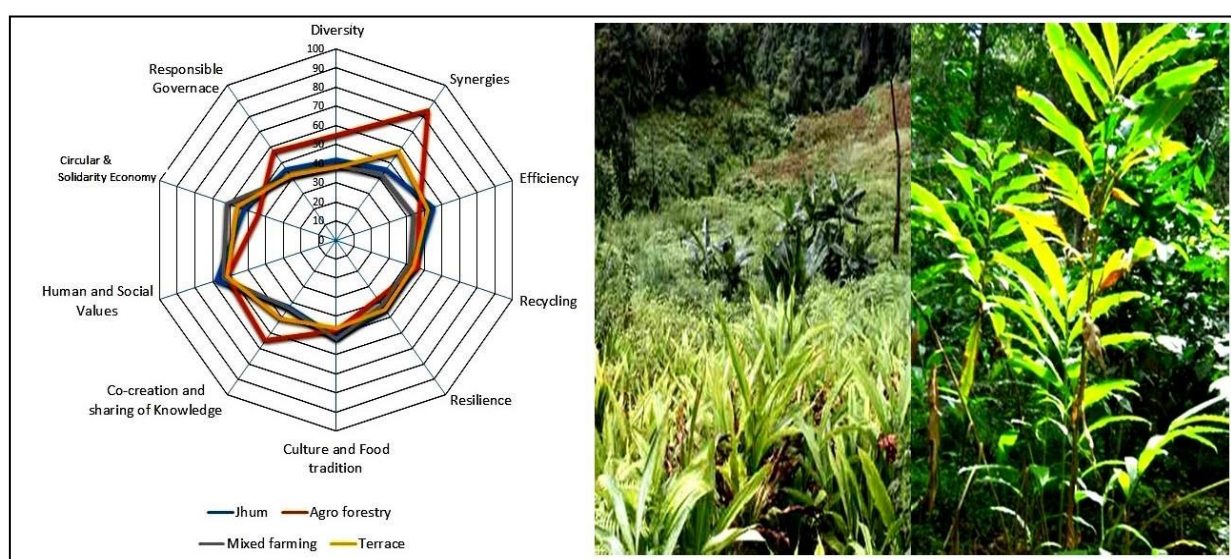


Figure 22. Visualization of the result of characterization of agroecological transition of four agroecosystems in the state of Mizoram

The data for different state revealed that significant efforts are required to improvise various agroecosystems on agroecological principles for managing them as a sustainable food production systems. These agroecosystems are managed at different altitudes, topography, environment, and socio-economic settings with a varied level of inputs. The agroecosystems that scored above 70% are advanced agroecological systems and currently, only the pulses farming in Jammu & Kashmir fall in this category. Those who scored between 50 to 70% are in transition to agroecology that covered all agroecosystems of Jammu & Kashmir, Uttarakhand, Meghalaya, Nagaland, and agroforestry in Mizoram. The agroecosystems with scores of <50% are non-

agroecological systems even if they are subsistence or conventional or market-oriented agriculture systems.

The data clearly showed that all states will have to work on local approaches, reforms, programs, and policies through an enabling environment to support and strengthen various agroecosystems and food production systems to manage them sustainably. An assessment of all agroecosystem on a 10-point scale also provided an opportunity to analyses as how and why different agroecology characteristics need to be strengthened. For example, **‘diversity’** in agroecological systems is key to ensuring food & nutrition security as well as enhancing natural resources. The diversity score across IHR states ranged between 23 to 90%. Most agroecosystems in IHR exhibit mix cropping comprising cereals, pulses, fruits, vegetables, animal products that enhances our food diversity as well as nutritional, socio-economic, and environmental benefits, Besides, it also creates more market opportunities. **‘Synergy’** in agroecosystems exhibits a crop-pulses, crop-livestock-aquaculture, and crop-tree (agroforestry, silvipastoral, agri-silvi pastoralism) integration comprising a combination of annual and perennial crops in farms. Such combination will bring a positive effect on yield, dietary diversity, soil health and fertility, pest control, etc. Across investigated systems it was estimated between 25 to 84%. Synergy is must for higher production and multiple ecosystem services (pollination, soil health, etc.).

‘Efficiency’ of agroecosystems is rated better if it is dependent more on local rather than external resources. It speaks of efficient use of natural resources (soil, water), biomass recycling, and management of soil fertility, diseases, and pests. Among all investigated agroecosystems it scored between 15 to 82% thus desire site-specific approaches to improve their efficiency. **‘Recycling’** of nutrients, biomass, and water within agroecosystems is important for sustained production. Among various studied agroecosystems it scored between 16 to 76%. In some investigated crop-livestock systems, it was observed that the crop residues are used as forage for livestock, and animal-manure is used as farmyard manure for agricultural fields. Similarly, in agroforestry, deep-rooting trees are preferred as these capture nutrients at lower soil depth thus help in annual crops. Therefore, such stands scored higher ranks.



Figure 23. Introduction of cash crops in jhum fields in NE

‘Resilience’ of agroecosystems is linked with stability of production and income over a period of time. For example, more diversified agroecosystems exhibit more capacity to recover from perturbations and extreme weather events (drought, floods). In this investigation, the range of score for resilience was estimated between 5 to 79%. Another important aspect of sustainability to agroecosystems is **‘Culture and food traditions’** that provide diversified and culturally appropriate diets to ensure better food and nutritional security, and a score of 34 to 87% was calculated for various investigated stands. It expresses human heritage and behavior by promoting the production and consumption of local foods.

Local agroecosystems also support **‘Co-creation and sharing of knowledge’** by a process of collective and participatory learning, sharing of knowledge, and novelties practices by farmers in their local environmental, social, economic, and cultural setups. This investigation recorded a score of 17 to 68% for different agroecosystems. Consideration of **‘Human and social values’** helps in caring and enlightening local livelihoods. This study recorded a score of 10 to 82% for different agroecosystems. The human and social values bring a family farming approach with greater equity, social well-being, and women and youth empowerment. Besides, it helps to devise adaptive capacities of communities and empowers them to overcome poverty, hunger, and malnutrition.

Also, the **‘Circular and solidarity economy’** of local food systems, which comprises of varied products and services, markets, and networks of producers, intermediaries, and consumers, is a key consideration for sustainable livelihoods. This study recorded a score of 25 to 75% for different food systems. High scores for some systems can be attributed to the preference to local food products and some of these are sold in local markets (weekly hats) thus supporting to farmers’ income. And finally, a sustainable food system also requires **‘responsible and effective governance’** for access to land and natural resources to support producers to transform their systems, traditional and customary governance, producer organizations, market regulations, etc. Various investigated agroecosystems recorded a score between 25 to 87%. Better governance can be achieved by creating an enabling environment (implementation of proper legislation, policies, programs, public investments, institutions, and research priorities) by local and central governments.



Figure 24. Strengthening home gardens

Improvising performance of agroecosystems

The foregoing discussion clearly revealed that there is enough scope for all states to improve the performance of existing agroecosystems to improvise them for agroecological transition based on agroecological principles so that they are developed as sustainable food production systems. This investigation provides a basis for evolving diverse food systems as per local agronomic, environmental, economic, and social dimensions. It would greatly help all the communities all over the Himalayan region. For this, all states in IHR will have to work on location-specific strategies, policies, and programs to support and strengthen all local food systems to manage them scientifically. The key dimensions for facilitating policy processes and enabling environment comprised **health & nutrition, economy, society & culture, environmental, and governance** considerations as well as increasing access to healthy and nutritious foods, safe and sustainably-produced food through markets, food environments, and enabling policy environments.



Figure 25. Wet rice cultivation in North East region

Health & nutrition perspective of agroecosystems speaks dietary diversity in the form of food grains, vegetables, roots and tubers, fruits, spices, and animal products that bring wide variety in local food practices which should be promoted. At the same time exposure to pesticides & insecticides should be minimized. Although the use of pesticides is negligible in most agroecosystems except for commercial farming systems.

Economy perspective of agroecosystems comprises status of productivity, income, and added value that needs to be improvised by managing soil health, access to water, quality seeds and other inputs, and

the package of practices suited to the crop and the agroecological region. Proper linkages between agriculture productions with market can transform rural livelihoods. Value addition to farm produces will increase the profitability of the farmers by empowering smallholders and poor section of the society and will also provide quality food to the consumers by reducing post-harvest losses.

Society & Culture perspective of agroecosystems recognizes women's empowerment and youth employment opportunity. The status of women's empowerment seems to be satisfactory though there is wider need for them to be involved in decision-making in agricultural activities. Youth employment opportunities need to be built through agricultural diversification, processing, and value addition. At present, the youth interest was seen mainly in commercial activities. At many places, they were found to be more inclined for white-collar jobs. There is a need to focus on the promotion of self-employment and entrepreneurship development.



Figure 26. Commercial fruits of North West region

Environmental perspective brings in the sustainability of food production systems that can be ensured by maintaining agricultural diversity and soil health. Maintaining the diversity of crops, animals, and trees on farms will improve the status of the agroecosystems. Also, maintaining soil health will increase the sustainability of food production systems.



Figure 27. Pineapple and ginger cultivation introduced in jhum fields

Governance perspective is important to cover all the above said aspects. It is required for secure land tenure to farmers for performing agricultural activities. In northwest states (Jammu & Kashmir, Himachal Pradesh, Uttarakhand) the communities own their agricultural land and perform activities as per their choice. In the northeast, however, shifting cultivation is undertaken on community lands and people have the customary rights on such lands that are limited only to cultivating the land. To help farmers to strengthen local food production systems there is a need to work with communities for locally applicable terms and land tenure types, including tenures that are legally recognized and documented. The comprehensive package of land tenure modules that cover individuals and households can be improved with needful changes of land use as per local choice to be adopted for the benefit of the communities.

A proper consideration of five key dimensions of agroecosystems (governance, economy, health & nutrition, society & culture, and environment), therefore, is greatly helpful in facilitating policy processes. There is a need to see the trends in farming practices and structures, consumer tastes, and agro-food industries and the effects they will have on sustainable farming. Also, there is a need to improve our understanding of the sustainability of farming systems and technology, particularly in the context of future demand for food and other agricultural products. Government's and market forces' role in stimulating the adoption of appropriate technologies to improve productivity, income, and sustainability at the farm level need to be considered. The sustainability of agroecology lies if it is capable of renewing itself as well as providing an

attractive avenue for youth to take up a career in farming. It can only be done by adopting appropriate technologies, implementing innovative approaches, encouragements, investments, and enabling policy backups. Such an approach will lead to a higher level of production from agroecosystems by converting them in economically-viable agriculture to facilitate a vibrant rural economy.



