



Organic Farming in Sikkim as a Strategy for Sustaining Ecosystem Services and Livelihoods



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Organic Farming in Sikkim as a Strategy for Sustaining Ecosystem Services and Livelihoods

(Supporting Implementation of Sikkim State Policy on Organic Farming)

Sikkim Organic Mission
Government of Sikkim

Technical Support Provided by
International Centre for Integrated Mountain Development
(An inter-governmental organization of the Hindu Kush Himalaya)

January 2019

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Foreword

The contemporary world is faced with a cardinal choice between maximizing production and growth, regardless of the cost to Mother Earth, or sustainable development through an eco-friendly approach. Sadly, in the neoclassical economic paradigm, ecosystem services are not considered or valued in their entirety. The interrelation between economic values and ecosystem services needs to be analysed thoroughly, keeping sustainability in mind all through, more so in the case of a mountainous region like the Himalaya.

Sikkim, in its humble way, made its choice and decided to prioritize a sustainable way of life as state policy. Our deep conviction that the environment is not a use-and-throw production facility has been central to our policy-making process. We have been taking non-conventional decisions ever since we formed the government in 1994: banning open grazing in forests; banning plastics; the sale and use of air- and sound-polluting fire-crackers; banning chemical fertilizers and pesticides used in agriculture; and stopping the import of non-organic fruits and vegetables. These were tough decisions which have upset people. In an electoral sense, these were not popular policy decisions. Winning people's confidence and support is not easy. However, we understood that there was an urgent need to take a stand for environmental security and sustainable development. That is how we created a new foundation for development and remained firm against all odds. As expected, numerous questions were asked, numerous doubts were raised, and numerous criticisms were hurled. However, we remained firm in our resolve to make Sikkim a success story in green development.

The Sikkim Organic Mission therefore is our gift to a world grappling with various pressing environmental issues and searching for solutions. We are encouraged and invigorated by the recognition and appreciation for our efforts from all across the globe. I believe the accomplishments of our state will go down in the annals of history as a significant milestone in the journey towards making farming fully environmentally friendly and sustainable.

We are quite aware that our state now has the responsibility of taking organic farming to another level. There are expectations of Sikkim and many challenges lie ahead. The farmers in the Himalayan region, including Sikkim, are already facing the impacts of climate change — and unprecedented they have been — in the form of drought, flash floods, cloudbursts, hailstorms, snowstorms, warmer winters, and increased incidence of pests and diseases.

Sikkim is a mountainous state, which means it faces mountain specific challenges such as marginality, vulnerability, inaccessibility, and fragility, all of which require special attention in terms of planning and design for sustainable development. And while our policies have led to a denser forest cover, they have resulted in new challenges involving increased human-wildlife interactions and crop depredation, leaving farmers to deal with the resultant economic loss. These are the costs of conservation success.

The other overwhelming task at hand is to mobilize the financial resources that are required to respond to climate change adversities in a mountain-specific environment, and plough our way towards sustainable development through organic farming. By forfeiting central government subsidy on chemical fertilizers, Sikkim has been contributing positively to the environment and to climate change mitigation. We hope that this forfeited subsidy would be made available to the state for incentivising organic farming. We expect the central government to

soon take such a decision to recognize and support Sikkim's positive efforts at green development.

Amid these challenges, there have been encouraging results. Several educated youth have taken to farming. Together with traditional farmers, many of them have formed NGOs, co-operative societies, and farmer groups to explore the agricultural potential of the state. This has resulted in many innovations in organic farming methods, production of mountain-niche goods and use of fallow lands for organic farming. This is positive progress indeed. We have also witnessed the emergence of agro-entrepreneurship, a great boost and impetus for "India's first fully organic state". And all along, our government has been exploring the various institutional and financial avenues to support them.

It does not need to be emphasized that organic farming is a non-violent, earth-saving, environment-friendly and life-protecting form of agricultural production. Our advocacy and practice of organic farming stem from our conviction that we need to adopt viable ways of developing sustainably. Our numerous conservation initiatives and environmentally-secure innovations also reflect the special bond that Sikkim has traditionally shared with nature. Our actions owe to our respect for the sanctity of all living organisms.

We have had a foretaste of what organic farming can do to a mountainous state like ours, and the time has now come for us to work harder and reap a greater harvest. The challenges ahead are perhaps the toughest ones, but not insurmountable. The confidence that we have gained from our journey till now shall stand us in good stead in the future.

My government is with all those farmers who deserve a good life, attached to a dignified profession. The state government will lend every possible support to the farmers by way of subsidies, rebates, start-up loans, consultations, capacity-building, and several other welfare measures. This support shall reach every farmer, agro-entrepreneur, and every young woman and man who dedicate themselves to organic farming.

Here, I must commend and appreciate the tremendous determination and efforts of all those involved in this noble mission—the farmers themselves, as well as the staff of the Food Security and Agriculture Development Department and the Horticulture and Cash Crops Development Department, Government of Sikkim.

All this is not to say that there are no gaps and no new challenges. But I can assure you that the state government is leaving nothing to chance while relentlessly working towards a sustainable Sikkim whose ecosystems services shall benefit not only the downstream basins, the nation and the Himalayan region, but also beyond.

Organic Farming in Sikkim as a Strategy for Sustaining Ecosystem Services and Livelihoods is a part of our effort to achieve this goal of a sustainable Sikkim.

I extend my heartfelt thanks to Dr. Eklabya Sharma, Mountain Environment and Development Adviser to the Government of Sikkim, and his team for their collective effort in bringing out this valuable publication. I am confident that the strategy laid out here will provide the much-needed vision and direction, as well as identify the necessary actions to further strengthen Sikkim's Organic Mission.

1 January 2019
Gangtok

Pawan Chamling
Chief Minister of Sikkim

Preface

The organic agriculture movement in Sikkim started in 2003 with a vision of sustainable livelihoods, conservation of the environment and healthy food for all. The idea was conceived and articulated by the Chief Minister Shri Pawan Chamling and he has led and inspired the movement over a decade and half to make Sikkim a fully organic state. The Sikkim Organic Mission was established in 2010 and the State Policy on Organic Farming was put in place in 2014. Today, Sikkim has emerged as a leader in organic farming in the entire country and among the mountainous regions of the world. The organic movement in Sikkim has since matured to embrace various aspects of sustainable farming, production and consumption of nutritious food, value addition, value chain development, marketing, social and business enterprise and niche product development.

Sikkim is a model Indian Himalayan state, which has made amazing progress in adopting environmental security in development plans and programmes. In the past 25 years, under the able leadership of Shri Pawan Chamling, Sikkim has achieved many milestones like making the State fully organic, transforming Gangtok into one of the cleanest mountain cities, increasing the area under forest cover and the quality of those forests, adopting biodiversity conservation models, managing and protecting high altitude wetlands, incorporating environmental concerns into development programmes, and increasing general awareness on environmental issues. All these policies and practices are important for sustainable development and are examples that other mountain states and cities can learn from and emulate. Sikkim has demonstrated that development should not come at the cost of the environment and the organic agriculture movement is an excellent example of this.

The preparation and publication of *Organic Farming in Sikkim as a Strategy for Sustaining Ecosystem Services and Livelihoods* is intended to further support the implementation of Sikkim's State Policy on Organic Farming. It has been prepared by a team of experts, government officers and member of Sikkim Organic Mission, and with inputs from progressive farmers and young entrepreneurs.

The strategy clearly describes the vision, mission and strategic goals for organic farming and entrepreneurship development in Sikkim. Global standards and principles of organic farming are considered in the strategy as they fit well with traditional farming practices in the state and meet the organic farming aspirations of Sikkim. The brief descriptions on the State Policy on Organic Farming, Sikkim Organic Mission and legislations on organic farming provide the context and policy framework for the strategy.

The strategy touches upon global mountain development in general and the development challenges in the Indian Himalaya and Sikkim contexts. It describes the mountain specificities that present various challenges and opportunities for organic farming. The background and present conditions of farming systems and livelihoods provides a situational analysis for the

state and, together with the emerging issues related to organic farming, provides the basis for the strategy. There is a section that deals with organic farming in Sikkim in relation to national policies and incentives. Finally, the strategy identifies and describes ten action areas and 65 targets for organic farming and green economic development over the next decade in Sikkim. These are summarized in a strategic framework table for better visualization.

I strongly urge all stakeholders both public and private to implement the strategy for healthy life and sustainable livelihoods in Sikkim.

1 January 2019

Gangtok

Eklabya Sharma, PhD, FNA, FNASc

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Government of Sikkim, and
Deputy Director General - ICIMOD

Acknowledgments

The historic success of the Sikkim Organic Mission has focused global attention on our beautiful Himalayan state. The need for documenting the story of Sikkim's journey to being an organic state was highlighted by our Chief Minister. In a meeting held on 6 November 2018 at Samman Bhawan, he emphasized the need for Sikkim to awake to a grave responsibility—to not only advocate organic farming as a path to sustainability but to also support practitioners, organizations and institutions in adopting organic farming and taking it to a new level. Documenting our experience, challenges, knowledge, skills and know-how is vitally important to address the global curiosity and research interest in the Sikkim model.

This publication is a precursor to a larger publication which will be put together under the able guidance of Dr. Eklabya Sharma, Mountain Environment and Development Advisor to the Government of Sikkim, Fellow of Indian National Science Academy and a globally acclaimed ecologist. I am confident that this publication – *Organic Farming in Sikkim as Strategy for Sustaining Ecosystem Services and Livelihoods* – will be one of the showpiece documents of the Sikkim Organic Mission.

I would like to extend my heartfelt thanks to the Committee that was formed to undertake this project. Their names and contributions are acknowledged and highlighted in the publication. I would like to thank the following individuals and departments in particular:

Dr. Eklabya Sharma, for ably spearheading the writing of this book. Despite his overwhelming responsibilities as Deputy Director General at the International Centre for Integrated Mountain Development (ICIMOD), he very kindly agreed to take up a major chunk of the writing.

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1 January 2019

Gangtok

R. S. Basnet

Principal Secretary to the
Hon'ble Chief Minister
cum Chairman of the Committee

Acronyms and Abbreviations

ABS	Access and Benefit Sharing
ADB	Asian Development Bank
APEDA	Agricultural and Processed Food Products Export Development Authority
AHLFVD	Animal Husbandry, Livestock, Fisheries and Veterinary Department
CBD	Convention on Biological Diversity
CMSES	Chief Minister's Self Employment Scheme, Sikkim
CMSUS	Chief Minister's Start-Up Scheme, Sikkim
EM	Effective Microorganisms
FAO	Food and Agriculture Organization
FPOs	Farmer Producers Organizations
FEWMD	Forest, Environment and Wildlife Management Department
FSADD	Food Security and Agriculture Development Department
GDP	Gross Domestic Product
GIAHS	Globally Important Agricultural Heritage System
GMOs	Genetically Modified Organisms
GPUs	Gram Panchayat Units
HCCDD	Horticulture and Cash Crop Development Department
ICAR-NOFRI	Indian Council of Agricultural Research–National Organic Farming Research Institute
ICIMOD	International Centre for Integrated Mountain Development
ICS	Internal Control System
ICT	Information and Communication Technology
IES	Incentives for Ecosystem Services
IFOAM	IFOAM - Organic International
IPM	Integrated Pest Management Practices
IPR	Intellectual Property Rights
KCC	Kisan Credit Card
KVK	Krishi Vigyan Kendra
MAPs	Medicinal and Aromatic Plants
MMA	Macro Management of Agriculture
MPS	Minimum Support Price
NABARD	National Bank for Agricultural and Rural Development
NAP	National Agriculture Policy of India
NAPCC	National Action Plan on Climate Change

NERAMAC	North Eastern Regional Agricultural Marketing Corporation
NFSM	National Food Security Mission
NITI Aayog	National Institution for Transforming India
NMSA	National Mission for Sustainable Agriculture
NMSHE	National Mission for Sustaining Himalayan Ecosystem
NPMSHF	National Project on Management of Soil Health and Fertility
NPOP	National Programme for Organic Production
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
NTFPs	Non-timber Forest Products
PMEGP	Prime Minister's Employment Generation Programme
PMFBY	Prime Minister Fasal Bima Yojana
POP	Package of Practices
PPVFR	Protection of Plant Varieties and Farmers Rights
R&D	Research and Development
REDD	Reduced Emissions from Deforestation and Degradation
RKVY	Rashtriya Krishi Vikas Yojana
RMDD	Rural Management and Development Department
SAPCC	State Action Plans on Climate Change
SDGs	Sustainable Development Goals
SOM	Sikkim Organic Mission
SSOCA	Sikkim State Organic Certification Agency
TAR	Tibetan Autonomous Region of China
TMI India	The Mountain Institute India
TRIPS	Trade-Related Aspects of Intellectual Property Rights
UNESCO	The United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework on Climate Change Convention
WB	The World Bank
WMO	World Meteorological Organization
WTO	World Trade Organization

1. Vision

Sikkim believes in a healthy and prosperous future where its people can experience enhanced livelihoods and secure social and environmental conditions. It dreams of a better life for future generations in the state and for downstream populations who enjoy the benefits and opportunities provided by the natural endowments of this small mountainous state.

Vision

People of Sikkim relish healthy food and enjoy sustainable livelihoods by practicing organic farming in a secure environment

Sikkim views organic farming as the most appropriate approach to achieve this broader vision. The organic farming movement in the state started as early as 2003 and in just over a decade, by 2016, Sikkim was declared as India's first fully organic state. Sikkim's organic movement has not only strengthened organic production and entrepreneurship with the goal of "Healthy Food for All" but has also inspired transformational change towards wellbeing in a rapidly changing world. This vision of organic farming promotes truly sustainable farming and consumption that enhances livelihoods and socioeconomic development, ensures environmental security including building climate resilience and meets the cultural aspirations of the people of Sikkim.

2. Mission

Sikkim is an organic state that wishes to lead the change and demonstrate an organic pathway for sustainable livelihoods and wellbeing to other hill and mountain states in India and neighbouring countries in the Hindu Kush Himalayan region. Sikkim's rich natural capital preserved and managed sustainably provides invaluable ecosystem services to the state, region and beyond. Organic farming further supports the rich natural endowment, sustainable livelihoods of the people and enhances the flow of ecosystem goods and services. The mission of organic farming is "to leave no one behind" in sustainable livelihoods development in the state.

Mission

To lead the change and leave no one behind by strengthening organic farming, entrepreneurship and green economic development

Sikkim's organic mission uses a definition that builds on the one from IFOAM – Organic International.

Organic farming is a production system that sustains the health of soils, ecosystems and people. It believes in ecological cycles and biodiversity support systems rather than the use of external inputs that have adverse effects. Organic farming combines tradition, innovation and modern science and technology to benefit the shared environment and promote fair relationships and a good quality of life for all involved.

Sikkim's organic movement supports sustainable farming, production and consumption of nutritious food, value addition, value chain development, marketing, social and business enterprise and niche product development. It builds on traditional food production systems; innovations in niche, high value crops and natural products development; and, promotes innovations in institutional mechanisms, including marketing. The state intends to mainstream and position organic systems as one of the main solutions needed to solve the tremendous challenges of sustainable mountain development, globalization and climate change faced by the region.

Sikkim is determined not to use any agrochemicals, pesticides, synthetic substances, hormones, growth regulators, feed additives, genetically modified organisms, antibiotics or other additives other than organic certified products for plant protection and organic fertilizers.



A typical small farm in the mid-hills

3. Strategic Goals

The Sikkim Organic Farming Policy of 2014 supports Sikkim's vision of holistic and integrated organic farming. In order to realize this vision, the State Government established Sikkim Organic Mission in 2010. Internal control systems and certification systems for organic farming are fully functional in the state. Most of the farmlands are certified, and chemical fertilizers and pesticides are no more used in Sikkim. These targets were achieved over the past decade. The focus now should be shifted to enhancing livelihoods, promoting entrepreneurship and business models, achieving economy of scale, support services and incentives, access to finances for promoting product development and marketing, use of bio-fertilizers and bio-pesticides, and enhancing ecosystem services. The strategic goals are:



Agriculture in high altitude area

- 1) Enhanced livelihoods through organic farming and diversified farm products, including niche and high value products
- 2) Increased income of farmers and people of Sikkim from organic products through enterprise and business development
- 3) Ensured engagement of women and men farmers, youth and private entrepreneurs for achieving critical mass, aggregation and economy of scale in organic production and green growth
- 4) Ensured delivery of functional support and services including climate services to organic farmers as incentives through government programmes, subsidies, soft loans and others, and enhanced climate change adaptation by farmers
- 5) Supportive policies and financial instruments are in place, accessible and used for entrepreneurship, value addition and processing, marketing, branding and export of organic products
- 6) Use of chemical fertilizers and pesticides eliminated and replaced by organic practices including use of bio-fertilizers and bio-pesticides
- 7) Enhanced and sustained ecosystem services through organic farming by preserving the environment

4. Principles of Organic Farming

Traditionally, farming in Sikkim has for centuries followed the principles of ecology, health of ecosystems and people, fairness with regard to the environment and opportunities, and care for future generations and the environment. These principles match well with those espoused by IFOAM – Organic International. Recognizing the global values of these principles that are also applicable to Sikkim, this strategy adopted the principles laid down by IFOAM – Organic International. These are inter-connected ethical principles to inspire the organic movement.

4.1 The principle of health

Organic farming should sustain and enhance the health of soil, crop, plant, animal and people and these are inseparable.

A healthy ecosystem is supported by healthy soil that produces healthy crops fostering wellbeing of people and ecosystems. This principle emphasizes the resilience of social-ecological system through healthy environment. Health is the wholeness and integrity of living systems. The role of organic farming, processing, distribution, or consumption, is to sustain and enhance the health of ecosystems and organisms, from microbes in the soil to human beings. In particular, organic agriculture is intended to produce high quality, nutritious food that contributes to preventive health care and wellbeing. In view of this it should avoid the use of fertilizers, pesticides, animal drugs and food additives that may have adverse health effects.

4.2 The principle of ecology

Organic farming should be based on living with ecological systems and cycles, work, emulate and help sustain them

This principle is based on organic farming as a part of ecosystems. The production should be based on ecological processes and recycling. Nourishment and wellbeing are achieved through the ecological systems of the specific production environment. In the case of crops it is the soil and for animals it is the farm ecosystem. Organic farming, pastoral and wild harvest systems should fit with ecological balance of nature. These ecological cycles are universal but their process is site-specific. Organic management must be adapted to local conditions, ecosystems, culture and scales, which is how it has to be applied in the different climatic zones of Sikkim. It calls for reducing inputs by reuse, recycling and efficient management of materials and energy in order to maintain and improve environmental quality and conservation of resources. Organic farming should attain ecological balance through the design of farming systems, establishment of habitats and maintenance of genetic and agricultural diversity. Those who produce, process, trade, or consume organic products should protect and benefit the common environment including landscapes, climate, habitats, biodiversity, soil, water and air.

4.3 The principle of fairness

Organic farming should build on relationships that ensure fairness with regard to the environment and opportunities

Fairness is characterized by equity, inclusiveness, respect, justice and stewardship of the shared ecosystem, connecting people with nature. This principle emphasizes that those involved in organic farming should ensure fairness to all connected, like farmers, labourers, processors, distributors, traders and consumers. Organic farming should provide everyone involved with a good quality of life, and contribute to food sovereignty and reduction of poverty. Natural capitals used for production and consumption should be managed with social and ecological justice that ensures good quality resources to the future generations. Fairness requires systems of production, distribution and trade that are open and equitable and account for environmental and social contributions.

4.4 The principle of care

Organic farming should be managed in a precautionary and responsible manner to care for the health and wellbeing of present and future generations and the environment

Organic farming is a dynamic system that responds to internal and external forces and situations. While farmers can enhance efficiency and increase productivity through organic farming, they should not be at the risk of health hazards and reduced wellbeing. The principle is to apply precaution and responsibility on the key concerns in management, development and technological choices in organic farming. Research and knowledge is necessary to ensure that organic farming is healthy, safe and harmonious to the ecosystem. Additionally, practical experience, accrued wisdom and traditional and indigenous knowledge offer valid solutions of care tested over time.

5. State Policy on Organic Farming

Sikkim became the first state in India to officially adopt organic farming in 2003 to maintain soil fertility, protect the environment, sustain ecosystem services, promote healthy food production and safe living, and reduce the risk of health ailments. Sikkim stopped imports of chemical fertilizers and promoted the use of organic manure for cultivation, which is an age-old practice in Sikkim.

The Sikkim State Policy on Organic Farming was put in place in 2014 and the Prime Minister of India declared Sikkim as India's first fully **organic farming state** in January 2016, during the Sikkim Organic Festival held at Saramsa, near Gangtok.

The State Policy dwelt on the conversion of the entire state of Sikkim to organic from the conventional system with a road map and a perspective plan. The road map considered broad strategies, plan of action, physical and financial targets, implementation mode, infrastructure and final outputs. The policy broadly considered four elements: internal control system development and certification; input support; processing and value addition; and, branding and marketing.

The Policy outlined 13 elements to be implemented in the state

- Internal control system (ICS) development as a mandatory requirement for organic certification and a conversion period of three to four years.
- On farm production of inputs and ban on the use of chemical fertilizers and pesticides
- Processing of organic produce and value addition within Sikkim
- Marketing of organic produce and supply chain including promoting and branding of products
- Research and technical backstopping for farmers and stakeholders with support from national and state institutions
- Infrastructure development such as establishment of soil testing laboratories, strengthening integrated pest management laboratories, production of bio-fertilizers of local strains for distribution to farmers, establishment of processing and packaging units, and training and capacity building at all levels and for stakeholders
- Preparation of action plans and strategies for five-year cycles using existing programmes of the state and union governments as incentives for organic farming
- Developing facilities and strategies for organic seed and planting materials production to meet the demands of farmers
- Developing strategies and practices for catering to animal husbandry related feed and fodder requirements of farmers
- Employment generation and manpower development to boost organic farming and related marketing opportunities
- Provide support to farmers using appropriate crop planning in the context of integrated farming to boost bulk and cluster production
- Develop bio-village and model farm with demonstrative value
- Develop and implement strategies on publicity and communication using different media for general awareness

6. Sikkim Organic Mission

The organic movement in Sikkim was supported by an enabling policy and institutionalized through the “Sikkim Organic Mission”. The Sikkim Legislative Assembly adopted a historic resolution to transform Sikkim into an organic state. This was the first policy initiative towards organic farming and Sikkim became the first State in the country to enact such a farsighted and visionary policy for adoption of organic farming concepts and approaches.

A roadmap and action plan for organic farming in Sikkim were drawn up in 2003. Steps to discourage the use of chemical fertilizers were initiated soon after. The use of chemical fertilizers was reduced in a phased manner by tapering off subsidy by 10% each year on fertilizers. There is no state subsidy on chemical fertilizers since 2007-08.

In the initial years, on-farm production of organic manure was promoted and farmers were encouraged to adopt the practice. This was done to improve soil fertility and farmers were urged to adopt various technologies of recycling farm wastes like traditional composting, vermicomposting, use of effective microorganisms, enriching rhizospheric microorganisms, microbe enriched bio-fertilizers, bio-dynamics, and use of bio-pesticides.

Capacity building efforts were also conducted for all the farmers to make appropriate changes in the package of practices and adoption of better technologies. Government officers and field functionaries were also trained on organic farming.

Various infrastructural facilities for post-harvest technology, seed processing centres, soil testing laboratories including mobile soil testing, vermi-culture hatcheries, ginger processing unit, and biofertilizer production were established from 2003 to 2010. During this period various consultancy services from national institutions were quite useful.

Organic certification efforts initiated in 2006 and supported by the relevant departments of the Government of Sikkim, NGOs, service providers, Krishi Vigyan Kendra and many expert groups have enabled farmers to register and have their farms certified. Service providers and certifying agencies engaged for internal control system and certification are now fully operational in the state.

A national workshop with the topic “Vision for Holistic and Sustainable Organic Farming in Sikkim - The Future Thrust” held in 2010 delivered ideas on vision and mission for the mountain state. The seven-year journey of Sikkim towards becoming a fully organic state received impetus when the Government launched Sikkim Organic Mission in 2010.

Sikkim Organic Mission was established with the following six objectives:

- Promote Sikkim as an Organic State
- Brand organic products of the state as “Sikkim Organic”

- Outline measures to discourage use of chemical fertilizers and pesticides in Sikkim and gradually substitute in organic plant nutrients with organic manure and fertilizers as well as manage and control diseases and insect pests by biological control measures
- Develop the basic infrastructure and statutory framework, which are pre-requisite for initiating organic farming in Sikkim
- Create or develop market linkage for organic produce along with the evolvement of suitable strategies
- Formulate a policy on organic farming in Sikkim.



Ginger cultivation

7. Legislation and Research Support to Organic Farming

After the launch of Sikkim Organic Mission, the State formulated its Organic Policy. The Policy laid out numerous strategies to ensure the transition from conventional to organic farming. Further, in order to ensure that no chemical inputs for farming are utilized in the State, a legislation was passed namely, “The Sikkim Agricultural, Horticultural Input and Livestock Feed Regulatory Act, 2014” which regulated the import, sale, distribution and use of inorganic agricultural, horticultural inputs and livestock feed. The Government of Sikkim also established the Sikkim State Organic Certification Agency (SSOCA) in the year 2015.

