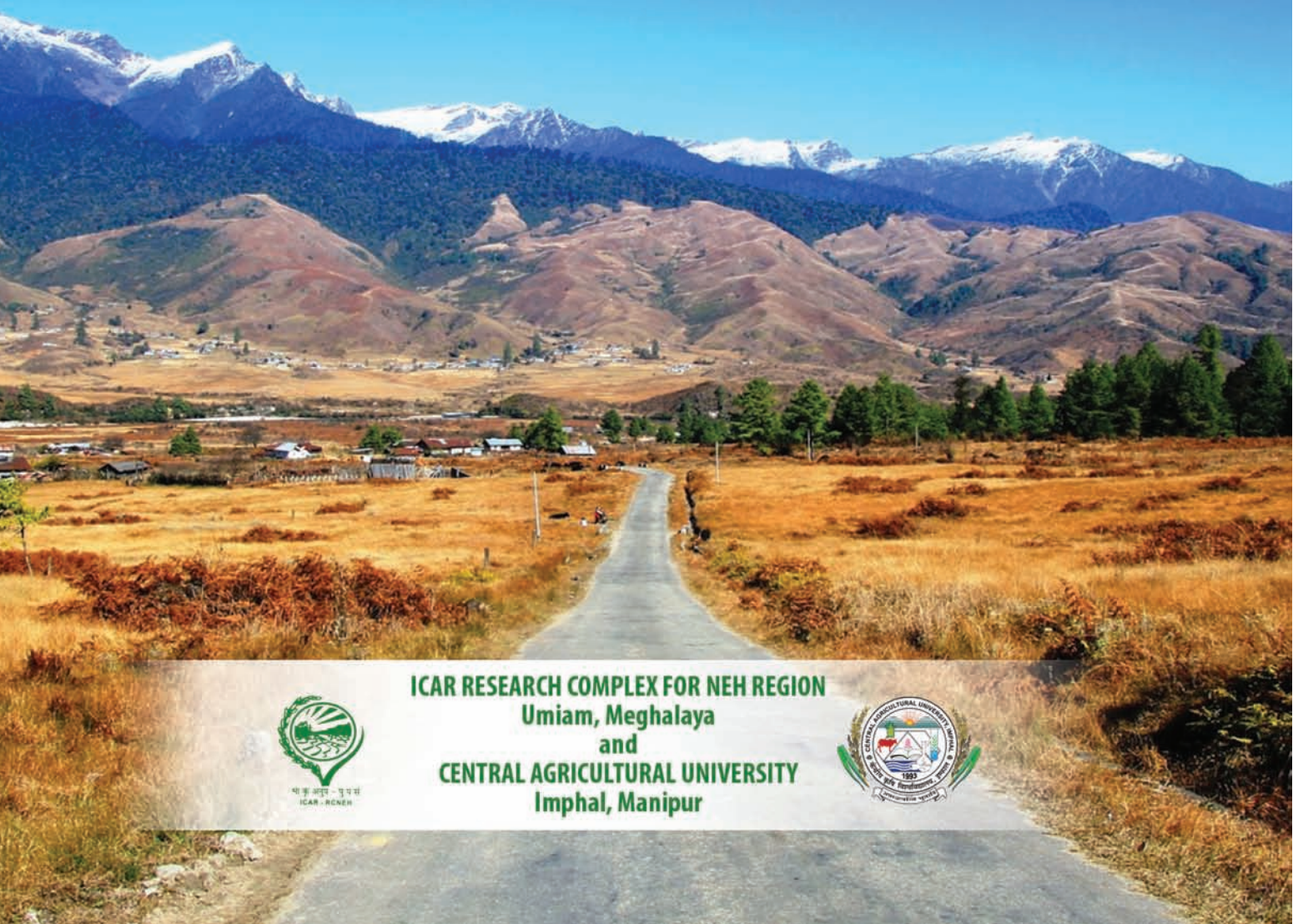
Strategies, Research Priorities, Monitoring and Extension Mechanism for Holistic Development of Eastern Himalayan Agro-Climatic zone



ICAR RESEARCH COMPLEX FOR NEH REGION
Umiam, Meghalaya
and
CENTRAL AGRICULTURAL UNIVERSITY
Imphal, Manipur

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Strategies, Research Priorities, Monitoring and Extension Mechanism for Holistic Development of Eastern Himalayan Agro-Climatic zone

Prepared and compiled by

Anupam Mishra, Vice Chancellor, CAU, Imphal
V. K. Mishra, Director, ICAR (RC) for NEH Region, Umiam,
Kadirvel Govindasamy, Principal Scientist, ICAR (RC) for NEH Region, Umiam
K. Mahadeva Reddy, Senior Scientist, ICAR (RC) for NEH Region, Umiam

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Task Force Committee on Agro Climatic Zone of Eastern Himalayas

(Ref. No. ICAR- F. No. NRM/2-14/2021-AFC dated 29th June 2021)

Chairman	**:**	Dr. Anupam Mishra, Vice Chancellor, CAU, Imphal
Convenor	**:**	Dr. V. K. Mishra, Director, ICAR (RC) for NEH Region, Umiam
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		Director, ATARI, Zone – VI, Guwahati

नरेन्द्र सिंह तोमर
NARENDRA SINGH TOMAR

D.O. No. 894 /AM

सत्यमेव जयते

आज़ादी का अमृत महोत्सव

कृषि एवं किसान कल्याण मंत्री
भारत सरकार
कृषि भवन, नई दिल्ली
MINISTER OF AGRICULTURE & FARMERS WELFARE
GOVERNMENT OF INDIA
KRISHI BHAWAN, NEW DELHI

संदेश

कृषि, भारत में 60 प्रतिशत से अधिक आबादी की आजीविका का मुख्य साधन है। अत्यधिक अनुकूलन व शानदार विकास के बावजूद यह क्षेत्र अनेक समस्याओं विशेषकर क्षणिक जलवायु परिवर्तन के कारण प्रभावी हो जाता है। भारत के माननीय प्रधानमंत्री के सुझावों के अनुसार भारतीय कृषि अनुसंधान परिषद (आईसीएआर) ने विभिन्न टास्क फोर्स गठित की ताकि बाधाओं का पता लगाया जा सके, अनुसंधान प्राथमिकताओं पर पुन: गौर किया जा सके और ऐसी नीतियां तैयार की जा सके जिनसे उत्पादन बढ़ाया जा सके व पूर्वी हिमालय क्षेत्र सहित देश में किसानों के लिए घरेलू खाद्य उपलब्धता, आय सुरक्षा व उनकी हालत में सुधार हो सके। मुझे यह जानकर खुशी हो रही है कि पूर्वी हिमालय क्षेत्र पर गठित टास्क फोर्स ने अपनी रिपोर्ट को अंतिम रूप दे दिया है और इस समिति ने पूर्वोत्तर हिमालय क्षेत्र में समस्त विकास हेतु अनुसंधान प्राथमिकताओं का पता लगाने तथा विस्तार व निगरानी तंत्रों संबंधी विभिन्न नीतियों पर अत्यंत उपयोगी सिफारिशें की हैं। मैं टास्क फोर्स के अध्यक्ष, संयोजक और सदस्यों को समय पर रिपोर्ट को अंतिम रूप देने के लिए उनके सार्थक प्रयासों के लिए उन्हें बधाई देता हूं। मुझे विश्वास है कि आईसीएआर इन सुझावों पर विचारोपरांत शीघ्रताशीघ्र कार्रवाई करेगा जिससे पूर्वोत्तर क्षेत्र में कृषि व संबद्ध क्षेत्रों में दूरगामी परीवर्तन आ सके।

(नरेन्द्र सिंह तोमर)

Office : Room No. 120, Krishi Bhawan, New Delhi-110 001 Tel.: 23383370, 23782691 Fax : 23384129
Resi. : 3, Krishna Menon Marg, New Delhi-110001, Ph. : 011-23794697 / 98, Fax : 011-23794696

सत्यमेव जयते
डॉ. हिमांशु पाठक
सचिव, एवं महानिदेशक
Dr HIMANSHU PATHAK
SECRETARY (DARE) & DIRECTOR GENERAL (ICAR)

भारत सरकार
कृषि अनुसंधान और शिक्षा विभाग एवं
भारतीय कृषि अनुसंधान परिषद
कृषि एवं किसान कल्याण मंत्रालय, कृषि भवन, नई दिल्ली 110 001
GOVERNMENT OF INDIA
DEPARTMENT OF AGRICULTURAL RESEARCH & EDUCATION (DARE)
AND
INDIAN COUNCIL OF AGRICULTURAL RESEARCH (ICAR)
MINISTRY OF AGRICULTURE AND FARMERS WELFARE
KRISHI BHAVAN, NEW DELHI 110 001
Tel.: 23382629; 23386711 Fax: 91-11-23384773
E-mail: dg.icar@nic.in

FOREWORD

The Eastern Himalayan States are characterized by their agrarian economy and rich natural resources to support the agriculture and allied sectors. However, the region is constrained by several infirmities viz. hard terrain, large scale deforestation, high prevalence of jhum cultivation, dwindling animal population and inadeqaute infrastructure and institutions, which have caused deceleration in growth of agriculture and allied sectors. Despite concerted efforts by the public sector agencies, the rate of adoption of improved technology by the farmers is slower in this region as compared to agriculturally agile regions in the country. Thea agriculture in India is experiencing a paradigm shift which includes nature positive and ecological farming as well. The Hon'ble Prime Minister of India has been reiterating for agro-climatic regional planning for agricultural development based on the the locally available resources.

ICAR formulated High Level Task Force for Eastern Himalayan Agro-climatic Region. The Task Force held detailed deliberations and discussions with various stakeholders. The huge sets of district level data were collected, arranged according to agro-ecological sub-zones and analyzed for mapping of the technological gaps and constraints in agricultural development in the Eastern Himalayan Region.

The report of task force has suggested strategy to address research priorities, build institutional linkages and measures for strengthening extension, and monitoring mechanisms in the region. The information contained in the report may be a reference material for researchers, development officials and policy makers for agricultural development in the region. The recommendations of the Task Force shall help the researchers to work on the novel areas and develop cutting edge technologies having much needed relevance to target communities of the region. The Governments of the various States in the region shall be benefitted with the recommendations related to infrastructural development which can accelerate growth and bring resilience in agriculture and allied sectors in the regions.

I complement the Chairman, Convener and Members of the Task Force for their efforts in bringing out the comprehensive report in time for the overall development of agriculture and allied sectors in the regions.

(Himanshu Pathak)

26 December,2022
New Delhi

भारतीय कृषि अनुसंधान परिषद
कक्ष क्र. 101, कृषि अनुसंधान भवन-II, नई दिल्ली-110 012, भारत
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
Room No. 101, Krishi Anusandhan Bhavan-II, Pusa, New Delhi-110012, India

डॉ. सुरेश कुमार चौधरी
उप महानिदेशक (प्राकृतिक संसाधन प्रबंधन)
Dr. Suresh Kumar Chaudhari
Deputy Director General (Natural Resources Management)

30.12.2022

Foreword

The economy of Eastern Himalayan states is basically agrarian in nature and the region is bestowed with rich natural resources that support growth in agriculture and allied sectors in the region. In view of several infirmities viz. hard terrain, over exploitation, large scale deforestation, high prevalence of Jhum cultivation, dwindling animal population and poor infrastructure development, the region is suffering form deceleration in growth rate in agriculture and allied sectors. Despite concerted efforts by the public sector agencies, the adoption of improved technology by the farmers in this zone at a slower pace compared to other regions elsewhere in the country.