Figure 28. Rice threshing in North East

Mapping high-value Agri-produces

The study identified diverse agribusiness models all over IHR, although most of them face challenges. All states have a maximum area under food grains (cereals and millets), followed by fruit, vegetables, and spices. In recent years, cultivation of medicinal & aromatic plants, floriculture, and aquaculture have also been introduced. Besides, animals and their products also play a key role in local livelihoods. As such, a wide variety of commodities and value-chains with diverse actors have been identified.

In **Jammu & Kashmir** other than cereals (including basmati rice), pulses, saffron, fruits (apples, pears, cherries, plums, grapes, pomegranates, mulberry, peaches, apricots, walnuts, and almonds) are important cash crops, and the state is doing very well in these crops. Floriculture and aromatic & medicinal plants has also been adopted in recent years. In temperate region, Gucci mushrooms owe the highest prices; however, its collection from wild habitats is often done illegally. For better returns, there is need to increase market related awareness among farmers along with due support of technical know-how and timely supply of quality planting material and other inputs.



Figure 29. Some commercial vegetables and spices

In **Himachal Pradesh**, other than the food grains (rice, wheat, maize), vegetables (potato, peas, cauliflower, cabbage, pumpkin, radish, turnip, tomato, brinjal, etc.) have been grown on a commercial scale. Also, spices including garlic, onion, turmeric, kalajeera are grown. The state also produces significant quantity of various temperate fruits (apples, pear, apricot, plum, peach, walnut, almonds, etc.). In many places, grapes, papaya, guava, mango, litchi, loquat, fig, orange,

lemon, pomegranate, kinnow, galgal, and kagzi lime are performing very well. The important marketing channels are in the form of intermediaries, local market and mandis. The CSIR-IHBT Palampur has also started trial production of Kesar and Heeng, and Tulip garden developed by it is a source of tourist attraction. Cinnamon cultivation is also one of the important achievements of this institution.

Uttarakhand state is performing well in marketing of foods such as cereals, millets, pulses, fruits (mango, apple, litchi, malta, orange, pear, peach, plum, papaya, and nuts), vegetables (potato, onion, beans, cabbage, cauliflower, tomato, bottle gourd, and radish, carrot, cucurbitaceous crops) all over the state. Besides, ginger and turmeric are also grown. Recently Kiwi fruit and MAP cultivate are also introduced and performing well. However, marketing facilities are need to be extended in rural areas.

Arunachal Pradesh produces rice, maize, and finger millet as major crops along with beans, tapioca, yam, sweet potato, chilies, and other vegetables. Besides, large cardamom, ginger, large cardamom, pepper, banana, cotton, tobacco, sesame, and apple, orange, and kiwi fruits are also produced and sold in the state.



Figure 30. Pisciculture

In **Meghalaya**, rice and maize are the major food crops, while orange, pineapple, lemon, guava, jack fruit, and bananas are important fruits grown and sold. The state also produces and sells potato, areca nut, ginger, turmeric (*Lakadong*), betel leaf, bay leaf, cotton, jute, and black pepper. Areca nut and cashew nut are leading plantation crops followed by tea. A few crops, such as broccoli, colored capsicum, strawberry, passion fruit, rose, lilies, anthurium, carnations, birds of paradise have been introduced in recent times and performing well.

In **Nagaland**, rice is the staple food crop. Although the high-value crops for the state are kidney bean (Kholar), large cardamom, king chilli, banana, orange, passion fruit, ginger, potato, tomato, tea, coffee, rubber etc. Besides, vegetables and spices are also grown in the state. The volume of

production of most crops is low. The important fruits of the state are banana, orange, pineapple, citrus, papaya, pear, peach, plum, strawberry, and nut fruits. In recent time jackfruit, passion fruit, and kiwi are also performing well in the state. The main vegetables are cabbage, cauliflower, tomato, knol-khol, radish, carrot, bean and different cucurbitaceous crops. All of them comprise significant market potential.

Box 7. Potential marketable species in the Indian Himalayan region

State/UTs	Marketed species	Fruits	Niche species
Ladakh	Potato, peas, onion, MAPs	Apricot, apple, sea buckthorn	Apricot, sea buckthorn
Jammu & Kashmir	Potato, peas, Pulses, MAPs, gram, rapeseed, mustered	Apple, walnut	Saffron, Kaljeera, kuth
Himachal Pradesh	Potato, peas, off-season vegetables, Pulses	Apple, pear, temperate fruits	Apple, Almond
Uttarakhand	Potato, tomato, peas, cabbage, other vegetables, pulses, sugarcane, soybean	Mango, peach, pear, apple, litchi	MAPs
Sikkim	Potato, onion, temperate veg., Ginger, turmeric,	Mandarin, citrus, banana	Large cardamom, MAPs, tea
Assam	Chilies, sweet potato, other veg., pulses, ginger, turmeric, black pepper, oil seeds,	Areca nuts, banana, coconut, papaya, mango	Citrus, Pineapple, Ginger, tea
Arunachal Pradesh	Potato, Seasonal veg., chilies, ginger, turmeric, pulses, gram	Apple, orange, Kiwi fruits	MAPs, wild edibles
Manipur	Seasonal veg., potato, onion, chilies, ginger, turmeric	Banana, citrus	Wild edibles, NTFPs
Meghalaya	Seasonal veg., potato, turmeric, bay leaf, black pepper, chilies, ginger, sweet potato,	Mandarin, pineapple, areca nut, banana, Strawberry	Wild edibles, NTFPs, broom grass
Mizoram	Seasonal veg., Pulses, Chilies, ginger, turmeric	Banana, betel nut, citrus, grapes	Wild edibles, bamboo shoots
Nagaland	Seasonal veg., tapioca, potato, Arhar, gram, King Chilli, ginger, turmeric, passion fruit, dragon fruit, coffee, rubber and tea	Citrus, banana, papaya, pineapple	Wild edibles, bamboo shoots, tea
Tripura	Potato, Seasonal veg. Pulses, Chilies, ginger, turmeric	Banana, mango, citrus, papaya, cashewnut	Wild edibles

Mizoram produces various kinds of crops like rice, maize, pulses, oilseeds, pineapple, orange, mangoes, lemons, carrot, lady's finger, cabbage, and peas, etc., in different parts of the state. High-value crops include bird's eye chilli, passion fruit, grape, kiwi, orange, lemon, dragon fruit, rubber, turmeric and areca nut, ginger, cabbage, sugarcane and tea, tomato and squash.

Thus in northwest states, cereals, millets, vegetables and fruits are grown as cash crops and sold in markets. In the northeast region tea and rubber are established cash crops. Sikkim has large cardamom as the main commercial crop. Potato, mustard, ginger, turmeric, areca nut, and betel leaf are also doing well in some northeastern states. In recent times, the cultivation of medicinal plants has also been introduced throughout the IHR. It is notable that niche-specific commercial crops perform much better in the region.



Figure 31. Healthy crop of apple and orange

Assessing existing value chains

All over the IHR agriculture marketing although has a special significance and a direct impact on the economy of farmers and primary producers; however, at present it suffers due to many constraints. The value chains comprises farmers and their activities from obtaining inputs, production in farms, and reaching to markets and consumers through stages such as processing, packaging, and distribution. There are a large number of high-value marketable products, such as cereals, millets, vegetables, animal products, horticultural produce, commercial crops, plantation crops, and medicinal plants all across IHR. Some species deliver agricultural products that are high in value, often but not necessarily due to processing. Such products are often consumer-ready and used as fresh, such as fruits, vegetables, eggs, and nuts. Most products are sold immediately after harvest in raw form without any processing. However, smallholders are mainly constrained due to low marketable surplus that limits their bargaining power and profits. Also, it takes a significant cost to reach the produce to nearby markets. Local marketing is characterized by the low volume and poor quality of products, perishable crops, seasonality, dispersed production, extensive varietal differences, transport bottlenecks, no grading, wastage, etc.



Figure 32. Road side sale of local agriculture production

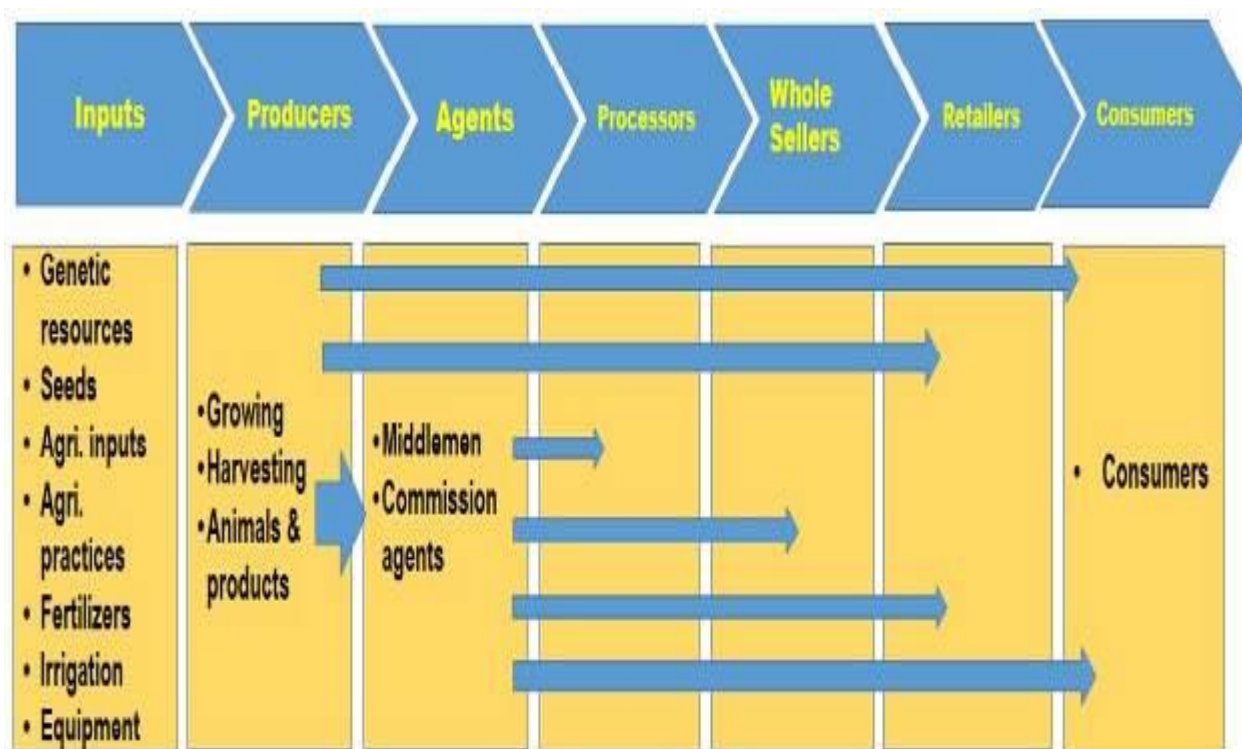


Figure 33. Existing and fragmented value chain of farm produces in various states of IHR

Most farmers sell their produces in the weekly markets, locally called as ‘*haats*’ wherever such facilities are available. Otherwise, the common approach to sell a commodity is through middlemen/ commission agents, who may buy it either for their own use or dispose it to other larger traders in towns or ‘*Mandi*. Generally, cereals, millets, spices, medicinal plants are sold in this way. Some ‘*melas*’ and fairs also play leading roles in the collection of local products. Most commonly the farmers sell their livestock, animal products, vegetable, etc. this way. In places where some bulk products are available, it is sold in ‘*Mandi*’ in towns and cities. Commercial grains, fruits, and vegetables are disposed this way. Another issue was related to highly fluctuating prices for most of the products, particularly for perishable commodities. Private traders (middlemen) play a greater role and largely monopolize village trade in all states. They collect, assemble, grade, store and transport the material to wholesalers/retailers/ consumers. At some places, semi-processed products are also sold in the form of juice, pickle, sauce, marmalade, and packet material (food grains, spices, MAPs, baked items). Exploitation of farmers lead them to continue with subsistence farming. Lack of grading, storage, processing and value addition, and a long chain dominated by middlemen were identified as major issues that limit market prospects. There was also a lack of market information access to credit among smallholders. All IHR states also lack nominal and basic amenities (such as godowns, cold storage facilities, market spaces, processing facilities). Thus, the existing value chains are highly fragmented and loose as there is not a proper relationship between various actors, which results in low earnings for farmers.