The Sikkim Organic Mission and ICAR Sikkim brought out a publication titled “*Handbook of Organic Crops Production in Sikkim*” in 2014, another first in the country with a package of practices on organic cultivation for more than 30 crops. This book mainly focuses on research and development based organic agriculture and horticulture production technologies suitable for Sikkim hills, with the majority of recommendations based on research undertaken at Indian Council of Agriculture Research, Sikkim Centre, Gangtok; National Research Centre for Orchids, Pakyong, East Sikkim; and, Indian Cardamom Research Institute, Sikkim Unit, Gangtok. The organic nutrient management component was developed in consultation with National Bureau for Soil Survey and Land Use Planning, Kolkata Regional Centre. Multidisciplinary group of scientists have contributed to this essential book.



Cheese processing and packaging

8. Mountain Development and the Sikkim Context

8.1 Mountain services

Mountains occupy 22% of the world's land surface area, are home to 13% of the world's population and provide ecosystem services of global significance in the form of water, hydroelectricity, timber, biodiversity, food and niche farm products, mineral resources, recreation, and flood management. About half of all humankind directly depends on mountain resources, primarily water and biodiversity.

Mountain areas have ecological, aesthetic, and socioeconomic significance, not only for people living there, but for those living beyond –especially those in the lowlands who benefit from the ecological services mountains provide. Mountains provide some of the last bastions of pristine, biodiverse 'islands' in a sea of transformed lowlands, providing a number of significant ecological functions extending beyond the mountains themselves and benefiting entire river basins and downstream countries. Additionally, natural and semi-natural vegetation cover in mountains helps to stabilize headwaters, preventing flooding and maintaining steady year-round flows by facilitating the seepage of rainwater into underground aquifers.

Mountains support 25% of world's terrestrial biodiversity and include nearly half of the Global biodiversity 'hotspots'. Of the 20 plant species that supply 80% of the world's food, six – apples, barley, maize, potatoes, sorghum and tomatoes – originated in mountains. Mountains are also centres of cultural and linguistic diversity. While about 915 million people live in mountainous regions, less than 150 million people live above 2,500 masl, and only 20-30 million people live above 3,000 masl. In general, poverty is higher in mountain regions and people are often at higher risk than people elsewhere.

Mountain areas are unique, characterized by limited accessibility and isolation, environmental fragility, social marginality and vulnerability, as well as rich in diverse ecosystems. In addition to the vulnerabilities and fragilities, mountain areas are also resilient, a characteristic that helps people and communities survive and thrive in isolation. Such features are described as "mountain specificities" by many of those working in mountain regions and with mountain peoples. These features have biophysical and socio-economic dimensions, and most of them are directly or indirectly inter-linked. There has been general realization on the importance of mountain specificities and perspectives, but they are not usually mainstreamed in policy, planning and investments.

Mountain geological formations are fragile and ecosystems are degrading fast because of both natural and anthropogenic drivers of change. At the same time, the relevance of freshwater,

biodiversity, farming systems, traditional knowledge and identification with local values, has brought mountains into focus and given them attention that these communities have never before experienced in modern times. Melting glaciers, intensification of floods and extended droughts are among the most visible and alarming signs of climate change. Compared to 30 years ago, mountain systems are now strategically seen as providers of ecosystem services, which are a prerequisite for food security and poverty reduction as well as a central argument for sustainable development especially given the effects of climate change. Small shifts in mountain climates can cause major problems in food production and security, especially in terms of water resources, potentially threatening the habitability of long-established communities.

As climate changes rapidly through elevation over relatively short horizontal distances, so do hydrology, vegetation, ecological conditions, farming practices and socio-economic settings. This rapid change over distance, in turn, also influences farming systems, cultural values and societies. In this way, it is important to recognise the complexities of environment-society interactions — culture and environment are mutually reciprocating systems in mountains.

Mountains have only recently begun to receive some attention, due in large part to the cascading impacts of climate change in mountain systems. Climate change and its impacts have raised a number of issues for which the relevance of mountains for providing global goods and services is realized. The enormous and often rapid economic growth in the vicinity of mountain regions; the dynamic development of communication and transportation linking mountain regions with each other and with non-mountain regions; and the increasing globalization of international relations and exchange of goods and services have all influenced the evolution of mountain communities including the rapid expansion of urban centres in line with the global trend of urbanization.

8.2 Hindu Kush Himalayan region and its services

The Hindu Kush Himalayan region is characterized by rugged terrain with a harsh environment, and an extremely varied climate along the mountain chain extending 3,500 km covering 4.2 million sq. km. It is often referred to as the 'Third Pole' and the 'Water Tower of Asia', as it stores a large volume of water, particularly in the form of ice and snow, contributing to and regulating the flow of ten major river systems in the region. The climatic and environmental conditions across the Himalaya create challenges, but also a wide range of opportunities for livelihood options including niche farming. Despite rich natural resources, they are home to some of the world's poorest peoples. The region remains geographically, politically and economically marginalized.

Himalaya's vast complex of hills, valleys, plateaus and mountains contain some of the world's tallest peaks and more than 60,000 km² of glaciers and 760,000 km² of snow cover. These massive reserves provide water for energy, tourism, domestic use, and food production, among other needs. Ten major rivers originating from the greater Himalayan region connect upstream and downstream areas in terms of trade, culture, commerce, communication, and

resource management, and provide (directly and indirectly) goods and services to 1.9 billion people in Asia, including 240 million who live in the mountains. The Himalayan river basins provide water to the most irrigated areas in the world contributing to the food security of about 3 billion people in Asia. Sustainable development of countries in South Asia, South-East Asia and China largely depends on resources originating in the Hindu Kush Himalayan region.

The mountain farming and cultures live with rich and remarkable biodiversity. The region, with its varied landscapes and soils, plus its variety of vegetation types and climatic conditions, is well known for its unique flora and fauna showing high endemism. Elevation zones across the Himalaya extend from tropical (< 500 masl) to alpine ice-snow (> 6,000 masl), with a principal vertical vegetation regime comprised of tropical and subtropical rainforest, temperate broadleaf deciduous or mixed forest, and temperate coniferous forest, including high altitude cold shrub or steppe and cold desert. These ecological and climatic zones provide conditions for huge diversity of farming practices and livelihoods. Endowed with a rich variety of ecosystems, species and gene pools with high endemism, it incorporates numerous ecosystems of global importance and several areas in the Himalayas are part of designated 'Global Biodiversity Hotspots'.

The Hindu Kush Himalayan region plays an important role in global atmospheric circulation, and the hydrological cycle, in addition to the unparalleled beauty of its landscape and provision of other ecosystem goods and services. The Himalaya region is also home to many diverse ethnic communities speaking about 1000 different living languages and dialects, with enormous socioeconomic and cultural diversity. Language is a good indicator of ethnic diversity, and the endangerment and death of minority languages clearly indicates the threat to mountain farming, traditions, traditional ecological knowledge and cultures. These communities practice a variety of traditional livelihoods, including diverse farming approaches, which have exploited agricultural land and reaped harvests sustainably despite harsh environment. A recent analysis shows that 30% of the Himalaya population lives below the poverty line, compared to 25% as the national average of these countries including plain areas, indicating that mountain peoples are poorer than those in non-mountain areas. Around 30% people in the Himalaya are still food insecure and 50% children malnourished. This raises an issue on how the farming systems should be diversified and developed to generate more income for mountain communities and ensure food and nutrition security.

The growing awareness of the importance of the Himalaya region gives new significance to the discussions around upstream-downstream relations. An important question is how upstream areas can be compensated for maintaining the flow of goods and services from mountains that benefit those in the downstream areas. That is, what are the policies and strategies, which make the services sustainable in the interest of regional development, factoring in mountain and non-mountain interests, and bringing in more investments to the Himalaya region.

8.3 Indian Himalayan Region and Sikkim

The Indian Himalayan Region is vast, diverse and is part of the youngest mountain system in the world. It stretches over more than 2,500 km in length and covers 533,000 sq. km area across 12 states namely, Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh, Meghalaya, Nagaland, Manipur, Mizoram, Tripura, and two hill districts each of Assam and West Bengal.

The region occupies the entire length of the strategic northern boundary (North-West to North-East) of the nation and touches the international borders that India shares with six countries. It accounts for about 16.2% of India's total geographical area and is inhabited by about 3.8% of the country's population. The snow-clad peaks, glaciers of higher Himalaya, forest cover and farming systems in the middle hills, cover most of the area.

Traditionally, indigenous communities in the region have been dependent on ecosystem services to meet their basic sustenance needs, notably food, fodder, fuel, fertilizer, shelter, and health care. More than 80% of the population in the region is involved in agriculture, horticulture, livestock based farming, forestry and other biodiversity dependent livelihoods. Among other bio-resources of economic value such as medicinal plants, high value products like wild edibles and other non-timber forest produce have great potential for development.

Among the 34 million people that inhabit the Indian Himalayan Region, a large percentage is of hill and mountain farming communities. They practice subsistence farming on marginal, rainfed and some irrigated farmland, which accounts for about 15.8% of the total area of the Indian Himalaya, roughly 54 million hectares.

The farming systems in the Indian Himalayan Region are of five major types: pastoralism, mostly high altitude livestock farming of yak, sheep and pashmina goats; agro-pastoralism, involving both agriculture and livestock based farming; middle hill farming systems, mostly rainfed with traditional crops; shifting cultivation practiced in north-east, popularly known as *jhum*; and, commercial crop based systems like apple farming, tea cultivation, large cardamom agroforestry and others.

Sikkim is one of the fully mountainous states of India. It covers an area of 7,096 sq. km with a total population of 610,577 from 2011 census. Sikkim is also one of the least densely populated Indian states, with only 86 persons per sq. km. However, it has a high population growth rate, averaging 12.36% between 2001 and 2011. Almost the entire state is hilly, with elevation ranging from 280 masl in the south at the border with West Bengal to 8,586 masl at the Khanchendzonga peak in the north bordering Nepal and Tibetan Autonomous Region of China.

Sikkim's bioclimatic classification and distribution are shown in Figure 1. The North District and small portions in the other districts experience extremely cold and mesic, and cold and mesic climate. The southern half of the state mostly experiences cool temperate and moist,

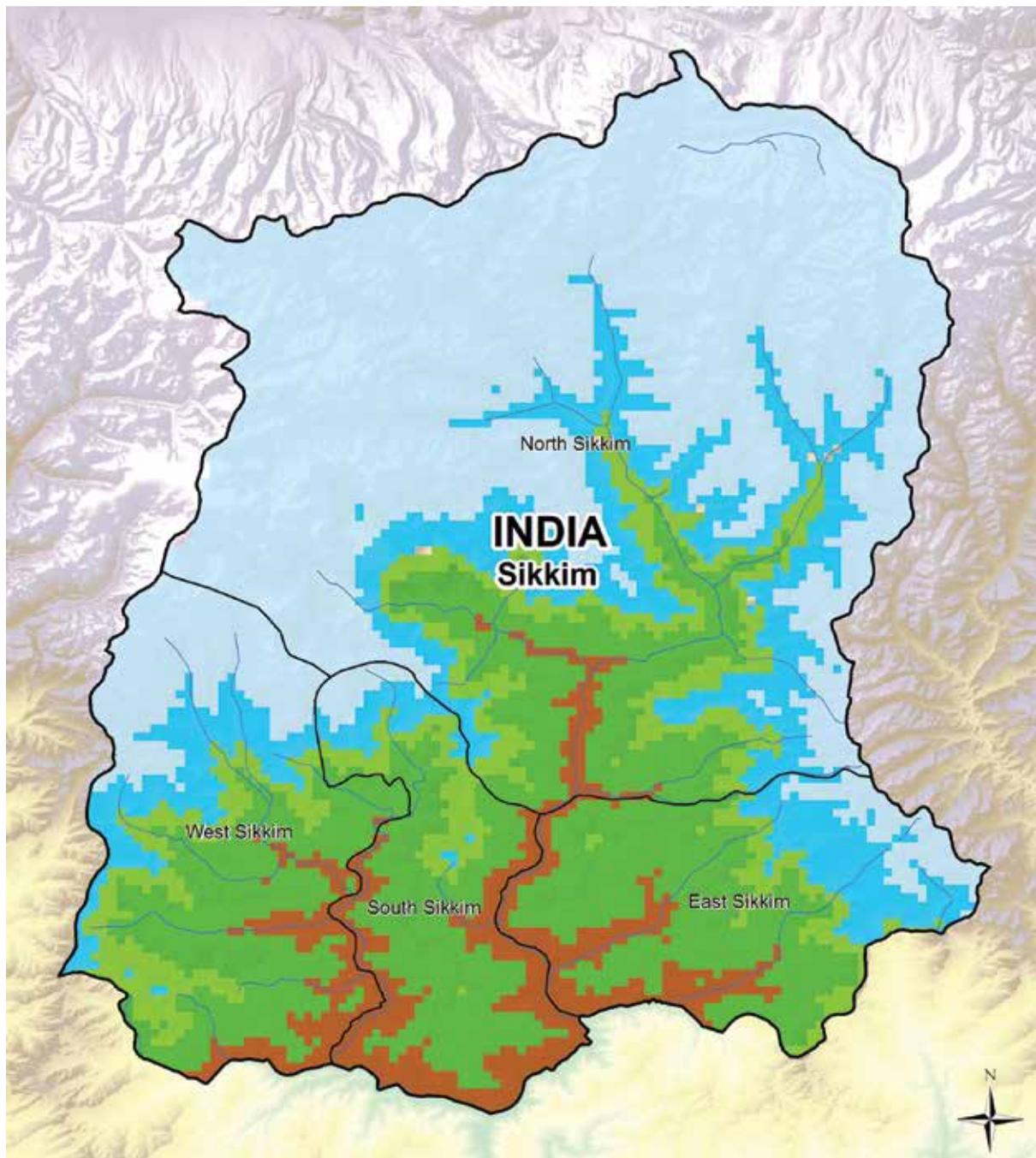
and warm temperate and mesic conditions. The areas adjoining the snow-covered areas experience cool temperate and mesic climate. Hot and mesic zones are a feature of the valleys and riparian areas at lower elevation.

The land use and cover map of Sikkim can be broadly classified into seven groups namely, grassland; water bodies; mixed forests; evergreen broadleaf forests; snow, ice and barren-land; built-up-land; and cropland, agroforestry systems and adjoining forests (Figure 2). Organic farming in Sikkim are mainly practiced in two land uses such as grasslands in high altitude areas, and cropland and agroforestry systems. Farming systems cover around one-tenth area of the state.

Sikkim's nominal State GDP was estimated at US\$1.57 billion in 2014 constituting the third smallest GDP among India's 28 states. The state's economy is largely agrarian, based on the terraced farming of paddy and the cultivation of crops such as maize, millet, wheat, barley, tea and large cardamom. Despite the state's minimal industrial infrastructure, Sikkim's economy has been among the fastest growing in India since 2000; the state's GDP expanded by 89.93 percent in 2010 alone.

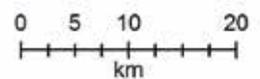
In Sikkim there are three major types of farming. The agro-pastoralism in northern high altitude areas includes agriculture and livestock rearing. The middle hill farming has mainly traditional rainfed crop cultivation like upland and wet terrace paddy, maize, pulses, millets, buckwheat, barley, turmeric, potatoes, soybean and mustard, vegetables, and others. The commercial crop based cultivation systems include large cardamom, tea, ginger, horticultural crops like orange and floriculture.

Figure 1: Bioclimatic classification of Sikkim



Legend

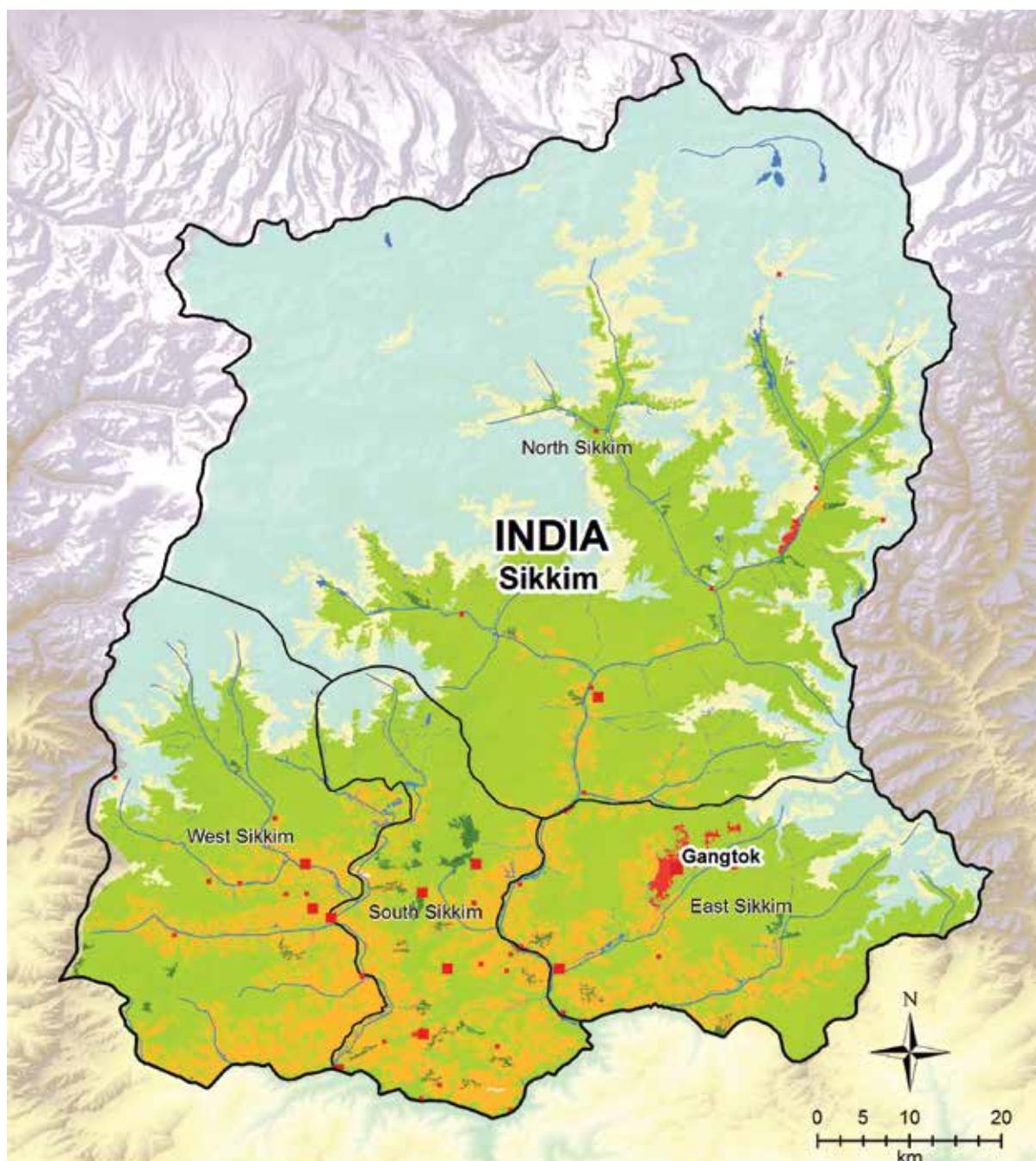
- | | | |
|--|---|---|
| Extremely cold and mesic | Warm temperate and mesic | District |
| Cold and mesic | Hot and mesic | State |
| Cool temperate and moist | | Drainage |



Elevation ranges (above mean sea level in metres)

- | | | |
|--------------------------|---|---------------|
| Hot and mesic | = | 250 - 1,000 |
| Warm temperate and mesic | = | 1,000 - 2,500 |
| Cool temperate and moist | = | 2,500 - 3,000 |
| Cold and mesic | = | 3,000 - 4,000 |
| Extremely cold and mesic | = | 4,000 - 8,500 |

Figure 2: Land use and cover map showing cultivated systems



Legend

- | | | |
|---|---------------------------|----------|
| Grassland | Mixed Forest | Drainage |
| Water Bodies | Evergreen Broadleaf F. | District |
| Built-up Land | Snow and Ice, Barren land | State |
| Cropland, Agroforestry Systems and adjacent forests | | |

9. Emerging Issues Related to Organic Farming

9.1 Climate change and impacts

Mountains are a hotspot of climate change where amplification by elevation-dependent warming is evident. Even a 1.5°C global temperature rise, as agreed to in Paris 2015, is too hot for the Himalayan region, which will warm more rapidly at higher elevations. At current emission levels, temperatures are expected to increase by 5.5±1.5°C by 2100 in the Himalayan region. This implies huge risks and impacts to natural resources and people both in the mountains and downstream.

Climate change has impacted glaciers as they have thinned, retreated, and lost mass since the 1970s in most parts of the Himalayan region. It is predicted that at 1.5°C at least 33% – and at current emission rates 69% - of glacier volume will be lost by 2100. Since glacier and snowmelt are important components of overall stream-flow in the Himalayan region, changes in this stream-flow will affect around two billion people in terms of water for food (especially irrigation and use in farming systems), water for energy (hydropower), and water for ecosystem services (riparian habitats, environmental flows, and rich and diverse cultural values). Climate change is currently and will continue to negatively impact water resources in the Himalaya, posing enormous challenges to sustainability.

Climate change impacts on farming systems are likely to have disastrous consequences on society, economy and ecosystems if timely and appropriate actions are not undertaken. Assessing climate risks and vulnerabilities, including developing regional climate services for better planning and risk management is crucial to support farmers. Investing in agricultural research, focusing on increasing water productivity and developing climate-smart crop varieties will be another dimension for adaptation.

The indigenous communities in Sikkim have perceived changes in the climatic conditions over several decades in the form of erratic rainfall/snowfall events, prolonged dry spells or droughts, warmer winters, unpredictable monsoon, disappearance of local springs, emergence of new diseases and pests in crops/fodder trees. These changes are expected to persist and intensify in the future. Such events are posing potential future risks to food and livelihood security, leading to increased drudgery, degradation of large cardamom plantations and mandarin orange orchards, crop failure, scarcity of water for drinking and irrigation, migration of farm labour and increased workload of women and the elderly, and increasing health problems. The farming communities in Sikkim are vulnerable to geographic exposure, low incomes, greater reliance on agriculture as well as limited capacity to seek alternative livelihoods, which if not addressed is expected to accelerate at a fast rate.

In the sub-alpine, alpine and trans-Himalayan zones (3,000 - 5,500 masl), nomadic pastoralism and agro-pastoralism symbolically integrates with the socio-cultural life of the indigenous communities and contributes to socio-ecological adaptability to changing climatic conditions. The climate change impacts in these areas have been felt in the last 20 years with the shift of snowfall events and timing. The herders have realized the increased summer temperatures followed by decline in snowfall by nearly 60%. An elderly herder remarked that 20 years ago at Thangu (4,000 masl), snowfall events lasted for seven to 15 days. In the last 10 years dramatic changes have been felt at Thangu, Zema, Muguthang, Lhonak Valley, Lashar Valley and Yumthang, with snowfall events now being occasional and lasting only for one to two days. The indigenous community mentioned increased rainfall in the Lachen and Lachung valley of North Sikkim. Herders recount that more than 3 m snowfall was natural at Thangu, Bamzey and Dambochey (4,000 - 4,700 masl) 15 to 20 years ago, which has declined by almost 50% in recent years. Rangeland degradation, flash floods, frequent landslides / mudslides, avalanches during winter, and reduction in pastoralism are commonly observed in the trans-Himalayan and alpine areas. These unusual natural events are threats to the nomadic agro-pastoral communities in high altitude areas.

Similarly, untimely and seasonal shift of snowfall events have also affected trans-Himalayan nomadic pastoralism in Muguthang, Gurudongmar-Tsho-Lhamu plateau and Lashar valley. As a consequence, the Dokpas, who depend upon the availability of grazing pastures for yak herding have become highly vulnerable. During 1995-96, outbreak of a serious respiratory disease and heavy snowfall killed a large number of sheep and yaks. As a result, sheep rearing was completely abandoned in Lhonak Valley. Currently, the only shepherd owns around 200 sheep in the trans-Himalayan belt. As an adaptation strategy, the Dzumsa, has banned the slaughter of sheep to restore the population. The herders also reiterated that new animal diseases such as foot and mouth disease killed a large number of animals in these areas around 10 year ago. The National Biodiversity Strategy and Action Plan for Sikkim reported that mosquitoes are appearing in Lhonak Valley well above 4,000 masl while house crows have spread to Lachung (2,800 masl), which is an uncommon sight.