It is at this juncture, finalization of report of task force committee is really a timely intervention and I am glad to know that committee has taken stock of various agro-ecological and social-economic situations, analyzed huge volumes of data, assessed various constraints, developed strategy to address research priorities and build institutional linkages and came out with measures for strengthening extension, linkage and monitoring mechanisms in the region. It is appropriate to mention that information contained in the document can be used as reference material for researchers, development officials and policy makers. I am sure that on the basis of suggestion and recommendations by the committee, the researchers would come out with cutting edge technologies having utmost relevance to target communities in the region. I am of the firm opinion that some of the recommendations would be useful for hastening up the infrastructure development by the respective state governments that would accelerate growth and resilience in agriculture and allied sectors in the regions.

I complement the Chairman, Convener and Members for their efforts in bringing out this report in time bound manner and coming out with appropriate recommendations for the overall development of agriculture in the regions.

(S.K. Chaudhari)

Ph.: +91-11-25848364 Fax: +91-11-25848366 Email: ddg.nrm@icar.gov.in Website: www.icar.org.in

केन्द्रीय कृषि विश्वविद्यालय
लम्फेलपात, इम्फाल - ७९५००४, मणिपुर (भारत)
CENTRAL AGRICULTURAL UNIVERSITY
LAMPHELPAT, IMPHAL-795004, MANIPUR (INDIA)

Dr. Anupam Mishra,
Vice-Chancellor

Tel : (0385) 2415933(O)
Email : vcofficecau@yahoo.in

PREFACE

Indian agriculture has been growing steadily by incorporating cutting-edge technology and scientific innovations meeting the diverse needs of various stakeholders. Nonetheless, Indian agriculture including the Northeast Region is constrained by several challenges. To address the issues related to research priorities in the domain of agriculture and allied sectors in the country, Agro-Climatic Zone (ACZ) wise Task Force Committees (TFC) have been constituted by the Indian Council of Agricultural Research (ICAR) to aid in fostering the growth, development and economic wellbeing of those engaged in farm and farm-based activities in the country including the Eastern Himalayan Zone. The Eastern Himalayan zone of India comprises of states of Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland, Sikkim, Tripura and three northern districts in West Bengal *i.e.,* Darjeeling, Jalpaiguri and Cooch Behar. This region has distinctive landscape characteristic of hilly and difficult terrain comprising of hills, plateau and plains.

The Task Force Committee constituted for Eastern Himalayan zone held several meetings and deliberations with various stakeholders in the region. Further the committee collected, collated and analyzed several data sets, delineated the profile of the region, described the current scenario of agriculture, horticulture and livestock and fisheries sectors in the region. The committee has pinned down research priorities under each of the sub-agro-climatic zones and assessed institutional mechanisms to address issues associated with research, development and policy in the realm of agriculture and allied sectors in the zone. Finally the committee came out with a strategy by delineating constraints and identified priorities that have more implication to research, extension and education in the zone. The systematically prepared and compiled report recommends concrete strategies, research priorities, monitoring and extension mechanism for holistic development of agro-climatic zone of eastern Himalayas.

As Chairman of the Taskforce Committee, I thankfully acknowledge the convener and members of the committee and other contributors for their valuable suggestions and inputs. I hope that this report will prove to be useful information resource for all those working for development of Indian agriculture

(Anupam Mishra)
Chairman, Task Force

Executive Summary

The Eastern Himalayan Region consists of states of Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland, Sikkim, Tripura and three northern districts of West Bengal i.e. Darjeeling, Jalpaiguri and Cooch Behar. This region has vast natural resources that include evergreen dense forests with diverse fauna and flora. Even though there are several advantages and huge natural resources, the growth and development in this region not significant compared to other regions in the country. This dismal state of affairs in this region is attributed to hardships associated with the terrain and climate, lack of infrastructure development and apathy with regard to investment by public and private sector agencies. On the basis of suggestions by the Hon'ble Prime Minister of India, agro-climatic zone wise task force committees have been constituted by the ICAR to look into the issues related to research priorities in the domain of agriculture and allied sectors to foster growth, development and wellbeing of farmers in the country. Accordingly, ICAR formed a committee for eastern Himalayan zone under the chairmanship of Dr. Anupam Mishra, Hon'ble Vice-Chancellor, CAU, Imphal, Manipur and appointed Dr. Dr. V. K. Mishra, Director, ICAR RC NEH, Umiam, Meghalaya as the Convener.

The Task Force Committee constituted for Eastern Himalayan zone held several meetings and deliberations with various stakeholders in the region. Further the committee collected, collated and analyzed several data sets, delineated the profile of the region, described the current scenario of agriculture, horticulture and livestock and fisheries sectors in the region. The committee has collected huge sets of district level data, and attempted to arrange the same as per agro-ecological sub-zones and analyzed the same, developed a profile of eastern Himalayan zone, mapped the current scenario on production and productivity, identified the gaps and constrains to growth and development, developed a strategy and came out with recommendations. The constraints that daunt the process of development in the region includes fragile ecosystem, climate change phenomenon, prevalence of jhum cultivation, small land holding size, soil infirmities, low crop productivity, low productivity in livestock and fisheries sector, lack of supply of improved seed and planting material, poor marketing system, lopsided postharvest processing facilities, poor status of farm mechanization, dismal logistic and supply chain infrastructure etc.

The committee has pinned down research priorities under each of the sub-agro-climatic zones and assessed institutional mechanisms to address issues associated with research, development and policy in the realm of agriculture and allied sectors in the zone. Finally the committee came out with a strategy by delineating constraints and identified priorities that have more implication to research, extension and education in the zone. In line with the constraints identified and strategy suggested, the committee has come out with more than 30 recommendation and important among them are ; i) Establishing an independent network institution i.e. AICRP on Agri-business Research Intelligence (AICRP-ABRI) under the aegis of NARS or altogether a new, independent and autonomous body especially of the status of a Bureau or Commission at national/state/ ACZ level with statutory powers so as to effectively coordinate with state government machinery or else to establish ATMA in each district with mandate of RBI in the realm of agriculture and allied sectors, ii) Developing Standard Operating Procedure (SOP) with

proper attributes and tags for ABRI, iii) Creating a web and mobile based software i.e. Farm and Farmer Inventory (FFI) for the use by researchers, extension workers and line department officials, iv) Creating standalone website on ABI for researchers and extension workers and Agri-business Technology Inventory (ABTI) for extension agents, farmers and other innovator, v)Creation of a network within the ACSZ i.e. Zonal Interface for Teaching Research and Education for Network Projects (ZITRENR) to be directly attached to lead state or central agricultural university within the ACZ, vi) Sending appropriate directions to the respective state governments to establish ATMA and entrusting the mandate of ATMA to the district level Head in the department of agriculture and make the KVKs to participate in regular meetings. vii) Creating a web and mobile based platform for farm advisory under the aegis of KVKs in the respective district, viii) Creating a software module i.e. Technology Foot Print Interface (TFPI) to map the spread of technologies across various micro-farming situations, ix) Characterization of soil erosion in terms of seasonality, quantum, frequency and intensity of erosion with concomitant impact on the production, productivity of ecosystem, loss of man days, loss of income and burden on state exchequer and come out with short, medium and long term preventive and curative measures and come out with a special project/programme with activities that can curtail the land degradation in EHZ states, x) Constituting a multi-disciplinary and multi-sector Pilot Project on Rain Water Harvesting Engineering under the aegis of North East Council to suggest short, medium and long term preventive and curative measures to mitigate water stress by construction of small and medium scale water storage reservoirs at suitable and high impact locations, xi) Conducting a Feasibility Study on large scale introducing micro-irrigation in the region by appropriate agency by looping an appropriate suitable private firm, xii) Formation of AICRP on Jhum Farming (AICRPOJF) under the aegis of NARS to generate data and develop strategy for short, medium and long term preventive and curative measures. xiii) Constitution of Task Force on Wetland Ecosystems under the aegis of North East Council with the mandate of mapping and effective utilization of wetlands and suggests appropriate policy on short, medium and long term strategy for conservation and effective utilization of wetlands, xiv) Formation of a Network Project on Wetland Ecosystem (NPOWE) to generate scientific information and devising of improved management practices for sustainable utilization of wetland, xv) Conducting a Scoping Study and Supply Chain Analysis on organically or naturally grown foods by appropriate agency having requisite expertise to enable demand driven production of organic commodities in the region, xvi) Establishing the quality control laboratory/state of the art facilities for crop and animal based organic produce and inputs since this region has potential for organic farming, xvii) Proper legislation especially establishing a Bureau or Commission or Board with statutory and regulatory powers for declaring the region as Niche Global Bio-Diversity Region (NGBDR) to restrain and fetter certain human activities that pose threat to bio-diversity and allow certain activities for effective utilization of genetic resources, xviii) Conducting a Scoping Study and Supply Chain Analysis on Seed Chain by an appropriate agency to suggest short, medium and long term measures to overcome shortage of seeds and planting materials and supply of improved breeds or species of animal and suggest enabling mechanism for community level seed production, xix) Conducting a Scoping Study and Supply Chain Analysis on farm mechanization in hilly based agro-ecosystems, formulate a policy for in the form of scheme or programme or project and commissioning of Custom Hiring mechanism of improved tools, implements, equipment, machinery etc. more in the nature

of PPP model to perpetuate the benefits at gross root level, xx) Conducting the Scoping Study on supply chain and market analysis of feed and feed supplements and suggesting measures with proper policy support for short, medium and long measures to develop mechanism to produce locally and supply globally, xxi) Formation of Task Force on Dwindling Animal Resources (TFODAR) under the aegis of North East Council with a mandate to have a comprehensive analysis of situation, reasons thereof and to suggest short, medium and long term preventive and curative measures to bring back normalcy in the sector, xxii) Conducting a Scoping and feasibility study on cold water fisheries in the selected areas for promotion of fisheries in the alpine and sub-alpine areas in the zone, xxiii) Establishment of a statutory body with quarantine function more in nature of Bureau or Board or Commission with a mandate of assessment, reporting and characterization of etiological agents and suggest short, medium and long term strategy and preventive and curative measures on curtailing the tarns-boundary diseases, xxiv) Formation of multi-institutional and multi-agency network project on Climate Change to characterize the climate change by conducting simulation studies and developing climate models under the aegis of IMD and NEH Council so as to predict the climate change effects on agriculture, horticulture, animal husbandry and economy of in the region and suggest short, medium and long term preventive and curative methods to cope up with climate change, xxv) Setting up of requisite logistic and supply chain infrastructure including capacity building, secondary and postharvest processing in place for speedy implementation of Hon'ble Prime Minister's initiative i.e. One District-One Product (ODOP) to the respective state governments on urgent basis, xxvi) Conducting a Scoping Study under the aegis of lead SAU and North East Council to appraise the policy makers to come out with legislative measures to make a provision for allocation of land to private sector agencies engaged in infrastructure development on lease for about 50 years or make a provision to develop infrastructure on Build, Operate and Transfer (BOT) model and also on imparting legal status for contract farming in the region.

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CHAPTER 1 INTRODUCTION

The Eastern Himalayan Region (EHR) in India comprise of the states of Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland, Sikkim, Tripura and three northern districts i.e. Darjeeling, Jalpaiguri and Cooch Behar in West Bengal state. This region has a total geographical area of 2,62,180 Km^2 and it shares about 4500 km of international border with five countries viz. Tibet, Bhutan, China, Myanmar and Bangladesh. Even though this region occupies nearly 8% of the total geographic area of the nation, but it is a home for a mere 4% i.e. 9.0 million of total countries' population. This region has distinctive landscape characteristic i.e. hilly and difficult terrain comprising of hills, plateau and plains to the extent of 60%, 12% and 28% respectively. The rivers in this region are perennial to semi-perennial in nature and the major river systems include Brahmaputra, Teesta, Karala, Manas, Kamang, Subansiri etc. This region is endowed with rich natural resources i.e. land, water and climatic regimes that make the region blessed with evergreen dense forests, diverse fauna and flora. This region is an abode of tribal communities which inherits rich cultural, ethnic, social and political diversity to the region in particular and the country in general. The people in this region are innovative and have mastered the art of converting adverse landscape and climate for their wellbeing over centuries. This region has global biodiversity hotspots that host a range of distinctive plant and animal species having global significance. The region is endowed with huge untapped potential of harnessing not only the natural resources especially agriculture and allied sectors but also the human resources for fostering growth, development and economy of the area.