Figure 34. Successful introduction of piper betel and areca nut in North East

Facilitating market support and strengthening appropriate infrastructure are important necessities for all the IHR states. It needs good and timely availability of transport facilities, advanced communication system, improved and scientific method of drying, grading, storage, warehousing, and access to finance (credit). It desires aggregation of produce through different well-connected market channels so that the products reach primary (local markets, haats), wholesale, terminal, fairs, and regulated markets. Also, sharing of market information and technology with farmers, and placing the process of certification on board is going to help farmers. Access to markets requires awareness on market information from identifying type, quality, volume of produce, transport to market place, and value addition facilities. Value added processing involves grading, sorting, cutting, packing, and processing of produce. Improvising information and communication technologies (ICTs) networks can play a big role in this. For this, the policies should be planned and implemented in such a way that they can encourage farmers to produce more and directly link them to markets. Strengthening marketing infrastructure also need to be taken up on priority basis.

To improve agriculture and ensure food security there is a need to support farmers with inputs, modern agriculture practices, and technologies to increase farming efficiency and yield per unit area. It requires increasing agricultural productivity, strengthening the consumer value proposition, and enabling policy and related capacity development. To smoothen smallholders' marketing due organizational, functional, and physical infrastructure is needed all across the IHR states. The organizational aspect comprises the state intervention in agricultural marketing by implementing the market regulation as an instrument to offer better prices to the farmers. This would control role of middlemen and private traders. The functional aspect need to take care of the bottlenecks of grading, weighing, pricing, payment, and other marketing operations. The physical infrastructure comprises strengthening of marketing outlets. At present there is a dearth of such facilities all over.

Wide range of products- cereals, millets, vegetables, fruits, pulses, spices, medicinal plants, animal products, forest products, niche-specific crops

Organic produces- high market demand

Sufficient scope to diversify rural income- from diversity of produces

Support to farmers: Ensured inputs, modern agriculture practices, seed, fertilizer, pesticides, farm equipment and machinery etc. and technologies to increase efficiency and productivity

Establishing the consumer value proposition- Better prices of local commodities

Strengthen organizational infrastructure- agricultural marketing, regulations, ownership/partnership to farmers

Functional infrastructure- Improve grading, weighing, pricing, payment, and other marketing operations

Physical infrastructure- proper road connectivity, transport, storage, processing, preservation, marketing outlets, etc

Capacity development- on all aspects of farming and marketing, information on market, etc.

Enabling policies– on all aspects

Box 8. Opportunities related to market

Improvising agroecological performance

Indian Himalayan region exhibits significant dependents upon agriculture as primary occupation. The agroecological performance of the states based on FAO framework not only narrated the ways to improvise them but also captured systems and policies for infrastructure, measures to improve shifting cultivation, and specific technical interventions for IHR states. The agriculture sector in the region is yet to be geared-up for market-oriented approach. Commercialization of the small farm sector requires the bulk production as well as development of modern marketing infrastructure and facilities to handle the movement and marketing of produce in an efficient manner. This requires a focused approach and state-specific action plan.

There is enough space for developing different types of agroecosystems ranging from typical traditional systems to highly evolved and commercial ones. Although the percentage of land under agriculture have not changed over the years, but it is definitely lessening in terms of per family land holding size which is making it difficult to make a livelihood out of it. Therefore, significant efforts are required to address this issue.

Improving traditional and commercial agroecosystems

The investigated agroecosystems comprised a variety of traditional and commercial agroecosystems. Most of the traditional systems have been in practice since time immemorial using family labor with minimum inputs. Traditional rainfed-based food grain cultivation and shifting cultivation are biggest example of it. In traditional agriculture, almost all types of crops are grown with a dominance of food grains. There is also a niche-based agroecology at many

places, such as saffron, fruits, vegetable, large cardamom and other spices, MAPs, etc., which are highly specialized systems at local level. As such, the traditional agriculture is a big gene pool reserve maintain a large diversity of crop varieties comprising food grains, millets, pseudo-cereals, pulses, spices, and wild relatives of crops and vegetables. Most systems are organic in nature, however, there is hardly any certification. However, due to low yield such systems are considered subsistence types and assumed as a symbol of backward economy. Predominant land holdings sizes are small and marginal that are decreasing further year after year thus putting substantial pressure on agricultural land. Due to small holdings the marketable surplus is minimal. Also, there is a change in use of local diets by local and at many places they are slowly shifting to market foods.

In recent times there is an increasing trend to opt for commercial farming that has a direct/indirect linkage with market all over the IHR. Dominance of horticulture crops, such as fruits, vegetables, spices, MAPs, etc. are examples of commercial farming. Most of the young age farmers are opting for commercial agriculture as it brings cash income to them. Although in most of the places the middle men play key role in such operations. Opting for commercial farming although brings good economic remuneration to farmers, however, it may be at the cost of local agriculture diversity. At places, such as in Uttarakhand, people are migrating to towns and cities to earn better livelihood thus abandoning agriculture fields. At many places menace of wild animals on crops is considered main reason to abandon agriculture.

All prevailing agroecosystems (settled and/or shifting agricultural systems) have evolved through a process of long trials and errors and suit local socio-cultural and environmental setups. Therefore, there is a need to strengthen/ rejuvenate these systems on agroecological principles. Adequate technical and financial assistance need to be provided to farmers with due technological know-how for adopting new cultivation methods, multiple cropping to increase cropping intensity, and wise application of agricultural inputs like seeds, fertilizers, plant protection, chemicals, etc. for increased crop production and productivity with proper mechanization (power tillers, pumps, sprayers, field implements, etc.). All states will have to identify region-specific high-value species and products that can improve livelihood and generate employment to rural youths and women. It would be helpful to curb out migration. All states need to work to strengthen road & communication networks along with warehouse facilities, processing units for grading, packing and storage to strengthen supply chains along with streamlining agricultural credit system. Strengthening of rural primary market network, market-intelligence, quality control certifying agency, processing for value added products, and establishment of export-oriented terminal and regional markets with appropriate facilities can help to a great extent. There is a need to promote a cluster-based approach for producing different agro-products along with strengthening of market infrastructure. Opening and strengthening of weekly market '*haat*' in a radius of 5-7 km in the areas where market facilities are not available can help smallholders. The production of surplus agricultural produce and participation in the markets with more bargaining power are key requirements for smallholders to earn better income. In recent years the country has been promoting agriculture marketing reforms with an aim to improve market access to primary producers. The benefit of such schemes should be extended to rural areas in IHR. Developing entrepreneurship skills of farmers is a must, and farmers' cooperatives/producers organizations and cooperative marketing societies

can play a leading role in this. Also, there is need for mitigating the human and wildlife conflict. Overall there is an urgent need for ensuring backward and forward linkage by safeguarding farmers for availability of quality planting material, demonstration of latest technology and up gradation of skills, mitigation from drought, support irrigation, reduction in post-harvest losses as backward linkages, and provide them access of markets as forward linkages for better price realization is highly desirable. All line departments will have to join hands to take up such tasks.

Improving agriculture infrastructure

For sustainable agriculture development, appropriate infrastructure is a prerequisite to deliver local farm products and expand their operations. There are many issues and challenges that need to be tackled immediately to assist farmers to take off and become sustainable across IHR states. It comprises of low production, limited use of modern techniques and inputs, lack of quality and hybrid seeds, fertilizers, herbicides, and deficiency of irrigation and farm/field mechanization. Also, there is poor postharvest handling and limited value addition to agricultural products. As such, there is a lack of volume of agriculture produce that can influence the market. Farmers have limited access to credit, they feel limitation in handling diseases and pests control. Remoteness and poor road network are other key features for most of the areas in IHR that substantially increase transportation cost. This limits in reaching local commodities. As such, there is very poor marketing infrastructure in all the states. Besides, there is an insufficient skills to handle these issues, and women are high marginalized group.

To maintain fairness and equity within and among the agricultural community it is strongly desired to have a strong agriculture infrastructure. Farmers should be organized and encouraged to grow quality and market-demanding commodities, and adopt new technologies to increase agricultural productivity. It is required to increase farmers' competitiveness in future. Therefore, development of agriculture and allied sectors, and building local skills and capacity should go hand-in-hand. Promoting cluster approach can help to produce such commodities in bulk. For this, the producers should be given all possible support from planting material to technological support, post-harvest know-how, and best possible processing and storage facilities. To reach commodities to markets also requires a dependable transportation system. There is an utter need to improvise storage, grading, processing, marketing and distribution of local commodities through a resilient marketing system. Fortunately, in recent years the demands for local commodities have increased substantially. Appropriate policies should be developed and implemented to realize this by creating new jobs opportunities for farmers.

Improving shifting cultivation

Improving shifting cultivation is considered a priority for entire northeast region. A sound and scientific approach is required that fits well as per local socio-economic milieu and livelihood base. It requires involvement of all stakeholders, jhumias, institutions, and concerned citizens to devise a holistic developmental plan for such land. The key consideration comprise local socio-cultural setups, safeguarding native crop diversity, along with conservation of environment and landscapes. As such, there is demand to tackle jhum lands for better income and landuse, and a number of programmes are being implemented for this. Opting for commercial forestry, home gardens, fallow forestry, horticulture, cash crop cultivation, tea cultivation etc. are being promoted in different parts of northeast. Watershed based management, contour hedgerow

farming system technology, sloping agriculture land technology, contour bund trenching, etc. are some technological approaches to restore jhum lands. The success of managing jhum lands vary from state to state. It requires more concerted efforts to rehabilitate such lands using a participatory, location-specific, and farmer-centric approach.