Climate change in Sikkim has contributed to an unpredictable or erratic rainfall pattern, drying up of local springs and streams, species migration to higher elevations, shift of sowing and harvesting period of crops, emergence of invasive species and incidence of diseases/ pests in crops as well as in fodder species. The climate change events observed and recorded over the years in the traditional farming systems revealed that frequent mudslides in terrace risers from unprecedented rains (in *khet* and *bari* systems), productivity decline of crops (e.g. cardamom, ginger, orange, paddy, maize, wheat, buckwheat), and emergence of diseases and pests have resulted in food insecurity in the mountain region, particularly in highly inaccessible areas. Farmers revealed that the sowing time of maize at the sub-tropical zone has been delayed by 15-20 days while harvest time has advanced. In the temperate zone, while the sowing time has remained the same the harvest time has shortened by 15-20 days.

In the mid and lower hills, days are hotter and cold days have declined. In high elevation regions, in some cases, rainfall has declined over some months and increased during the peak

season causing rainstorms, thunderstorms, and consequently landslides in the steep terrain. Windstorms have also increased damaging houses and property. The peak monsoon season brings heavy rain while other months are dryer compounding water scarcity and impacting farming systems.

The agricultural practices in the mid and low hills depend on the monsoon from May to September, which accounts for around 90% of the annual rainfall. Climate change impacts exacerbated by rainfall fluctuations, drought and floods make crops unstable adding to the workload of women. Productivity of crops is showing declining trend. New diseases and crops have infested the agriculture crops. Along the Teesta River valleys, mostly in the mid hills, during the time of normal rainfall pattern until the 1980s, farmers practiced double rice cropping, while more recent trends with the fluctuation and increasing number of dry periods in the dry months (November-March) there is a shift to single rice cropping. Issues of water scarcity and dryness prevail in non-monsoon months. Winter rainfall now hardly exceeds 10%, which around 20-30 years ago was more than 20% negatively impacting productivity. Landraces of rice, maize, pulses, ginger, wheat, buckwheat finger millet, yams and pumpkin are rapidly disappearing due to climate change impacts.

In the mid-hills, farmers reported that cardamom in the temperate region (>1,800 masl) is performing well with fewer incidences of diseases while plantations at lower altitudes have declined. The extreme climatic conditions such as long dry spells, emergence of viral and fungal diseases have contributed to large reductions in the plantation area and dramatic decline in productivity.

Similarly, mandarin orange in Sikkim has declined both in terms of productivity and plantation area. Since the 1990s, emergence of new diseases (citrus dieback, root/foot rot, powdery mildew, scab, sooty mould, anthracnose, red rust, nematodes, vascular-borne disease caused by Tristeza virus, colonization of citrus twigs and roots by ants) have been observed in almost all citrus growing areas of Sikkim. Yields have declined on average by about 5 times compared to 15 years ago.

9.1.1 Incidence of pests and diseases in crops and fodder species

Another greatest challenge after climate change impacts is the incidence of diseases and pests in Sikkim, which are the major factors contributing to crop loss and periodic productivity decline. The resulting losses are, to a significant extent, the consequences of crops grown in monocultures and emergence and spread of new pests and pathogens. The crop genetic diversity and the associated traditional ecological knowledge is used by smallholder farmers to meet their livelihood needs. Under the traditional practices, cultivation of a diversity of traditional crop varieties (cereals, pulses, tubers, horticultural crops, fruits etc.) continues to be part of disease management strategy in genetically diverse systems for such farmers. Therefore, the loss of traditional crops, which reduces the varietal choice, also reduces the farmers' capacity to cope with changes in pest and disease infestations, and has led to yield decline and instability.

Over the last 20 years, farmers in Sikkim have observed and experienced a large number of incidences of pests and diseases in crops. It is found that rice is the most vulnerable crop followed by maize both of which are staple crops of the marginal farmers of Sikkim. Similarly, among the high value cash crops, large cardamom is the most vulnerable after ginger. In recent years, pests and diseases have been observed in horticultural trees, cucurbits such as chayote, pumpkins, gourds, leafy vegetables, peas, barely, wheat, pulses and beans. This means that almost all the vegetables and cereal crops are vulnerable to pests and diseases and it is imperative that management of these issues need technological support and investment.

9.1.2 Invasive species in the farms

The traditional agro-ecosystems of Sikkim have been invaded and colonized by non-native species over the past 20 to 40 years. This presents a serious management challenge to traditional farming systems and a potential threat to organic farming systems.

There is an increased incidence of invasive species colonizing farmlands and adjacent forests areas. Species such as *Chromolaena odorata*, *Bidens biternata*, *Eupatorium adenophorum*, *Artemisia nilgirica*, *Lantana camara*, *Ageratum conyzoides*, *Cestrum auranticum*, *C. fasciculatum*, and *Galinsoga parviflora* have caused serious problems in the farmlands, forests, traditional agroforestry systems, fallow lands, croplands and wetlands. These invasive species are fast colonizing and spreading from sub-tropical to temperate agro-climatic region. Rapid spread of these alien species has resulted in a reduction in production of cereals and pulses, and also fodder grasses.

Spread of invasive species like *Mikania micrantha*, *Lantana camara*, *Eupatorium odoratum*, *Ageratina adenophora*, *Bidens biternata*, *Artemisia nilgirica*, *Ageratum conyzoides*, *Cestrum aurantiacum*, *C. fasciculatum*, and *Galinsoga parviflora* has been observed in both sub-tropical and temperature agro-climatic zones covering the terrace edges of farmlands, forests, traditional agroforestry systems, fallowlands, croplands and wetlands. The spread of invasive species have also negatively impacted the production of fodder grass, and some invasive species like *Mikania micrantha* cover the canopy of fodder trees thereby reducing the tree fodder production. The spread of *Artemisia nilgirica*, *Bidens biternata*, *Eupatorium adenophorum*, *E. odoratum*, *Chromolaena odorata* etc. have resulted in a decline of grasses, thatch grass, and the growth and productivity of firewood and timber species. The cumulative impact of all these invasive species is not only on farming systems but also on the structure and composition of forest areas. This results in shortage of quality food and fodder in the forest and causes wild animals to invade croplands.

Furthermore, crop performance and growth has been negatively impacted while productivity has declined in the areas of invasion. The management of invasive species is highly labour intensive, expensive and unmanageable as they invade even low fertility and dry soils. Mitigating the impact of invasive species is critical for good farming systems and for quality production.

9.2 Mountain specific challenges

Sikkim is uniquely characterized because of limited accessibility and its historical isolation for very long, environmental fragility because of its young geology, social marginality in the national context and vulnerability in general. Sikkim is economically marginalised and isolated, and the people are at a clear disadvantage in comparison with other non-mountainous states of the country. The physical attributes of mountainous terrain, steep slopes, instability and ecological complexity make the region extremely vulnerable to environmental risks. Sikkim's huge economic potential lies in its niche and biodiversity products, freshwater, hydropower, forests products, and aesthetic and recreation values.

The topography, elevation distribution, inaccessibility, and climatic variations present mountain specific challenges and obstacles for development and require special attention in the design of development plans. The naturally suitable high value or niche products have great potential but also have challenges.

Spatial dimensions result in diversity or locational advantages in terms of resources, products and activities that provide comparative advantage to the specific location or area. This advantage may be in terms of production of unique or niche products (e.g., large cardamom, mandarin orange, fruits, vegetables, flowers, medicinal plants, seeds, non-timber forest products and others). Harnessing such resources optimally provides livelihood security to the communities; however, overuse can have adverse impacts on the sustainability of resources and needs good regulation.

Adaptation to the environment, to include the human interaction with the environment for sustainable livelihood in the broader sense, is the key to overcome constraints generated by the specificity characteristics. The adaptation mechanisms designed by the indigenous communities have evolved over a long period of time through trial and error to overcome the constraints and hazards generated by the specificities and climate variations. These adaptation mechanisms in the form of both traditional knowledge and wisdom have helped sustainable use and conservation of resources over time. These specificities are interrelated and have multi-dimensional features having great bearing to common biophysical and socio-economic life of the people of Sikkim.

9.3 Human wildlife interfaces in the context of organic farming

Human wildlife interactions and conflict have been increasing over the years, particularly after grazing was banned in forest areas in Sikkim. For traditional farmers in Sikkim, the adjacent forests have been a source of litter for livestock and manure, non-timber forest products, water for domestic use and irrigation, fuelwood and timber. The proximity of a diversity of farmlands adjacent to the forests is one of the reasons why wild animals intrude in search of food. Human wildlife interactions are on the rise due to increasing forest cover, and increased area under agroforestry systems that have trees in the cultivated landscapes. These areas function as corridors for wildlife movement. The other reason is the conversion of forest and

agriculture lands into development projects that have impacted on the natural behaviour of wild animals.

Over the years, open cropped areas have been gradually converted into farm-based agroforestry, as these farmlands have been abandoned due to shortage of labour. Almost 90% of the farmlands are adjacent to the protected areas, reserved forest areas, and forests demarcated for grazing and fodder collection (*Khasmal* and *Gaucharan*). The wild animals therefore have easy access to move into farmlands. Elsewhere, human-wildlife conflicts occur mostly because of degradation or loss of wildlife habitat and migratory biological corridors, decreased food availability, and human incursion into wildlife habitats. In the case of Sikkim the above issues are not true as the state follows strict conservation measures. Therefore, in Sikkim there is an increasing challenge to understand the behavioural aspects of wild animals for safeguarding crops and domestic animals from depredation.

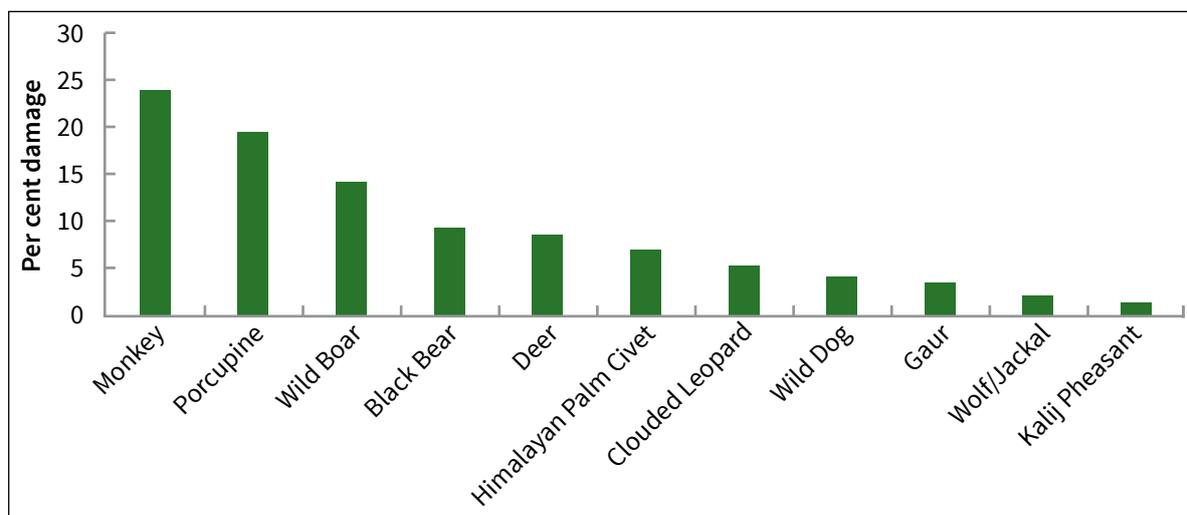
The state of Sikkim has strict conservation policies. Conservation data shows that over 84% of the state's geographical area is under the Forest, Environment and Wildlife Management Department, of which 82% comprises Reserve Forests (including forests in biosphere reserve, national parks and wildlife sanctuaries; rangelands; snow and glacier covered areas) and 2% *Khasmal* and *Gaucharan* forests. There has been a 10% increase in forest cover in Sikkim from 1975 to 2009. Although there are enough forest types and wildlife habitats, and strict norms to regulate resource extraction by the fringe villages, the wild animals are still frequently visiting farms to raid crops and prey on domestic animals.

Human-wildlife conflict in Sikkim is not a new concern. However, the magnitude has been rising greatly in recent years. Asiatic Black Bears have been frequently visiting farmlands to feed on maize or destroy large cardamom bushes, sometimes attacking humans or preying on domestic animals. The number of injuries due to bear attacks has dramatically increased especially in the fringe villages in the proximity of protected areas.

The most common wildlife raiding the farmlands are Monkeys (*Macaca mulatta* and *Macaca assamensis*) Porcupines (*Hystrix brachyura*), Wild Boars (*Sus scrofa*), the Asiatic Black Bear (*Ursus thibetanus*) and to a lesser extent Clouded Leopard (*Neofelis nebulosa*), Jackal/Red Fox (*Canis aureus*, *Vulpes vulpes*), Kalij Pheasant (*Lophura leucomelanos*) and Indian Peafowl (*Pavo cristatus*), which damage standing crops or prey on domestic animals (Figure 3). Boars and monkeys often inflict extensive damage to crops during a single visit to the field.

Almost all the agricultural crops and fruit orchards are raided by wild ungulates, primates, and granivorous and frugivorous birds, which cause damage to both food crops and young shoots of other crops and plantations in the farmlands. Monkeys have become notorious for attacking women and children when they are chasing them out of farmlands. Monkeys have been observed attacking domestic dogs in the recent years when they come to raid grains stored in houses.

Figure 3: Damage by wild animals in farms on the fringes of Pangolakha and Maenam wildlife sanctuaries



Bio-fencing has been adopted by a large number of farmers in Sikkim although they are not effective at keeping monkeys and wild boars away. In some areas barbed wire fencing has been tried but it has not been successful. Barricading crop fields will require extensive fencing of the entire village, which is a costly proposition. Digging of deep trenches to prevent wild boars from entering farmland has been tried, but the animals find other ways to enter.

There are areas where people have abandoned the farmlands and homesteads due to recurrent and severe crop damage and destruction by wildlife. Field studies on human-wildlife conflict and other aspects of human-wildlife interface are still to be carried out in Sikkim and there is an urgent need to estimate the total economic loss due to wildlife depredation on crops and domestic animals. Further, there is an immediate need to understand the causes for the increased attacks on humans by black bears in Sikkim. Similarly, wildlife depredation on domestic animals has been increasing across the state. Ex-gratia provision doesn't reach many families in remote villages where such incidences are very high.

All the wildlife involved in depredation and conflict are provided legal protection under the The Wildlife (Protection) Act 1972 and therefore wilful killing of the wildlife is prohibited under law. Compensation for crop damage by wildlife is not usually made or even if paid it is very low that farmers express dissatisfaction.

The Ministry of Agriculture and Farmers Welfare, Government of India has introduced yield based Pradhan Mantri Fasal Bima Yojana and weather index based Restructured Weather Based Crop Insurance Scheme from 2016 to provide financial support to farmers suffering crop loss/damage due to natural calamities/adverse weather conditions, and to stabilize the income of farmers. These schemes need to reach the organic farmers of Sikkim and benefit them soon.

9.4 Opportunities and challenges for farming systems

The people of Sikkim are largely family farmers who base their livelihoods on highly diversified farm and off-farm activities. Over generations, these communities have developed unique, resilient and sustainable production systems adapted to their local environments, from tropical to sub-tropical and alpine to trans-Himalaya, along altitudinal gradients with ecological zones favouring niche and mountain-specific products and services.

There is worldwide demand for quality, high-value and traditional foods and crafts produced in mountain areas, particularly organic products. The State of Sikkim has already developed many high value commodities such as large cardamom, tea, ginger, mandarin orange, medicinal plants based products, underutilized and lesser known crops based products, mushroom, mountain honey, and products developed from non-timber forest produce. Similarly, hard cheese made from yak milk; traditional handicrafts made out of a variety of bamboo, cane and wood; and herbs and spices are being produced. Due to the small size of farmlands owing to fragmentation of families, small-scale agriculture can hardly compete with the large volumes of lowland production, but there is scope to tap into niche markets such as organic, fair trade, or high-end quality products, and fetch premium prices for Sikkim's farmers.

With the conversion of conventional farms to organic, there is an excellent opportunity for commercial and high-value products based systems and services. Communities have an opportunity to improve their livelihoods by generating additional employment and income. Women also have an important role in managing niche products, as they are the custodians of knowledge and resources like seeds.

It is crucial that access to markets, extension services, credit and information are improved for supporting producers and for enhancing their economic engagement. Due to geographical isolation, remoteness, marginality and limited support services, the potential for exploiting niche products is adversely affected. Producers do not get a fair price because of the increasing number of middlemen in the value chain for most mountain niche products. There is a need for establishing an efficient price fixing system to ensure more benefits to farmers.

Incentives, promotion of entrepreneurship and modernization will attract youth and keep them engaged in organic farming. Large cardamom, mandarin orange, horticultural crops, vegetables, underutilized crops (buckwheat, millets, tubers and others), wild edibles and other niche products have immense potential for commercialization while also contributing to conserving diversity and the natural environment. Large cardamom and ginger farming have proven to be promising production systems on marginal farms along the slopes. However, strong institutional support is needed to improve value chain, including production, processing, packaging and marketing. Support for branding and promotion of organic products is also necessary. There is also a need to consolidate the action areas through convergence between Food Security and Agriculture Development Department; Horticulture and Cash Crop Development Department; Rural Management and Development Department;

Animal Husbandry, Livestock, Fisheries and Veterinary Services Department; and Forest, Environment and Wildlife Management Department.

To capitalise on the tremendous opportunities for mountain specific niche products, there is an urgent need to develop research and development policies, institutions, infrastructure, technologies and service delivery considering the needs and potential of Sikkim's farmers. Around 90% of the farmers are smallholders and have limited access to technologies, inputs, markets and policy decisions, and therefore, enabling policy reforms are vital. There is a need to support and encourage the farmers through targeted support on inputs, marketing, and capacity building for their contribution to maintain environmental services.

Some of the challenges that need immediate attention are:

- Migration of youths for off-farm employment opportunities in urban centers within the state and outside is one of the biggest challenges observed in Sikkim. This has consequently caused labour shortage in the farms. Large areas of cultivable land are abandoned, or left uncultivated due to shortage of farm labour.
- Farmers are facing problems because of limited infrastructural support for value addition, storage and transport of organic products to the final destination.
- The inadequate capacity in economic valuation of farm products including the entire value chain is preventing farmers from getting the right price for their produce. Farmers lack information on the prevailing market price for their products. A huge gap in information flow from the market to the producer is observed. There is a need to have price fixing mechanism in the state.
- Availability of farm technologies matching the modernization requirements of organic farming is limited.
- Water scarcity during the lean period is becoming a huge issue and there is a need to improve irrigation facilities and water use efficiency.
- Pests and diseases are causing immense problems to farmers.
- Crop and production loss due to unprecedented climate conditions and natural calamities is becoming more frequent and is a major concern in the state.
- Crop depredation by wildlife has become a common problem in the state. Wildlife depredation of domestic animals is another challenge farmers have been facing in recent years.
- Mountain specificity related policy issue in organic product business, and government plans and programmes extremely important issue to be considered.
- Need for an effective communication system as a part of climate services specifically information related to hailstorms, rainfall, flash-floods and drought, etc. so as to protect farms, crops, property and life.
- Need for increased coordination, convergences and exchange between the relevant government departments and research and development agencies

10. Sikkim's Farming Systems and Livelihoods

10.1 Traditional farming systems

Sikkim is part of the Eastern Himalayan Agro-biodiversity Region, one of 22 agro-biodiversity hotspots in India, and a part of the globally significant Eastern Himalaya biodiversity hotspot. Sikkim houses diverse agro-ecosystems, farming cultures, agro-climatic regimes, traditional landraces, and local livestock breeds. Local and indigenous communities in the state have, over centuries, tested and adopted innovative strategies for conserving and harnessing native agro-biodiversity, primarily for food security and improving their livelihoods. The diversity of the landscape, land use stages, and specific land use categories on temporal and spatial scales have provided opportunities to manage agro-diversity and nurtured human-nature relationships. A diversity of ecosystem goods and services is bestowed by the agro-diversity elements from the local to global level.

Farming practices in Sikkim follow the traditional mountain farming setup where slopes are worked into terraces and over which the crops are cultivated, either rainfed or irrigated. In the earlier days, the aboriginal people of Sikkim, the Lepchas, followed agriculture in its most basic form with the use of simple tools. The fire-stick method of cropping was used to prepare land and grow corn and upland rice combined with an assortment of lentils and squash. As a major part of their diet came from hunting and gathering wild edibles, their engagement in farming was limited. The Bhutias followed simple agricultural practices combined with pastoral activities for livelihoods. Bhutias were mostly engaged with livestock based farming, raising yaks, sheep, cattle and mountain horses. The Nepalese changed agriculture in Sikkim by introducing new germplasm along with improved farming techniques and practices. Agricultural development picked up pace after Sikkim became part of the Indian union and today it is a leader in organic farming in the country.

The basic farming elements for traditional farmers in Sikkim constitute the cropping fields, a source of water supply, farm animals, feed/fodder supplies, and agricultural work force. Irrigated (*Khet*, usually paddy fields) and non-irrigated (*Bari*) are the two major land use types all over the state, with the latter supporting more agricultural diversity. The *Khet* is richer in diversity at the landrace level while the *Bari* represents more diversity at species and several intra-species levels (Table 1). A large section of crops, mainly cereals, are wind pollinated and the rest of the crop are insect pollinated, especially by bees, butterflies and bumble bees, as well as birds.

Sikkim's unique agro-diversity landscape can be categorized into four prominent systems based on ecological indicators, including social, economic, and ecological conditions; traditional knowledge systems; biophysical and management diversities; and land use types.



Transplantation of paddy in terraces

Table 1: Indigenous system of farmland design in traditional farming systems

Land Units	Land parcel	Attributes of practices
<i>Ghar-ghyryan</i> (Homestead)	<i>Rachyan-ghuryan</i> (Home garden)	Land parcel around a household, allocated for growing seasonal vegetables (beans, leafy vegetables, squash, yams, taro, chillies, turmeric, etc.), fruits (banana, guava, pear, plum, jack fruit etc.), medicinal plants and some traditional crops
<i>Khet</i> (Irrigated)	<i>Pakho-khet</i> (Terraced paddy field on sloping land)	Terraced paddy fields of >30° slope. They are mostly rain fed, irrigated subject to availability of water from the nearby springs, streams and <i>ghoras</i> . Crops grown are rice, pulses, maize, and trees for land stabilization and for fodder. Terrace-fall during monsoon frequently causes excessive soil loss.
	<i>Byansi</i> (Flat paddy field)	Also called <i>Thang</i> these are the flat lands along the river beds, mostly irrigated from the nearby streams. Rice, wheat, oil seeds (mustard), pulses (on the bunds), buckwheat and maize are grown. Nutrient rich soils accumulate from up-stream, very fertile with high productivity. Some examples in Sikkim are <i>Tareything-byansi</i> , <i>Pithang-byansi</i> , <i>Tanak-byansi</i> , <i>Dundi-byansi</i> , <i>Samardung-byansi</i> , and <i>Daramdin-byansi</i> .
	<i>Shim/Kholyang</i> (Paddy field with a natural spring)	Rice fields with a spring source and irrigated. <i>Shim</i> is waterlogged paddy field. Domestic animals are grazed. Wild animals also visit for water. Usually, water is also stored in small dug ponds. Farmers conserve springs by planting suitable plant species in their catchments. Springs are tapped for domestic use through pipes.
	<i>Bagarey</i> (Paddy field on river bank)	Rice fields at the river banks, full of <i>pango mato</i> (clay soil), farmers call it <i>malilo mato</i> (fertile soil) for crops. Productivity is high. Farmers cultivate rice, wheat, pulses, buckwheat and soybean.
	<i>Birauto</i> (Newly terraced paddy field)	Farmers maintain the farmland, repairing and managing the slopes by terracing and repairing the terraces during the fallow period. The newly terraced rice field is called <i>birauto</i> . They grow maize, field peas, beans, finger millet etc.
<i>Bari</i> (Rainfed)	<i>Tar bari</i> (Flat dry field)	A flat dry field, non-irrigated, meant for growing maize, vegetables, ginger, orange, wheat, barley, beans, pulses, oilseeds, millets, buckwheat etc. <i>Tar bari</i> is mainly rain-fed due to shortage of water.
	<i>Kothe bari</i> (Homestead garden)	<i>Kothe-bari</i> is a home-garden for growing seasonal and off-season vegetables. Home-garden is the centre of diversity of crops, fruit crops, bananas, chillies and a number of local vegetables. This is also a knowledge centre.
	<i>Pakho bari</i> (Steep dry field)	Farmland with >30° slope. Centre for underutilized and lesser known crops. Terraced dry fields where farmers grow maize, tapioca, millets, soybean, beans, cucurbits, potatoes, barley, wheat and pulses, and fodder grass along the terraces. The land remains fallow during dry seasons; farmer slash and burn as a management practice.
	<i>Bhasmey/Khoria</i> (Sloping land, slashed and burned for cultivation)	In sloping fallow areas, farmer clear, slash and burn during December-February, and cultivate mixed landraces of pulses, cowpea, horse gram, buckwheat, or maize. After harvest, land remains fallow. The system cycle was once in two to three years, but now worked annually. This land supplies fodder, and litter for mulching. Such land parcels are unsuitable for terracing or other agriculture land use. Animals are grazed during winter.
	<i>Siru-bari</i> (Dry field for growing thatch grass)	Dry infertile field allocated for <i>Khar</i> (<i>Imperata</i> sp., used as thatch), where farmers also grow timber trees, fodder and fuel-wood tree species. Small holders use <i>khar</i> for thatching roofs of houses and animal sheds.
	<i>Alainchi bari</i> , (Large cardamom agroforestry)	Traditional agroforestry of large cardamom under alder <i>Alnus nepalensis</i> or mixed forest tree species. Large cardamom agroforestry has been an age old practice of traditional agriculture developed by indigenous small holders.
	<i>Suntola bari</i> (Mandarin orange agroforestry)	Mandarin orange based agroforestry with mixed multipurpose tree species. Under the trees ginger, beans, pulses, potatoes, tubers, cucurbits, gourds, oil seeds, and other underutilized crops are grown.
<i>Jungle</i> (Forest Parcel)	<i>Bans-ghari</i> + Jungle (Bamboo groves and forests)	Parcel of land allocated for growing bamboo and other fuelwood/timber species. Farmers lop branches of trees during November-February for green fodder and fuelwood and also as a management practice. Timber harvested as per need. <i>Bans-ghari</i> at the edge of the agriculture fields protects farmlands, prevent landslides, and acts as a shelterbelt during fierce weather, reduces soil loss and provides household requirements.