Despite several advantages and rich natural resources, this region is not witnessing the requisite pace of growth. The people here remain mute spectators to the process of rapid development as compared to elsewhere in other states of the country. Even though there have been concerted efforts by various agencies including the then and present union and state governments, it is attributed that hardships associated with the terrain and climate, lack of logistic and supply chain infrastructure and meager presence and lack of unified efforts by research and development organization have become impediments and the region has become highly impregnable for bringing necessary change in the system.

It is at this juncture and on the basis of suggestions given by none other than the Hon'ble Prime Minister of India, Agro-Climatic Zone (ACZ) wise Task Force Committees (TFC) have been constituted by the Indian Council of Agricultural Research (ICAR) to look into the issues related to research priorities in the domain of agriculture and allied sectors in the country to aid in fostering the growth, development and economic wellbeing of those engaged in farm and farm based activities in the country including the Easter Himalayan Zone. The following Terms of References (ToR) were assigned to the TFCs:

1. To suggest the suitable strategies for identifying common constraints, research priorities, and addressing the same within the ACZ
2. To identify the institutions, linkage and monitoring mechanism among various agricultural education and research institutions including AICRPs/AINPs within ACZ and
3. To suggest the strategy for extension mechanism within the ACZ involving KVKs, ATMA and line department

Accordingly, the Division of Natural Resource Management, ICAR, New Delhi formed 15 committees representing various ACZ. The committee responsible for Eastern

Himalayan Region (EHR) was serial numbered at II vide the Council circular F. No. NRM/2-14/2021-AFC dated 29.6.2021. The details of committees to deal with the issues in Eastern Himalayan states are as follows:

Name of ACZ	Names of States	No. of districts	ICAR Institutes	CAU/SAUs	TFC details
Eastern Himalayas	Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura and three districts of West Bengal	AP = 26 AS = 35 MN = 16 MG = 12 MZ = 11 NG = 16 SK = 06 TR = 08 WB = 03 **Total = 133**	ICAR RC NEH, NRC Mithun, NRC Orchids, NRC Pig, NRC Yak and ATARIs	CAU, AAU and UBKV	**Chairman**: VC, CAU Imphal **Convener**: Director, ICAR-RC-NEH, Umiam **Members**: Vice-Chancellors, Directors of rest of the SAUs/ Institutes

In order to achieve the above said mandate, a meeting of the Committee designated to EHR was convened by Dr. V. K. Mishra, Director, ICAR RC NEH, Umiam and met under the Chairmanship Dr. Anupam Mishra, Hon'ble Vice-Chancellor, CAU, Imphal on 15th February, 2022. After a series of deliberation, the road map for future course of action was finalized. The following are the action points which emerged during the committee meeting:

1. The strategies for the development of different ecosystems namely, Hills, Mountains, Valleys and Wetlands.
2. Developing location specific low cost soil and water conservation.
3. Development of Agroforestry/IFS models for different agro-ecology, socio-economic set up and natural resource base.
4. Scientific management and conservation of wetlands for sustainable livelihood improvement.
5. Promoting organic/natural farming with special reference to hill agriculture.
6. Conservation and utilisation of plant genetic resources including underutilized and traditional crops viz. small millets, linseed, faba bean, rice bean, etc.
7. Promotion of farm mechanisation and development of small and light weight farm implements and machinery.
8. Augmentation of post harvest and value addition for fruits, vegetables, medicinal and aromatic plants.
9. Use of artificial intelligence for mitigation of climate change impact on agriculture.
10. Promotion and development of low cost feed for animals including fish.
11. Transboundary disease diagnostic and management program.
12. Exploration of cold water, ornamental fish resources in rivers and streams.
13. Establishment of FPOs/ Farmer organic committees for fetching fair prices for the farmers.
14. Linking of land tenure systems with credit institutes for effective credit flow and recovery for the needy farmers.

Profile of Eastern Himalayan Region (EHR)

The EHR encompasses the North Eastern Region (NER) extending from Nepal in the West to Arunachal Pradesh in the East. The

EHR lie between 82.700 E-100.310 E latitude and 21.950 N-29.450 N longitude that includes Five Countries (Nepal, Bhutan, India, China and Myanmar). The EHR in India comprise mainly of eight North Eastern States (NES) i.e. Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland, Sikkim, Tripura and three northern districts of West Bengal i.e. erstwhile undivided Darjeeling (except Siliguri), Jalpaiguri and Cooch Behar districts (Fig. 1). After reorganization of the districts, Kalimpong was carved out of Darjeeling and the Alipurduar from Jalpaiguri during mid previous decade (2010-20) and thus now the five northern districts i.e. Darjeeling (except Siliguri), Kalimpong, Jalpaiguri, Alipurduar and Cooch Behar form part of EHR.

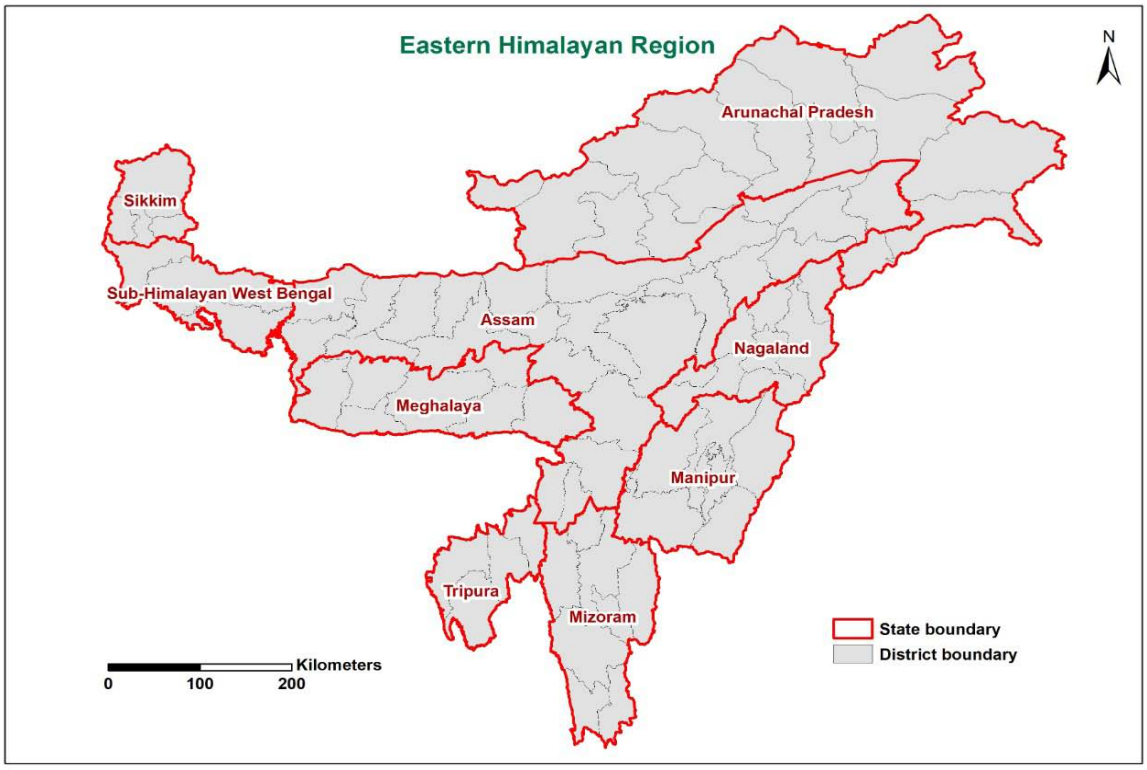


Fig.1. Map of EHR

This region is characterized by hills and mountains with some peaks reaching above 6000 m MSL, valleys that include Bramhaputra, Barak and Imphal valley, wetlands like Loktak lake and riverine systems particularly the river Brahmaputra. The region is drained mainly by the Brahmaputra river and its tributaries: the Teesta drains Sikkim and the Darjeeling areas, and the Manas drains part of Bhutan and Arunachal Pradesh. The Kameng and the Subansiri are the other important rivers that drain the eastern Himalayas. The second most major river system in the region is Barak. Both the rivers i.e. the Bramhaputra and the Barak after traversing various districts across different states merge with some other rivers in Bangladesh and finally make their way to the Bay of Bengal. Apart from the Bramhaputra river system, the state wide other major rivers include the Rangeet in Sikkim, the Teju Arunachal Pradesh , the Barak in Assam, the Manipur in Manipur, the Myntdu in Meghalaya, the Kaladan in Mizoram, the Doyang in Nagaland and the Gomati in Tripura.

The climate in the region includes arctic, sub-arctic, temperate, subtropical and warm tropical regimes. On an average 70% area is under forests. The forests in the region comprise of moist, dense, evergreen, semi-

evergreen, or temperate types. In view of high precipitation and dense forest coverage, humid regime is maintained in most parts of the region. The forest ranges include Sal forests and dense evergreen forests represents all along the foothills in this region, while subtropical forests that spreads across hills up to 2000 m MSL. The forest that represent above 3000 m MSL are temperate mixed and alpine in nature with tree species that mainly include *Abies, Juniperus communis, Rhododendron arboreum*. Apart from rich forest species, this region is also known for its rich fauna of utmost importance i.e. slow loris, rhinoceros, golden languor, tiger, Indian civet, clouded leopard and golden cat, while the important bird species include heron, white winged wood duck and snow cock.

This region has uniqueness in terms of its physiographic diversity and ecological richness with regard to diversity of plant and animal species. The zone has rich biodiversity both in terms of endemic floral and faunal species which holds significant value as genetic resources of regional, national and international importance. EHR is known for its global significance as it holds several hotspots of biodiversity that include Crisis Eco-regions, biodiversity hotspots, endemic bird areas, mega diversity countries and global eco-regions (Brooks et al. 2006). The region represents three main global Biodiversity Hotspots that include 12 in the Himalayan Hotspot, 8 in the Indo-Burma Hotspot and 5 in the mountain of Southwest China (Chettri et al. 2008). Nineteen out of 25 hotspots are of utmost worldwide significance especially from global conservational view point. Further, this region is known as "*Centre of Origin*" for many cultivated food crops and horticultural species.

The EHR also represents ethnic and cultural diversity in the country and it is a homeland for around 140 tribal communities. The state-wise tribal communities include Abor or Adi, Aka, Apa Tani, Dafla, Khampti, Khowa, Mishmi, Momba, Miri, and Singpho in Arunachal Pradesh, Bodo, Karbi, Mising, Sonowal Kacharis, Deori, Rabha, Dimasa, Tai-Phake, Singpho, Kuki, Khelma and Tea-Tribe in Assam, Aimol, Anal, Chiru, Chothe, Gangte, Inpui, Hmar, Kharam, Khoibu, Koirao, Kom, Lamkang, Liangmai, Mao, Maram, Maring, Mate, Monsang, Moyon, Paite, Poumai, Purum, Ralte, Rongmei (Kabui), Simte, Suhte, Tangkhul, Tarao, Thadou, Thangal, Vaiphei, Zeme and Zou in Manipur, Lushei, Ralte, Hmar, Paihte and Pawi or Poi in Mizoram, Garo, Khasi and Jaintia in Meghalaya, Angami, Ao, Chakhesang, Chang, Dimasa Kachari, Khiamniungan, Konyak, Kuki, Lotha, Phom, Pochury, Rengma, Sangtam, Sumi, Yimchungrü and Zeliang in Nagaland, Tripura/Tripuri, Riang, Jamatia, Noatia, Uchai, Chakma, Mog, Lushai, Kuki, Halam, Munda, Kaur, Orang, Santal, Bhil, Bhutia, Chaimal, Garo, Khasia and Lepcha in Tripura, Lepcha, Bhutia and Pahari of Sikkim and Bhutia, Lepcha, Sherpas and Yolmo in north West Bengal i.e. Darjeeling Hills.