Improving policy measures

Different states have been implementing different agricultural policies at a varied pace. Major policy support comprised subsidies for input, supply of seeds of high yielding varieties and planting material, fertilizers, pesticides, crop insurance, etc. which aim to increase production and income of farmers. There are also policies related to institutional credits in agriculture sector through NABARD and other banks so as to avoid exploitation of farmers from moneylenders. Central/local governments extend support in the form of MSP, Public Distribution System (PDS) of food grains, subsidy during natural calamities, support for protection measures, etc. MSP provides procurement and support prices for various crops to ensure better returns to farmers. The government also run food security program in the form of Public Distribution System (PDS) to supply food grains and other essential goods at subsidized rates and acts as a 'safety net' to poor and marginal people all over the IHR. BPL strata is given special consideration under this. For the benefit of marginal people the government also run various rural employment programmes (such as MGNREGA) to increase their purchasing power.

The major drawback with the policies is that are applied in sectoral way rather than in an integrated manner. Small and marginal holders are least benefitted as they have low volume of production. There is also a frequent complain of timely supply of the inputs and other support. Remoteness also play key role in extending the benefits of policies to far-off villages. There is a strong need to increase advocacy for smallholders.

In recent times, nature-based agriculture is considered a sustainable agriculture form as it optimizes use of ecological processes and integrates them into local farming practice. It has a strong bearing on a local and healthy soil and crop diversity by producing diverse foods within the boundaries of local environment that positively impact climate. Govt. of India has been promoting nature-based agriculture in recent years. Traditional farming should be brought under such umbrella as it comprise significant crops diversity that has significant implications for future particularly for developing new crop varieties. Also, the niche-specific crops has high future prospects for sustainable agriculture. There are many crops that are grown as main crops while some are commercial crops. However, many crops are still considered as minor crops. **This** needs to capture policy focus to promote crops as per local environmental settings. Also, proper policy thrust is required to strengthen market linkages and value chains to farmer income. Promoting Farmer Producer Organisations (FPOs) to motivate farmers by forming location-specific clusters across IHR along with forming CBBOs (Cluster Based Business Organizations) can help to bring proper decision-making, timely supply of inputs, credit, insurance, marketing support and other technical and financial resources close to local agri-clusters.

Specific technical interventions for each state

The IHR states exhibit many common issues that needs to address collectively to realize the fullest possible potential of agriculture. For example, for all agroecosystems, there is a need to

improve agricultural efficiency and enhances agriculture sustainability, which can be done by planting more crops, increasing inter-plantation and plant density, proper manuring, soil health enhancement soil management, and opting for appropriate water use and irrigation facilities. At the same time there is also a strong need to extend technological backups, market support, and credit and insurance facilities for promoting agricultural economy across IHR states. Implementation of land reforms are also desired to improve agricultural productivity particularly in areas under shifting cultivation. It required adequate provision to educate and train farmers, reducing cost of inputs, encouraging women and youths in farming sector, and forming farmer-cooperatives. Selected state-specific suggestions for improving farming sector are narrated below:

Jammu & Kashmir, and Ladakh region

- Promote commercial farming and connectivity to market for those living in hilly areas.
- Grow multiple crops of high market value. For example, maize can be used for corn flakes that can bring more return.
- Encourage vertical farming (in-house) particularly in snowfed and extreme cold areas.
- Promote cultivation of high-value cash crops, such as guchi mushrooms, bell pepper, saffron, olive, lavender, etc. Also, support cultivation of citrus, walnut, picknut, medicinal plants in newer areas as these crops require less water. Also, convert uncultivated land into the farming
- Commercialize animal by-products (cheese, ghee, butter, etc.) and improve accessibility of animal products to markets.
- Promote integrated farming with dairy, horticulture, pisciculture etc..
- Create farmers awareness about government schemes, and organise farming community for market and commercial agriculture, and built their capacity.
- Improve marketing infrastructure including cold storage, processing and value addition facilities
- Create more Farmer Producer Organizations or Cooperatives
- Introduce certification process of local commodities
- Replace conventional agricultural hand tools used in tilling, ploughing etc. with improvised ones.
- Strengthen agroforestry by introducing cultivation of Himalayan Pine tree, a highly demanding species in the valley for house panelling and furniture industry
- Develop agriculture clusters on the concept of ‘one village one crop’ with all support in such pockets.
- Address wildlife menace in agricultural fields.
- Support artificial intelligence, weather based guidance to the farmers.

Himachal Pradesh

- Improve grading, packing and cold storage facilities for different agricultural produces.
- More emphasis required to establish processing units all over the state.
- Rejuvenate ill orchards with proper technical know-how and support
- Proper technical support to uproot old trees in orchards and planting new ones along with financial assistance.

- Develop proper production technology for citrus fruit in lines of other temperate fruits. Improve quality of Himachal Santra varieties.
- Promote cooperative marketing to realize better share to the producers and to remove intermediaries.
- Educate and train farmers in post-harvest management of fruits so that Himachal fruit can better compete with fruits of other state.
- To arrest temporal and spatial price fluctuations, there should be provision of adequate storage facilities.

Uttarakhand

- Strengthen commercialization of local agricultural commodities
- Promote animal based enterprise
- Promote valley-based cultivation
- Use appropriate water harvesting techniques for domestic as well as agricultural purposes.
- Improve marketing infrastructure, setting up of processing units, developing value added products and storage facilities
- Impart awareness and training for value added products and promote local branding
- Develop and strengthen FPOs as facilitators of agriculture development
- Strengthen value chain and promote high value products
- Drastically improve road network and transportation facilities
- Promote rural markets or village ‘hats’ (weekly market) to collect material and increase business skills of farmers
- Promote entrepreneurship development among the rural youths to curb migration by generating local employment and income.
- Use women participation in the decision making process and credit access
- Promote renewable energy use and production among the households.
- Address and mitigate the wildlife conflict in the state
- Effective implementation of on-going Govt. schemes

Arunachal Pradesh

- Restore jhum lands as a profitable economic venture
- Strengthen market infrastructure, cold storages, development of ancillary and complementary service network, food processing units, and road connectivity, etc.
- Document local knowledge on agriculture systems and promote lateral integration with scientific knowledge.
- Strengthen village institution and built local skills for agriculture promotion, developing location-specific schemes, use of modern technology, and PHM.
- Adopt location-specific cluster approach promoting agriculture and horticultural crops.
- Support communities in technical know-how, quality planting material and other inputs to derive higher land equivalent ratio (LER), higher productivity and inter-dependency with respect to the inputs.
- Widespread education and awareness on government schemes and programmes. Involve local communities in the policy making and implementation of schemes

- Strengthen supply chain, publicity of local produces, and distributional channel.
- Organize communities and their roles in re-balancing tradition and modern skill and habits, bringing them together in a harmonious way that promotes agriculture production activities
- Promote education related to healthy food production and consumption
- Resolve land ownership issue in a participatory way with a well-structured legal system.
- Support credit and loan to promote agricultural activities by infusing commercial and organic farming in the state.
- Promote biological means to control weeds and insect-pests
- Take appropriate policy reforms, strategies, partnership and interventions of all the relevant stakeholders to achieve rapid socio-economic transformation through agricultural diversification.

Meghalaya

- Support timely delivery of agricultural inputs like seeds, fertilizers, plant protection, chemicals, etc. for increased crop production and productivity
- Convert jhum land into permanently cultivatable tracts.
- Promote local seeds banks to use proper seeds as per soil types and local climatic
- Dissemination of modern technology and new methods of cultivation.
- Promote multiple cropping to increase cropping intensity with all packages of practices of crop production.
- Ensure water supply either through irrigation or rainwater harvesting in rainfed area.
- Promote cultivation of market demanding commodities, and popularize use of fertilizers, HYV seeds, plant protection measures, and integrated pest management.
- Promote use of power tillers, power pumps and sprayers, and train farmers to use them.
- Provide a detailed package of practice on each crop along with postharvest management
- Organise farmers/ groups for proper marketing, develop value chain avoiding middlemen
- Create more awareness of market demands and prices
- Strengthen market infrastructure along with storage, grading, processing, and value addition facilities
- Strengthen road network for transportation of agricultural commodities to markets.\
- Promote cultivation of citrus, ginger, papaya, tapioca, areca nut etc.in clusters with the support of producers' cooperatives, farmers associations, NGOs, and/or autonomous district councils.
- Need to create an export wings to sell agri-produce in outside markets.
- Promote regulated rural markets all over the state

Nagaland

- Manage Jhum cultivation by promoting terrace cultivation, agroforestry, mix-cropping by fostering agri-horti-silvi-pastoral approach by opting for high value and demand-driven market led approach of commodities.
- Promote adoption of animal based enterprise for maximizing profitability.
- Integrate crop-livestock-aquaculture model at farmers' fields
- Manage soil health with mulch crops and residues to maintain productivity.

- Promote water conservation and use techniques.
- Appropriate capacity building for technology adoption to take up high value crops at commercial scale.
- Increase participation of smallholders in markets
- Support market infrastructure, processing units, value addition, storage facilities and local branding
- Promote FPOs in the state to facilitate farmers
- Strengthen local supply chain and avoid middleman in this process
- Support proper transportation facilities, agri-link roads, warehouses, market linkages, access to credit etc. to farmers.
- Involve women in decision making process and access to credit .
- Entrepreneurship development among the rural youths for promoting employment and income, and check migration,

Mizoram

- Build farmers viewpoint on future of agriculture and its prospects in local employment and income by analysing future trends, risks, and opportunities
- Manage shifting cultivation areas for permanent agriculture by promoting horticulture, agroforestry, mix-cropping, etc.
- Identify potential areas for diverse crops along with projections on volume of production, and market potential
- Take forward farming as a sustainable agriculture development strategy with short, medium and long terms goals
- Strengthen farmers support from inputs, technical know-how, package of practice, PHM, marketing, value addition, etc.
- Promote use of renewable sources of energy.
- Encourage farmers to adopt animal based enterprise to maximize income
- Strengthen water conservation and harvesting measures in rainfed areas.
- Build skills and capacity of local farmers for technology adoption and to take up high value crops at commercial scale.
- Strengthen marketing infrastructure, from collection of produce to transport to market, storage, grading, value addition and local branding
- Strengthening supply chain to domestic and international markets.
- Develop appropriate transportation network, market linkages, and access to credit and value addition.
- Take up measures for entrepreneurship development among the rural youths and women to check migration.

Based on the foregoing discussion, a broad framework for developing agriculture should comprise a strong market approach with a focus to increase production base, enhancing management on agroecological principles, and equipping rural areas with infrastructure, funding, and appropriate support systems, and strengthening rural employment. If such an approach can be implemented, it can bring a lasting impact on socio economic status of Himalayan people.