This uniqueness and diversity is an added advantage for promoting the best agro-ecosystems and organic farming practices for current and future sustainability. They occur at different agro-ecological zones covering diverse ecosystems at elevations between 300 and 5,500 masl.

1. High elevation pastoralism and agro-pastoralism in the alpine and trans-Himalayan zones (4,000–5,500 masl)
2. Mixed farming (subsistence agriculture) in the temperate zones (2,500–4,000 masl)
3. Terrace rice cultivation-based mixed farming in the subtropical zone (above 300 masl)

10.1.1 High elevation pastoralism and agro-pastoralism

Indigenous Dokpa, Lachenpa and Lachungpa people in the cold, trans-Himalayan deserts of Lhonak Valley, Muguthang, Thangu, Tso Lhamo, Lashar and Yumthang Valley in northern part of Sikkim engage in rotational pastoralism and agro-pastoralism (nomadic yak and sheep/goat grazing) at altitudes between 3,500 and 5,000 masl. This example reflects not only the conservation and management of livestock and agro-diversity but also of the judicious management of wildlife habitats of endangered species such as blue sheep, Himalayan tahr, and the critically endangered snow leopard.

The Muguthang areas of Lhonak Valley, the Tso Lhamu Plateau, and Lashar Valley have been home to the agro-pastoralist Dokpas for centuries. Nomadic Dokpa pastoralists are guardians of trans-Himalayan ecosystems and offer a unique example of how people survive drought and freezing temperatures through mobile livestock production systems (Table 2). Their economic activity is restricted to the herding of yak (*Bos grunniens*), dzos (cow-yak hybrids),



Pastoralism with yak in high altitude areas

Table 2: High altitude farming systems

Agro-ecological zone	Traditional Farming Systems
Alpine and Trans-Himalayan agro-pastoralism (3,600-5,500 masl)	<ul style="list-style-type: none"> • Yak, sheep, horses, mules and goats grazing in alpine areas of Tshoka-Dgongri, Narkola, Tsogmo-Gnathang, Lachen-Tso Lhamu, Thangu-Muguthang, Lachung Yumesamdong, Upper Dzongu areas • Rotational grazing; sharing of grazing lands and their use, seasonal moments of animals, forage production for lean season etc. • Production and value addition of a variety of animal products (alpine cheese, yak butter, meat, wool, traditional carpets etc.)
Sub-alpine to Alpine agriculture (3,600-4,500 masl)	<ul style="list-style-type: none"> • Farming of potatoes, cabbage, leafy vegetables, radish, barley, at Lhonak valley (Muguthang area), Dambuchey-Bamzey area, Thangu, Yumesamdong area Upper Dzongu area in North Sikkim • Promotion and cultivation of medicinal and aromatic plants at Lhonak valley (Muguthang area), Dambuchey-Bamzey area, Thangu

sheep (*Ovis aries*), and pashmina goats (*Capra hircus*) in the plateaus and meadows of north Sikkim. The area remains under snow for about 5-6 months and receives around 80–500 mm rainfall during June-August.

Adapting to harsh climatic conditions over several centuries, the *Dzumsa* (a traditional, local self-governance institution in Lachen, Lachung and Muguthang) and the Dokpas have regulated and managed the grazing regimes of the alpine and transition zones, and the trans-Himalayan meadows. The *Dzumsa* specifies dates for the movement of herds from one location to another based on the lunar calendar. It strongly controls rotational grazing, ecosystem management, and regeneration of species. Grazing regimes are chosen depending on the availability of forage in pasture areas, the number of grazing animals, snowfall events, and appropriate seasons. The unique alpine and trans-Himalayan ecosystem and the last surviving flagship mammals of the landscape such as snow leopard, Tibetan gazelle, blue sheep, Tibetan wild ass, and Himalayan tahr, and the endangered and migratory black-necked crane, are guarded and conserved by the indigenous communities through farming and herding practices that conserve biodiversity and nature.

10.1.2 Mixed farming in the temperate zone

10.1.2.1 Subsistence agriculture

In the temperate zone between 2,000 and 3,600 masl, ethnic communities, mostly Lepcha, Bhutia, Manger, Limboo, and Sherpa, practice subsistence agriculture by cultivating a variety of crops and fruits (Table 3). Barley, wheat, potato, cabbage, apple, maize, peas, beans, millets, and medicinal plants are the principal crops. Principal agro-ecosystems consist of *bari*-land, farm-based agroforestry systems, and farm-forest agroforestry systems. Both farm-based agroforestry, and farm-forest agroforestry systems differ significantly in terms of farm size, cropping intensity, use of farm inputs, tree species diversity, tree density, home to forest distance and agricultural labour force. Intercropping of a variety of cereal crops, vegetables, fruit crops and fodder species is practiced in these agro-ecosystems while socio-ecologically important trees protect agricultural fields from soil erosion, function as

Table 3: Subsistence farming systems

Agro-ecological zone	Traditional Farming Systems
Temperate (2,000-3,600 masl)	<ul style="list-style-type: none"> • Cultivation of maize, barley, apple, plum, peach, large cardamom, Tibi-shonglon beans, potatoes, radish, peas, cabbage, cauliflower, broccoli, barley, buckwheat, millets in Lachen, Lachung, Upper Dzongu area in North Sikkim, Uttarey, Upper belt of Ribdi-Bhareng area in West Sikkim, Lingee-Sokpay, Rabongla area in South Sikkim, and Phadamchen-Zaluk, Upper Rigu area in East Sikkim • Growing of a diversity of fodder species, timber species, bamboo groves • Mainly dry agriculture, livestock-cattle, yaks, sheep, horses, mules are reared. Lachung, Lachen, Yuksam, Sindrabong, Damthang, Rabongla, Zaluk, Phadumchen, Hiley, Okhrey, Ribdi and Bhareng are areas in this climatic type

catchments for springs and prevent them from drying up, prevent land slips and landslides, and maintain stream flows. Local communities collect a variety of non-timber forest products for food, medicine, fodder, or fibre. Many of these non-timber forest products are also sold in local markets. Snowfall is common during December-January and heavy rainfall (average 3,000 mm per year) occurs during April-October.

10.1.2.2 Agroforestry systems

The dynamic agroforestry practices (agri-horti-pastoral system, agri-silvopastoral system, horti-silviculture system, agri-horti-silvopastoral system, livestock-based mixed farming, and sericulture-based farming), are designed and redesigned on a rotational basis according to situation, requirement and time. The agroforestry systems in Sikkim in general include home-gardens, alley cropping, multipurpose trees and shrubs on farmland, boundary planting, farm woodlots, orchards or tree gardens, plantation/crop combinations, shelter-belts, windbreaks, conservation hedges, fodder banks, live fences, trees on pasture, livestock and beekeeping.



Large cardamom agroforestry

Traditional agroforestry practices in Sikkim can be broadly categorized into five types: farm-based, forest-based, *Alnus*-cardamom-based, forest-cardamom-based and *Albizia*-mixed tree-mandarin-based systems (Table 4).

Table 4: Agroforestry system diversity with their common characteristics

Agri-horti-silvipastoral system	Agri-silvi-pastoral system	Horti-silviculture system		
Farm-based	Forest-based	<i>Alnus</i> -Cardamom	Forest-Cardamom	<i>Albizia</i> -mixed tree-mandarin
Multi-layered vegetation structure with fodder species, shrubs and understorey crop based garden agroforestry	Multipurpose tree species and bamboo groves for fodder, fuel, fodder and timber, and other productive needs	Large cardamom-based agroforestry with <i>Alnus nepalensis</i> as shade tree for the understorey cardamom crop	Mixed tree species as shade trees for understorey cardamom crop	Multi-layered arrangement of fruit orchards predominantly with mandarin orange trees as the main horticultural crop
Multiple intercropping in terraced productive zones, multipurpose trees and shrubs grown on the terrace edges; agrobiodiversity is high, paddy grown on terraces and pulses on the bunds	Managed as support land for fuel, medicines, fodder, building materials, NTFPs and other minor forest products, as pasture land and catchments for water sources	Acts as catchment for recharging springs, corridor for mammals, habitat for wildlife, provides fuelwood and ground fodder	Diversity of timber trees and fodder trees are grown, acts as catchment for recharging springs, corridor for mammals, habitat for wildlife	Agrobiodiversity rich, fodder trees, multi-cropping of understorey traditional crop varieties, buckwheat, beans, protein crops, yams, taros, etc.
Homesteads involving animal husbandry, traditional beekeeping, vegetable crops, medicinal plants, etc.	Grazing livestock, remunerative to farmers for food and cash	Highly remunerative system in term of ecological adaptability and economic return	Ground fodder, NTFPs, medicinal plants, soil and water conservation, highly remunerative	Highly remunerative as cash crops such as orange /ginger and tuber./food crops, vegetables are grown
Nutrient exhaustive, high input system	Low input system	Low input system	Low input system	Nutrient exhaustive, high input system

In farm-based agroforestry, farmers manage multipurpose tree species for fodder, fuel and timber, along with other direct and indirect uses within and around open cultivable land. In many instances, trees are planted on terrace risers to improve soil stabilization and intercropped with a variety of other plants used in the household economy. This system consists of *Sukha-bari* (rainfed field) with maize-potato, maize-ginger and vegetables and *Pani-khet* (irrigated) with rice followed by winter crops and vegetables. Here, the management of fodder trees along with vegetable and cereal production is integral to maintaining livestock.

Farm forest-based agroforestry is a managed support forestland adjacent to open cropped areas, where farmers grow multipurpose trees on certain parcels consisting of bamboo and multipurpose timber species. Under farm forest-based private agroforestry, farmers do not cultivate food crops; instead they allow non-timber forest produce to grow in the understorey. In a unit of household landholdings, apart from other land uses, the forest-based agroforestry functions as a catchment for aquifer recharge. Farm forest-based agroforestry is practiced, with multi-purpose species grown for fruits, timber and fuel wood. Farmers grow bamboo and timber trees for making ploughs and other farming implements and primarily for protecting the open agriculture terraces.

Large cardamom-based agroforestry is categorized into two sub systems: *Alnus*-cardamom and forest-cardamom systems. Large cardamom (*Amomum subulatum*) is a high-value cash crop which, when properly cured, stores well for extended periods. Large cardamom generally produces low volume per hectare but has high value; the trade-off is that it requires relatively low labour inputs and grows on marginal lands. Himalayan alder (*Alnus nepalensis*) is a naturally occurring tree associated with large cardamom that provides appropriate shade, fixes atmospheric nitrogen and generates nutrient-rich litter supporting efficient nutrient cycling. It is a pioneer species on freshly exposed landslide soils, degraded habitats, rocky and landslide-affected slopes, steep stream banks and natural areas, and is a boon to farmers.

The indigenous farmers know that alder trees support soil fertility, and thus they plant or allow *Alnus* to grow naturally in different land use systems. Scientific analysis of *Alnus*-mix tree cardamom agroforestry systems has shown that this traditional practice is economically remunerative, ecologically adapted, with comparatively high carbon sequestration potential. Sikkim produces about 40% of the world's large cardamom, second only to Nepal. This is a traditionally innovated, self-reliant agroforestry system – one which exploits a naturally occurring plant guild in order to take advantage of its variety of ecosystem services while simultaneously meeting a unique market niche.

Albizia-mix tree-mandarin is another promising agroforestry system at lower elevations (250-1,800 masl), in which mandarin orange trees are the principal cash crop intercropped with maize, ginger, buckwheat, finger millet, pulses, oilseeds, taro and yam. *Albizia*, another nitrogen fixing tree species, is also commonly grown with other trees in this farm based agroforestry system. The diversity of crops and associated tree species is maintained in the system for meeting household food, fodder, medicine and other subsistence needs.

10.1.2.3 Terrace rice cultivation-based mixed farming

Terrace cultivation by converting slopes into productive fields is a unique indigenous engineering technique. These farms support much of Sikkim's agro diversity where as many as 77 landraces of paddy, 34 different landraces of pulses, beans and other protein crops, 26 landraces of wheat, 4 landraces of buckwheat, 6 landraces of oil seeds, 2 landraces of potatoes and a diversity of other minor crops are grown across altitudes, agro-ecosystem types and growing seasons. The valleys along riverbanks called '*byansi*', and the typically terraced slopes in the lower hills contribute to the large genetic pool of traditional varieties of rice, pulses and soybeans, tubers and yams. The landscape is a complex and highly evolved system, with high levels of socioeconomic and socio-ecological efficiency that illustrate the value of traditional ecological knowledge in the sustainable management of ecosystems for harnessing their services.

As contributed by newer development schemes, some of the traditional dry-land rice varieties (*ghaiyya-dhan*, *takmaru*, *bhuindhan*, *marshi*, etc.) and wet rice (*gauria*, *krishna bhog*, and *mansaro*) have largely disappeared from the system. Some irrigated rice varieties (*atthey*, *timmurey*, *jhapaka*, *krishnabhog*, *bacchhi*, *nuniya*, *mansaro*, *baghey-tulasi*, *kataka*, *champasari*,

sikrey, and *taprey*) that are adapted to agro-ecological zones between 300 and 1,800 masl are still cultivated.

The typical terrace rice agro-ecosystem still houses high quality rice varieties such as *Krishnabhog*, *nuniya*, and *kataka* which are famous for their aroma, medicinal qualities, and fine grain. After the rice is harvested in October-November, farmers grow maize, wheat, buckwheat, oilseeds, and vegetables. In between the terraced open rice fields and along the slopes, bamboo groves, forest based agroforestry, large cardamom-based and forest-based agroforestry systems are managed as protective zones. The landscape mosaic consisting of open cropped compartments surrounded by multifunctional agroforestry is characteristic of the unique agro-ecosystem management practices in the landscape. Additionally, this type of system supports water conservation and flood control and provides nutrients and biomass to the farm and homestead. Under changing climatic conditions and cropping patterns, crop seasons have been gradually changing over the last two decades.

Agro-diversity elements in terrace farming are supported by traditional irrigation, management practices, and diversified cropping systems with diverse crops including medicinal plants, wild edibles and a large number of underutilized potential crops, semi-domesticated crops, and their wild relatives. In Sikkim, household land parcels are classified into different sections for establishing agroforestry, terraces for growing crops, and for resource allocation and utilization – primarily managed by farm families. Further, local and indigenous farmers derive a variety of food and other associated products, as well as crop residue that is used for various purposes (Table 5).

In addition to crops cultivated on farms, a large number of wild plants are used to prepare traditional food items and contribute significantly to food security. Some of the plants used are Nettle (*Girardinia diversifolia*), Chinday (*Pentapanax leschnaultii*), Greater Yam (*Dioscorea alata*), Koiralo (*Bauhinia variegata*), Halhalay (*Rumex nepalensis*), Kabra (*Ficus virens*), Kanney Cheu (*Pleurotus sajor-caju*), Kukurdainu (*Smilax zeylanica*), Laharay Timmur (*Xanthoxylum oxyphyllum*), Lapsi (*Choerospondias axillaris*), Nakima (*Tupistra nutans*), Patlay Sisnu (*Urtica parviflora*), Simrayo (*Rorippa nasturtium-aquaticum*), Sauney Ningro (*Diplazium maximum*), Sil Timmur (*Litsea citrata*), and Titay Ningro (*Diplazium laxifrons*). The ethnic communities of Sikkim prepare a number of fermented and non-fermented foods from these wild edible plants and as many as 15 different instant pickles and relishes depending upon the season.

In other areas where water is unavailable for irrigation, farmers have designed dry terraces (*pakho bari*) where they grow ginger, turmeric, maize, legumes, millet, colocasia, tapioca, and yam under multipurpose trees raised along the edges. Sloping land use systems are repositories of highly diverse cereals, tubers, bamboos, and agroforestry trees.

During excessive rainfall, soil subsidence, mudslides, and land degradation are frequent in areas with tall terraces that are 2–6 m in height. The repair and maintenance of terraces is labour intensive and demands farm budgeting knowledge and skills. Expert farmers have advanced skills and traditional ecological knowledge for identifying ideal and feasible

Table 5: Low and mid hill farming systems

Traditional Farming Systems	Attributes of the agro-diversity systems
Traditional agriculture Systems (300-3,000 masl)	<p><i>Diversity of crops and associated species</i></p> <ul style="list-style-type: none"> • large number of landraces of rice, maize, buckwheat, beans, pulses, finger millets, yams and tubers and oil seeds are grown in rotation • inter-cropping (mandarin-based intercropping, ginger-maize, paddy-soybean, pulses-turmeric, maize-potato-wheat and vegetable crops are grown as under-storey crops) • Incorporation and cultivation of high value cash crops e.g. large cardamom, mandarin orange, ginger and potato in the different agro-ecological zones under the integrated farming • Green manure and nitrogen-fixing species (<i>Alnus nepalensis</i>, <i>Albizia</i> sp., <i>Erythrina</i> sp., <i>Hippophae salicifolia</i>)
Traditional Agroforestry Systems (300-2,500 masl)	<p><i>Agroforestry systems</i></p> <ul style="list-style-type: none"> • Diversification of agro-forestry systems such as farm based agro-forestry (Agro-silvi-animal systems), farm-forest-based agro-forestry (Agro-silviculture systems) and high value cash crop based agro-forestry (Agri-horti-silviculture systems) such as large cardamom, mandarin orange, ginger and other under-storey crops cultivation • Agro-forestry ensures multiple production options and services
Land resource management	<p><i>Organizational and management diversity</i></p> <ul style="list-style-type: none"> • Most of the cultivated land in the mountains and hills is under diverse agro-forestry systems to reduce soil erosion, and ensure substantial production • Terrace-based agriculture • Multipurpose trees grown on terrace edges • Farmers establish shelterbelts on the farm edges for maintaining water table and to reduce negative impacts of drought • Conservation tillage with raised bunds at the terrace edges prevents run-off and wash out during excessive rains
Water resource management	<ul style="list-style-type: none"> • Seepages and ponds are managed to ensure water retention and protection within the farm-based agro-forestry for potable water and water for irrigation • Plantation of water retaining species in and around the springs for conserving the catchment.
Livestock management	<ul style="list-style-type: none"> • In recent years, farmers have initiated stall feeding of farm animals • Winter feeding of livestock in the fields to fertilise the land and reduce labour costs for transporting manure from the sheds • Many farmers have started growing large number of fodder species (both tree fodder and under-storey grasses) on terraces

measures that can be adopted using local resources to effectively repair and manage the damages. The effect of random landslides and flooding can increase the disparities between rich and poor owing to their differential adaptive and management capabilities.

10.2 Crop genetic biodiversity in the traditional farming systems

Of the total 5,580 plant species (including orchids, bamboos, rhododendrons, tree ferns, ferns and fern allies, and oaks) found in Sikkim as per Sikkim Biodiversity and Action Plan of 2012, around 550 species have food value and 50% of them are cultivated species. The traditional farming systems in Sikkim are repositories of diverse gene pools that consist of more than 126 landraces of cereals including rice (77), maize (26), and millet (7); 18 cultivars of oilseeds; 34 cultivars of pulses and beans; 132 species of vegetables; 38 spices/condiments, and 33 landraces of tubers/roots. As many as 64 fruit tree species are commonly grown on farms, with more than 200 species of wild edibles naturally growing on farm-based, forest-based,

and large cardamom-based agroforestry lands. The region's traditional agricultural systems also house a rich diversity of protein banks with a total of 14 landraces of *rajma* (kidney beans) and seven landraces of rice beans, as well as 20 landraces of chillies, 55 landraces of squash, and four of ginger. The morphological and molecular characterization, including specific descriptors for genetic differentiation of these crops have not yet been done. More than 119 species of multipurpose agroforestry trees (used for timber, fuelwood, fibre, fodder, dye, soil binders on terraces, minor construction materials) are grown. While 52 crop species have high social and cultural importance, 69 other species are sacred to indigenous communities. Further assessment of agro-biodiversity at various levels of biological complexity, namely at the level of genes, species, communities, ecosystems, and landscapes, will confirm their abundance and richness in Sikkim and their use and intrinsic values.

10.2.1 *Ex situ* and *in situ* conservation

The *in situ* conservation of agro-biodiversity in farms is the only practice followed in Sikkim, and this is primarily passed down from one generation to another of farmers. It is a highly dynamic form of management of plant and animal genetic resources that allows the processes of both natural and human selection to continue to function in the agro- and forest-ecosystems. *Ex situ* conservation in seed banks, cryopreservation, DNA storage, and pollen storage involving advanced technologies for conserving and managing the gene pools requires well-developed facilities (storage, laboratories, information). The Convention on Biological Diversity emphasizes the *in situ* approach to conservation and views both *in situ* and *ex situ* conservation as complementary. However, facilities and technology extension for *ex situ* conservation are lacking in northeast India.

10.2.2 Home-gardens

The homestead in a marginal farm consists of organic based production systems of cereals (Paddy, Maize, Wheat), pseudo-cereals also referred to as potential crops (e.g., Sorghum, Rye, Millet, Buckwheat, amaranths, chenopods, etc.), legumes (e.g., Horse Gram, beans, pulses, Soybean, lentils, etc.), oilseeds (Rapeseed and Mustard, Nigerseed), vegetables (e.g., leafy vegetables, Coriander, spices, cucurbits, etc.), fruits and nuts (e.g., Banana, Jackfruit, figs, Litchi, Tamarind, Guava, Pineapple, Peach, Pear, Plum, etc.), roots and tubers (yams, Tapioca, Colocasia, potatoes etc.), climber vegetables (Bitter Gourd, Sponge Gourd, Squash etc.), medicinal or aromatic plants, and multipurpose trees as per land availability. The crops grown in homesteads are consumed for subsistence needs and the surplus is sold in the nearby local weekly markets. The size of a household homestead on marginal land in Sikkim ranges from 0.2 to 2 ha. A large diversity of useful crops (60–75 species) are grown for food which is a means of germplasm conservation in homesteads. About 40 to 70% of the total landholding consists of homesteads in a marginal farm, providing more than 50–80% of the household's nutrition requirement. Homesteads are traditional sources of food and nutrition and are important contributors to food security and livelihood of farming communities. Diversification of crops is a traditional practice of the ethnic communities and is critical for the sustenance of marginal households during periods of environmental uncertainty.

Homesteads are therefore the basic units of agro-biodiversity conservation and *in situ* gene banks for a large number of horticultural/fruit/tuber crops, and they often provide significant economic benefits to the marginal farmers.

Livestock rearing supports homesteads and is closely related to on-farm management of agro-biodiversity. Livestock provide manure for the field, milk, meat, wool, and are used as draught and pack animals. Soil fertility is mostly maintained through livestock-based manure and farmyard manure. More than 80% of the farmers have improved livestock breeds as traditional breeds have disappeared in the process of development.

Thus, homesteads are dynamic production systems where farmers make changes every season or year. Their contribution to conservation ensures the maintenance of adapted materials, which provide direct benefits to the owners and users of the homestead's products. The genetic diversity maintained is part of this contribution. Homesteads also help conserve biodiversity at the ecosystem, inter-species and intra-species or genetic levels. They provide complex, multi-layered environments in which farmers can maintain large numbers of useful plant or animal species over many years. They may also provide basis for the *in situ* maintenance of significant amounts of intra-species (genetic) diversity of useful plant species.

10.2.3 Livestock keeping and animal genetic resources

Livestock keeping is an integral part of traditional farming system. Most farmers keep a few dairy animals, which are typically stall-fed or grazed on the farm during the winter. Forage for farm animals is collected from crop residues, grasses from farmland, and farm-forest agroforestry systems or nearby forests. Raising livestock requires considerable labour, while the net return from the farm enterprise is still minimal. Over 80% of mountain farmers in Sikkim own livestock, which provides them with supplementary income as well as other nutrient-rich animal products (Table 6). Livestock rearing is the backbone for sustaining cultivation, crop diversification and livelihoods, and this can be an added advantage for organic farming.