The geographic and demographic details of target region are furnished in Table. 1. As per the current data, this region has a total of 115 districts across nine states with highest number i.e. 35 in the state of Assam and lowest number i.e. four in Sikkim. The total geographical area in this region is 271047 km^2. The total population in this region is 537 lakh people and the highest being in Assam and the lowest being found in Sikkim state. With regard to density of population, Arunachal Pradesh has lowest density of 17 persons km^2 and highest density of 622 is seen in five northern districts of West Bengal state, while the average population density in the zone stands at 212 persons per km^2. So far as So far as per sex ratio i.e. no. of females to 1000 males is concerned, the Sikkim state has the lowest ratio i.e. 890 and Meghalaya has recorded the highest female ratio i.e. 989, while the average for zone is 954. Further, a comparison of literacy rates among nine states reveals that highest literacy (91.33%) was found in Meghalaya and Arunachal Pradesh recorded lowest literacy rate (65.38%), while the average literacy rate for the region was found to be 77.68%.

Table 1. Geographic and demographic profile of EHR

State	No. of districts	Total geographical Area (km^2)	Population (lakhs)	Population density (Persons/ km^{-2})	Literacy rate	Sex Ratio (Per 1000 male)
Arunachal Pradesh	17	83743	13.84	17	65.38	938
Assam	35	78438	312.06	398	72.19	958
Manipur	16	22327	28.56	128	76.94	985
Meghalaya	11	22429	26.67	132	74.43	989
Mizoram	8	21081	10.97	52	91.33	976
Nagaland	11	16579	19.79	119	79.55	931
Sikkim	4	7096	6.11	86	81.42	890
Tripura	8	10486	36.74	350	87.22	960
Sub-Himalayan West Bengal* (3 districts)	3	8868	82.87	622	70.73	958
Total	**113**	**271047**	**537.61**	**212**	**77.69**	**954**

*Sub-Himalayan West Bengal (Darjeeling including Kalimpong (except Siliguri), Jalpaiguri, Cooch Behar (including Alipurduar)

The number of total agricultural households in North East Hilly (NEH) states is about 1381 thousand numbers which is 67% of the total rural households (NSS Report No. 587). Nagaland has the maximum share (~80%) of agricultural households; while the Tripura has the minimum share (41.4%) of agricultural households. The maximum number of agricultural households was recorded in Meghalaya and minimum was with Mizoram. About 72.9% of the total households are self-employed in crop production, 1.2% in livestock farming, 3.8% in other agricultural activities and 3.7% in other non-agricultural enterprises. Further, 1.5% and 10.4% of the rural households are earning regular wage/ salary in agricultural and non-agricultural activities, respectively. In addition, 1.3% and 3.7% of the total rural households works as casual labourers in agriculture and non-agricultural activities, respectively; whereas, 1.3% of the rural households are engaged in other activities. In terms of per cent distribution of rural households by size class of land possessed, 41.53% of rural households in NEH states possess 0.40 to 1.00 ha land; followed by 25.14% (1.01-2.00 ha), 24.81% (0.01-0.4 ha), 8.03% (2.01-4.00 ha), 0.46% (4.01-10.00 ha) and 0.03% (more than 10 ha). The total number of cultivators and agricultural labourers in NEH states were 25.52 and 8.34 lakhs, respectively during 2011 (Agricultural Statistics at a Glance 2020, Ministry of Agriculture and Farmers Welfare, Government of India). An increase to the extent of 7.42% and 27.30% in the number of cultivators and agricultural labourers, respectively was observed during 2001 to 2011. In view of the region dominated by hilly terrain, the scope for existence of large sized land holding is not feasible. About 80% of the farmers in this region belongs to small (less than 1.44 ha) and marginal (less than 0.40 ha) category. With the increase in population, the average size of land holding is gradually decreasing over the years. The average size of land holding is highest in Nagland (6.92 ha) and lowest in Tripura (0.97 ha).

The region is very rich in Indigenous Technical/Traditional Knowledge (ITK). This knowledge consists of many facts and has helped farmers to evolve many practices which have been tested over long periods of time and has proved to be beneficial. They depend entirely on locally available resources and knowledge base for maintaining productivity of crops and livestock. It is used in weather forecast, for good seed germination, soil fertility management, soil and water management, management of insect pests and diseases of plant and animals, post harvest management etc. There are several indigenous cultivation practices like wetland rice cultivation of *Apatani* tribe of Arunachal Pradesh, Zabo system of farming and Alder agriculture in Nagaland, large cardamom plantation in Sikkim, traditional mixed cropping etc. which are still in vogue in organic agriculture in NEH region which are sustainable, eco-friendly, viable and cost effective.

CHAPTER 2 CURRENT SCENARIO

Natural Resources

Agro-Climatic Zone

The climate in this region is basically tropical montane ecosystem that is classified in to six Agro-Climatic Sub-Zones (ACSZ) consisting of Alpine, Sub-alpine and Temperate, Sub-tropical Hill, Subtropical Plain (Valley), Mild Tropical Hill and Mild Tropical Plain. The details of zone wise physical features, state wise areas and important crop resources are presented in Table 2. The area under each zone varies with the state and can be further divided into four ecosystems i.e. Mountains (above 1500 m AMSL), Hills (800 m to 1500 m AMSL), Foothills and Valleys (up to 800 m AMSL) and Wetlands and Riverine areas. The climate consistes of a typical tropical rainforest climate with hot and wet regimes all round the year, while the chilly winters prevail mainly in the higher elevations. The eastern Himalayas are relatively warmer compared to western counterpart. The average minimum temperature during the month of May recorded at an elevation of 1,945 m MSL in Darjeeling is 11°C. The hot season commences from April with temperature reaching its maximum during June, while hot season comes to a halt in the month of August. The average summer temperate in the region is about 20^{0}C. The higher elevations in the region experience snowfall during December, January and February months.

Table 2. Agro-climatic profile of EHR

ACSZ	Physical Features	Important Areas/Districts	Crops & horticultural species	Animals species
1. Alpine Zone (>3500 m)	Area: 47068 km2, Rainfall: 750 mm, Mean Temperature: Maximum: 17^{o}C Minimum: 2^{o}C	**Arunachal Pradesh:** Parts of West Kameng, Upper Siang, Anjaw, East Kameng, Tawang **Sikkim:** Parts of East District, North District, West District **West Bengal**: Darjeeling, Kalimpong	Pasture and grass species , cherry, walnut, chestnut, medicinal plants viz. *Picrorhiza kurroa*, *Aconitum sp.*, *Panax sp.* , strawberries, finger millet, maize, barley, cowpea,	Yak, sheep, cattle, fish and poultry
2.Temperate Sub-Alpine Zone (1500 – 3500 m)	Area: 33564 km2, Rainfall: 2000 mm, Mean Temperature: Maximum: 20^{o}C Minimum: 11^{o}C	**Arunachal Pradesh:** Parts of Anjaw, East Kameng, East Siang, Lohit, Lower Dibang Valley, Papumpare, Tawang, Upper Siang, Upper Subansiri, West Kameng, West Siang **Meghalaya:** Upper Shillong, Mawphlang and Mairang of East Khasi Hills district	Small millets, rice, potato, maize, soybean, apple, pear, peach, plum, walnut, kiwi fruit, potato, cole crops, root crops, solanaceous vegetables, pea and beans	Cattle, buffalo, pig, goat, sheep, poultry, mithun and fish

ACSZ	Physical Features	Important Areas/Districts	Crops & horticultural species	Animals species
		Manipur: Mao & Maram areas of Senapati district, Upper reaches of Ukhrul district, Laithang areas of East Imphal district. **Sikkim:** Parts of East, North, South, West Districts **Mizoram:** Blue mountain of Lawngtlai, Tuipang in Saiha district, Nauzuarzo Tiang of Champai district **Nagaland:** Parts of Tuensang and Zunhoeboto district, Vangkong area of Wokha district, higher areas of Mokokchung district **West Bengal**: Darjeeling, Kalimpong, Jalpaiguri and Alipurduar		
3.Sub-tropical Hill Zone (1000 – 1500 m)	Area: 29021 km2, Rainfall: 2000 mm, Mean Temperature: Maximum: 30°C Minimum: 12°C	**Arunachal Pradesh:** Changyak, Naga and Khonsa area of Tirap district, Basar area of West Siang district, Upper Siang, Papumpare, lower reaches of Ajnaw, Changlong, Namsai, Longding and Kurung Kumey **Assam:** West Karbi Along, Karbi-Anglong and N. C. Hills **Meghalaya:** Jowai sub-division of Jaintia Hills, part of Nongstoin sub-division, Nokrek and Kailash area of West Garo hills and Western part of East Garo Hills. **Sikkim:** Namchi South District, Gayzing West Sikkim, Rongli, Rehnok and Gangtok of East District, Mangan and Changthang of North Sikkim,	Rice, maize, wheat, mustard, soybean, citrus, kiwi, passion fruit, strawberry, pineapple, plums, pears, all cruciferous and solanaceous vegetables, peas, french bean, sweet potato, potato, turmeric, ginger, gladiolus, orchid, and carnation	Cattle, buffalo, pig, goat, sheep, poultry, duck, mithun and fish

ACSZ	Physical Features	Important Areas/Districts	Crops & horticultural species	Animals species
		Mizoram: Aizawl, Champhai, Kolasib, Lawngtlai, Lunglei, Mamit, Sahia, Serchhip and rest of the state except lower valleys of Northern and Western part and area adjoining Cachar district and lower parts of Chhimtuipuii district. **Nagaland:** Mokokchang district, lower parts of Kohima, Wokha district and Mon district. **West Bengal**: Darjeeling, Kalimpong, Jalpaiguri, Cooch Behar and Alipurduar		
4. Sub-tropical Plain Zone (400-1000 m)	Area: 812 km2 Rainfall: 1600 mm Mean Temperature: Maximum: 27°C Minimum: 10°C	**Arunachal Pradesh:** Changlong, Namsai, Longding and Kurung Kumey **Assam:** South Salamara-Mankachar, Baska, Chirang, Barpeta, Bongaigaon, Dhurbi, Goalpara, Kamrup, Kokrajhar, Nalbari, Biswanath, Darrang, Dhemaji, Lakhimpur, Sonitpur, Udalguri **Manipur:** Imphal Valley of Imphal East, Imphal West, Thoubal and Bishnupur **Nagaland**: Mokokchung **Meghalaya:** Umkiang area of Jaintia hills **West Bengal**: Darjeeling, Kalimpong, Jalpaiguri, Cooch Behar and Alipurduar	Low land rice, maize, wheat, mustard, soybean, mango, lemon, guava, banana, strawberry, passion fruit, winged bean, Perkiaroxburghii, broad bean and common vegetables, orchids, anthurium and gerbera	Cattle, mithun, buffalo, pig, goat, sheep, poultry, duck and fish
5.Mild Tropical Hill Zone (200-800 m)	Area: 26349 km2 Rainfall: 1400 mm Mean Temperature: Maximum: 30°C Minimum: 12°C	**Arunachal Pradesh:** Southern part of lower Subansiri district **Assam:** Cachar and North Cachar **Meghalaya:** Southern part of Jowai subdivision adjoining Karimganj, Southern part of Nongpoh sub-division of	Upland rice, maize, pulses, cotton, wheat, pineapple, mandarin,	Cattle, buffalo, pig, goat, sheep, poultry, duck mithun and fish