Identification of a workable marketing model

Based on the investigation on status of agriculture in different states, performance assessment of agroecosystems, mapping of high value agri-produces, and assessment of existing value chains, a workable marketing model for sustainable livelihood can be devised to fit into local socio-cultural, economic and environmental setups. The model emphasizes to undertake a holistic approach by targeting agriculture and allied sectors concurrently in the best interest of the communities with a due backing of diverse physical, socioeconomic, institutional, infrastructural, technological backups, and enabling environment.



Figure 35. Commercialization of farming systems in recent years

Framework for transition to agroecological-based marketing

The key considerations for the model are that it should be aiming for marginal and smallholders, consider all the resources that support communities in rural areas, take a cognizance of all actors, infrastructure and existing governance systems in a given region (Fig. 5). It advocates to expand local production base for better access to food and income; improving performance of agroecosystem based on agroecological principles; promote agriculture diversification to increase production of crop, animals, other produces, and cash crops for generating more marketable surplus; support value-added processing and product development; strengthen on-farm activities and off-farm enterprises (farming produces + animal husbandry + aquaculture + forestry) for generating local employment and livelihoods in rural landscapes; strengthen market infrastructure in rural areas; and create an enabling environment for all above for simultaneous implementation. Some important points are discussed in subsequent paragraphs.

Evolving agroecosystems on agroecological principles

Traditional rainfed cultivation, wet rice cultivation, shifting cultivation, vegetable cultivation, agroforestry, home gardens, maintaining firewood species are the most prevalent agroecosystems. The agroecological transitions of the existing agroecosystems need to be addressed with a notion of sustainability. Community knowledge needs to be blended with scientific knowledge for each agroecosystem. Ecological conditions of agricultural farms and adapting existing biological and genetic potential (crops and animals) should be considered

rather than modifying it. Productive potential of crops and cropping patterns and their limitations need to be worked out. Dependence on external inputs should be minimized. Soil fertility management through biological means and efficient nutrient recycling must be promoted. Conservation of soil, water, energy and biological resources need to be promoted. Instead of controlling weeds, pests and diseases there is a need to manage them. Also, the renewable energy sources need to be used.



Figure 36. Processing of agricultural products for marketing

Diversification of agriculture and allied sector

Within agriculture systems, diversification can be done using food and non-food crops, conventional crops and horticulture, high value and low-volume crops, etc. Cropping intensity needs to be increased up to 180% by using the same land for growing more crops. It can be achieved by maintaining a cropping intensity of 60-70% for food grains (cereals and millets), 50-60% for fruits, 40-50% for vegetables, and 10 to 20% for other crops (pulses, medicinal plants, oilseeds, etc.). It can be done either through horizontal diversification by growing multiple crops instead of a single crop and by vertical diversification by opting for horticulture, agroforestry, livestock rearing, medicinal & aromatic plant cultivation, etc., as well as by opting for off-season cultivation. Protected cultivation and poly-film tunnels can also be useful in areas with harsh climates and short growing seasons. Such activities will bring beneficial results for smallholders. It would not only increase food production per unit area but also income of local farmers. At the same time, it will also help in mitigating climate change.

The contribution of agri-allied sectors is also significant in local livelihoods. It comprises livestock (cattle, dairy, sheep, goat, poultry, and piggery), aquaculture (inland fisheries and aqua-farming), horticulture (including fruits, vegetables, flowers, spices, medicinal and aromatic plants- MAPs), and sericulture. All these have significant scope for development and increasing the income of rural communities. Social forestry and plantation crops also comprises of considerable possibilities. Livestock raising & nurturing is done for meat, milk, wool, skin, etc., and breeding purposes. The other benefits are using the livestock for plowing farms, transportation, producing farmyard manure, etc. The dairy provides a substantial opportunity for employment by rearing cows, buffaloes, and goats for milk and its by-products like butter, milk powder, ghee, etc. Taking such activities at the commercial level can provide employment to a

considerable size of the rural population. Farmers need to be encouraged to adopt animal-based enterprises and adoption of improved breeds of animals for higher profitability.

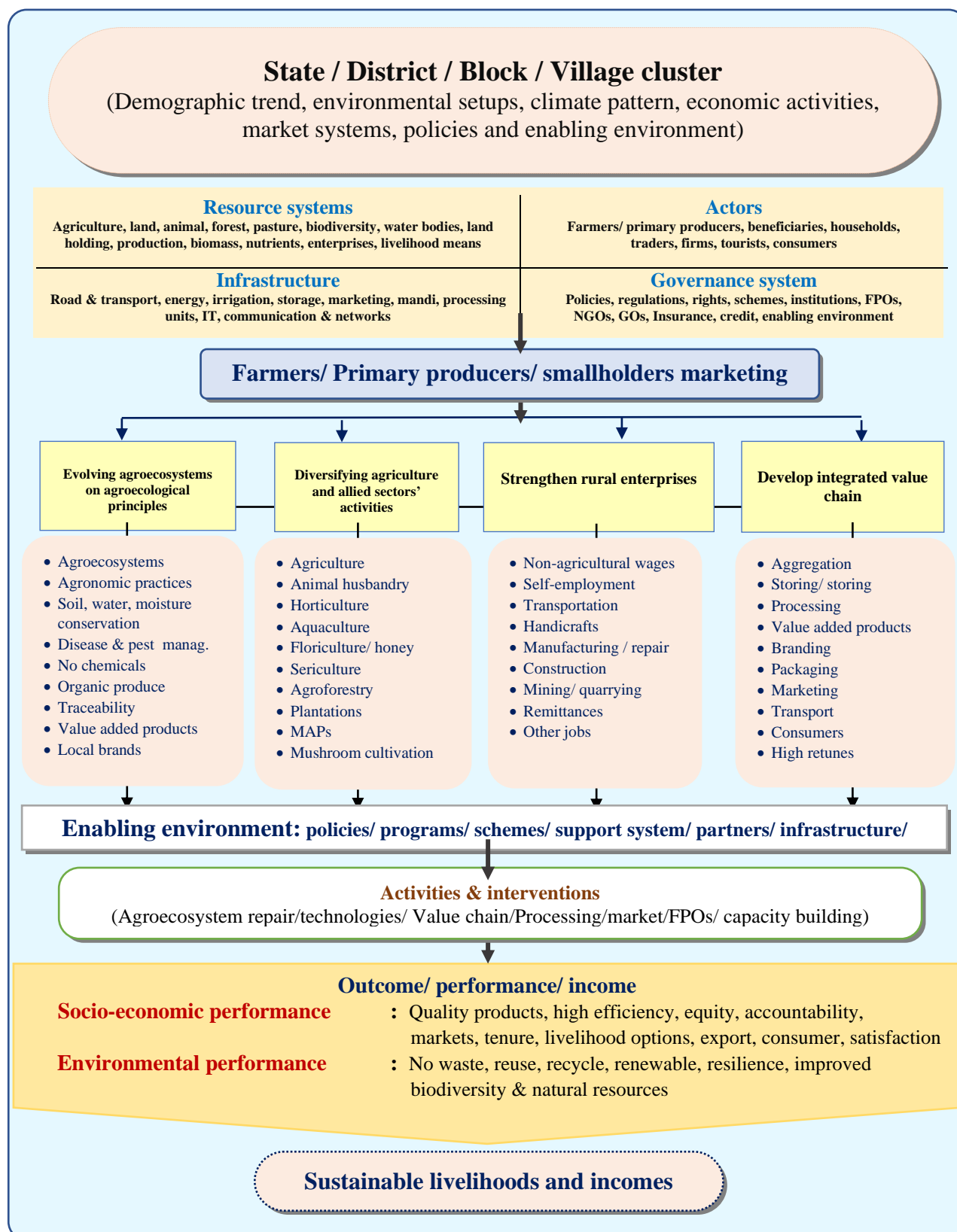


Figure 37. Framework for transition to agricultural-based market model for livelihood enhancement in the Himalayan States

Aquaculture involves culturing of fish, although currently, its contribution is negligible in local income. However, it has huge potential in local systems wherever water availability is sufficient. The fisheries and aquaculture together is recognized as the sunshine sector not only for nutritional security but readily available market to earn a good income

Horticulture comprises the cultivation of crops like fruits, flowers, vegetables, etc. that has significant regional, national, and international demands. This sector already employs a significant size of the workforce and should be extended further. In recent years all state governments have been trying hard to adopt medicinal and aromatic plants cultivation and floriculture activities as well.

Sericulture is a sub-sector of the textile industry. Mulberry, Eri, Muga, and Tasar-silk are major silk that has huge potential for the IHR region. It offers rich opportunities to marginal and smallholders for income enhancement by creating family employment round the year. Some states have already taken initiatives in this direction.

Strengthening an enabling environment

An enabling environment need to be created for alternative off farm employment by developing training schools for acquiring abilities to become skilled labour, processor, storage and various other related activities. Farmers will be permitted to cultivate or rent/lease out their lands for short/long term basis, while maintaining ownership of land. They can use same land as and when required, or keep earning from farm rentals, or keep families back home. In this approach the small and marginal farm holdings can collectively be transformed into profitable farming enterprises using local niche and institutions with the support of qualified entrepreneurs, tech startups, educated mass, FPOs, private partners by extending technological support and strengthening of other services. Local women and youths should be involved in such ventures. It may lead to convert all villages into small agribusiness-enterprises managed by experts from within or outside villages.

A national scheme is required to be put in place for encouraging conversion of small holdings into an economic unit to revitalize rural economy all across IHR. Such program requires a 10 to 20 years of backing from government side by providing enough financing provision and incentives and not subsidies. Initially such project can be run on pilot basis.

Strengthening rural enterprises

Other than agricultural activities households also engage in diverse off-farm activities to generate more income. Such activities bring new provisions for the market demanding produces at the local, regional, national, and international markets. It provides a cushion to counter the effects of poverty through more income. Generally, non-agricultural wages, self-employment, remittances, and other jobs come under this category. It includes processing, marketing, handicrafts, manufacturing, construction, mining, quarrying, repair, transportation, and community service related employment in the rural areas. For the transformation of the rural economy strengthening and promoting farmers participating in off-farm activities is highly desirable.

Promote value-added processing

Value-added processing (sorting, drying, grading) is required to increase the economic value of primary farm commodities through simple processes. The value-added processing enables farmers to align with consumer choice for agricultural or food products with quality characteristics. Such features do not exist in conventionally-produced raw agricultural commodities. The cleaning, grading, packaging, processing, extracting, and other processes change a product from its original raw form. For example, simple cleaning and grading of fresh vegetables and fruits; ginning, milling, and mixing of cereals grains, spices, meat, animal feeds; can bring good prices of all commodities. Also, organic produce or a regionally branded product enhances consumer appeal and willingness to pay a premium price over similar but undifferentiated products. Processing and value addition can transform the raw agricultural products into quality products thereby raising incomes and reducing farm wastages. Unfortunately, most states lack value addition, particularly at the primary producer level except for some horticultural crops. There is an increasing focus on value-added processing that is transforming small and medium enterprises into large units with the support of modern technology, assured quality, and linkages with primary producers for getting quality raw material. It also reduces the load of cultivating a vast tract of land or raising a large number of animals to be profitable. It is most beneficial for smallholders as a viable farming option. There are many such crops that can bring worthy economic returns to local farmers if taken up for value addition.