In the high altitude areas above 3,000 masl, the principal livestock include sheep, yak, high altitude goats, high altitude horse, mules and donkeys and cattle, poultry and pigs of different kinds. Similarly, in the mid to low hills, a number of domesticated species such as sheep, goat, cattle, poultry, pigs and buffaloes are reared by the communities. Before 2000, local *siri* cattle were predominantly reared in large numbers in farmlands up to 4,000 masl. With the introduction of high yielding Jersey and Holstein Friesian hybrids, and the ban on open grazing in the forest areas, the population of *siri* breed declined by about 98%.

Most of the crossbred animals were brought from neighbouring Kalimpong and Darjeeling. In addition, Sikkim also imported pure Jersey stock from Australia and Denmark. Artificial insemination was introduced in the State in 1987 and has become very popular. The importance of the local *siri* breed was not realized and eventually they were all replaced by 'improved' breeds.

Table 6: Domesticated animals and their importance

Name	Breed/variety	Household use/farm use
Cow	Local (<i>Pahadi, Siri</i>)	Milk, cheese, manure, butter, procreation, and meat
Ox	Local (<i>Pahadi, Siri</i>)	Draught animal, manure, breeding
Buffalo	Local	Milk, cheese, procreation, meat, skin
<i>Phe-Yak</i>	Original Tibetan breed (Trans-Himalaya: Tso Lhamu, Lhonak, Lashar, Muguthang)	Milk, cheese, butter, meat, fur, skin, procreation, pack animal in high altitudes (Thangu-Muguthang)
Yak	Nepalese breed (Greater Himalaya: Dzungri, Lhonak, Lashar, Muguthang)	Milk, cheese, butter, meat, fur, skin, procreation, pack animal in high altitudes (Yuksam-Dzungri)
<i>Lho-Yak</i>	Yaks brought from the southern part of Tibet, i.e., Bhutan (Yumesamdong-Lachung)	Milk, cheese, butter, meat, fur, skin, procreation, pack animal in high altitudes (Yuksam-Dzungri)
Dzo (yak-cow/bull)	Male offspring (crossbreed of cow and yak)	Travel animal in Yuksam-Dzungri trekking trail, meat
Dzomo/Urang	Female offspring (crossbreed of cow and yak)	Travel animal in Yuksam-Dzungri trekking trail, meat
Byanglung (Sheep)	Tibetan breed (found in North Sikkim: Tso Lhamu, Lhonak, Muguthang)	Wool, meat, milk, procreation
Banpale (Sheep)	Local breed (found in West Sikkim: Pokhari, Dzungri, Yambong, Narkhola)	Wool, meat, milk, procreation, rituals (sacrifice)
Goat	Chyangra (found in North Sikkim: Tso Lhamu, Lhonak, Muguthang)	Meat, procreation, customary rituals (sacrifice), <i>khadgo-katne</i> (sacrifice during illness)
Horse	Local	Pack animal
Pig	Local Sungur/Bangur	Meat
Mule	Local	Pack animal
Dog	Tibetan Mastiff	Guard yak/sheep/goat herds (Greater and Trans Himalayas)
Dog	Local breed	Guarding house, agriculture field against wild animals
Cat	Local	Control of pests, especially rodents
Domestic fowl	Local	Egg and meat, customary rituals (sacrifice)
Duck/Goose	Local	Egg and meat, customary rituals (sacrifice)
Pigeon	Local	Meat, customary rituals (sacrifice)

With the advent of climate change, there is renewed interest in the *siri* breed. The *siri* breed has been found to be most suitable and adaptive cattle across four districts and agro-ecological gradients. *Siri* milk is considered to contain higher proportion of omega-3 fatty acids and they also provide mineral rich manure. The *siri* breed bulls have been the most proficient draught animals for ploughing and farm operations.

10.3 Soil fertility maintenance in farming

The diverse ethnic communities have rich traditional knowledge of soil fertility management. They apply simple and widely adopted sustainable soil management and agronomic practices, which are based on efficient use of local resources, include improvement in preparation and management of farmyard manure and bio-compost, systematic collection of cattle urine and its use as a base for bio-pesticide and liquid fertilizer. In addition to this, green manuring, use of nitrogen fixers in the farm, collection of forest litter for mulching, burning biomass and crop residue in the farm, *in situ* manuring, integrating legumes and fodder crops into cropping systems, and small-scale collection of rain and run-off water, and improved water use efficiency are other traditional methods for replenishing and maintaining soil fertility. Based on the farmers' perceptions, these practices result in significant increase of soil fertility levels, and improve moisture, texture and workability of soils, resulting in improved productivity levels. However, with increasing diversion of farm labour to other sectors, and decrease in livestock population, decreasing amount of organic matter collection from the nearby forest, farmers are increasingly facing problems in maintaining soil fertility. Some practices for maintaining soil fertility are application of farm-yard manure; bio-compost from plant material and animal dung; field-based biomass burning soon after farm clearing during the winter; burning of fodder remains; *in situ* manuring by stocking livestock in agriculture fields; on-farm mulching; green manure by growing nitrogen fixing plants and green biomass mulching; on-farm decomposition practices for paddy; fallowing of land; and new soil fertility techniques introduced by government line departments such as vermicomposting, bio-composting, *Azolla* and use of beneficial microorganisms.

10.4 Gender roles in agriculture and decision-making

In Sikkim, there are gender specific differences in the nature of work, customary rituals, natural resource use, consumption patterns, lifestyles, access to and control of resources, and power. There are rapid changes occurring in the agriculture sector due to climate change which presents opportunities and challenges for gender differentiated roles and responsibilities. The roles, responsibilities, knowledge and decision making of men and women differ in overall management of agriculture as well as other intra and inter-household activities.

Both men and women engage in on-farm and off-farm activities. Despite differences in roles and responsibilities between men and women, women play a major role in many of the agriculture and livestock management activities irrespective of economic status and agro-climatic zone.

Women of all ethnic groups and economic status across all elevations are actively involved in household chores like collection of drinking water, fodder and fuelwood collection, and livestock rearing. However, gender roles and relations may differ across ethnic groups. Field evidence also indicates that women play a major role in intra household economic activities and are also engaged in agriculture and livestock management. However, women



Women selling farm produce at a weekly market

have limited control and decision making power in economic decisions of the household, for instance decisions related to crop choices, livestock trade, investment and use of household income.

In the context of Sikkim, since farming practices are work-intensive, and since many women are heavily engaged in smallholder farming, it is important to target gender equality, especially in relation to traditional perceptions that certain responsibilities and types of work, decisions, privileges and assets are linked to both men and women. These aspects clearly need to be addressed when, for example, facilitating the development of networks, training, farmer field schools, and marketing opportunities.

10.5 Cash crops and traditional products

10.5.1 Underutilized and lesser-known species

There are as many as 30 underutilized crops and around 200 underutilized species of wild edibles have been recorded in Sikkim. These species are adapted to difficult conditions and thrive on marginal lands. They contribute to the diversity and stability of agro-ecosystems and have immense potential for diversification of mountain agriculture. Most of these crops do not require high inputs and can be successfully grown on marginal, degraded or wastelands with minimal inputs, contributing to agricultural production and food and nutritional security. They enhance crop diversification and improve the environment, and have the potential to contribute useful genes for developing crop varieties capable of withstanding climate shocks and improving food security. They have high potential for being developed into commercial products.

Underutilized crops include buckwheat (*Fagopyrum esculentum*, *F. tataricum*), horse gram (*Macrotyloma uniflorum*), turmeric (*Curcuma domestica*), and beans (*Phaseolus vulgaris*, *Lablab purpureus*), as well as traditional vegetables such as chayote (*Sechium edule*), amaranth (*Amaranthus* spp.), eggplant (*Solanum* spp.), drumstick tree (*Moringa oleifera*), bitter melon (*Momordica charantia*), yam (*Dioscorea* spp.), leafy mustard (*Brassica juncea* var. *rugosa*), and many gourd species. These are of considerable commercial value and can make a significant contribution to the household economy (Table 7).

10.5.2 Fruit crops

Traditional agro-ecosystems are home to a diversity of fruit crops although currently at the subsistence level. Important fruits grown are banana (*Musa* spp.), dry galls (*Rhus chinensis*), guava (*Psidium guajava*), plum (*Prunus domestica*), custard apple (*Annona squamosa*), apple (*Malus* sp.), peach (*Prunus persica*), passion fruit (*Passiflora edulis*), citrus (*Citrus* spp.), jackfruit (*Artocarpus lakoocha*), mango (*Mangifera indica*), litchi (*Litchi chinensis*), areca nut (*Areca catechu*), hog plum (*Choerospondias axillaris*), Indian crab apple (*Docynia indica*), Indian gooseberry (*Phyllanthus emblica*), papaya (*Carica papaya*), pear (*Pyrus communis*), wood apple (*Aegle marmelos*), grape (*Vitis vinifera*), Indian hogplum (*Spondias pinnata*), Himalayan walnut (*Juglans regia*), tejbala (*Zanthoxylum rhetsa*), pomegranate (*Punica granatum*), avocado (*Persea americana*), pineapple (*Ananas comosus*), common persimmon (*Diospyros virginiana*), Indian butter tree (*Diploknema butyracea*) and chestnut (*Castanopsis hystrix*). Similarly, the trade potential of medicinal plants such as mel (*Docynia indica*), bhakmilo (*Rhus chinensis*) and tarubo (*Hippophae salicifolia*) is yet to be explored although chuk making from these plants is an age old practice and used for curing a range of gastrointestinal ailments.



Seabuckthorn also called tarubo (*Hippophae salicifolia*) fruiting in high altitude areas

Table 7: Some traditional crop species having potential for value addition and trade

Crops	Type	Importance to livelihood/ potential to scale out and scale up
Finger millets (<i>Eleusine coracana</i>), Foxtail millet (<i>Setaria italica</i>), Proso millet (<i>Panicum miliaceum</i>)	Cereals	High/highly nutritious crop, potential to scale up, value added products have potential for trade
Buckwheat (<i>Fagopyrum esculentum</i> , <i>F. tataricum</i>)	Pseudo-cereals	High/Highly nutritious crop, value added products have potential for trade
Naked barley (<i>Hordeum vulgare</i>)	Cereals	High/high altitude barley is nutrient rich cereal and has potential to scale up, commercial products can be developed for trade
Amaranthus (<i>Amaranthus caudatus</i>)	Pseudo-cereals	High/highly adaptive to climatic stress conditions, potential to scale up for trade
Traditional cultivars of rice (<i>Oryza sativa</i>)	Cereals	<i>Krishnabhog</i> , <i>Nuniya</i> , <i>Mansaro</i> , <i>Kataka</i> , <i>Dudhkalam</i> , <i>Chirakehy</i> etc. are high quality traditional cultivars; potential to scale up production and trade
Beans (<i>Phaseolus vulgaris</i> , <i>Lablab purpureus</i>), Lathyrus (<i>Lathyrus sativus</i>), Rice bean (<i>Vigna umbellata</i>), Butter bean (<i>Phaseolus lunatus</i>), Horse gram (<i>Macrotyloma uniflorum</i>)	Legumes	High/as many as 36 different cultivars of pulses are grown/ commercial products can be developed for trade
Taro (<i>Colocasia esculenta</i>)	Root crop	High/ 6 different traditional landraces are grown/ contain medicinal properties; commercial products can be developed for trade
Yam (<i>Dioscorea</i> spp.)	Root crop	High/ 15 different traditional landraces are grown/ contain medicinal properties; commercial products can be developed for trade
Rayo, leafy mustard (<i>Brassica juncea</i> var. <i>rugosa</i>)	Leafy vegetable	High/lean season vegetable crop, local people make fermented products; can be scaled up for trade
Oal, arum (<i>Amorphophallus campanulatus</i>)	Root crop	Medium/ part of local food culture and climate resilient crop
Chayote (<i>Sechium edule</i>)	Young shoots, fruits and tubers	High/Chayote is a multipurpose plant, tubers, fruits and young aerial shoots are used as vegetables.
Sponge gourd (<i>Luffa cylindrica</i>), Drumstick (<i>Moringa oleifera</i>), Bitter melon (<i>Momordica charantia</i>), Nakima (<i>Tupistra nutans</i>)	Young fruit Vegetable crops	Rural people sell these vegetable crops and earn/ highly potential crops to scale up/ value added products can be developed
Chiuri (<i>Aesandra butyracea</i> syn. <i>Madhuca butyracea</i>), Mel (<i>Docynia indica</i>), Amala (<i>Phyllanthus emblica</i>), Bhakmilo (<i>Rhus chinensis</i>), Lapsi (<i>Spondias mombin</i>), S. axillaris, Seabuckthorn (<i>Hippophae salicifolia</i>)	Fruit trees	High/ potential to scale up, fruits/berries are used to make commercial products
Besar (<i>Curcuma domestica</i>)	Rhizome	Highly medicinal, used for a variety of ailments
Rukh-katahar (<i>Artocarpus lakoocha</i>), Muslindey (<i>Elaeagnus latifolia</i> syn. <i>Elaeagnus conferta</i>), Bimiro (<i>Citrus medica</i>), Chaksi (<i>Citrus limetoides</i>), Jyammir (<i>Citrus jambhiri</i>), Kali-jyammir (<i>Citrus junos</i>)	Fruit trees	High/highly medicinal horticultural adaptive crops, potential to scale up, value added products have potential for trade. Potential for ABS.
Bhuin-katahar (<i>Ananas comosus</i>), Ambak (<i>Psidium guajava</i>), Kera (<i>Musa</i> sp.), Supari (<i>Areca catechu</i>), Pan-patta (<i>Piper betle</i> Linn.), Marich (<i>Piper nigrum</i>)	Fruit	High/ potential to scale up, fruits are used to make commercial products

10.5.3 Other economically potential spices

The agro-ecological variation of Sikkim provides conducive microclimatic environments for the cultivation of a diversity of species with economic potential. Large cardamom (*Amomum subulatum*), ginger (*Zingiber officinale*), turmeric (*Curcuma longa*), black pepper (*Piper nigrum*), cinnamon (*Cinnamomum zeylanicum*), Himalayan caraway (*Carum bulbocastenum*), hemp (*Cannabis sativa*), coriander (*Coriandrum sativum*), fennel (*Foeniculum vulgare*), garlic (*Allium sativum*), mint (*Mentha arvensis*), nigerseed (*Guizotia abyssinica*), garden cress (*Lepidium sativum*), mountain pepper (*Litsea cubeba*), sweet flag (*Acorus calamus*), and Nepal pepper (*Zanthoxylum armatum*) are some of the potential spices grown on farmlands and agro-forestry systems.

10.5.4 Tuber crops

There are opportunities to capitalise on tuber crops grown on organic farms. A few potential crops are yams (*Dioscorea* spp.), potato (*Solanum tuberosum*), sweet potato (*Ipomea batatas*), tapioca (*Manihot esculenta*), elephant's foot yam (*Amorphophallus campanulatus*), chayote (*Sechium edule*), taro or cocoyam (*Colocasia esculenta*), radish (*Raphanus sativus*) and edible canna or arrowroot (*Canna edulis*). Recently, ground apple also called yacon (*Smallanthus sonchifolius*) is introduced in Sikkim.

10.5.5. Large cardamom

Large cardamom is a high value, low volume, non-perishable and less labour intensive cash spinner cultivated at elevations from 600 to 2,300 masl across four districts of Sikkim. It has been a major source of income for marginal and small holder farmers. As per the records of the Spices Board, Government of India and Horticulture Department, Government of Sikkim, the total area under large cardamom was 22,714 ha in 2003. The year 2004 showed record production of cardamom in Sikkim and it became the largest producer in the world. With consistent decline in plantation area after 2007, the production also significantly declined to 2,745 metric tonnes in 2008, making Sikkim the second largest producer after Nepal. Every year large cardamom fetches around \$30-40 million considering fluctuating market prices. Large cardamom can be one of the major organic products from Sikkim. However, there is a need to develop disease resistant varieties, production practices, post-harvest processing, value addition (quality packaging) and marketing.

10.5.6 Tea

The tea garden was established in 1969 covering an area of 176 ha along steep hillsides from 1,200-1,800 masl. The market for tea is established in the international market and fetches good prices. The Temi tea estate is run by the Government of Sikkim and produces around 100 metric tonnes annually. The garden processes and packages the tea. Recently the Institute of Marketology of Switzerland has certified this tea garden as organic and hence the demand for this certified tea has increased.

10.5.7 Medicinal and Aromatic Plants

Sikkim is considered as one of the richest repositories of plant diversity of which more than 95% have medicinal value. The wide altitudinal variation from sub-tropical to trans Himalayan zones provides a multitude of habitats that harbour more than 5,000 species of medicinal plants which are still not explored fully for their economic values.

A large number of plant species have high market demand mostly for their medicinal and therapeutic properties. Almost all the medicinal plants found in Sikkim have curative properties due to the presence of various complex chemical substances, which are found as secondary plant metabolites in one or more parts of these plants. However, research in this area is limited and the major source of information is the ethno-botanical/ ethno-medicinal knowledge of traditional practitioners and community elders. There is a need for research to understand their phytochemical, pharmacological and clinical aspects. Mass cultivation and propagation of economically potential medicinal and aromatic plants, processing and marketing should be developed to benefit farmers.

10.5.8 Non-timber forest produce

In Sikkim, a large number of non-timber forest products (NTFPs) from the agroforestry systems and adjacent forests are harvested for their food and medicinal values. There is extensive NTFP trade potential within the urban centres of Sikkim and outside the state. The economic valuation of these NTFPs is yet to be done and value chain development of the products should be taken up.



Selling bamboo shoots

10.5.9 Beekeeping and honey production

Beekeeping is an age-old traditional practice and an integral part of income generation activity for many farmers in Sikkim. The local people rear native species of honeybees, mostly *Apis cerana*, using many types of traditional hives. Beekeeping and honey hunting have been practiced for long, especially in forest areas and cliffs. Over the last 10 years, the State Institute of Rural Development, Jorethang and Agriculture/Horticulture Department of Government of Sikkim have initiated programmes to develop the traditional honey industry through more market driven, productive, profitable and sustainable beekeeping

for rural farmers and entrepreneurs. The farming of stingless bees or Putka (*Trigona* sp.) is also a traditional practice of indigenous communities in the state. This practice requires low investment and yields high profits. Honey from *Trigona* bee (*Putka-ko-maha*) is considered highly medicinal and is used to treat over 20 different ailments in traditional systems of medicine. There is an established market for pure mountain honey, and packaging of honey and market linkages can boost the household economy of bee keepers.

10.6 Microbial diversity and traditional fermented foods

The local and indigenous communities of Sikkim have rich traditional biotechnological knowledge of traditional food processing and product development. Traditional food products are generally categorized into fermented and alcoholic beverages produced by microorganism(s), and non-fermented foods. These traditional products are culturally important and form an important part of the diets of indigenous communities and ethnic groups. Some products such as pickles, confectionery, condiments and alcoholic beverages, supplement and enhance nutrition with palatability, wholesomeness, flavour and texture. Value addition and establishing wider markets for these products could provide economic opportunities for communities that possess these traditional skills and knowledge. Ethnic food processing and product development can be promoted as small scale family business involving a large number of households. Two very important products, *kinema* and *maseura* are the most important fermented products which can be promoted for wider marketing after value addition. *Dahi*, *mohi*, *gheu*, *chhurpi* (hard), *chhurpi* (soft), *chhu*, *somar*, and *philu* are processed milk-products that are unique to the Himalaya. *Sukako maacha*, *gnuchi*, *sidra* and *sukuti* are preserved fish products. *Marcha*, *kodo ho jaand* or *chyang*, *bhaati jaand*, and *raksi* are alcoholic beverages. *Dheroh*, *phulaurah*, *momo*, *thukpa* or *gyathuk*, *pakku*, *kodo ko roti*, *phapar ko roti*, *chambery*, *achar*, *su zom*, *po ngu zom*, *khu zom*, *wachipa*, *alum*, *foldong*, *falki*, *chhwelaa*, *kwanti*, *chatamari*, and edible ferns, are some of the traditional non-fermented foods of Sikkim which are a regular part of the diet of local communities.

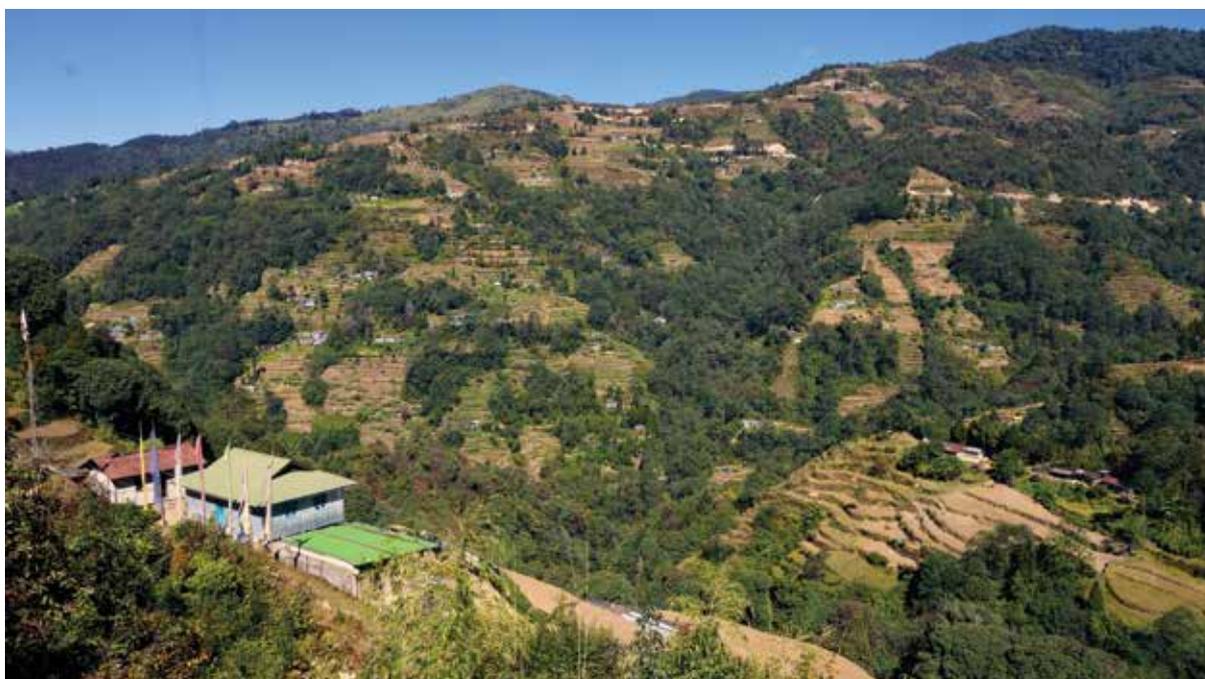
These are typically organic products whose processing, value addition and marketing can bring about significant economic returns for farmers and small businesses. These fermented foods have found place in local cuisine for tourists in homestays and hotels of Sikkim. The knowledge and the resources are already available with our traditional communities, while external inputs such as start up support, value addition, storage facilities and marketing need to be established.

10.7 Globally important agriculture heritage site

The Food and Agriculture Organization of the United Nations defines Globally Important Agricultural Heritage Systems (GIAHS) as “outstanding landscapes of aesthetic beauty that combine agricultural biodiversity, resilient ecosystems and a valuable cultural heritage”. Located in specific sites around the world, they sustainably provide multiple goods and services, food and livelihood security for millions of small-scale farmers. Unfortunately, these agricultural systems are threatened by many factors including climate change and increased

anthropogenic activities. These ancestral agricultural systems constitute the foundation for contemporary and future agricultural innovations and technologies. Their cultural, ecological and agricultural diversity is still evident in many parts of the world, maintained as unique systems of agriculture.

Sikkim Himalayan Traditional Farming Systems had been considered for the Globally Important Agricultural Heritage Systems recognition in 2009. Dr. Ghanashyam Sharma while in the United Nations University (Tokyo, Japan) prepared a dossier for Sikkim Himalayan Agriculture Systems as per the criteria for GIAHS recognition, which was technically vetted by International Centre for Integrated Mountain Development (ICIMOD) and approved by the Agriculture Department of the Government of Sikkim. The proposal for final recognition as a GIAHS is still pending. The Government of Sikkim should further develop the proposal with recommendation of the Government of India.



The agricultural landscape of Sikkim is a mosaic of farms and forests

11. Action Areas for Sustainable Livelihoods and Ecosystem Services

11.1 Conversion of farmlands, organic certification, and support to farmers

Sikkim is a farming state with over 80 per cent of the rural population dependent upon agriculture and allied sectors for economic, food and nutritional security. It has around 76,000 ha of cultivable farmland, all of which are under traditional farming systems and practices. With the historic decision of the Sikkim Legislative Assembly to transform Sikkim into a fully organic farming State, a concept paper for organic farming in Sikkim was prepared in May 2003 along with a road map and an action plan. The use of chemical fertilizers was discouraged and subsidies were phased out by 10 per cent each year. Consequently, there has been no government subsidy since 2008.