ACSZ	Physical Features	Important Areas/Districts	Crops & horticultural species	Animals species
		Ri-Bhoi district, eastern part of east Garo hills and West Khasi Hills. **Manipur:** Juibam of Jiribam district, Churachandpur, Thanlon of Pherzawal district. **Sikkim:** Rongpoh -East district **Mizoram:** Lower valley of Northern and Western parts and Chhimtuipuii district. **Tripura:** Jampui Hills of North Tripura **Nagaland:** Medziphema area of Dimapur district. **West Bengal**: Darjeeling, Jalpaiguri, Cooch Behar and Alipurduar	banana, papaya, litchi, arecanut, coconut, black pepper, coffee, brinjal, tomato, okra, beans, sweet potato, rose and orchids	
6.Mild Tropical Plain Zone (0- 200 m)	Area: 29333 km2 Rainfall: 2000 mm Mean Temperature: Maximum: 33°C Minimum: 17°C	**Arunachal Pradesh:** Pasighat, Singphow area of Tirap district and lower parts of Lohit district. **Assam:** Hojoi, Marigaon, Nowgaon, Dibrugarh, Golaghat, Jorhat, Sivasagar, Tinsukia, Majuli, Charaideo **Meghalaya:** Lower part of West Garo Hills district **Mizoram:** Parts of Kolasib adjoining Cachar district of Assam and parts of Mamit district adjoining North Tripura district **Tripura:** Dhalai, Gomati, Khowai, North Tripura, Sepahijala, South Tripura, Unakoti, West Tripura excepting Jampui Hills **Nagaland:** Southern part of Dimapur district excluding Medziphema area **West Bengal:** Darjeeling, Jalpaiguri and Cooch Behar	Irrigated and rainfed rice, oilseeds, sugarcane, jute, pineapple, litchi, mango, banana, jackfruit, citrus, cashewnut, betel leaf, arecanut, black pepper, coconut, tea, coffee, cucurbits, beans, brinjal, sweet potato, potato, gerbera, tuberose and chrysanthemum	Cattle, buffalo, pig, goat, sheep, poultry, duck and fish

Agricultural crops

The area, production and productivity of cereals and millets in ACSZ are presented in Table 3. Highest productivity of cereals is recorded in Mild-Tropical Hill Zone (2358 kg/ha) followed by Mild-Tropical Plain Zone, Sub-Tropical Hill Zone, Sub-Tropical Plain Zone and Temperate Sub-Alpine Zone

Table. 3. Area, production and productivity of cereals and millets in EHR

ACSZ	Area (ha)	Production (t)	Productivity (kg/ha)
Alpine Zone	-	-	-
Temperate Sub-Alpine Zone	11258499	23910597	2123
Sub-Tropical Plain Zone	40616177	88704008	2184
Sub-Tropical Hill Zone	22762816	51538197	2264
Mild-Tropical Plain Zone	12225440	28533774	2334
Mild-Tropical Hill Zone	26652843	62837716	2358

Similarly, the area, production and productivity of pulses in ACSZ are presented in Table 4. Highest productivity of pulses is recorded in Sub-Tropical Plain Zone (1326 kg/ha) followed by Mild-Tropical Hill Zone, Sub-Tropical Hill Zone and Sub-Tropical Plain Zone.

Table. 4. Area, production and productivity of pulses in EHR

ACSZ	Area (ha)	Production (t)	Productivity (kg/ha)
Alpine Zone	-	-	-
Temperate Sub-Alpine Zone	464129	467496	1007
Sub-Tropical Hill Zone	677979	690294	1018
Sub-Tropical Plain Zone	972160	1289127	1326
Mild-Tropical Hill Zone	469532	564425	1202
Mild-Tropical Plain Zone	-	-	-

Further, the area, production and productivity of oilseeds in ACSZ are presented in Table 5. Highest productivity of oilseeds is recorded in Sub-Tropical Plain Zone (1490 kg/ha) followed by Mild-Tropical Plain Zone, Mild-Tropical Hill Zone, Sub-Tropical Hill Zone and Temperate Sub-Alpine Zone.

Table. 5. Area, production and productivity of oilseeds in EHR

ACSZ	Area (ha)	Production (t)	Productivity (kg/ha)
Alpine Zone	-	-	-
Temperate Sub-Alpine Zone	843502	873454	1036
Sub-Tropical Hill Zone	1123120	1251761	1115
Sub-Tropical Plain Zone	1725533	2570872	1490
Mild-Tropical Hill Zone	802136	933950	1164
Mild-Tropical Plain Zone	304322	421064	1384

Horticultural crops

The area, production and productivity of vegetables in ACSZ are presented in Table 6. Highest productivity of vegetables is recorded in Sub-Tropical Hill Zone (23.44 t/ha) followed by Temperate-Sub-Alpine Zone, Sub-Tropical Plain Zone, Mild-Tropical Plain Zone and Mild-Tropical Hill Zone.

Table. 6. Area, production and productivity of vegetables in EHR

ACSZ	Area (ha)	Production (t)	Productivity (t/ha)
Alpine Zone	-	-	-
Temperate Sub-Alpine Zone	710530	14702002	20.69
Sub-Tropical Hill Zone	552390	12950214	23.44
Sub-Tropical Plain Zone	817371	6037442	7.39
Mild-Tropical Hill Zone	475901	2192943	4.61
Mild-Tropical Plain Zone	72340	502692	6.95

The area, production and productivity of spices in ACSZ are presented in Table 7. Highest productivity of spices is recorded in Temperate-Sub-Alpine Zone (7.45 t/ha) followed by Sub-Tropical Hill Zone, Mild-Tropical Hill Zone, Mild-Tropical Plain Zone and Sub-Tropical Plain Zone.

Table. 7. Area, production and productivity of spices in EHR

ACSZ	Area (ha)	Production (t)	Productivity (t/ha)
Alpine Zone	-	-	-
Temperate Sub-Alpine Zone	72050	536838	7.45
Sub-Tropical Hill Zone	143243	953761	6.66
Sub-Tropical Plain Zone	817371	942018	1.15
Mild-Tropical Hill Zone	101780	623068	6.12
Mild-Tropical Plain Zone	53764	166858	3.10

The area, production and productivity of plantation crops in ACSZ are presented in Table 8. Highest productivity of plantation crop is recorded in Alpine Zone followed by Temperate Sub-Alpine Zone, Sub-Tropical Plain Zone, Mild-Tropical Hill Zone, Mild-Tropical Plain Zone and Sub-Tropical Hill Zone.

Table. 8. Area, production and productivity of plantation crops in EHR

ACSZ	Area (ha)	Production (t)	Productivity (t/ha)
Alpine Zone	1703	24297000	14267.176
Temperate Sub-Alpine Zone	65435	155612202	2378.119
Sub-Tropical Hill Zone	318800	27337288	85.751
Sub-Tropical Plain Zone	470339	1061679397	2257.264
Mild-Tropical Hill Zone	216209	398110028	1841.320
Mild-Tropical Plain Zone	135862	241236086	1775.596

Horticulture crops i.e. fruits, vegetables, plantation crops, spices, flowers etc. are important source of household income and nutritional security for the people in the EHR states. Assam stands first in terms of area (168870 ha) and production (563970 MT) of fruits followed by Mizoram, Tripura, Arunachal Pradesh, Manipur, Meghalaya, Nagaland, and Sikkim with regard to area and Tripura, Manipur, Meghalaya, Mizoram, Nagaland, Arunachal Pradesh and Sikkim in production (Table 9). The important fruit crops in the region include banana, mango, pineapple, Jackfruit, guava, mandarin and other citrus species. This region contributes to 7.10% of area and about 5% of production in fruits of the in the country. With regard to vegetables, Assam has highest area (318970 ha) and production (4012380 MT) followed by Meghalaya, Tripura, Nagaland, Sikkim, Manipur, Mizoram and Arunachal Pradesh in area and Tripura, Meghalaya, Nagaland, Manipur, Sikkim, Mizoram and Arunachal Pradesh in production (Table 10). The important vegetables grown in the region are potato, sweet potato, colacasia, tapioca, cabbage, cauliflower, carrot, brinjal, chilies etc. This region contributes to 5.50% of area and 3.47% of production of vegetables in the country. The EHR has a distinction with regard to production of spices in the country. The major spice crops grown in the region include turmeric, ginger, chillies, pepper, large cardamom, coriander and tea spices viz. nutmeg, clove, cinnamom and garcinia. The highest area and production of spices in the region is Assam (104620 ha and 331020 MT) followed by Sikkim, Mizoram, Meghalaya, Arunachal Pradesh, Nagaland, Manipur and Tripura with regard to area and Mizoram, Sikkim, Meghalaya, Arunachal Pradesh, Nagaland, Tripura and Manipur in production (Table 11). This region contributes about 6.0% of area and 8.0% of production of spices in the country. With regard to area and production of plantation crops in EHR, Assam stands first in area (108620 ha) and production (214640 MT) followed by Meghalaya, Tripura, Mizoram, Sub-Himalayan West Bengal, Nagaland, Manipur, Arunachal Pradesh and Sikkim in area and Tripura, Meghalaya, Sub-Himalayan West Bengal, Mizoram, Nagaland, Manipur, Arunachal Pradesh and Sikkim in production (Table 12). This region contributes to 4.31% of area and about 2.0% of production of plantation crops in the country. The important plantation crops grown in the region are coconut, oil palm, cashew, tea, coffee, rubber etc. The EHZ is a treasure house of medicinal and aromatic crops mostly used by the households as herbal medicines and therapeutic purposes. Tripura stands first in area (4550 ha) and production (880 MT) followed by Sikkim, Nagaland, Mizoram and Meghalaya (Table 13). The important medicinal and aromatic crops in the region include *Oroxylum indicum, Euphorbia nerifolia, Scoparia dulcis, Jatropha curcas,* and *Kaempferia rotunda* and betel vine. The EHR region is endowed with floricultural crops especially the orchids. With regard to area and production of floriculture crops in this region, flowering species are grown on an area of 5730 ha and the total production stands at 51390 MT of loose flowers and 85190 MT of cut flowers. Even though, this region contributes to only 2.0% of area under flowering species, however it has immensely contributed to 11.18% of the total cut flower production in India.

With regard to productivity of horticultural crops, Assam stands first in productivity of fruits (15.30 t/ha) followed by Manipur, Meghalaya, Tripura, Nagaland, Mizoram, Sikkim and Arunachal Pradesh, while Tripura recorded highest productivity of vegetables (17.47 t/ha) followed by Assam, Nagaland, Manipur, Meghalaya, Arunachal Pradesh, Sikkim and Mizoram and Meghalaya recorded highest productivity of spices (4.81 t/ha) and Nagaland has highest productivity of plantation crops (4.47 t/ha) (Fig. 2).

Table 9. Area and production of fruit crops in EHR.

Year 2019-20	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura	Sub-Himalayan West Bengal
Area ('000 ha)	48.14	168.87	47.90	37.60	62.93	33.69	19.54	54.81	-
Production ('000 MT)	125.84	2562.30	527.97	393.51	347.02	315.62	55.45	563.97	-

Table 10. Area and production of vegetables in EHR.

Year 2019-20	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura	Sub-Himalayan West Bengal
Area ('000 ha)	2.62	318.97	36.84	49.09	34.65	40.71	38.80	47.98	-
Production ('000 MT)	17.39	4012.38	391.35	515.87	200.44	452.32	231.40	838.23	-

Table 11. Area and production of spices in EHR.