Promote product development

Food processing comprises industrial potential that can engage a good number of jobs and employment. Product development as per market needs brings consumers to the fore front. Processing of crops, livestock, fishery, and forest products is highly remunerative. The cooking, pasteurization, canning, dehydration, fermentation, and extraction of dairy products, fruits & vegetables, meat, and beverages can fetch high prices to local commodities. However, despite the significant scope, this component has rarely touched upon in most states in IHR. Some states process fruits, oilseeds, vegetables for juice, beverages, and oils, but in low quantum. At places, some dairy and animal products are also processed. Building further on these efforts will not only improve food supplies and reduce losses but also assure better market opportunities for farmers. Even non-agricultural products (such as NTFPs, wild plants) can be processed into high-value products. Product development is extremely useful in increasing self-life, self-reliance, and income. There are guidelines issued by Ministry of Food Processing Industries (MoFPI, Government of India) for horticulture, cereals, oilseeds, health foods, confectionery, ready-to-eat foods, nutraceuticals, milk, meat, fish, etc. that needs to be adopted while making products. There are also schemes and programs for product development. All stakeholders should take best benefit of that. All farmers and producers should be treated as strategic business partners in all such programs.



Figure 38. Integrated value chain of local commodities

Developing integrated value chain

An integrated value chain is highly required for assimilating all agricultural activities from obtaining inputs to production, processing, packaging, and distribution to the consumer. Due to limited marketing infrastructure, most of the farmers sell their produce at low prices. A workable model for promoting high-value products should include processing, branding, and strengthening the supply chains. It requires proper transportation facilities and rural road network, setting up of processing units, warehouse facilities, infrastructure, market linkages, and access to credit, value addition, and assured income to the farmers. Training and capacity building for creation of value-added products and strengthening FPOs (Farmer Producer Organizations) is also necessary so that end-to-end support technical and other services can be extended to the smallholder related to marketing, processing, and other aspects of cultivation inputs. This approach will help various states in creating better avenues for income and employment. The key characteristics of an integrated value chain encompass tactical business relations among all actors including farmers along with sharing of technology and market information. All stakeholders use their knowledge and skills for developing value-added products thus exhibiting a greater commitment to the welfare of farmers.

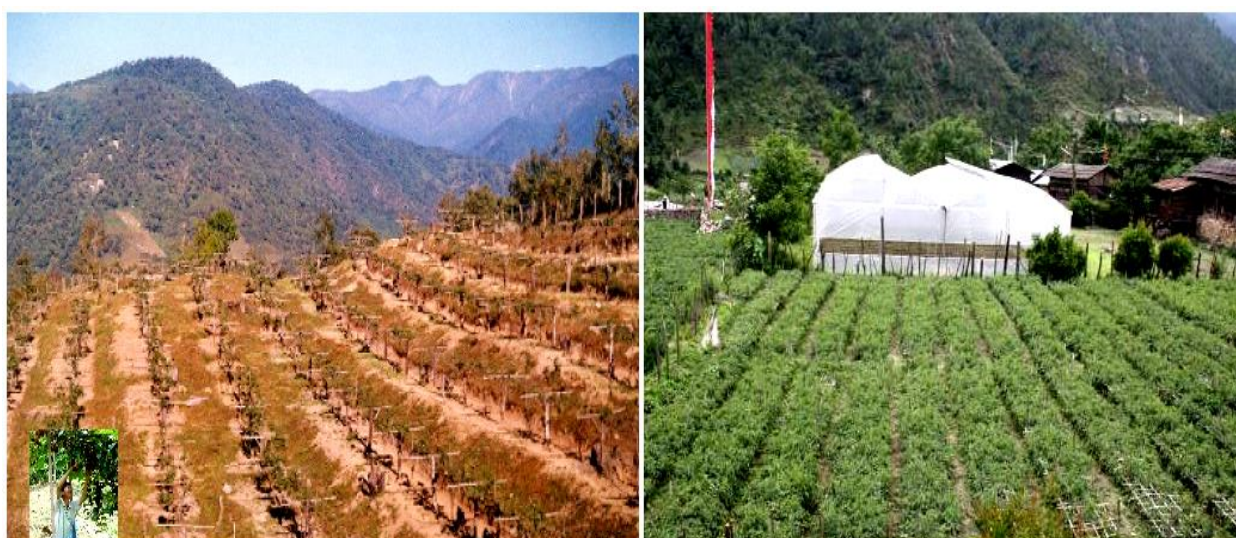


Figure 39. Kiwi and off-season tomato cultivation

Technological support

Agricultural and allied sectors need continuous technical support at all stages for the development of agriculture, horticulture, and aquaculture with the aim of improving yield, efficiency, and profitability. In recent times using technologies in the agriculture sector has gone a long way from the selection of high-yielding varieties and modern farm operations to the use of advanced technology, such as using robots, drones, temperature and moisture sensors, aerial images, GPS technology, machines, and information technology. However, for smallholders, access to such technologies is highly limiting. Farmers still use OPV (Open-pollinated varieties) of crops. Therefore, technological support is required right from crop planning, using high-yielding varieties, adopting scientific agronomic practices, increase cropping intensity, inputs like seeds, fertilizers, plant protection measures, new implements, and application of fertilizers.



Figure 40. R&D demonstration on cash crops

There is a dearth of availability of hybrid seeds, particularly for high-altitude areas. A similar situation prevails with the animal sector. There is a need to develop new hybrid varieties suiting to local crops and animals that support high yield with disease resistance. Also, crop yields are significantly different in irrigated and rainfed conditions. There is an utter need to increase water efficiency along with the adoption of water-harvesting technologies. As such, dry land farming needs special attention for the scientific incorporation of millets, pulses, oilseeds, and other crops as per local socio-cultural and environmental setups. Further, improving crop-livestock integration can increase farm productivity many times. A significant loss was also observed during post-harvest and its storage. Therefore, post-harvest technologies could bring good benefits to farmers. The use of fertilizers and pesticides also needs due consideration. The local governments are making soil health cards so to help farmers to plan their crops as per soil condition. However, its applicability is going to take time. Farmers also need timely access to inputs, and loan & credit facilities.



Figure 41. Local agricultural product in mandi

Market information

In most of the areas, a significant information gap was observed in relation to market information. The market reforms have also not penetrated to rural landscape in IHR. There is also a dearth of local capacity related to aggregation, value addition, product development, and marketing. Value addition to local commodities will help generate skilled jobs and income for smallholders. Incorporating appropriate technologies in the agricultural sector to deal with local challenges and also to procure a better position in the market will go a long way for smallholders. All these require better communication with farmers with a strong focus on skill and capacity building in diverse aspects of the agroecosystems so as to provide safer access to foods by increasing crop productivity and decreasing the use of water, fertilizer, and pesticides. There is also a need to reduce the impact on the environment and natural resources as well.

Promote cluster-based approach

There is a need to maintain and sustain adequate agriculture land under crop production to bring economic prosperity in rural areas. The productivity of various agroecosystems and food production systems can be done by the consolidation of holdings using a cluster approach, by overcoming natural factors, application of modern techniques, by adopting economic measures, and human resource development. Consolidation of land holding was undertaken by some government but received limited success as there are various locational advantage and disadvantage of farm fields. This demands a cluster approach or collective farming approach. The approach suits to small and fragmented holdings across IHR. In such system, a cluster of farm holdings is collectively identified for cultivation of a particular crop by producers in a participatory way. Such clusters are targeted for opting to a mutually agreed form of agriculture transformation through by involving village community in decision making. The land and its production assets are possessed by individual farm families or cultivators while the land

ownership is maintained to its existent holders. It helps to produce volume of agricultural produce. Entire village community may constitute a general body to take collective farming. This approach can also help to bring back abandoned farms into collective cultivation systems. In fact, such an approach has been in practice with relation to traditional agriculture in settled and shifting cultivation areas but limited to produce food for house needs only. In this process, the entire agricultural land is divided into two or more parts and used for cultivation of different crops as per the season. Currently, most of the policies are individual farmer based and they lack collective approach. Cluster farming will be highly beneficial for taking the advantage of various government schemes, farm related inputs and mechanization, and harvest activities at a place. It will help to decipher timely and needful advice and guidance, capacity building and other social services, awareness, education, processing, storage to farmers. And more importantly, it would produce good volume of a commodity that can fetch better market. For this the scope of existing policies need to be expanded.

The study also identified state-specific species of market potential to be promoted through cluster approach. For **Ladakh** region the potential marketable species are apricot, apple, and sea buckthorn. Besides, potato, peas, onion, MAPs, etc. have significant scope to be promoted in cluster approach. In **Jammu & Kashmir**, potato, peas, Pulses, MAPs, gram, rapeseed, mustered can be promoted along with apple, walnut, Saffron, Kaljeera, and kuth. In case of **Himachal Pradesh** apple, pear, almond, and other temperate fruits are already performing well which can be further strengthened by promoting cultivation of pulses, potato, peas, and various off-season vegetables. In **Uttarakhand** state, potato, tomato, peas, cabbage, other vegetables, pulses, sugarcane, soybean, mango, peach, pear, apple, litchi, and MAPs comprised significant scope to be promoted in cluster approach and many of these species are already performing well. **Sikkim** state is well known for cultivation of large cardamom and tea. The state comprises significant scope to promote cultivation of mandarin, citrus, banana, potato, onion, temperate vegetables, ginger, turmeric, and MAPs. **Assam** is globally recognized for cultivation of tea. The state has high scope of cultivating chilies, sweet potato, other vegetables, pulses, ginger, turmeric, black pepper, oil seeds, areca nuts, banana, coconut, papaya, mango, citrus, pineapple, ginger, etc. In recent years **Arunachal Pradesh** has shown substantial possibilities for cultivation of apple, orange, and Kiwi fruits. There is significant scope to promote cultivation of potato, seasonal vegetables, chilies, ginger, turmeric, pulses, gram, MAPs, and wild edibles in the state. In case of **Manipur**, cultivation of seasonal vegetables, potato, onion, chilies, ginger, turmeric, banana, citrus, wild edibles, and other NTFPs should be promoted in cluster approach that can bring good return to locals. For **Meghalaya**, seasonal vegetables, potato, turmeric, bay leaf, black pepper, chilies, ginger, sweet potato, mandarin, pineapple, areca nut, banana, strawberry, wild edibles, NTFPs, and broom grass cultivation can produce good return to the communities. **Mizoram** state can further strengthened cultivation of seasonal vegetables, pulses, chilies, ginger, turmeric, banana, betel nut, citrus, grapes, wild edibles, and bamboo (for shoots) for the benefit of locals. In case of **Nagaland**, seasonal vegetables, tapioca, potato, arhar, gram, king chili, ginger, turmeric, passion fruit, dragon fruit, citrus, papaya, pineapple, wild edibles, and bamboo shoots cultivation has noteworthy scope. Besides, coffee, rubber and tea can also be promoted in state. **Tripura** state has high scope to promote cultivation of potato, vegetables, pulses, chilies, ginger, turmeric, banana, mango, citrus, papaya, cashewnut and wild edibles.