Following this, the infrastructure and services to support this transformation, such as post-harvest technologies, seed-processing centres, and soil-testing laboratories, including mobile soil-testing, were introduced in the state. During 2006–09, eight units of vermiculture hatcheries were established in five government farms and three Krishi Vigyan Kendras (KVKs). Similarly, a ginger-processing unit was established at Birdang Farm, West Sikkim district. In 2010, the Sikkim Organic Mission was launched with the objectives of promoting Sikkim as an organic state, branding the organic products of the state as “Sikkim Organic”, developing



Paddy cultivation terraces with patches of agroforestry and adjacent forests

the basic infrastructure and required statutory mechanisms required for conversion and certification, developing suitable strategies for promoting organic farming and market linkages for organic produce, leading to the formulation of a policy on organic farming in the state.

In the process, 14 Service Providers and 6 Certifying Agencies were engaged to set up an Internal Control System (ICS) and certification, and 74,303 ha of agricultural land was targeted for conversion. The government introduced the “State Organic Policy” in 2014 and a five-year plan was prepared for guiding the entire process. As a regulatory mechanism, the Government of Sikkim enacted “The Sikkim Agricultural, Horticultural Inputs and Livestock Feed Regulatory Act” in 2014 and “The Sikkim Agricultural, Horticultural Inputs and Livestock Feed Regulatory Rules 2015”.

In this regard, four broad strategies were developed:

1. ICS development and certification;
2. Input support;
3. Processing and value addition; and
4. Branding and marketing

Strategies and action at the state level

- Facilitate certification of all kinds of farming systems, local processes and practices across all agroecosystems and adjacent forests as per the guidelines of the National Programme for Organic Production (NPOP) and the Agricultural and Processed Food Products Export Development Authority (APEDA). The Government of India under the Agricultural and Processed Food Products Export Development Authority Act of 1985 established APEDA.
- Facilitate group certification through the Organic Mission, since individual certification was too expensive for small holders
- Engaging APEDA-accredited certification agencies with clean credentials by inviting separate tenders.
- Facilitate “on farm production of inputs” by eradicating the use of chemical fertilizers and pesticides.
- Ensure participation and convergence of all relevant government departments (Agriculture, Horticulture, Animal Husbandry, Forest, Rural Management and Development, and Tourism).
- The Organic Mission will produce handouts, publish case studies and best practices, and make videos, posters and other awareness materials to reach out to all sections of the society, especially women.
- Provide support for organic farmers/groups involved in raising cows, buffaloes, ducks, fish, poultry and goats, preferably of traditional breeds, to ensure integrated farming and availability of farmyard manure and urine for use as agricultural inputs.

Research and development needs

- Involve R&D institutions (ICAR-National Organic Farming Research Institute; Spices Board and Indian Cardamom Research Institute; G.B. Pant National Institute of Himalayan Environment and Sustainable Development; National Research Centre for Orchids; Central Integrated Pest Management Centre; Ashoka Trust for Research in Ecology and Environment; The Mountain Institute India; Horticulture Department, Sikkim University; College of Post-Harvest Technology, Central Agricultural University, Sikkim; and other relevant institutions) for development of farm-based technologies for testing soil moisture, water-holding capacity and fertility improvement, pest and disease management in crops, bio-compost production techniques, value addition techniques and productivity improvement.
- Ensure production of bio-fertilizers of local strains—Azotobacter, Azospirillum, Rhizobium, and other microorganisms—that have the capacity to fix atmospheric nitrogen and provide other plant nutrients, which can be distributed to organic farmers.
- Establish functional soil-testing laboratories, and integrated pest management (IPM) laboratories, and support farmers’ field schools for trials and training.
- Establish traditional livestock breeding centres to ensure availability of indigenous varieties to the organic farmers.

At the community level

- Facilitate promotion of on-farm production of inputs by providing subsidies for infrastructure like rural compost and vermi-compost units, bio-fertilizers and green manure; these subsidies should cater to young entrepreneurs.
- Develop model organic villages and farms with an organic package of practices for training and demonstration.
- Provide “Organic Certificates” for farms, processes and products to encourage organic farmers. This will ensure their active participation.
- Promote IPM practices and non-pesticide pest management, and provide bio-pesticides and local botanicals.
- Facilitate, support and encourage biodynamic farming, Rishi Krishi, Panchagavya Krishi, natural farming, Natueco farming, Jaiva Krishi, etc., which are cheap and farm resource-based practices.
- Provide incentives for inputs like bio-fertilizers, Azolla and blue-green algae ponds, microbial composting agents, soil amendments, and other similar modern technologies.
- Establish agro-clinics in each gram panchayat unit of Sikkim to help forecast and address disease and pest attack and provide advisories on control remedies.
- Link solid waste management with the production of organic manure.
- Provide adequate training and capacity-building measures.
- Provide subsidies so that farmers can take up crop–livestock (including poultry) integrated farming as part of organic farming.
- Support bee-keeping, fisheries, duckeries and similar enterprises as part of the mixed farming programme.

11.2 Development of traditional crops, niche products, and value addition

The local and indigenous communities of Sikkim have been maintaining, cultivating and processing traditional food crops which sustain their cultures and livelihoods, thereby ensuring community resilience in a changing environment. They have, through generations of innovation and experimentation, established a variety of land-use systems to nurture a great diversity of both wild and domesticated plants and animals. The diversity of traditional crops is extremely high in the agroecosystems. These include as many as 126 landraces of cereals; 18 cultivars of oilseeds; 34 cultivars of pulses/beans; 132 species of vegetables; 38 species of spices/condiments; 33 landraces of tubers/roots; and 64 species of fruits. These traditional food crops have been the fundamental sources of food, nutrition and medicine for the indigenous communities.

A value-added product simply means any physical state or form of a product or action that helps to raise the value of a product and the profit margin. Sikkim's organic products have immense potential for value addition. In the context of Sikkim, fruits, nuts, root and tuber crops, vegetables, legumes and pulses, spices (large cardamom, pepper, round chilies), condiments, tea, coffee, cut flowers and ornamental foliage, are all considered high-value specialty crops that significantly contribute to the household economy. In addition, mountain communities offer non-timber forest products, cold-water fish, honey, livestock products, handicrafts, handmade paper, woollen materials, and cane/bamboo products, which are easily distinguishable and capable of fetching good market prices. The high-value niche products of Sikkim can fetch better returns through value addition, packaging and marketing



Yartsaganbu (*Ophiocordyceps sinensis*), a high value product



A woman selling pulses

through the Sikkim Organic Mission. The high, mid and low hills of Sikkim also offer high-value products such as ginger, turmeric, timur (Sichuan pepper), honey, medicinal and aromatic plants. These provide a livelihood base to many rural households. The alpine areas of the state offer a unique high-value caterpillar fungus *Ophiocordyceps sinensis*, often referred to as “Himalayan gold” because of its high value, apart from other medicinal and aromatic plants. This fungus is locally called yartsagunbu, and is collected in the northern and eastern parts of the state by the indigenous communities, which helps them earn a significant amount of income. Yak-based products, too, provide a special niche opportunity for the state.

Due to mountain specific challenges such as limited access and marginality, the local and indigenous communities of Sikkim face many difficulties in producing, marketing and selling high-quality, high-value products. The Sikkim Organic Mission has now paved the way for creating better opportunities. Sikkim should provide good communication infrastructure; information, training and expertise in modern agricultural and other technologies; registration, certification and labelling of products; provide training and support for marketing and entrepreneurship; provide wider market access; establish transport facilities; and promote fair trade opportunities.

Strategies at the state level

- Provide value addition facilities such as grading, cleaning, slicing, drying, grinding, distilling, packaging, storing, and transporting—all conforming to “National Programme for Organic Production” standards.
- Value addition for organic products and a brand name given to every item with the Organic Sikkim logo.
- Provide cold storage and refrigerated van facilities, as well as cold storage facilities for temporary purposes and transportation of products.



Sikkim's Temi tea

- Establish an internationally accredited laboratory and certification scheme with the Organic Sikkim brand
- Facilitate and process Geographical Indication registration of certain high-value crops and products
- Facilitate through the Sikkim Biodiversity Board, and Biodiversity Management Committees the access and benefit-sharing of bio-resources or associated traditional knowledge under the Biodiversity Act 2002 (Rules 2004), and Protection of Plant Varieties and Farmers' Rights Act 2001.
- Facilitate registration of “extant varieties” or “farmers’ varieties” in the “National Register of Plant Varieties” of the National Bureau of Plant Genetic Resources for conservation of plant varieties and benefit-sharing.

Research and development needs

- Involve R&D institutions of Sikkim (ICAR-National Organic Farming Research Institute; Spices Board and Indian Cardamom Research Institute; G.B. Pant National Institute of Himalayan Environment and Sustainable Development; National Research Centre for Orchids; Central Integrated Pest Management Centre; Horticulture Department, Sikkim University; College of Post-Harvest Technology, Central Agricultural University, Sikkim; and other institutions) for promotion of niche products and value addition.
- Explore and make inventories, document and study the availability of all potential high-value niche products, including traditional crops, non-timber forest products, medicinal and aromatic plants, and identify them for certification.
- Facilitate the registration of “extant varieties” or “farmers’ varieties” of traditional crops.
- Develop farmer-friendly agro techniques for cultivation of traditional crops, high-value niche crops and medicinal and aromatic plants for transfer to the farms.
- Develop an organic package of practices for each crop and carry out efficacy trials of different bio-pesticides and local botanicals on different crops in the farms.

At the community level

- Provide training and capacity-building skills on agro techniques, post-harvesting, and storage at the household level.
- Facilitate training of organic farmers on value addition of organic certified products through packaging, processing, cooling, drying, and extraction.
- Ensure and facilitate fixed market price for organic produce, marketing support and timely cash payments for farmers.

11.3 Entrepreneurship, youth engagement, value chain development, and marketing

Rural enterprise and entrepreneurship development should target both farm and non-farm sectors. On the one hand, it should look into farm-sector development such as agriculture and horticulture, forestry and agroforestry, and fisheries and animal husbandry; on the other hand, it should look into non-farm-sector development such as tourism and cultural services, trade and services, transportation, collection and storage, and handicrafts. A mountain-specific rural enterprise development approach for income generation can ensure sustainability, inclusiveness, and good governance. The selection of such an enterprise involves three steps: selecting entrepreneurs with unique and niche products which are clean and green; identifying areas of interventions to empower the communities so that they use their own traditional crafts/skills and innovate; and facilitating the implementation of these interventions.

It is encouraging to see many educated young people getting involved in organic farming and allied sectors. There has been a recent surge of 'agripreneurs' in the state who are ushering in new ways of conducting traditional livelihoods. With the Internet acting as a platform for facilitating business, young farmers in Sikkim are now independently exporting locally grown organic produce to other parts of the country. This has been economically beneficial to all the



Processed and bottled organic produce



Ground apple (*Yacon*) syrup processed, branded and marketed

parties involved. The Kanchan Panda Start-Up Festival held in Gangtok in October 2017 saw the coming together of aspiring, early-career entrepreneurs as well as the established ones from across the country and Sikkim, which gave some interesting insights into the start-up environment in northeast India. It was clear that opportunities are plenty and that the market environment is highly conducive for innovation and diversification.

These are the young people the state needs to target, as many of them have learnt the production processes. The state needs to encourage more young entrepreneurs and start-ups to innovate in the field of organic farming. With the Internet becoming a part of everyday life, the opportunities are plenty. Added to this is the demand for organic goods in India and beyond, bolstered by the worldwide organic movement.

The promotion of indigenous products that are in demand in the local market is a useful approach. To get the best out of this, it is important for farmers and entrepreneurs to discuss the value and price of these organic products. The establishment of an effective value chain is key. An example that can be put forward here is of the Shoten Group which helps farmers in Sikkim grow two distinct crops—yacon and shiitake mushrooms, both of which are suited to the cold climate of the state, and hence capitalizing on Himalayan exclusivity. Diversification is a key part of innovation. The Shoten Group focuses on products that yield a high income with minimum risk. This is a good example of new-age farming.

In the organic farming process, the selection of entrepreneurs and enterprises, the willingness of communities to get into the organic business, and the possibility of synergy with the private sector as well as other line organizations are important components for building resilient livelihoods. The unique niche products and services of Sikkim, as well as their comparative advantages are listed below:

- Rich indigenous knowledge systems of the indigenous farming communities.
- Mountain-specific high-value, low-volume products such as large cardamom, Temi tea, yarsagumba, and tibi beans.
- Scalability and sustainability of the niche products and their availability within the hills and the mountain agroecosystems.
- Microclimatic variations across various altitudes, their niche potential and the advantage of less competition with crops grown in the plains.
- Advantages of geographic location (e.g., Temi tea, Lachen tibi beans), or the nametag associated with a particular community (Limboo kinema).
- High demand for products and services in emerging national and international markets.
- Focus on economies of scope (baskets of products using a similar or same chain).\

The organic farming initiative will succeed only when a complete value chain, from production to end consumer, is established. Value chain is therefore a powerful tool for finding ways to create greater value additions to products. The value chain structure comprises the following activities performed in order to complete production: post-harvest storage, packaging, design, branding, marketing, and delivery. The Sikkim Organic Mission should promote a value chain approach that emphasizes a range of activities and market linkages to help farmers enhance the quality of products and market them at a higher price, thus increasing household income. The value chain interventions should be based on several criteria such as rural farmers, remoteness, poverty level, possibility of improving product quality through intervention, and availability of markets.

The value chain analysis and development can be a significant tool for poverty reduction and enhancing livelihoods in Sikkim. Increased income can be achieved by addressing the following issues: (i) the profitable participation of the organic farmers in the value chains—this is rather weak at the moment, and can be improved rapidly through functional and process upgrading; (ii) diversification of mountain-niche products and services. In such efforts, mountain specificities such as poor accessibility, marginality, fragility, vulnerability, and diversity should be considered.

The selection of the right value chain is one of the most important steps in Sikkim's organic farming initiative. Therefore, not only should there be a thorough analysis of the chain, but also an in-depth understanding of the wider mountain context in order to determine whether or not an intervention is sustainable in the long term. The specialists must first understand what the mountain-specific challenges of a selected chain are in order to select the right mix of strategies to address them. A significant difference between mountain value chains and other value chains is the heterogeneous and scattered nature of production in the mountain areas, which results in difficulties in realizing economies of scale. Hence, the central strategy should be to focus on a basket of products or services that can be supplied along the same market chain, rather than on the development of one single product or service.

The Sikkim Organic Mission can adopt the following strategies for value chain development interventions:

- 1. Identify products/services with competitive advantage**
 - Mountain niche products and services
 - Economies of scope
 - Economies of scale
- 2. Establish business development capacities and skills**
 - Bring in entrepreneurs and develop skills among the young farmers
 - Business plan development for young entrepreneurs and other actors
 - Help communities to produce sustainable high-value, low-volume quality product/ services through process innovation, technology, and quality standardization
- 3. Develop entrepreneurship**
 - Encourage young entrepreneurs and farming families to take up organic farming by providing incentives, subsidies, soft loans, and insurance schemes
 - Facilitate livelihood diversification
 - Provide adequate training and information on capacity-development activities
- 4. Promotion of institutional mechanisms**
 - Create conditions in the state for business development of organic products, provide supportive instruments and facilities for export of products and promote the marketing of organic products
 - Generate employment and business opportunities for young entrepreneurs at various stages in the value chain, starting from ICS development and certification, production of organic commodities, processing and packaging, marketing and supply; engage local educated, unemployed youths in ICS development
 - Establish bio-village for showcasing organic technologies; this should involve the convergence of all relevant government departments and R&D agencies. Model organic farms should be developed for demonstration and technological training on the production of organic inputs for nutrient management, pest and disease management, nurseries for planting material, manure production, development of bio-pesticides/ herbicides, and so on.

5. Rural entrepreneurship

Rural enterprises/entrepreneurship development for promotion of organic farming can adopt the following strategies and processes:

Strategies

- Livelihood diversification through innovations
- De-risking strategies for farmers and entrepreneurs
- Strengthen access to markets, finance, technology and services



Processed and bottled cherry pepper (*Dalle chilli*) sauce

- Improve related policies to support rural entrepreneurship
- Promotion of producer organizations/ companies
- Product development for indigenous commodities and value addition

Processes

- Select entrepreneurs and enterprises
- Identify products/services with competitive advantage
- Develop business development capacities and skills
- Set up incubation centres to strengthen access
- Monitoring and evaluation
- Promote farmer producer organizations
- Promote value-added, indigenous and tribal products
- Promote value addition of those crops that are indigenous, unique and specific to Sikkim

6. Marketing strategies

- Strengthen institutions and forward and backward linkages
- Initiate value chain and enterprise development which involves various steps, starting from the provision of inputs
- Establish integrated packing houses and cold storage facilities
- Set up joint ventures with other agencies for a complete organic value chain system
- Engage farmer producer organizations in developing common packaging and labelling, common literature and common brand promotion material, as a part of branding and marketing initiatives
- Apply the brand/logo “Sikkim Organic” in packaging and advertising, and on all marketing communication vehicles used by the wholesale buyers/exporters and retail firms



Yak farming – a source of various high value niche products

Box 1: Yak Value Chain Development

Domesticated yak (*Bos grunniens*), an icon of the Himalayan highlands, is an important part of the livelihoods in the region. Yaks are considered an important part of the organic practices. Recently, the traditional genetic resources have been degrading and at risk. A yak-based system needs special strategies for its maintenance and enhancement. The high potential of this value chain can be developed as outlined below:

- Support the local institutions (*Dzumsa*) of Lachen, Lachung and Muguthang for maintaining the continuity of livestock herds, including yak, for conservation of genetic resources
- Diversify yak and livestock-based products for regional and global markets to strengthen the Organic Mission and better income generation
- Enhance local skills for product development and linking markets, including in tourism
- Create space and enable policy for agro-pastoralist communities for continuity of their culture
- Strengthen existing institutions, and establish new local institutions and networks for genetic exchange and developing niche products for a common market
- Facilitate exchange of genetic resources within the region and enhance productivity
- Facilitate developing quality products and marketing for entrepreneurs

11.4 Inputs and services for organic farming

The farming systems of Sikkim are purely traditional and the first step for converting them to organic farming is to improve the fertility of the soil. The state has already enacted laws and banned the use of synthetic inputs, and has encouraged the use of organic and biological inputs. Currently, for nutrient management and enhancing soil fertility, farmers use crop residue, animal dung, forest leaf/twig litter, nitrogen-fixing species, farmyard manure, poultry waste, cattle dung, and green manure. The nutrient value of the raw material and the composting techniques determine the quality of the produce. Biological resources such as bio-fertilizers and other microbiological inputs have attracted a lot of attention and are being promoted on a large scale. It is vital for the success of organic certification to track all inputs and ensure that they meet the organic standards under the National Programme for Organic Production (NPOP) and as per the guidelines of the Agricultural and Processed Food Products Export Development Authority (APEDA). The protection of organic crops can be achieved by farm management, multiple or intercropping, crop rotation, release of pest predators and parasitoids, and the use of botanical and bio-pesticides. The requirement of these inputs should be met by their production at the farms with available on-farm resources and they should also be available in markets within Sikkim.

At the state level

- Sikkim can offer incentives for entrepreneurs to come forward and establish production facilities that produce consistent quality farm inputs and make them available to farmers at a competitive price
- Critical inputs required for integrated farming which cannot be produced on-farm will be produced/bought or facilitated at reasonable prices

The following inputs would be required to support organic farming:

- Organic quality seeds and seedlings
- Viable breeds of local and improved genetic resources of livestock
- Nutritional management aids for plant and animals
- Disease management aids for plants and animals by way of health care as allowed under organic standards and plant protection guidelines
- Quality organic planting materials for mandarin, cardamom, ginger, turmeric and other important cash crops should be produced locally and plantations developed in an organic way
- Strengthen and upgrade integrated pest management (IPM) laboratory for control of pests and diseases of various crops organically
- Upgrade production of bio-fertilizers of local strains such as Azotobacter, Azospirillum, and Rhizobium, which have the capacity to fix atmospheric nitrogen and mobilize other soil nutrients; ensure availability of phosphate-solubilizing bacteria that have the capacity to release fixed phosphates
- Establish and strengthen soil-testing laboratories in the state

Research and development

- Assess the nutrient values of the raw material used in making manure and compost to improve soil fertility
- Develop disease-free planting materials
- Promote local and improved breeds of livestock

At the community level

- Provide facilities and encourage the production of various types of compost on the farm itself, including bio-composting, farmyard manure, vermicomposting, and biogas slurry
- Facilitate participatory design and implementation of special measures for increasing biomass and organic manure, especially in rain-fed areas where soil depletion is high due to long dry spells
- Provide facilities to produce more indigenous species of earthworms and effective microorganisms which can be used in composting
- Facilitate and establish a decentralized system to produce organic manure from biodegradable organic waste segregated at source
- Provide facilities and emphasize on-farm production of inputs for which incentives should be provided to farmers for construction of compost pits, vermicompost pits, effective microorganism pits, etc.
- Provide incentives to organic farming households for production of on-farm inputs such as bio-fertilizers, Azolla and blue-green algae ponds, microbial composting agents, and soil amendments

11.5 Addressing farmer-wildlife interface issues

Sikkim is known for its biodiversity and as home to charismatic and globally threatened wildlife species such as the Snow Leopard, Red Panda, Himalayan Black Bear, and Musk Deer. The conservation efforts initiated by the state have brought it global recognition, with UNESCO declaring the Khangchendzonga Biosphere Reserve as one of its few mixed Heritage sites. With these successes, the challenges in terms of human-wildlife conflict have also increased over the last couple of decades, resulting in crop damage, livestock depredation, human injury and death, and death of wildlife. As the Organic Mission is not against wildlife conservation, there are strategies that need to be implemented for addressing the challenges of farmer-wildlife interactions and conflict.

At the community level

- Building awareness on wildlife behaviour can make communities more prepared for conflicts
- Creating a space for dialogue and support mechanisms whereby communities and government personnel can work together to address the issues
- Ensuring effective communication in terms of inter-sectoral coordination beyond the forestry sector

- Developing local human resources and facilities for quick responses to the conflict
- Strengthening local institutions for providing crop and life insurance

At the state level

- Understanding the migratory patterns of wildlife species and allowing migratory passage through the identification and establishment of conservation corridors
- Assessing and restoring wildlife habitats and enriching natural forests with adequate food sources
- Extending research and interventions on population management based on carrying capacity
- Conducting collaborative research on related socioecological topics such as on the behaviour and population of wildlife species, and the impact of mitigation measures on wildlife mobility and behaviour
- Including human–wildlife conflict mitigation measures in payment for ecosystem services schemes, for example by promoting wildlife tourism incentives could be generated for farmers

11.6 Food and nutrition security

According to FAO food and nutrition security entails the following conditions: when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets the dietary needs and food preferences for an active and healthy life. Achieving this, however, is not straightforward as food and nutrition security is a highly integrated concept wherein food production, food diversity, food value, food quality, food access, availability, and affordability, and food trade and markets have all got to be simultaneously addressed. The concept reflects concerns at scale—from an individual’s right to acquire food and remain healthy to a nation’s responsibilities in addressing wider concerns of sustainable production, equitable consumption, and fair distribution, to the global goal of achieving “Zero Hunger”.

Food contamination is a matter of growing concern around the world today and customers are steadily becoming more aware of the health risks of contaminated food. The figures presented by the Union Health Ministry to the Parliament in India in 2018 are a glaring pointer to the issue. Almost one in four food samples tested in 2016–17 were found to be adulterated. In 2014–15, 19.5 per cent of the food samples were found to be contaminated in some form or the other, while in 2016, this increased to 23.4 per cent. Sikkim is aware of this issue of contamination, and is addressing it by promoting organic farming.

As most of the farms in Sikkim are on marginal lands, the state is not self-sufficient in food production. However, the diversity in traditional food consumption provides some amount of nutrient security. Sikkim may have to build a strategy whereby high incomes are generated through the organic farming of high-value products, development of enterprise, and export to other parts of the country and abroad. This will bring in greater cash returns to the people.

As a mountainous state, the food and nutrition security challenges are amplified, with vulnerabilities related to hilly and fragile terrain, limited space for cultivation and low per capita land availability, and transportation and wider market linkages. The Sikkim Organic Mission has recognized the following as the major constraints to achieving food and nutrition security: long-term soil nutrient management; limited irrigation facilities; limited organic seed production and storage facilities; higher insect, pest, and disease infestations; low public investment in agriculture; and inadequate market connectivity for organic farm produce. More than 70 per cent of Sikkim's rural population depends on agriculture for economic, food and nutritional security. Within its diverse agro-climatic zones, from subtropical to alpine, Sikkim's farmers grow maize, rice, wheat, millet, buckwheat, potato, pulses, soya bean, barley, oilseeds, and several high-value cash crops such as large cardamom, ginger, mandarin, and ground apple. The production systems are mostly rain-fed, mixed farming (agriculture, horticulture, and animal husbandry), and organic. The cropping patterns have gradually transformed from a cereal-dominated subsistence system to high-value cash crop and fruit-dominated (horticulture) systems. Floriculture is gradually emerging as an important income-generating sector, providing the economic basis for food security. Also, given the diversity of agro-climatic zones, the production systems in Sikkim, although dispersed and low scale, are well suited for the development of "future smart foods" (as coined by FAO), which are not only well adapted and resilient to climatic variability but also economically efficient for farming communities.