Year 2019-20	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura	Sub-Himalayan West Bengal
Area ('000 ha)	15.46	104.62	11.10	15.67	28.21	11.39	35.70	6.82	-
Production ('000 MT)	47.43	331.02	27.34	75.38	101.49	44.24	79.74	30.94	-

Table 12. Area and production of plantation crops in EHR.

Year 2019-20	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura	Sub-Himalayan West Bengal
Area ('000 ha)	0.07	108.62	0.90	27.01	12.08	1.77	0.00	14.59	2.44
Production ('000 MT)	0.21	214.64	0.31	29.76	8.35	7.92	0.00	33.17	16.55

Table 13. Area and production of medicinal and aromatic crops in EHR.

Year 2019-20	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura	Sub-Himalayan West Bengal
Area ('000 ha)	0.24	4.55	0.04	0.00	0.76	0.13	-	-	-
Production ('000 MT)	0.16	0.19	0.12	0.00	0.78	0.88	-	-	-

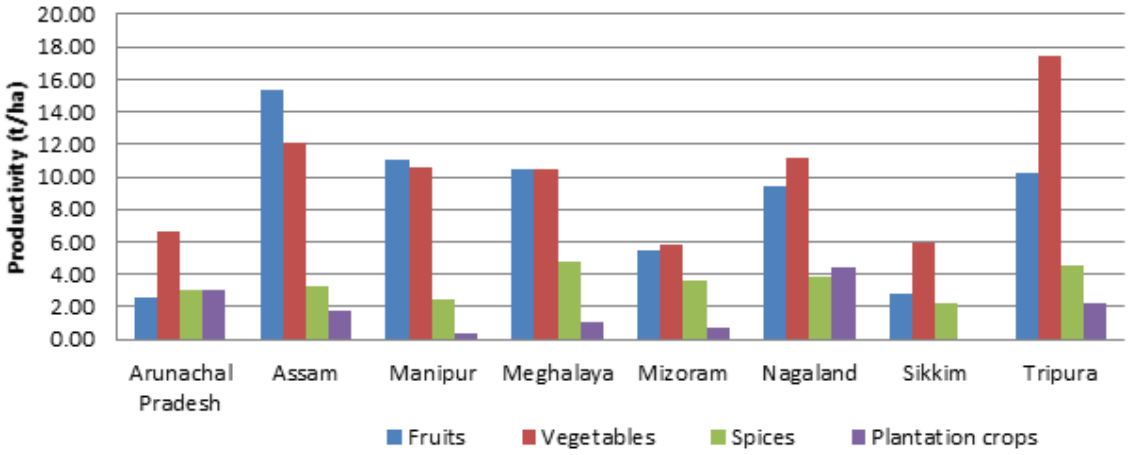


Fig 2. Productivity of horticultural crops in EHR

Livestock sector

The population of different livestock in ACSZ is presented in Table 14. Highest cattle population is recorded in Sub-Tropical Plain Zone (34.93 lakhs) followed by Temperate Sub-Alpine Zone, Mild-Tropical Plain Zone, Alpine Zone, Mild-Tropical Hill Zone and Sub-Tropical Hill Zone. Highest pig population is recorded in Mild-Tropical Hill Zone (35.29 lakhs) followed by Mild-Tropical Plain Zone, Sub-Tropical Plain Zone, Sub-Tropical Hill Zone, Temperate Sub-Alpine Zone and Alpine Zone. Highest goat population is recorded in Sub-Tropical Plain Zone (10.03 lakhs) followed by Mild-Tropical Plain Zone, Sub-Tropical Hill Zone, Mild-Tropical Hill Zone, Temperate Sub-Alpine Zone and Alpine Zone. Highest sheep population is recorded in Sub-Tropical Plain Zone (3.09 lakhs) followed by Mild-Tropical Hill Zone, Alpine Zone, Temperate Sub-Alpine Zone and Sub-Tropical Hill Zone. Highest poultry population is recorded in Sub-Tropical Plain Zone (1427.48 lakhs) followed by Sub-Tropical Hill Zone, Mild-Tropical Hill Zone, Mild-Tropical Plain Zone, Temperate Sub-Alpine Zone and Alpine Zone.

Table. 14. Population of different livestock in EHR

ACSZ	Cattle	Pig	Goat	Sheep	Poultry
Alpine Zone	10.31	0.21	0.81	0.1	4.72
Temperate Sub-Alpine Zone	15.47	0.94	1.15	0.02	20.40
Sub-Tropical Hill Zone	3.67	6.01	3.98	0.02	158.39
Sub-Tropical Plain Zone	34.93	7.49	10.03	3.09	1427.48
Mild-Tropical Hill Zone	6.73	35.29	1.70	0.7	120.43
Mild-Tropical Plain Zone	10.43	33.20	5.74	-	73.38

Even though, agriculture is the major source of livelihood for the foremost rural population in EHR, livestock serve as household income and nutritional security in the region. As per 20th Livestock Census-2019, even though the cattle and pig population has increased by 5.03 and 7.35% respectively, however there was 41.33% reduction in buffalo during 2012 to 2019 (Fig. 3 & 4). The goat and sheep population in the region has also declined to the extent of 36.87% and 26.78% respectively during 2012-2019 (Fig.5). However, positive growth of population of yak (61.87%) and mithun (29.94%) population was noticed

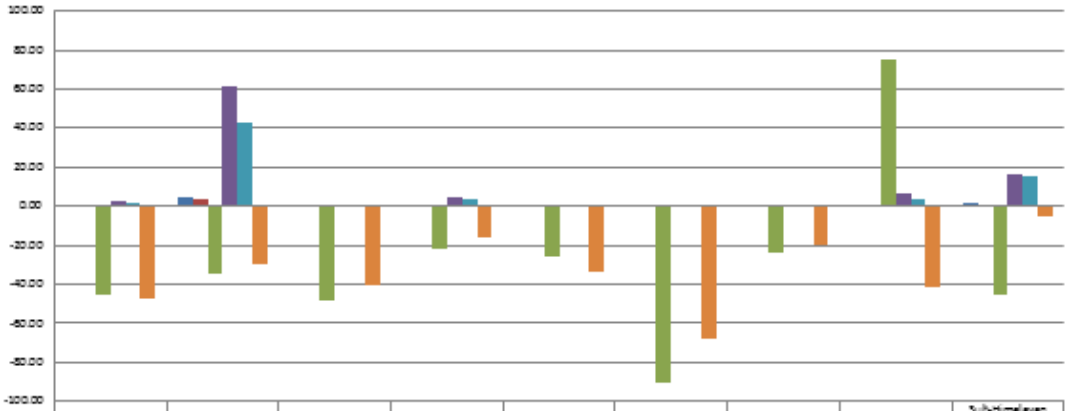
in the region during 2012-2019 (Fig. 6). Similar trend was also observed with regard to poultry sector (60.09%). The population of fowl and duck increased to 62.51%, 61.42% respectively (Fig. 7). A total of 1525.23 MT of milk, 253.51 MT of meat and 1175.06 millions of eggs were produced during 2019-20 (Table 15).

	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura	Sub-Himalayan West Bengal
Cattle (Lakhs) 2012	4.64	108.08	2.64	8.96	0.35	2.35	1.40	9.49	20.53
Cattle (Lakhs) 2019	3.39	109.09	2.24	9.04	0.46	0.78	1.48	7.39	27.28
Change (%)	-26.85	5.83	-14.92	0.84	32.19	-66.68	5.37	-22.11	32.87
Buffalo (Lakhs) 2012	0.06	4.35	0.66	0.22	0.05	0.33	0.01	0.11	0.16
Buffalo (Lakhs) 2019	0.06	4.22	0.36	0.16	0.02	0.16	0.01	0.07	0.21
Change (%)	6.85	-2.99	-45.41	-28.76	-59.24	-52.16	62.73	-34.01	36.18

Fig 3. Population of cattle and buffalo in EHR

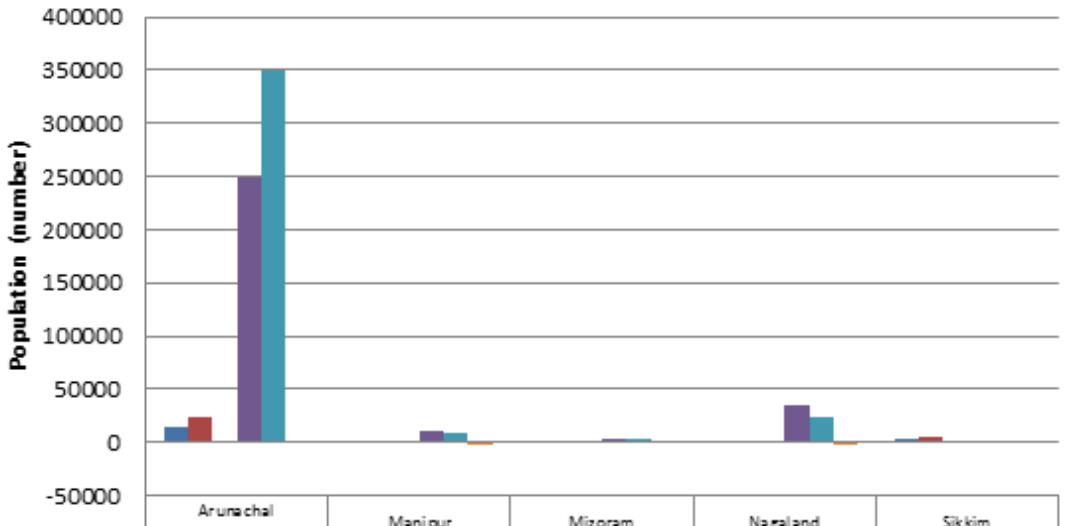
	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura	Sub-Himalayan West Bengal
2012	3.56345	16.36	2.77215	5.43381	2.45238	5.03688	0.29907	3.62534	1.59227
2019	2.71463	20.99	2.35255	7.06364	2.92465	4.04695	0.2732	2.06035	1.73417
Change (%)	-23.82	28.30	-15.14	29.99	19.26	-19.65	-8.65	-43.17	8.91

Fig 4. Population of pigs in EHR



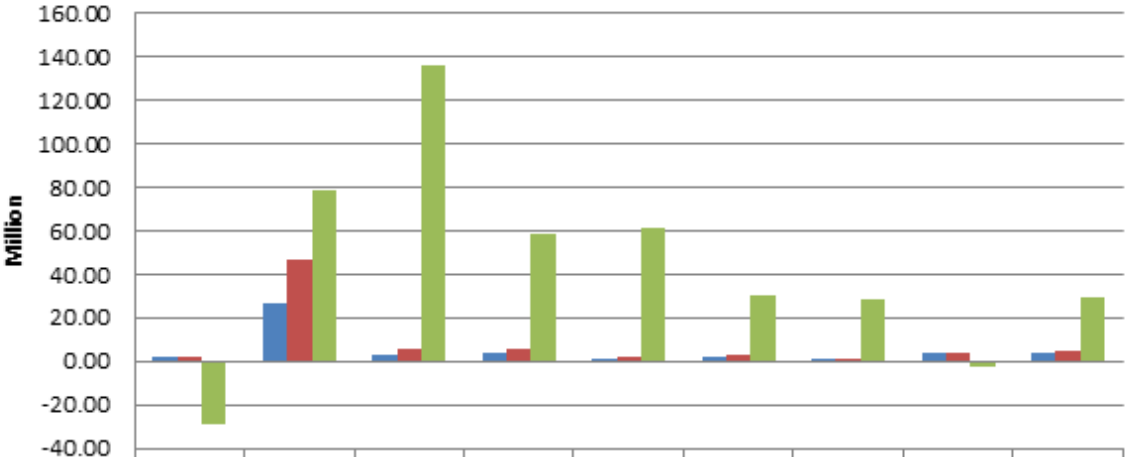
	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura	Sub-Himalayan West Bengal
Sheep (Nos.) 2012	0.14	5.11	0.11	0.20	0.01	0.04	0.05	0.05	1.46
Sheep (Nos.) 2019	0.07	5.52	0.06	0.16	0.00	0.00	0.02	0.05	0.81
Change (%)	-45.79	-55.05	-45.55	-21.96	-25.56	-90.59	-25.46	75.56	-44.92
Goat (Nos.) 2012	5.06	61.69	0.65	4.75	0.22	0.99	1.15	6.11	15.69
Goat (Nos.) 2019	1.60	45.15	0.39	5.96	0.15	0.52	0.91	5.60	15.10
Change (%)	-47.72	-50.05	-40.61	-15.97	-55.26	-66.19	-20.16	-41.04	-5.00