Strengthening system

The capability of farming systems in long run is largely dependent on their economic viability for producing good income. To strengthen the agriculture and allied sectors each state government will have to strengthen a continued support system to farmers along with strengthening infrastructure. Adopting proper land management strategies, providing needful support for seed, nursery, extension services, training, quality control, transport, and adequate market facilities by increasing the number of micro-mandis to connect smallholders is required. Farmers need to be encouraged to adopt two to three options of livelihood for maximizing the income and profitability. All sectors also opt for integrated soil management by covering it with residues for sustainable production. Also adopting water conservation techniques and equipment should be promoted. Establishment of different types of agro-based industries in rural areas, provision for adequate credit and marketing facilities, granting minimum support prices and crop-insurance scheme to cover the various risks in agriculture is also the need of the day. Although there are schemes related to that, however, they are not mainstreamed with smallholders.

Further, a demonstration of potential crops and their products by various institutions, universities, R&D institutes, KVKs, and other centers can provide practical insight to local farmers. For example, CSIR-IHBT centre at Palampur (H.P.) has developed 11 Ready-to-eat (RTE) food products that can be used to strengthen traditional food systems. Besides, it has also developed another 11 beverages and herbal products. Further, it is willing to work with different universities to map local and available technologies for developing niche products as per field applicability. Such opportunities must be harvested by all concerned. In short, all states in IHR require working as per various agro-climatic and economic conditions in their respective state, as all problems cannot be solved with a single strategy.



Figure 42. Commercial farming

Involve youth in Agri-tech startups

It would be highly pleasing if youth can see a future in agriculture and allied sectors. Agritech startups can provide opportunities for new jobs and employment by practicing and promoting farming of herb, fruit, vegetable, or animal produces; production of various inputs and equipment required in these sectors, opting for organic farming, and through value addition & processing at different levels of agri-value chains. Such activities will bring farming as a profitable venture. In recent years there is consistent rise of E-commerce, particularly of organic produces, which will increase further in years to come. New startups will bring more innovation in this sector in production of inputs (seed, feed, fertilizer, energy, equipment, machinery, etc.), commodities (raw or processed food items), and facilitative services (insurance, marketing, credit, processing, storage, packaging, transportation, etc.). Youths should be motivated for these activities. Our education system should be revamped by extending such skills. This requires due support from government side and other agencies.



Figure 43. An orchard of Apricot

Human resource development

Training, upskilling, new skilling and capacity building is a continued need at all levels. It is required from mobilizing the farmers to participatory planning and action, execution of farm/on-farm activities, using new inputs and implements, managing and maintaining the different components and interventions, value addition and processing, and various other aspects.

Strengthening farmers-producers organizations

Farmer-producers organization are registered body and a legal entity to work as a platform for facilitate collective actions for the benefit of farmers. Producers are shareholders in such bodies which needs to be strengthened.

Strengthen public-private partnership and institutional networking

Public-private partnership are important to link and support farmers at all levels from improved access to inputs, adoption of modern farm technology and practices, training, resources, support to supply chain, value addition, and linking with line departments, NGOs, CBOs, corporate world. At present public-private partnership is minimal in IHR states that need to be improved substantially. The institutional net working at behest of NABARD, SIDBI, Dairy Boards, etc. can contribute significantly to the growth of horticulture and farm activities in the IHR region particularly in the north east region.

An enabling policy environment

As stated earlier there are large number of policies and programs to support agriculture and allied sector development. Local governments are implementing them in their best capacity. However, many a times the results are not as good as desired. One possible reason is that they are implemented in large areas with different programs in different regions. An enabling environment is desired to support farmers and other stakeholders in the form of an advisory service on various policy and programs along with other issues related to proper land management and tenure, input supply, technological backups, agricultural finance, natural resource management, market & trade information, value addition and processing, and taking local produces to market. It would greatly help farmers, particularly smallholders.



Figure 44. Agriculture landscape in Himachal pradesh

Way forward

Supply of food and nutrition to the growing population and avoiding malnutrition and poverty are major global challenges. Despite a considerable growth in food production, there is a growing concern for social and environmental costs of increased food production. For a better-living, the food needs to be sourced from healthy ecosystems that also bring more socioeconomic benefits and cause less environmental harms. Fortunately, a number of native societies still meet a considerable share of their food demand from traditional agroecosystems. It is argued that investigating agroecology can lead to transition to more sustainable food systems by suggesting novel management approaches based on ecological processes and natural features of ecosystems.

India has made a significant stride in development of agriculture sector and already achieved national food security. However, the growth has been inequitable among states, and within plain and hill areas. In the Indian Himalayan Region, the contribution of agriculture sector in local economies has been declining fast in recent years. The region observed low impact of green revolution, blue revolution (water, fish), white revolution (milk), and yellow revolution (flower, edibles). Although traditional agriculture is location-specific knowledge and innovation based, however it is constraint by rainfed conditions, and low and inequitable production. All states are observing land-use change due to varied reasons that is creating adverse impact on agriculture and livelihoods. As a result, a significant quantity of food and other commodities are imported. Though the region is observing a fast rate of urbanization, however there are very limited opportunities for employment and income generation. As a result, youth of these areas are migrating to cities and towns for employment and education. The region is constrained in infrastructure development and even the agriculture-related structure is minimal.

It is also observed that the changes are taking place in rural areas all over the IHR but at a slow pace. Although there are a large number of policies on agriculture & allied sectors (central sector, state and district level) that have benefited farmers to some extent but the growth is not equitable. An important cause of poverty is lack of access to various services and programs. Socio-economic backwardness, illiteracy, inadequate purchasing power, lack of adoption of modern agricultural practices and technologies, marketing surplus and infrastructure, and awareness about government programs are major constraints for smallholders. Unfortunately, the government support and intervention in land, labour and credit to smallholders is also meager.

It means, a better narrative for agriculture development is to be set in such a way that it substantially improves status and wellbeing of farmers, particularly the smallholders. In other words, the agriculture and its sectors development should be targeted not only to produce more food but to create wealth for rural communities. This vision holds great promise as still agriculture is the key sector for engaging maximum workforce all over IHR. It requires proper strategy, commitment, collective efforts, policy support, developing local capacity, and infrastructure. If properly planned, the agriculture sector can bring more employment, prosperity and more GDP for states and nation as such.

There is an urgent need to change subsistence farming to commercial farming through appropriate support systems, technological and financial provisions, and by developing infrastructure. The region produces cereals (rice, wheat, maize), millets, pulses, spices, vegetables, and fruits. All states produce a large variety of fresh vegetables (potatoes, beans, green peas, cauliflowers, cabbage, pumpkins, brinjal, okra, squashes, gourds, green vegetables, etc.), and fruits (apricots, apple, mango, litchi, walnut, guavas, citrus, peach, pear, plum, betel nut, banana, pineapple, papaya, kiwi, etc.). Important spices of the region are saffron, ginger, turmeric, onion, chilies and peppers, garlic, large cardamom, kalajeera, etc. Oil seeds and pulses are also grown in various states. Commercial plantations of tea, rubber, and coffee are also found in eastern and northeastern states. The animal sector is equally diverse and the dependence on animals increases with elevations. This offers a significant scope to develop agriculture and allied sectors. Therefore, a sound strategy is desired for sustainable development of the region that could stimulate rural development by creating more jobs and curbing migration.

The study suggests a best possible approach for rural sector development is to simultaneously promote agriculture diversification, strengthening of economic activities, opting for agroecological transition, initiating value-added processing and product development, and supporting on-farm and off-farm enterprise (animal husbandry, dairy, fisheries, poultry, mushroom cultivation, handloom, weaving, etc.). The agriculture diversification will increase cropping intensity by opting for multiple crops from a small field which will increase production and income both.

For this to happen, we recommend a location-specific approach for identification & development of ecologically preferential and suitable crop varieties, focusing and empowering smallholders and marginal farmers, and promotion of organic agriculture and food processing. It can be achieved by establishment of seed/propagule production centres of quality planting material (QPM), single window facilitation and developing value chain of local brands, development of better harvesting technologies, promotion of crop consolidation and post-harvest processing hubs for quality end products. The best benefits can be realized by strengthening infrastructure, credit, and policy support, promoting digital platforms for information dissemination, promotion of modern systems of storage/ packaging and transportation, and linking food processing with circular economy. For this, promoting awareness, education, and innovation along with training, capacity building and human resource development are key areas to work for development of rural areas. At the same time, better usage of water resource and water efficiency, improvising soil fertility measures, and controls of pest & diseases along with empowerment of women also require equal attention. Besides, strengthening research & development, Institutional collaboration, and public-private partnership is also required to give desired boost to agriculture and allied sectors. Agri-tech startups on diverse aspects of agriculture and its allied sectors will help to attract youth to use latest technologies to attain profitability and efficiency with a due advantage of the produce processed through hill startups being totally organic in nature. All these areas also have tremendous opportunities for investment in rural areas. Such an approach would create more opportunities for youth and smallholders to be lured towards agroecology and thus reduce income disparities.

For this each state government will also have to identify its major crops and commodities that can be processed in each state (food grains, millets, spices, fruits, vegetable, MAPs, animal

products, tea, etc.). Also, the Government officials, planners, community members, and other stakeholders will have to join hands to develop agriculture sector as an area of pride for regional/national economy. For this, all GOs, NGOs, stakeholders, line departments, resource persons should join hands to undertake developmental work in right pursuits with proper work execution and monitoring. There is large number of ongoing programs of Government of India (MoA&FW) that should also be implemented in an integrated way in a region for taking best benefit out of them.

The present report advocates providing good and transparent governance for agroecology as best practice for enhancing biodiversity and ecosystem services in IHR states, and strengthen policy processes for up scaling traditional food and agricultural systems for sustainable livelihoods. It will increase the knowledge base for agroecological management of traditional food systems thus enhances the resilience of local communities and ecosystems. An integrated development approach to rural areas can boost up the chances of local employment and become the game changer for growth of the overall economy of the region. It would enable the sustainable development of IHR by conserving, protecting, and enhancing traditional food-based livelihoods and social well-being, which is in tune with Sustainable Development Goals (SDGs).