Within this foundation of progressive, integrated organic farming, can Sikkim ensure adequate food production, fair distribution, and equitable consumption in an environmentally and economically sustainable manner? The way forward in food and nutrient security lies in strengthening farmer-led integrated resource management and future smart food-based microenterprises; raising awareness on healthy food and food habits; reducing/recycling farm waste; and promoting the use of organic farm technologies and small-scale farm-friendly implements. A study from the Himalayan region suggests that the following issues have to be tackled in the area of food and nutritional security: poverty and low food energy intake; drinking water, sanitation and hygiene; nutritional knowledge of women, and education; decline in agro-biodiversity; changing diets; and climate change and environmental degradation.

The strategies that the Organic Mission could consider in order to address the issue of food and nutrition security are:

Establishment of food security information systems: Helps to better understand patterns of food security, poverty and malnutrition, and raises awareness on agriculture for nutrition and health.

Seasonal survey of food availability in all districts: Helps to identify hotspots of food and nutrient security/insecurity and the underlying factors; an inventory can be prepared on nutrition-driven health impairments. This allows the capturing of per capita availability of

food, their physical access as well as the demand and consumptions patterns—especially, the extent of diversification towards high-value commodities, and the composition of the overall food basket.

Efficient use of the hilly terrain and all production spaces: Helps to optimize the use of soil nutrients and microclimatic conditions in all the eight agro-climatic zones, thereby rejuvenating the local production systems and addressing periodic food insufficiencies. This will also allow diversification of crops and animal husbandry, thus promoting nutritionally rich future smart foods, horticultural crops, non-farm wild edibles, and non-timber forest produce.

Creation of organic seed multiplication and distribution system: Helps to develop and certify seeds of improved and high-yielding crop varieties suited to organic farming conditions. This will also address the farmer's challenge in acquiring and storing high-quality seeds. Government farms need to invest in continual seed/livestock breed improvement research and development.

Enhanced farmer's use of organic farm technologies and gender-friendly small-farm mechanical innovations: Helps to renew capacities and efficiency of organic farms through strengthening farm-composting, vermicomposting and green manuring facilities, as well as improving access to safe drinking water and sanitation facilities. Sufficient attention is needed on the post-harvest storage and processing technologies.

Position organic agriculture as an enterprise for healthy living: Helps to increase public interest and investments, and to mainstream food and nutrition security issues across all development programmes, including healthcare systems. This also implies strengthening value chain support mechanisms for branded organic produce from Sikkim. Focus should also be on strengthening social safety net programmes and public distribution systems, especially for the poor and marginalized farming communities.

11.7 Organic farming, ecosystem services and incentives

11.7.1 Organic farming and ecosystem services

Sikkim has four major ecosystem types: forests, farmlands, rangelands, and wetlands. Historically, organic farming is linked to all these ecosystem types and supports biodiversity richness. Sikkim's overall vegetation cover and biodiversity provide enormous ecosystem services to the people living in Sikkim, and those living downstream, nationally, regionally, and globally. The mosaic of farmlands and forests in the watersheds and landscapes of Sikkim provide all four types of ecosystem services identified by the Millennium Ecosystem Assessment:

- **Supporting services:** Supports primary and secondary production, biogeochemical cycling of nutrients, provision of habitats, and agro-biodiversity and biodiversity in general, which are necessary for sustaining the goods and services that mountain societies enjoy from

these ecosystems. The ecosystems support habitats of wildlife, water purification and water retention, pollination, seed dispersal, and soil fertility.

- **Provisioning services:** Provision of produce such as food, fuelwood, fodder, pasture forage, timber/poles, leaf litter, medicinal plants, wild edible fruit and vegetables, mushrooms, fibre, thatch, dyes, domestic use of water, irrigation water, boulders, and sand.
- **Regulating services:** Regulate carbon sequestration; water and climate; protection from natural hazards such as floods, landslides, and avalanches; water and air regulation; and natural disease and pest control.
- **Cultural services:** The sacred landscapes and natural ecosystems of Sikkim are of great spiritual, cultural and aesthetic value. They provide space for ecotourism, education and research, recreation, nature worship, and spiritual enrichment. Sikkim's people have played a vital role in conserving and protecting these ecosystems for present and future generations.

Organic farming has proven to be an effective method for conserving biodiversity as seen in Sikkim. Biodiversity is an important basis for many ecosystem processes and system function. Various farm practices and landscaping measures implemented in organic farming—such as forgoing the use of chemicals, use of organic manure, diversified crops and crop rotation, conservation tillage, and more diversified farm structure—have shown a positive influence on biodiversity. These factors not only enhance biodiversity, but strengthen natural cycles and improve environmental performance, which, in turn, increases the sustainability of organic farms. When managed within the framework of organic principles, an organic farm becomes more permeable for pollinators and other wildlife, and the surrounding ecosystem itself becomes more naturally complex, stable and resilient, offering an array of services. Organic systems encourage the expansion of crop varieties, and the preservation of older, locally bred varieties and breeds.

Microorganisms break down the organic matter and help maintain soil fertility, while also recycling nutrients. Beneficial insects colonize a farm's native plants in wilder areas. Their presence at the first sign of pest outbreak can mean significant savings from other costlier pest-control measures. Insectivorous birds and bats benefit from nesting and roosting on habitats on or near farms, as do rodent-eating raptors. Providing the needs of larger predators also creates habitat for insect pollinators and small animals.

Research in organic farming has shown that organic systems have the potential to support biodiversity conservation by increasing the number and variety of wild species found on farms; supporting high levels of agro-biodiversity; maintaining healthy soils and soil fauna such as earthworms; reducing the risk of water pollution; being energy efficient; and lowering carbon emissions.

Habitats with numerous species are shown to better adapt to environmental changes. For instance, the species-rich mountain meadows erode less and allow for more stable yields during dry periods. The higher biodiversity and larger population densities of various species found in organic farms influence critical ecological processes. Organic farming shows

significant improvements for functions such as pollination, reduction in soil erosion on arable land, faster decomposition in pastures, and natural pest reduction in soil and crops. More diverse flora and fauna in organic soil result in a revitalized and more active soil life. The diversity of habitat for wildlife, including birds, butterflies and other flora and fauna, also supports aesthetic and recreational services for the global community.

Similarly, terrace cultivation in the mid-hills of Sikkim is a source of diverse provisioning services, such as food, shelter and medicine, including the regulating services of the surrounding forested areas. They support a wide variety of agro-biodiversity as a source of nutrition for mountain people. The mosaic of ecosystems (forest and wetland) in the mid-hills is a source of nutrients for agriculture, and supplies organic matter to the system. The forested areas also act as catchments for springs (including rivulets and seepages), as soil erosion controllers and water purifiers, contributing to regulation and supporting services.

Agroforestry has the potential to improve livelihoods as it offers multiple alternatives and opportunities to farmers to improve production and incomes; it also provides productive and protective (biological diversity, healthy ecosystems, protection of soil and water resources, terrestrial carbon storage) forest functions to the ecosystem. It is promoted widely as a sustainability-enhancing practice that combines the best attributes of forestry and agriculture. The large cardamom-based agroforestry system is observed to accelerate nutrient cycling, increase soil fertility and productivity, reduce soil erosion, conserve biodiversity, protect water and soil, serve as a carbon sink, improve the living standards of the communities by increasing farm incomes, and also provide aesthetic values for mountain societies.

The impact of organic farming on natural resources favours interactions within the agro-ecosystem which are vital for both agricultural production and nature conservation.

Soil-building practices such as crop rotation, intercropping, symbiotic associations, cover crops, organic fertilizers, and minimum tillage are central to organic practices. These encourage soil fauna and flora, improve soil formation and structure, and create more stable systems. In turn, nutrient and energy cycling is increased and the retentive abilities of the soil for nutrients and water are enhanced, compensating for the non-use of mineral fertilizers. Such management techniques also play an important role in soil erosion control. The length of time that the soil is exposed to erosive forces is decreased, soil biodiversity is increased, and nutrient losses are reduced, helping to maintain and enhance soil productivity. Farm-derived renewable resources usually compensate crop export of nutrients, but it is sometimes necessary to supplement organic soils with potassium, phosphate, calcium, magnesium, and trace elements from external organic sources.

In many farmlands, the pollution of groundwater by the use of synthetic fertilizers and pesticides is a major problem. Use of chemicals is prohibited in organic agriculture; these are replaced by organic fertilizers (e.g., compost, animal manure, green manure) and the use of more biodiversity (in terms of the species cultivated, and permanent vegetation) which

enhance soil structure and water infiltration. Well-managed organic systems with improved nutrient-retentive abilities, greatly reduce the risk of groundwater pollution. In areas where pollution is a real problem, conversion to organic farming is highly encouraged as a restorative measure.

Organic agriculture reduces the use of non-renewable energy by decreasing agrochemical needs that require high quantities of fossil fuel for their production. Organic agriculture contributes to mitigating greenhouse gases by sequestering carbon in the soil. Many management practices in organic farming (e.g., minimum tillage, returning crop residues to the soil, the use of cover crops and crop rotation, and the greater integration of nitrogen-fixing species) increase the return of carbon to the soil, raising productivity and favouring carbon storage. A number of studies have revealed that the organic carbon contents in the soil under organic farming are considerably higher. The more organic carbon is retained in the soil, the more farmlands contribute to the mitigation of the effects of climate change.

Good nutrition is vital for maintaining health and preventing disease. As organic foods are high in nutritional quality, they can play an important role in promoting human health. Among the most notable health benefits are the absence of food additives, preservatives and chemical residues.

11.7.2 Economic valuation and incentives

For a mountainous state like Sikkim, ecosystems are ready-made natural capital that provide a wide range of benefits. Recently, there has been an increasing interest in applying economic thinking to the use of ecosystem services. The two critical points to consider are: why prosperity and poverty reduction depend on maintaining the flow of benefits from the ecosystems; and why successful environmental protection needs to be grounded in sound economics, including explicit recognition, efficient allocation, and fair distribution of the costs and benefits of conservation and sustainable use of natural resources. There is also a compelling cost-benefit case for public investment in ecological infrastructure, especially in restoring and conserving forests, river basins, wetlands, and agriculture farmland along the valleys and over slopes. Another dimension is that the incentives for ecosystem services (IES) are generating considerable attention because they have the potential to create new funding opportunities like Reduced Emissions from Deforestation and Degradation Plus (REDD+) for ecosystem protection, ecosystem services and societal benefits that contribute to human well-being. There is an urgent need for an evaluation of ecosystem services, and for exploration of opportunities and possibilities for incentives in the context of Sikkim. Lack of knowledge about the monetary value of ecosystem services is not the only factor leading to resource degradation. There are many other proximate factors such as existing policies and practices, demand on existing services, and the opportunity costs of conserving services, which add complexities to our understanding of the value of these resources. As a result, there is suboptimal investment in conservation and management, which leads to ecosystem deterioration.

Forest Survey of India estimated the biomass in the forests of Sikkim at about 29.46 million metric tonnes as per the State of Forest Report in 2012. Importantly, the temperate forests contain the maximum forest carbon to the tune of 8.46 million metric tonnes, while the least carbon (1.03 million tonnes) is stored in moist alpine scrub. The natural systems of Sikkim sequester a significant amount of carbon that deserves incentives in some form from the national government and global investments for green development.

The agroforestry in Sikkim is an efficient management system where the ratio of output to input is 13 times more compared to rain-fed agriculture. A cost-benefit analysis showed that large cardamom agroforestry brings 5.7 times more returns to farmers compared to rain-fed agriculture. This agroforestry system is a unique example of ecological sustenance and economic viability for farmers while also providing goods and services to downstream users. In the context of large-scale land use change the role of large cardamom agroforestry is quite promising for ecological and economic sustainability.

The concept of ecosystem service value can be a useful guide for Sikkim when distinguishing and measuring where trade-offs between society and the rest of nature are possible and where they can be made to enhance human welfare in a sustainable manner. However, while win-win opportunities for human activities within the environment may exist, they also appear to be increasingly scarce in a “full” global ecological economic system. This makes valuation all the more essential for guiding future human activity. For Sikkim, quantifying the economic value of ecosystem services is useful for strengthening the case for conservation and providing a base for informed policy decisions; however, methodological difficulties remain an obstacle to estimating economic value. The mountain specificities of inaccessibility, fragility, marginality, and physical and economic vulnerability, as well as the fact that inadequate attention has been paid to the subject in the mountains, are additional factors limiting our understanding of the true value of resources.

There are various reasons why it is important to value ecosystem services in the context of Sikkim. There are different ways in which economic valuation helps in improving ecosystem management and brings benefits to the state. Among others, economic valuation is a prerequisite for developing programmes on incentives for ecosystem services. Some of the major steps for economic valuation in Sikkim can be summarized as below:

Raising awareness: Assigning a monetary value to ecosystem services in Sikkim will help to raise awareness on the importance of the services that upstream landscapes provide to downstream users. For example, when biodiversity conservation or carbon sequestration in mountain ecosystems is expressed in monetary terms, it will highlight the significance and contributions of these ecosystems to local, national, regional and global communities, and can help to overcome existing policy dilemmas concerning their conservation.

Creating a “market” for ecosystems: Valuation of ecosystem services is essential for creating a market. Economic valuation of ecosystem services not only demonstrates the importance

and value of mountain ecosystems, but also provides insights about the gains and losses faced by different stakeholders directly or indirectly due to ecosystem degradation and subsequent loss of these services. Economic valuation can contribute to the conservation of mountain ecosystems by rewarding mountain communities for their conservation of the ecosystem resources.

Improving management mechanisms: Valuation also helps in deciding between different policy options, in identifying more efficient and cost-effective alternatives, and in designing appropriate institutional and market (and non-market) instruments, including incentives for ecosystem services. While valuation is a necessary first step, it is usually not sufficient in and by itself. For example, to make the incentives operational, it will also be necessary to mount a concerted effort in which clear roles are defined for multiple stakeholders and well-defined mechanisms are put in place to facilitate and negotiate transactions and decision-making.

Providing a framework for decision-making: Valuation techniques will provide supporting arguments for the protection of biological resources. They would also help to improve our understanding of ecosystems in general by evaluating the costs and benefits of development and environmental decisions as a trade-off between the resources and their utility values. Valuation will play an important role in decision-making and prioritization in resource allocation, distribution, and management. For example, assigning a monetary value to the services is important because it means that the benefits associated with biodiversity can be directly compared with the economic value of alternative resource-use options. Policymakers increasingly recognize the role of environmental valuation methodologies in policy formulation. The Convention on Biological Diversity's Conference of the Parties decision IV/10 acknowledges that "economic valuation of biodiversity and biological resources is an important tool for well-targeted and calibrated economic incentive measures" and encourages parties, governments, and relevant organizations to "take into account economic, social, cultural, and ethical valuation in the development of relevant incentive measures".

Extending justice and equity: When valuations have been conducted, it is possible to show how costs and benefits are distributed across society. In addition, when a compensation mechanism exists, it is possible to extend justice and equity by distributing the benefits and costs of any change in the ecosystem services. This can facilitate cost-sharing for management initiatives that provide incentives to the poor, who are the main custodians of mountain ecosystems.

The traditional knowledge systems, and the promotion of access and benefit-sharing (ABS) of genetic resources, are important elements to be considered. In general, mountain people are the custodians of mountain ecosystem services and downstream communities are beneficiaries. IES schemes are based on the principle that those who benefit from ecosystem services should pay for them in some form, and that those who contribute to generating the services should be compensated. They focus directly on creating a conditional benefit transfer between the providers of ecosystem services and the beneficiaries. However,

providing an equitable share at the micro level (such as for the poorest of the poor) is still a challenging task. Hence, the approach seeks to create mechanisms that internalize what would otherwise be an externality.

Some of the recommended actions for Sikkim are:

- Understand both tangible and intangible values and importance of organic farming and its associated ecosystems and services
- Undertake interdisciplinary analysis to understand the economic-ecological system in organic farming
- Explore incentives for ecosystem services system for water, flood control and climate services provided by Sikkim
- Use the regulatory role of ecosystems in Sikkim, including organic farming, for exploring REDD+ opportunities
- Focus attention on conflicts associated with the use of ecosystem services and trade-offs between conservation and poverty reduction

In the Indian context, people living in the downstream of the Himalayan areas are also poor, and so the payment for ecosystem services mechanism doesn't work. One of the viable options is that Union government compensates upstream states like Sikkim in some form through national schemes or compensation schemes for ecosystem services provided.

11.8 Adaptation strategies and mitigation of climate change

India's National Action Plan on Climate Change (2008) highlights eight missions on: i) enhancing energy efficiency; ii) use of renewable energy; iii) developing climate-friendly sustainable habitats; iv) integrated water resources management; v) sustainable agriculture; vi) enhancing the ecosystem services of the forests and its carbon sequestration efficiency; vii) sustaining Himalayan glaciers and mountain ecosystems; and viii) development of a strategic knowledge base to address the concerns of climate change. Within the mission's framework, Sikkim developed its State Action Plan on Climate Change (SAPCC) that describes its climate vulnerabilities and action plans by different sectors – water; agriculture, horticulture and livestock, energy, urban and rural habitats, and forests and biodiversity – to address them. The SAPCC clearly highlights concerns over lesser winter rains and warmer winters, increased frequency of extreme climate events, erratic rainfall patterns and late onset of monsoon, reduced discharge from springs, and increased torrential rains and surface run-off.

For Sikkim, climate impacts on agriculture have manifested in terms of declined productivity of winter crops, increased incidence of forest fires, reduced lean-season discharge from springs, increased risk of loss of traditional crop varieties, decreased soil fertility due to topsoil erosion, crop damage due to hailstorms and untimely heavy rains, and outbreak of pests and diseases in the field and during storage. How farming communities adapt to these changing conditions or what could facilitate better adaptation and climate resilient systems are important questions before the Sikkim Organic Mission.

Adapting to and mitigating climate concerns requires an integrated approach that not only builds awareness and access to climate information, but also considers institutional, financial and governance arrangements, and promotes decisions related to climate-smart practices and green technologies. The SAPCC highlights the following as effective strategies to adapt to and mitigate climate concerns: effective water management; effective soil conservation; resilient crop/livestock variety development, including popularization of indigenous varieties; crop/livestock-based livelihoods diversification; integrated pest/diseases management; seed production and certification; farm mechanization; institutional strengthening; and reducing climate risks and hazards.

The strategies that the Organic Mission could consider to address adaptation and mitigation issues of climate change in the context of organic farming are:

Infrastructure improvement to cope with water stress and disaster situation: Provides effective means to conserve and use water, especially during moisture-stress conditions. Water-saving irrigation systems, gravity drip irrigation, rainwater harvesting, and bench terraces can be promoted. Likewise, installation of small weather stations per block is desirable to monitor location-specific changes, thus allowing the farmers to take preventive measures to minimize loss due to climate impacts. Use of agroforestry to reduce climate-induced soil erosion is highly recommended. Agri-engineering activities suited to hill farming and minimum tillage have to be explored.

Cropping information system: Promotes the use of stress-resistant crop varieties and livestock breeds. Short-duration high-yield cereal/fruit crops with good markets are desirable. Alternative cropping patterns capable of withstanding the extremes of weather, drought, floods, and variable moisture availability are to be promoted. This implies relying on and balancing both indigenous knowledge and technology-driven modern knowledge. Mapping and *in situ/ex situ* conservation of existing traditional varieties, local landraces and breeds are required together with the maintenance of crop germplasms in the wild. Such interventions provide a genetic backup for future food and is a foundation for nutritionally rich organic farming.

Organic agriculture advancement as a climate-smart concept: Given that Sikkim is a small state with limited space for agriculture development, precision agriculture with biotechnological innovations such as integrated pest management, biological nitrogen fixation and EM technology, feedstock technology for cattle, and fodder banks need to be promoted together with the improvement of ICT and energy services to optimize productivity and maximize profits. Information needs within the government departments about climate baseline data and measures will play a crucial role in identifying right risk-mitigation and risk-aversion interventions.

Strengthen crop insurance programmes, including buy-back mechanisms and emergency extension services: Helps cope with crop/livestock and income loss, and is an essential risk

management mechanism for farmers. Strengthen the minimum support price facility to guarantee adequate benefit to farmers from their farm produce as well as institute insured credit facilities that allows farmers to experiment with new crop varieties and livestock breeds, including intensifying prospects for floriculture and off-season vegetables. Extension services in terms of health camps for livestock and seed provisions for crops have to be strengthened.

Institutional advancement and connect: Improve support to district- and local-level institutions to advance effective local farming systems management and the implementation of adaptation and mitigation strategies. It is essential to ensure adequate participation of and outreach to women and the poor. A farmer's network with peers and connect to experts, administrators, and investors are important means to diversify climate risks.

11.9 Climate services

Climate services are tools and information that will help the government and people of Sikkim and those living downstream to make better decisions for a sustainable future, whether it is by way of a farmer needing information on when it is expected to rain, or a tour operator informing tourists about unfavourable weather for sightseeing, or a local politician or official wanting to keep houses safe from landslide and flash floods. Climate services will provide an early warning system for Sikkim, connect from space to village, and also support decision-making at local, national and regional levels.

Increasing awareness of the impact of climate change on mountains, as highly fragile systems, and the consequences of this for the rest of the world, have put mountains at the centre of international climate discourse. While climate change is a global problem requiring global solutions, mountain systems are particularly sensitive to climate change and must be considered separately. Responding to climate change in mountain regions calls for very specific, tailor-made solutions.

Substantial glacial mass and area losses, higher variability in river flows and more water in pre-monsoon months are expected to lead to a higher incidence of unexpected floods and drought. Recent vulnerability assessments show that over 40 per cent of households in the mountainous region of the Himalaya are facing decreasing yields in their most important crops as a result of floods, droughts, frost, hail, and disease.

The Himalayan region at large and Sikkim Himalaya in particular are identified as one of the critically sensitive regions of the world in the context of climate change and its impacts. Climate-risk sensitive growth sectors like agriculture, tourism, water, energy, and health are affected due to climate variability and change in terms of loss of productivity, property, and lives. This calls for effective support by way of climate forecasts and actionable advisories addressing diverse stakeholders to manage the risks and opportunities of climate variability and climate change.

Climate services provide climate information to help governments, research and development agencies, individuals and organizations make climate-smart decisions. National and international databases provide high-quality data on temperature, rainfall, wind, soil moisture, and atmospheric circulation, as well as maps, risk and vulnerability analyses, assessments, and long-term projections and scenarios; however, procuring and using such data base are utterly complex. Socio-economic variables and non-meteorological data such as agricultural production, health trends, human settlement in high-risk areas, road and infrastructure maps for the delivery of goods, may be combined, depending on user needs. Climate services are also essentially conceptualized as a network of actors that interact and influence each other in the production, translation, tailoring and use of climate information, tools and products which are salient, credible and legitimate in character.

Considering the geographic location of Sikkim, climate variability has a large influence on farming, which is heavily dependent on rainfall, sunshine, and temperature. Climate change is a global issue contributed by emissions mostly by industrialized countries. Such global climate changes also have impacts in local areas and regions such as Sikkim. As per the World Meteorological Organization, climate scientists expect an increase in the frequency and intensity of extreme events such as floods and droughts that will ultimately impact crops and livestock, and Sikkim will not be spared.

11.9.1 Climate applications

The global framework of climate services (GFCS) proposes a framework for implementing climate services, which includes user interface, climate service information system, observation and monitoring system, research, modelling, prediction, and capacity building.

The potential translation or transformation of climate information into useful climate applications (in the form of agro advisories, flood outlooks, tourist advisories, and health advisories) embodies local social and institutional settings, risk information on resources and communities, system responses to extreme events and associated damages, abilities of the users to avail of the service, developing innovative tools and delivery systems for integration and coupling these diverse components as a credible operational credible service to connect the right people with right information at the right time. The progress in the development of climate applications, especially for agro advisories, has been quite good in India. Therefore, Sikkim has to position itself to benefit from such climate services that are already available in India.

ICIMOD is collaborating with meteorological and agricultural institutions in the Himalaya to establish an agricultural drought monitoring and early warning system. This initiative will help improve the capacity of national agro-meteorological and agricultural agencies in developing data products related to drought monitoring and enhancing the capacities of agencies to interpret and disseminate climate services in country-specific contexts. Sikkim can take benefit of this evolving system.

The system will assist local governments and the agricultural sector with drought monitoring and forecasting for the implementation of short- and long-term mitigation measures during and before droughts. It will provide drought monitoring and seasonal forecast conditions at ten-day intervals with a spatial resolution of five kilometres. An associated database on crop distribution and local cropping calendars will help the decision makers and end users in the agriculture sector to understand and interpret the data for effective use.