Fig 5. Population of sheep and goat in EHR



	Arunachal Pradesh	Manipur	Mizoram	Nagaland	Sikkim
Yak 2012	14061				4086
Yak 2019	24075				5219
Change (%) Change (%)	71.22				29.31
Mithun 2012	249000	10131	3287	34871	
Mithun 2019	350154	9059	3957	23123	
Change (%) Change (%)	40.62	-10.58	20.38	-33.69	

Fig 6. Population of yak and mithun in EHR



	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura	Sub-Himalayan West Bengal
2012	2.24	26.19	2.50	3.40	1.27	2.18	0.45	4.27	3.83
2019	1.60	46.71	5.90	5.38	2.05	2.84	0.58	4.17	4.96
Change (%)	-28.73	78.35	135.95	58.22	61.07	30.32	28.11	-2.45	29.50

Fig 7. Population of total poultry in EHR

Table.15. Production of meat, milk and egg in EHR

Year 2019-20	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura	Sub-Himalayan West Bengal
Meat ('000MT)	22.67	52.96	28.7	46.35	16.41	32.09	3.76	50.57	-
Milk ('000MT)	60.63	919.94	89.65	87.6	25.53	61.64	83.94	198.6	-
Egg (million)	60.49	514.88	108.18	110.20	43.34	38.16	4.83	294.98	-

Fisheries sector

Fish is an important source of protein for the people in this region and more than 90% of people in the region consume fish. Fish is produced mainly in inland water resources i.e. ponds, lakes, reservoirs and rivers. The total fish production in the region stands at 5.18 lakh MT and highest fish producing state is Assam followed by Tripura, Manipur, Meghalaya, Sikkim, Mizoram and Arunachal Pradesh (Table 16).

Table 16. Fish production in EHR

Year 2019-20	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura	Sub-Himalayan West Bengal
Fish Production (Lakh MT)	0.05	3.73	0.32	0.14	0.07	0.09	0.00	0.78	-

Crop coverage

The EHR shares 8.36% of the country's total geographical area. Of the total 27467 thousand ha, 28.40% (7803 thousand ha) is gross cropped area, while 19.19% (5273 thousand ha) is net sown area (Table 17). The area under fallow land, other uncultivated land and land not available for cultivation were 780, 2102 and 3366 thousand ha respectively. The region also has the pride of sharing 20.74% (14938 thousand ha) of the total forest cover in India.

Table 17. Agricultural land use type in EHR

State	Area ('000 ha)						
	Total geographical area	Gross cropped area	Net sown area	Forest cover	Land not available for cultivation	Other uncultivated land	Fallow land
Arunachal Pradesh	8347	313	232	6725	62	113	96
Assam	7844	4045	2723	1853	2509	1191	93
Manipur	2233	469	469	1699	27	8	0
Meghalaya	2243	309	252	940	240	549	214
Mizoram	2108	186	145	1585	75	60	174
Nagaland	1658	521	385	863	95	156	153
Sikkim	710	146	77	336	10	8	12
Tripura	1049	491	255	629	147	14	2
Sub-Himalayan West Bengal	1275	1323	735	308	201	3	36
Total EHR	27467	7803	5273	14938	3366	2102	780
All India	328726	200203	139415	72020	44823	25702	26356
EHR Share (%)	8.36	3.90	3.78	20.74	7.51	8.18	2.96

Sub-Himalayan West Bengal (Darjeeling including Kalimpong (except Siliguri), Jalpaiguri, Cooch Behar (including Alipurduar)

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Table18 . Status of irrigation in EHR

State	Gross irrigated area ('000 ha)	Net irrigated area ('000 ha)	Net sown area ('000 ha)	Share of irrigated area to net sown area (%)
Arunachal Pradesh	56.25	55.95	232	24.1
Assam	542.90	424.98	2723	15.6
Manipur	54.21	6.86	469	1.50
Meghalaya	142.30	100.63	252	39.90
Mizoram	21.02	16.16	145	11.10
Nagaland	122.90	115.50	385	30.00
Sikkim	0.850	0.850	385	0.20
Tripura	118.06	89.06	255	34.90
West Bengal (Three districts)	539.00	176.00	735.00	23.90
Total	**1597.49**	**985.99**	**5581**	

West Bengal (Darjeeling including Kalimpong (except Siliguri), Jalpaiguri, Cooch Behar (including Alipurduar)

State wise Scenario of Agriculture

The main agricultural crops in the region include cereals (8046746 ha), oilseeds (550324 ha) and pulses (335418 ha) during 2018-19. predominant crop in the cropping systems followed by maize, rapeseed and mustard, blackgram, peas and beans, small millets and wheat (Fig. 8). This region contributed to 7.16% area and 7.02% production of food grains in the country during 2018-19. The area and production of total food grains in different EHR states during the last ten years is presented in Table 19. The total area under rice in EHR is 7426 thousand hectares during 2018-19, while the production stood at 17713 MT during the same period (Table 20). The highest area under rice is in Assam followed by Sub-Himalayan West Bengal, Tripura, Nagaland, Meghalaya, Manipur, Arunachal Pradesh, Mizoram and Sikkim, while the highest rice producing states in the regions include Assam, Sub-Himalayan West Bengal, Tripura, Nagaland, Manipur, Meghalaya, Arunachal Pradesh, Mizoram and Sikkim. The productivity of rice in this region is low compared to the national average (2994 kg/ha) and it ranged from 1722-2556 kg/ha with lowest in Mizoram and highest in Arunachal Pradesh during 2018-19 (Fig. 9).

Table. 19. Area and production of total food grains in different EHR states.

Year 2018-19	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura	Sub-Himalayan West Bengal
Area ('000 ha)	22.67	52.96	28.7	46.35	16.41	32.09	3.76	50.57	-
Production ('000 MT)	413	11318	786	678	152	1178	101	1676	3710

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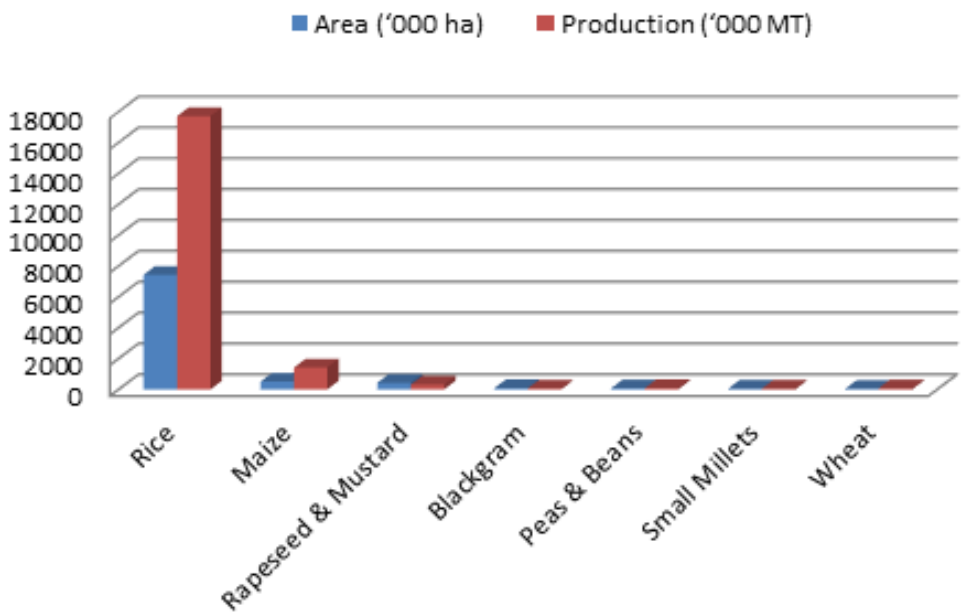

Fig 8. Area and production details of major crops in EHR

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Table 20. Area and production of rice in EHR

Zones	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
Area ('000 ha)										
EHR Total	6996	7286	7334	7124	7302	7171	7495	7488	7426	7426
All India	41918	42862	44006	42753	44136	44110	43499	43993	43774	44156
EHR share (%)	16.69	17.00	16.67	16.66	16.54	16.26	17.23	17.02	16.97	16.82
Production ('000 tonnes)										
EHR Total	12755	14899	14313	15106	15950	15738	16662	16737	17192	17713
All India	89093	95980	105301	105232	106646	105482	104408	109698	112758	116478
EHR share (%)	14.32	15.52	13.59	14.36	14.96	14.92	15.96	15.26	15.25	15.21

*Sub-Himalayan West Bengal

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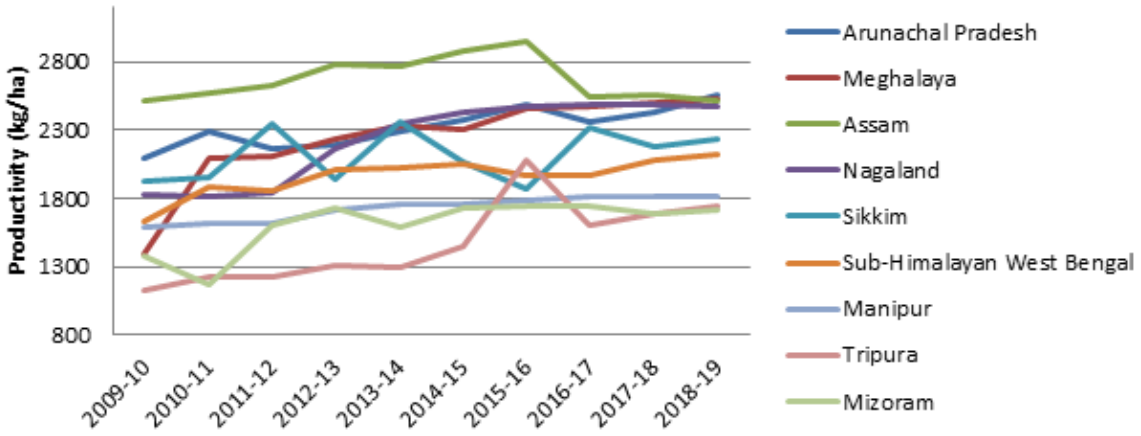

Fig. 9. Productivity of rice in EHR

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The total area under wheat in the region is 43778 ha during 2018-19 and a clear cut declining trend is noticed in wheat area in the region from 2009-10 to 2018-19. The highest area under wheat is in Assam followed by Sub-Himalayan West Bengal, Arunachal Pradesh, Nagaland, Manipur, Meghalaya, Sikkim and Tripura. During 2018-19, a total of 75922 tonnes of wheat was produced in the region with highest production reported from Sub-Himalayan West Bengal followed by Assam, Arunachal Pradesh, Nagaland, Manipur, Meghalaya, Tripura and Sikkim. With regard to productivity of wheat, highest productivity was in Manipur (2396 kg/ha), lowest in Sikkim (1041kg/ha) and the productivity in Sub-Himalayan West Bengal is highly fluctuating over the years.