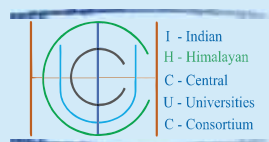
Selected reading

- Anonymous 2018. Agricultural Statistics at a Glance. Directorate of Economics & Statistics, New Delhi
- Anonymous 2020. Pocket Book of Agricultural Statistics, Directorate of Economics & Statistics, New Delhi.
- Arnab R and Uday K 2018. Emerging farming systems in Western Himalaya: A state level analysis of sustainability. *Int J Environ Sci Nat Res.* 9(2): 555-757.
- Bhatt BP 2003. Agroforestry for sustainable mountain development in NEH region. In: Central Himalaya Environment and Development: Potentials, Actions, and Challenges, (MSS Rawat, Ed.), pp. 206–223, Transmedia Publisher, Uttaranchal, India, 2003.
- Chandra R 2014. Sustainability through organic agro-biotechnology with special reference to Jammu & Kashmir scenario. *International Journal of Genetic Engineering and Biotechnology* 5(2): 169-178.
- Chappell MJ, Bernhart A, Bachmann L, Goncalves AL, Seck S, Nandul P, dos Santos AC 2018. Agroecology as a pathway towards sustainable food systems. *Bischofliches Hilfswerk, MISEREOR, Aachen, Brazil.*
- Choudhary AK, SK Thakur, DS Yadav 2012. Development of integrated farming system model for marginal and small farmers of Mandi district of Himachal Pradesh - An innovative extension tool. *Journal of Hill Agriculture* 3(1): 46 -52.
- da Costa, A (Ed.) 2015. Agroecology: India's journey to agricultural prosperity- The evidence and path forward through agroecology. Report submitted to Govt. of India, Organic India and UPLIFT
- Directorate of Economics & Statistics. 2017. Pocket Book of Agricultural Statistics. New Delhi.
- Dollo, M., P.K. Samal, Sundriyal, R.C. and K. Kumar 2009. Environmentally sustainable traditional resource management and conservation in Ziro valley, Arunachal Pradesh, India. *Journal of American Science* 5(5): 41-52.
- FAO 2015. Agroecology for Food Security and Nutrition. Proceedings of the FAO International Symposium, 18-19 September 2014. FAO, Rome, Italy.
- FAO 2017. The future of food and agriculture – Trends and challenges. FAO, Rome, Italy.
- FAO 2019. Tool for agroecology performance evaluation process of development and guidelines for application. FAO, Rome, Italy.
- FAO, IFAD, UNICEF, WFP and WHO. 2020. The State of Food Security and Nutrition in the World 2020, FAO, Rome, Italy.
- FAO. 2002. Smallholder farmers in India: food security and agricultural policy. Thailand
- FAO. 2015. Training manual for Organic Agriculture. FAO, Rome, Italy.
- FAO. 2017. The future of food and agriculture – Trends and challenges. FAO, Rome, Italy.
- FAO. 2017. The future of food and agriculture – Trends and challenges. Rome.

- FAO. 2019. TAPE- Tool for Agroecology Performance Evaluation– Process of development and guidelines for application. FAO, Rome, Italy.
- Francis C, Lieblein G., Gliessman S, Breland TA, Creamer N, Harwood R, Salomonsson L, Helenius J, Rickerl D, Salvador R, Wiedenhoef M, Simmons S, Allen P, Altieri M, Flora C and Poincelot R 2003. Agroecology: the ecology of food systems. *J. Sustain. Agric.*, 22(3): 99-118.
- Gliessman SR 2013. Agroecology: Growing the Roots of Resistance. *Agroecology and Sustainable Food Systems* 37: 19-31.
- Gliessman SR 2015. Agroecology: the ecology of sustainable food systems. 3rd Edition. Boca Raton, FL, USA, CRC Press, Taylor & Francis Group.
- Grogan P, F Lalnunmawia, SK Tripathi 2012. Shifting cultivation in steeply sloped regions: a review of management options and research priorities for Mizoram state, Northeast India. *Agroforestry Systems* 84: 163–177.
- IFPRI 2011. Leveraging agriculture for improving nutrition and health: The way forward. International Food Policy Research Institute (IFPRI), Washington, DC.
- Jeeva SR, C Laloo BP, Mishra 2006. Traditional agricultural practices in Meghalaya, northeast India. *Indian Journal of Traditional Knowledge* 5(1): 7-18.
- Khajuria A and Jain D 2016. Organic farming potential as sustainable agriculture: A J&K perspective. *International Journal of Scientific and Technical Advancements* 2(4): 257-260.
- Kumar BM, Handa AK, Dhyani SK and Arunachalam A 2018. Agroforestry in the Indian Himalayan Region: An Overview. *Temperate Agroforestry Systems*, 2nd Edition (eds. A.M. Gordon, S.M. Newman and B.R.W. Coleman), CAB International 2018.
- Kumar V (2010). Exploring potential of traditional mountain agro-ecosystems in addressing food security and climate change issues in the central Himalaya. *Journal of Hill Agriculture* 1 (2): 94-101.
- Kuotsuo R, D Chatterjee, BC Deka, R Kumar, M Ao, K Vikramjeet 2014. Shifting Cultivation: An ‘Organic Like’ Farming in Nagaland. *Indian Journal of Hill Farming* 27(2): 23-28.
- Lenis, SO, Liverpool-Tasie, A Wineman, S Young, J Tamb, C Vargas, T Reardon, G S Adjognon, J Porciello, N Gathoni, LBizikova, A Galiè and A Celestin 2020). A scoping review of market links between value chain actors and small-scale producers in developing regions. *Nature Sustainability* 3: 799–808.
- Magesa MM, Michael K, and Ko J 2015. Towards a framework for accessing agricultural market information. *The Electronic Journal of Information Systems in Developing Countries*, 66(1): 1-16.
- Maikhuri RK, Rao KS and Saxena KG 1996 Traditional crop diversity for sustainable development of Central Himalayan agroecosystems. *International Journal of Sustainable Development & World Ecology*, 3 (3): 8-31.
- Maikhuri RK, Sundriyal RC, Negi GCS, and Dhyani PP 2015. Smallholders and family farming in the Himalayan region of India: policy considerations. *Policy in Focus* 34: 21-23.
- Manjula, M. (2021). The smallholder in the agriculture market reforms in India. *Economic and Political Weekly* 56(15): 23.

- Méndez VE, Bacon CM, Cohen R (2013) Agroecology as a transdisciplinary, participatory, and action-oriented approach. *Agroecol Sustain Food Syst* 37: 3–18
- Mukerjee et al. (2018) Smallholder farming systems in the Indian Himalayas: Key trends and innovations for resilience. IIED Country Report. IIED, London
- Mukerjee P et al. 2018. Smallholder farming systems in the Indian Himalayas: Key trends and innovations for resilience. IIED Country Report. IIED, London. <http://pubs.iied.org/17618IIED>.
- Paloma, SG, L Riesgo, K Louhichi 2020. The role of smallholder farms in food and nutrition security. Springer, Thiverval-Grignon, France.
- Palsaniya DR and Ghosh PK 2016. Agroforestry for natural resource conservation- Livelihood security and climate change mitigation in Himalayan agroecosystems. *Conservation Agriculture* 203-223.
- Pandey R, Jha SK, Alatalo JM, Archie KM, and Gupta AK 2017. Sustainable livelihood framework-based indicators for assessing climate change vulnerability and adaptation for Himalayan communities. *Ecological indicators* 79: 338-346.
- Pingali P, A Aiyar, M Abraham, A Rahman 2019. Transforming food systems for a rising India. Springer Nature, Switzerland.
- Punam A, PK Khosla 1992. Himachal Himalayan Agroecosystem Status—a Case Study. *Journal Biological Agriculture & Horticulture. Intern J. Sust. Prod. Sys.* 10(4): 271-286.
- Ramakrishnan PS 1992. Shifting agriculture and sustainable development: An interdisciplinary study from north-eastern India. UNESCO-MAB Series, Paris, France.
- RBI 2021. Handbook of statistics on Indian states. Reserve Bank of India, Mumbai.
- Saha R, RS Chaudhary, and J Somasundaram 2012. Soil Health Management under Hill Agroecosystem of North East India. *Soil Management for Sustainable Agriculture* 2012: 1-9.
- Samal PK, Lodhi MS, Arya SC, Sundriyal RC, Dhyan PP 2016. Eco-technologies for agricultural and rural livelihoods in northeast India. *Current Science* 111(12): 1929-1935.
- Sehgal JL, Mandal DK, Mandal C and Vedivelu S 1990. Agro-ecological Regions of India. NBSS&LUP Publications, Nagpur, India.
- Shimrah T, KS Rao, KG Saxena 2015. The shifting agricultural system (jhum) and strategies for sustainable agroecosystems in northeast India. *Agroecology and Sustainable Food Systems* 39(10): 1154–1171.
- Sundriyal RC 2001. Hill agro-ecosystems and sustainable development in Arunachal Pradesh. *Arunachal Forest News* 19(1&2): 186-206.
- Sundriyal RC and M Dollo 2013. Integrated agriculture and allied natural resource management in northeast mountains- transformations and assets building. *Agroecology and Sustainable Food Systems* 37(6): 700-726.
- Sundriyal RC, Rai SC, Sharma E & Rai YK 1994. Hill agroforestry systems in south Sikkim, India. *Agroforestry Systems* 26(3): 215-235.
- Teixeira HM, Van den Berg L, Cardoso IM, Vermue AJ, Bianchi FJ, Peña-Claros M, and Tittone P 2018. Understanding farm diversity to promote agroecological transitions. *Sustainability*, 10(12): 4337.

- Tilak R 2017. Agricultural Marketing in Himachal Pradesh: Problems and Prospects. Political Economy Journal of India 2017.
- Tittonell P, and Giller KE 2013. When yield gaps are poverty traps: The paradigm of ecological intensification in African smallholder agriculture. Field Crops Research 143: 76-90.
- Tittonell PA 2013. Farming systems ecology: Towards ecological intensification of world agriculture. Wageningen Universiteit.
- Tiwari PC and Joshi B 2012. Natural and socio-economic factors affecting food security in the Himalayas. Food Sec. 4: 195–207.
- Tripathi N, Singh RK, Pal D and Singh RS 2015. Agroecology and sustainability of agriculture in India: An overview. EC Agriculture 2.1: 241-248.
- Uma P and Singh JS 1984. Energetics of hill agro-ecosystems: a case study from Central Himalaya. Agricultural Systems 13 (2): 83-95.
- Wezel A, Bellon S, Doré T, Francis C, Vallod D, David C 2009. Agroecology as a science, a movement or a practice. A review. Agron Sustain Dev 29:503–515. <https://doi.org/10.1051/agro/2009004>
- Yadav RP, Bisht JK, Meena VS and Choudhary M 2018. Sustainable Agroecosystems for Livelihood Security in Indian Himalayas. <http://dx.doi.org/10.5772/intechopen.74495>



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