11.9.2 Actions for Sikkim

The state of Sikkim should help rural communities access tailored weather and climate information that they can easily understand and use to take decisions to strengthen their farming practices. It is important to use an integrated approach to help co-design and deliver reliable and easy-to-understand information via dedicated radio programmes, mobile phone applications, and training of agricultural intermediaries. As Sikkim is embarking on high-value products and marketing, it would require timely weather information, crop advisories and market price information. All these could be packaged into robust state-level “Climate Services”.

The following steps are required to establish climate services in Sikkim:

Develop methodologies, tools, and models, and understand user landscape: Significant efforts need to be made to understand several processes and approaches to produce useful climate information, including identifying the information needs of users; translating, communicating, and sharing knowledge; building capacity in the user community to understand and utilize the climate-science information; and maintaining a flexible and dynamic institutional support.

Improved climate data system: Identify different sources and mechanisms to draw and assimilate reliable and relevant state and national real-time spatially explicit weather and forecast information. Develop open-access operational spatially explicit diurnal rainfall and temperature products through appropriate blending of satellite and *in situ* measurements.

Delivery mechanism: The products delivered could be digital data, images, maps, display boards, pamphlets and pictures. Various communication strategies could be used such as mass media, social media, radio and service delivery agencies to deliver climate services targeted to users at different levels.

Climate application services: The need for climate information exists at all stages of agricultural activities—from land preparation, growing, maturing to harvesting, and even post-harvest storage and distribution. Mountain-specific forecasts of severe weather could provide lead time to farmers to mitigate water- and hazard-related damage.

Partnerships and capacity development: Formal linkages with state line agencies such as hydro-met departments; agriculture, horticulture and animal husbandry departments; disaster management authorities; and district offices. Linkages with universities and academic institutions will be important to generate a critical mass that can assist in promoting the use

of the services. Another important strategy will be to link up with ongoing initiatives at local and national levels to build synergies and avoid duplication of efforts. The private sector is coming up strongly in developing new business models on climate services, particularly in the field of agriculture advisory services, the insurance sector and tourism industry.

11.10 Financial strategy and entrepreneurship

India has been reeling under the burden of humongous farm distress in the last two and a half decades. Agriculture is a state subject as defined in the Constitution of India. In trying to balance food security, price stability, and farmer incomes, the central government has distorted the market mechanism. The troubled lives of farmers—involving variations in weather patterns, and farm-gate prices—in India is a serious matter; the people who bring food to the consumer's table have many worries.

India is targeting to double the income of farmers by 2022 by adopting a couple of pro-farm measures like cutting input cost, ensuring fair prices for crops, preventing post-harvest losses, and creating alternative sources of income. A new agriculture export policy to boost farm income has also been in the works since farmers are now operating in a global market. The budget allocation for agriculture in India has almost doubled in the current plan compared to the previous one. The recent hike in MSP for crops is a positive step. The Pradhan Mantri Fasal Bima Yojana (PMFBY) is a comprehensive crop insurance scheme that provides coverage to crops from pre-sowing to post-harvest against non-preventable natural hazards. The premium for insurance coverage has been kept at 2 per cent for kharif and 1.5 per cent for rabi crops. For commercial and horticultural crops, the farmers are required to pay an enhanced premium of 5 per cent. The rest of the premium (98.5 per cent for rabi crops and 95 per cent for commercial crops) is shared by the central and state governments. Clearly, various attempts are being made, but are these lasting solutions or are these just to provide temporary relief to farm distress?

Sikkim and the North-east buck the trend of farm-loan waivers because there are very little loans given anyway. The figures of the National Bank for Agriculture and Rural Development (NABARD) on ground-level credit (GLC) shows that it is less than a percentage point for all the north-east states. So, farmers in the North-eastern states have learnt to live and work with little or no credit.

Sikkim has worked very differently over the last 25 years. The state has wiped out poverty. Every citizen has a roof over her/his head and gets to eat two square meals a day. The nutrition levels are up, and it is on track to become a fully literate state by 2020. Livelihood opportunities are aplenty. With the world-feted Organic Mission, the state now has a unique platform to provide livelihoods to young people well into the next decade within the organic farming and value chain space. Combined with the state's tourism potential, there will be many possibilities of making every household in Sikkim financially secure many times over, and building a secure future for Sikkim.

There are conventional financing options like the Kisan Credit Card (KCC) and NABARD. There are also some opportunities under the Prime Minister's Employment Generation Programme (PMEGP) which provides loans for setting up new units in the manufacturing and business sectors. Other routes are microfinance models provided by institutions like Bandhan Bank.

In Sikkim, the Chief Minister's Start-Up Scheme (CMSUS) and the Chief Minister's Self Employment Scheme (CMSES) are two programmes which aim to promote entrepreneurship by providing loans to educated, unemployed youth for setting up employment ventures through service and business routes.

The state is exploring new ways of getting funds for entrepreneurs and start-ups. It will have to ensure this through a combination of new kinds of start-up financing, and put together a wholly new financing vehicle.

The future is bright if the state combines the education of young entrepreneurs with the markets which have woken up to healthy eating. Sikkim is well positioned for this. Even though the state understands that financing is just one of the pillars, we have to think of giving a head start to our young, educated agripreneurs. A special financing vehicle which can be in the range of INR 1,000 crore (approx. USD 143 million) can be put together with global climate financing, World Bank loans, Asian Development Bank (ADB), NABARD, and other central government agencies. This is not out of reach. This will enable the state to kick-start a programme that promises to raise the living standards of Sikkim's farmers. The market is not just in India. Sikkim's organic produce is now in demand in Japan, South Korea and Europe as well.

A typical loan for a young start-up will now be around INR 50 lakh (approx. USD 71,512). With this funding, the start-ups can construct a valuable business to the tune of INR 2 crore (approx. USD 286,060). The state can be looking at seed funding for about 1,000 start-ups. It will mean a total value of INR 500 crore (approx. USD 71.5 million). The state can double this number in five years.

The loan contribution can be just 50 percent. Hence, a typical loan can be about INR 25 lakh (approx. USD 35,757). There are many banks in Sikkim which can work on this and the state will have to ensure that the agripreneurs are serious about their business as well. It could be done along the lines of how loans were given to hotels and other tourism-related businesses. Past experience has shown that tourism sector-loans have had good paybacks.

What needs to be worked on urgently is the improvement of infrastructure. The strategic mix will be the Government of Sikkim spending on infrastructure and creating an enabling environment, like it has been done in the tourism sector. Spending on attractions has meant that many entrepreneurs have benefited by using this as a springboard. The banks and special funding agencies have not shied away. A look at the portfolios of the banks will reveal that they favour tourism-led projects, including vehicle financing. We just need to emulate this

and create an environment conducive to start-ups and entrepreneurs in the agriculture and organic farming space.

What young people want is a clean and quick regulatory environment and a level playing field and access without red tape. This can be done using technology and collaboration among stakeholders.

The income of farmers can be substantially increased by four times in the next five years. However, serious effort needs to be put into building a robust system by building infrastructure, processing facilities, and providing other technical and financial support. Help from academic institutions will be needed for nurturing the spirit of entrepreneurship in the minds of the youth. Moreover, academic institutions will also have to play a crucial role in disseminating scientific knowledge that can guide the entrepreneurs in finding innovative solutions to the needs of the market.

Sikkim is very well positioned to attract investments in promising business areas such as organic products and ecotourism through state, national and international funding. There are new opportunities for the state to receive funding from the Green Climate Fund (GCF), the Adaptation Fund, and the Global Innovation Fund (GIF), and to consider green bonds and other alternatives for entrepreneurship and business development of organic farm products. All of these will require investments in skill development of both public and private stakeholders.

12. Sikkim's Organic Farming *vis-a-vis* National Policies and Initiatives

Sikkim was the first state in India to officially adopt organic farming as state policy in 2003. It was followed by the establishment of the Sikkim Organic Mission in 2010. The “State Policy on Organic Farming” was put in place in 2014 and by 2016 Sikkim was declared as India's first fully organic farming state.

This pioneering effort has been recognised globally. Sikkim won the Future Policy Award 2018, given by the Food and Agriculture Organisation of the United Nations (FAO), the World Future Council (WFC) and IFOAM – Organics International. The citation said, “Sikkim's policy on organic farming implemented a phase out of chemical fertilizers and pesticides, and achieved a total ban on sale and use of chemical pesticides in the state. The transition has benefitted more than 66,000 farming families. As such, Sikkim sets an excellent example of how other Indian states and countries worldwide can successfully upscale agroecology.” This award reaffirms that Sikkim is on the right path in achieving some of the global agendas such as Sustainable Development Goals (SDGs) and contributing to meet some of the climate change mitigation targets within the United Nation's Framework Convention on Climate Change (UNFCCC).

The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) has emerged as the basic framework for ensuring intellectual property rights (IPR) across the world. Every member of the World Trade Organization (WTO) is obligated to include TRIPs provisions in their domestic intellectual property legislations. For India, the WTO's TRIPs agreement became binding from 2005 onwards. The intellectual property rights regime of India has been modified by a number of legislations since 1995. The Patent Amendment Act (2005), Copyright Amendment Act (2010), and others were made to strengthen the domestic legal framework and to fulfil India's obligations and ensure harmonization of national laws with the WTO's TRIPs agreement. The Biological Diversity Act, 2002 also supports the IPR regime of the country. Several modifications are also expected in the near future to fine-tune the country's IPR regime in the post-TRIPs era. Sikkim's Organic Mission should review the TRIPs and IPR regime in the context of the state being organic and rich in traditional knowledge systems, and how its support to farmers and entrepreneurs for trade can comply with and benefit from this global agreement to which India is party.

There are many complementary strategies and policies in Sikkim that support elements of organic farming. The Sikkim Biodiversity Action Plan (2012) recommends strategies for agrobiodiversity conservation, protection, and promotion. It has given a set of responsibilities, with corresponding time frames, to research and development agencies such as Indian Council of Agricultural Research (ICAR); National Bank for Agricultural and Rural Development

(NABARD); National Biodiversity Authority; Department of Agriculture Research and Education under the Ministry of Agriculture and Farmers Welfare; and the National Bureau of Animal Genetic Resources, including the Agriculture, Horticulture, and Animal Husbandry departments of the Government of Sikkim, to ensure that markets are available for organically farmed local crop varieties. These agencies are also tasked with the certification and preservation of local germplasm of farm and horticultural crops.

The organic policy of Sikkim is in compliance with the Indian legislative framework for the protection of biodiversity, genetic resources, and associated traditional knowledge all of which are covered by the Patents Act 1970 (amended in 2005); the Patents Rules 2003 (amended in 2006); the Geographical Indications of Goods (Registration and Protection) Act 1999 (Rules 2002); the Biodiversity Act 2002 (Rules 2004); and Protection of Plant Varieties and Farmers Rights Acts 2001.

The organic policy of Sikkim also contributes to the Protection of Plant Varieties and Farmers Rights Act 2001 (PPVR) of India that recognizes farmers as breeders, making them eligible to register the plants they have developed under the specific category of an ‘extant variety’ or a ‘farmers’ variety’ for the purpose of conservation and benefit sharing in the National Register of Plant Varieties. This Act provides opportunities for protection of plant varieties and gives rights to farmers and plant breeders for encouraging the development of new varieties. A new variety is registered under this PPVR Act if it conforms to the criteria of novelty, distinctiveness, uniformity and stability. The Sikkim Organic Mission can provide support to farmers for registration of plants genetic resources, or crop breeds developed by traditional breeders (farmers) and ensure benefit sharing. Sikkim is committed not to use genetically modified organisms (GMOs).

The organic policy of Sikkim can also contribute to comply with the National Bureau of Animal Genetic Resources for registration of domestic and semi-domesticated animals such as cattle, buffalo, sheep, goat, equines, poultry and others. ICAR-National Bureau of Animal Genetic Resources, Karnal (NBAGR) is the nodal agency for the registration of newly identified germplasm of livestock and poultry of the country. The *Siri* breed of cattle has been registered but a large number of animal genetic resources from Sikkim are still to be registered. One of the strategic actions of the organic farming mission should be on establishing institutional mechanisms for registration of indigenous breeds of domesticated and semi-domesticated animals. It can also consider establishment of “breed conservation centres” for *in-situ* conservation. Sikkim can contribute to national initiatives by using the country’s infrastructure of gene banks, DNA banks and somatic cell banks for *ex-situ* conservation, which will be a remarkable step for conservation of economically important and environmentally well-adapted animal breeds and crop varieties of Sikkim.

The “Agriculture Policies in India”, proposes a comprehensive set of policy measures that, taken together, would improve the incomes and well-being of farm households, improve nutrition outcomes for the most vulnerable members of Indian societies, enable the farm and food sector to grow sustainably, and strengthen India’s competitiveness in global

food markets. With strong political commitment, Sikkim has embarked on developing an exemplary model state in the country in the agriculture sector. This policy has a direct bearing on the development aspects of the National Agriculture Policy of India 2000 (NAP) and its various initiatives. Some of these are the creation of a Watershed Development Fund, introduction of Technology Mission for Integrated Development of Horticulture in the North Eastern Region in 2000-01, among others. During the Eleventh Five Year Plan (2007-12) several programmes like National Food Security Mission (NFSM), Rashtriya Krishi Vikas Yojana (RKVY), Macro Management of Agriculture (MMA), National Mission for Sustainable Agriculture (NMSA), National Project on Management of Soil Health and Fertility (NPMSHF) were introduced. There are ample opportunities for Sikkim to benefit from these centrally established initiatives and support systems to further the objectives of Sikkim Organic Mission.

The farmers of Sikkim can also benefit from the National Seed Policy 2002, that envisages development of new and improved varieties of plants, timely availability of quality seeds, compulsory registration of seeds, creation of infrastructure facilities, quality assurance, promotion of seed industry, abolition of licencing for seed dealers, facility for import of best quality seeds, encouraging export of seeds and creating Seed Banks and National Seed Grid.

The registration of high value crops or handicrafts under Geographical Indication of goods (Registration and Protection) Act, 1999 is a new area for Sikkim to ensure legal protection from bio-piracy and ensure economic returns for producers in the state. On 23 March 2015 “Sikkim Large Cardamom” was registered under the Geographical Indications Registry. With this the intellectual property is now secured. The registration of “Lepcha Handloom” is in process.

The strategic action plan of organic farming policy of Sikkim is in accordance with the basic objective of the “National Agroforestry Policy 2014 (NAP)”. Major policy initiatives, including the National Forest Policy 1988, the National Agriculture Policy 2000, Planning Commission Task Force on Greening India 2001, National Bamboo Mission 2002, National Policy on Farmers 2007 and Green India Mission 2010, emphasize the role of agroforestry for efficient nutrient cycling, organic matter addition for sustainable agriculture and for improving vegetation cover. The strategic action of the organic policy of Sikkim can support NAP by enabling coordination, convergence and synergy among various elements of agroforestry scattered in various existing plans, missions, programmes, schemes and agencies pertaining to agriculture, environment, forestry, and rural development sectors and improving the productivity; employment, income and livelihood opportunities of rural households, especially of smallholder farmers through agroforestry. The declaration and conversion of the entire farming sector into organic also complies with the Nagoya Protocol on Access and Benefit Sharing of the Convention on Biological Diversity (CBD). Sikkim’s Organic Mission contributes to one of its three objectives: the fair and equitable sharing of benefits arising from the utilization of genetic resources. This landmark agreement is relevant to a variety of commercial and non-commercial sectors that use and exchange genetic resources from the farming systems of Sikkim. The Government of India is a signatory to the Nagoya Protocol (signed 11 May 2011, ratified 9 October 2012).

Organic farming in Sikkim also contributes to India's National Action Plan on Climate Change (NAPCC 2008), specifically on (i) developing climate friendly sustainable habitats, (ii) sustainable agriculture, and (iii) enhancing ecosystem services of forests and its carbon sequestration efficiency. NAPCC's National Mission for Sustaining Himalayan Ecosystem (NMSHE) is focused on the Indian Himalayan States. Under the Mission's framework, Sikkim developed its State Action Plan on Climate Change that describes its climate vulnerabilities and the action plans by different sectors – water, agriculture, horticulture and livestock, energy, urban and rural habitats, forests and biodiversity – to address these vulnerabilities.

In 2018, the National Institute for Transforming India (NITI Aayog) released a set of reports on “Sustainable Development in the Indian Himalayan Region”. These reports cover five thematic areas: (1) Inventory and revival of springs in the Himalaya for water security; (2) Sustainable tourism; (3) Shifting cultivation – towards a transformational approach; (4) Strengthening the skill and entrepreneurship landscape; and (5) Data and information for informed decision by multiple stakeholders. Sikkim Organic Mission can contribute to the revival of springs for farm water security, to sustainable tourism by promoting organic food in local markets and use in hotels and through farm tourism, by building skills and entrepreneurships in organic product development and businesses, and on data and information sharing. During the launch of these reports, the idea of establishing Himalayan State Council and a mass movement for awareness to action, or “Himalayan Calling” were announced. Sikkim Organic Mission can link to these national efforts where Sikkim can be projected as a model organic state.

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Annexure 1: Strategic framework for organic farming in Sikkim with long-term (10-year) targets

Vision

People of Sikkim relish healthy food and enjoy sustainable livelihoods by practicing organic farming in a secure environment

Mission

To lead the change and leave no one behind by strengthening organic farming, entrepreneurship and green economic development

Strategic Goals

- 1) Enhanced livelihoods through organic farming and diversified farm products, including niche and high value products
- 2) Increased income of farmers and people of Sikkim from organic products through enterprise and business development
- 3) Ensured engagement of women and men farmers, youth and private entrepreneurs for critical mass, aggregation and economy of scale in organic production and green growth
- 4) Ensured delivery of functional support and services including climate services to organic farmers as incentives through government programmes, subsidies, soft loans and others, and enhanced climate change adaptation by farmers
- 5) Supportive policies and financial instruments in place, accessible and used for entrepreneurship, value addition and processing, marketing, branding and export of organic products
- 6) Use of chemical fertilizers and pesticides eliminated and replaced by organic practices including use of bio-fertilizers and bio-pesticides
- 7) Enhanced and sustained ecosystem services through organic farming by preserving the environment

Action Areas and Targets

Action Area 1: Conversion of farmland, organic certification and support to farmers

- All farming systems are fully organic, certified and maintained, organic certificates issued to all farmers' groups, individuals or producers as per NPOP standards
- All livestock based products, fermented products, traditional food items, and indigenous preparations are certified
- Internal Control System (ICS) in the state functional in accordance with national initiatives like NPOP and APEDA
- All relevant government departments and programmes of Sikkim participate and converge in achieving the goals of SOM
- MGNREGA (a flagship programme) labour force used for improving organic production in agriculture
- Technical inputs and organic packages of practices developed by R&D institutions are used by farmers

- Model organic villages are developed and used for training and capacity building of farmers
- Propose Sikkim Himalayan Organic Agriculture as a Globally Important Agricultural Heritage System (GIAHS) for global recognition to promote public understanding and awareness about sustainable agriculture

Action Area 2: Development of traditional crops, niche products and value addition

- Agro-techniques and organic packages of practices for cultivation of traditional crops, underutilized and lesser known crops, high value niche crops, horticultural and spice crops, NTFPs, and MAPs are transferred and used by farmers
- R&D institutions continuously make available modern technologies and inputs to government programmes and farmers
- Infrastructure facilities for value addition, storage and transportation as per NPOP standards are available in the state and are used by stakeholders
- Sikkim brand names are developed and used on organic products
- Geographical Indication (GI) and registration of farmer's varieties in National Register of Plant Varieties (NRPV) for conservation and benefit sharing to the state and the farmers
- Capacity of farmers built on production and value addition of high value organic products

Action Area 3: Entrepreneurship, youth engagement, value chain development and marketing

- Organic products with comparative advantage of mountain niches having economic scope and economy of scale promoted and adopted by farmers
- Rural enterprises are promoted with innovative livelihoods, value chain development, marketing, modern technologies, finances and services, including de-risking strategies for farmers
- Social enterprises are promoted and incentivized to benefit farmers
- Young farmers engaged, trained, and encouraged with incentives and subsidies to take up organic farming
- Business development skills of youth and entrepreneurs built to encourage entrepreneurship and business in organic products
- Entrepreneurships help in livelihood diversification and increased income of farmers in the state
- Institutional mechanisms for business development and marketing are developed by government and private organizations and used by young entrepreneurs and farmers
- Marketing of organic products including through aggregation strengthened with both forward and backward linkages
- Market information systems are in place for the state, and minimum support prices for organic products are established and used for the benefit of farmers and entrepreneurs

Action Area 4: Inputs and services for organic farming

- Quality seeds, seedlings, and viable breeds of local and improved genetic resources of livestock, are available and accessible to farmers
- Technological support and inputs for agriculture and animal production systems are in place and accessible to farmers
- Integrated Pest Management and Integrated Disease Management for all crops, fruits and vegetables with modern facilities are available for supporting farmers

- Soil fertility in organic farmlands is maintained and production efficiency increased by using improved farmyard manure, green manure, bio-fertilizers, bio-composting, including vermi-composting, and nitrogen fixing plant species
- Vermi-culture hatcheries, bio-fertilizer production units, bio-compost production units, and fruit/vegetable and agro-waste compost production units established in all the GPUs
- Farm inputs are made available to farmers at retail shops in rural areas
- Livestock production promoted for increased manure production
- Farmers receive incentives and support in terms of farm inputs and services under various state and national programmes

Action Area 5: Addressing farmer-wildlife interface issues

- Farmers are fully aware of wildlife behaviour supported by studies for those species that they encounter on their farms
- Effective communication between relevant departments such as forest, agriculture, horticulture and animal husbandry for addressing farmer-wildlife conflict and depredation
- More effective mechanisms to prevent intrusion by wild animals established by the relevant government departments (AHLFVD, FEWMD, FSADD, HCCDD) in collaboration with other R&D agencies
- Farmers trained for quick response to crop and livestock depredation issues
- Strengthen local institutions to support crop and livestock insurance for farmers
- More effective mechanisms established for compensation or ex-gratia to farmers for crop and livestock depredation by wildlife

Action Area 6: Food and nutrition security

- Food security information system established in the state and regularly used by relevant agencies
- Strengthened production systems with future smart crops, horticultural crops, NTFPs and livestock products established and available to people in the state for nutrient sufficiency
- All services like seed multiplication, distribution and post-harvest storage centres established and used for the benefit of farmers
- Organic agriculture established as an enterprise to provide income to ensure both food and nutritional security
- Social safety net on public distribution systems established and used

Action Area 7: Organic farming, ecosystem services and incentives

- Tangible and intangible values of organic farming associated ecosystem services estimated and used in government programmes for benefit of farmers
- Ecosystem services and trade-offs between conservation, development and poverty reduction included in the design of government programmes for the benefit of farmers
- Incentives and compensation negotiated with national government and international agencies for Sikkim's contribution to maintaining biodiversity, water, flood control and climate regulation services
- Diversity of agroecosystems (agro-pastoral, agroforestry, terrace farms and open cropped areas) in all the cultivated systems protected, conserved and preserved for the future

Action Area 8: Adaptation strategies and mitigation of climate change

- Infrastructure improved and support systems established to help farmers deal with water stress and natural disasters for reducing climate risks
- Agriculture information system established to support adaptation by Sikkim's farmers
- Climate smart agriculture and production systems promoted in the state
- Strengthened crop and livestock insurance systems for de-risking support to farmers on climate induced problems
- Institutional support at district and local levels for implementation and mitigation strategies for climate change adaptation and implementation of climate mitigation strategies
- Climate action plans prepared by the state in the context of SAPCC implemented for the benefit of farmers
- Adaptation and mitigation measures developed through coordination and convergence involving all relevant government departments (AHLFVD, FEWMD, FSADD, HCCDD, and RMDD)

Action Area 9: Climate services

- Climate services related methodologies, tools and models are developed and used at the state level
- Improved climate data systems provided for the benefit of farmers and entrepreneurs
- Delivery mechanisms of climate services systems established and effectively used in the state
- Climate application services for agriculture related adaptation and mitigation established and made available to all stakeholders in the state
- State agencies partner with national and global institutions to build capacity on climate services for the state machinery

Action Area 10: Financial strategy and entrepreneurship

- Pradhan Mantri Fasal Bima Yojana (PMFBY) fully utilized by farmers practicing organic farming in Sikkim
- Sufficient ground level credit systems facilitated through NABARD for farmers and entrepreneurs of Sikkim
- Organic farm products and ecotourism linked for access to finances
- Credit schemes like Kisan Credit Card, and schemes like Prime Minister's Employment Generation Programme (PMEGP), Sikkim Chief Minister's Start Up Scheme (CMSUS) and Sikkim Chief Minister's Self Employment Scheme (CMSES) fully used by farmers and entrepreneurs
- Innovative financing systems for young entrepreneurs established and extended across the state
- International funding secured for organic products, ecotourism development and climate adaptation and mitigation through Green Climate Fund (GCF), Adaptation Fund, Global Innovation Fund (GIF) and others
- Skills of public and private stakeholders in the state enhanced for accessing international financing

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