The total area under maize in the region is 511000 ha during 2018-19 and there is a constant increase in maize area in the region from 2009-10 to 2018-19 (Table 21). The highest area under maize is in Sub-Himalayan West Bengal followed by Nagaland, Manipur, Arunachal Pradesh, Sikkim, Tripura, Assam, Meghalaya and Mizoram. During 2018-19, a total of 1426000 MT of maize was produced in the region with highest production reported from Sub-Himalayan West Bengal followed

by Nagaland, Manipur, Assam, Arunachal Pradesh, Sikkim, Tripura, Meghalaya and Mizoram (Table 17). With regard to maize productivity, highest was noticed in Sub-Himalayan West Bengal (4340 kg/ha), lowest in Tripura (1624 kg/ha) and the productivity in Sikkim and Assam is highly fluctuating over the years.

Table 21. Area and production of maize in EHR

EHZ	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
Area ('000 ha)	380	366	372	372	401	407	428	429	524	511
Production ('000 MT)	664	966	748	808	1003	1016	1071	1036	1450	1426

*Sub-Himalayan West Bengal

https://aps.dac.gov.in/APY/Public_Report1.aspx

The total area under coarse cereals in EHR is 66 thousand hectares during 2018-19, while the production stood at 67 thousand MT during the same period (Table 22). The highest area under coarse cereals is in Arunachal Pradesh followed by Nagaland, Sub-Himalayan West Bengal, Sikkim, Assam, Meghalaya and Tripura, while highest producing state is Arunachal Pradesh followed by Nagaland, Sub-Himalayan West Bengal, Sikkim, Meghalaya, Assam and Tripura. The productivity of coarse cereals in this region ranged from 567-1151 kg/ha with lowest in Assam and highest in Sub-Himalayan West Bengal during 2018-19.

Table 22. Area and production of coarse cereals in EHR

EHR	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
Area ('000 ha)	65	60	52	55	57	60	62	64	61	66
Production ('000 MT)	54	57	49	56	58	61	63	65	60	67

*Sub-Himalayan West Bengal

https://aps.dac.gov.in/APY/Public_Report1.aspx

The total area under pulses in EHR is 335 thousand hectares during 2018-19, while the production is 296 thousand MT during the same period (Table 23). The highest area under pulses is in Assam followed by Nagaland, Tripura, Sub-Himalayan West Bengal, Manipur, Arunachal Pradesh, Meghalaya, Sikkim and Mizoram, while highest production is in Assam followed by Nagaland, Manipur, Tripura, Sub-Himalayan West Bengal, Arunachal Pradesh, Meghalaya, Mizoram and Sikkim. Among the pulses, highest area is occupied by blackgram (91000 ha) followed by peas and beans, masoor, greengram, redgram, cowpea, bengalgram, khesari and horsegram. The productivity of pulses in this region ranged from 712-1518 kg/ha with lowest in Tripura and highest in Mizoram during 2018-19.

Table 23. Area and production of pulses in EHR

EHR	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
Area ('000 ha)	219	190	215	230	244	260	279	318	348	335
Production ('000 MT)	157	134	153	168	196	229	239	276	301	296

*Sub-Himalayan West Bengal

https://aps.dac.gov.in/APY/Public_Report1.aspx

The total area under blackgram is 9108000 ha during 2018-19 and there is a constant increasing trend seen during 2009-10 to 2018-19 (Table 24). The highest area under blackgram is in Assam followed by Sub-Himalayan West Bengal, Tripura, Arunachal Pradesh, Sikkim, Manipur and Nagaland. During 2018-19, a total of 6276000 MT of blackgram was produced in the region with highest production reported from Assam followed by Sub-Himalayan West Bengal, Tripura, Arunachal Pradesh, Sikkim, Manipur and Nagaland (Table 20). As far as productivity of blackgram is concerned, highest was recorded in Manipur followed by Arunachal Pradesh, Sikkim, Nagaland, Assam, Tripura and Sub-Himalayan West Bengal.

Table 24. Area and production of blackgram in EHR

EHR	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
Area ('000 ha)	64.03	69.43	77.92	74.29	75.87	74.80	79.03	89.39	92.53	91.08
Production ('000 MT)	39.02	41.18	47.04	44.52	46.08	50.65	54.07	63.70	61.82	62.76

*Sub-Himalayan West Bengal

https://aps.dac.gov.in/APY/Public_Report1.aspx

The total area under oilseeds in EHR was 550000 ha during 2018-19, while the production was 435000 MT during the same period (Table 25). The highest area under oilseeds is in Assam followed by Nagaland, Sub-Himalayan West Bengal, Manipur, Arunachal Pradesh, Tripura, Meghalaya, Sikkim and Mizoram. So far, where crop wise area under oilseeds is concerned, highest area (434000 ha) was noted with rapeseed and mustard followed by soybean, sesamum, groundnut, linseed, niger, sunflower and safflower (Table 25). With regard to production of oilseeds Assam stands first followed by Nagaland, Sub-Himalayan West Bengal, Arunachal Pradesh, Manipur, Tripura, Meghalaya, Sikkim and Mizoram. With regard to productivity of oilseeds it ranged from 611-1315 kg/ha with lowest in Assam and highest in Meghalaya during 2018-19.

Table 25. Area and production of oilseeds in EHR

EHR	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
Area ('000 ha)	494	440	444	483	470	481	489	537	560	550
Production ('000 MT)	318	313	304	353	348	375	384	419	439	435

*Sub-Himalayan West Bengal

https://aps.dac.gov.in/APY/Public_Report1.aspx

The total area under rapeseed and mustard was 434000 ha during 2018-19 and there is a constant increasing trend in area noticed during 2009-10 to 2018-19 (Table 26). The highest area under rapeseed and mustard was in Assam followed by Sub-Himalayan West Bengal, Manipur, Arunachal Pradesh, Nagaland, Meghalaya, Tripura, Sikkim and Mizoram. During 2018-19, a total of 315000 MT of rapeseed and mustard was produced in the region with highest production reported from Assam followed by Sub-Himalayan West Bengal, Arunachal Pradesh, Nagaland, Manipur, Meghalaya, Tripura, Sikkim and Mizoram (Table 26). With regard to productivity of rapeseed and mustard is concerned, highest was recorded in Arunachal Pradesh followed by Nagaland, Meghalaya, Sikkim, Manipur, Tripura, Mizoram, Sub-Himalayan West Bengal and Assam.

Table 26. Area and production of rapeseed and mustard in EHR

EHR	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
Area ('000 ha)	397	333	339	380	372	375	382	418	441	434
Production ('000 MT)	243	214	210	254	249	267	281	302	320	316

*Sub-Himalayan West Bengal

https://aps.dac.gov.in/APY/Public_Report1.aspx

The total area under sugarcane in the region was 45720 ha during 2018-19 (Table 27). The highest area under sugarcane was in Assam followed by Manipur, Nagaland, Arunachal Pradesh, Mizoram, Tripura, Sub-Himalayan West Bengal and Meghalaya. During 2018-19, a total of 1749540 MT of sugarcane was produced in the region with highest production reported from Assam followed by Manipur, Nagaland, Arunachal Pradesh, Mizoram, Tripura, Sub-Himalayan West Bengal and Meghalaya (Table 23). With regard to productivity, highest was recorded in Sub-Himalayan West Bengal followed by Tripura, Manipur, Nagaland, Assam, Mizoram, Arunachal Pradesh and Meghalaya.

Table 27. Area and production of sugarcane in EHR

EHR	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
Area ('000 ha)	40.10	43.25	43.40	43.42	39.89	44.98	45.09	46.61	45.81	45.72
Production ('000 MT)	1538.21	1662.32	1765.18	1703.05	1594.57	1824.44	1789.77	1901.47	1836.25	1749.54

*Sub-Himalayan West Bengal

https://aps.dac.gov.in/APY/Public_Report1.aspx

The Jute and mesta are important fiber crops grown in the region. The total area under jute and mesta in the region was 193381 ha during 2018-19 (Table 28). The highest area was in Sub-Himalayan West Bengal, Assam, Meghalaya, Nagaland and Tripura. During 2018-19, a total of 2346 thousand MT of jute and mesta was produced in the region with highest production reported from Sub-Himalayan West Bengal followed by Assam, Meghalaya, Tripura and Nagaland (Table 24). With regard to productivity, highest productivity of jute and mesta was reported in Sub-Himalayan West Bengal followed by Tripura, Assam, Meghalaya and Nagaland. Productivity of crops, coarse cereals, oilseeds, pulses and fibre crops in different states of EHR is shown in Figs 10, 11 and 12.

Table 28. Area and production of jute and Mesta in EHR

EHR	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
Area ('000 ha)	212787	199569	202739	200922	206319	203945	201505	195101	190608	193381
Production ('000 MT)	2447	1953	2221	2157	2240	2433	2317	2258	2321	2346

*Sub-Himalayan West Bengal

https://aps.dac.gov.in/APY/Public_Report1.aspx

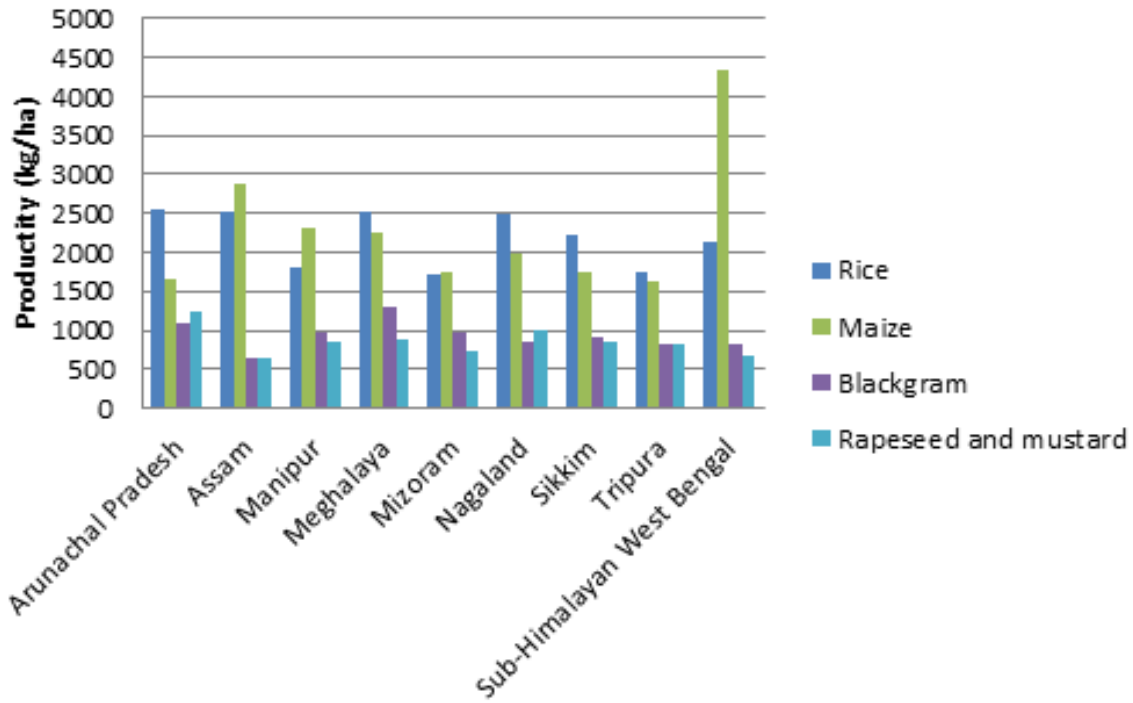

Fig. 10. Productivity of crops in EHR

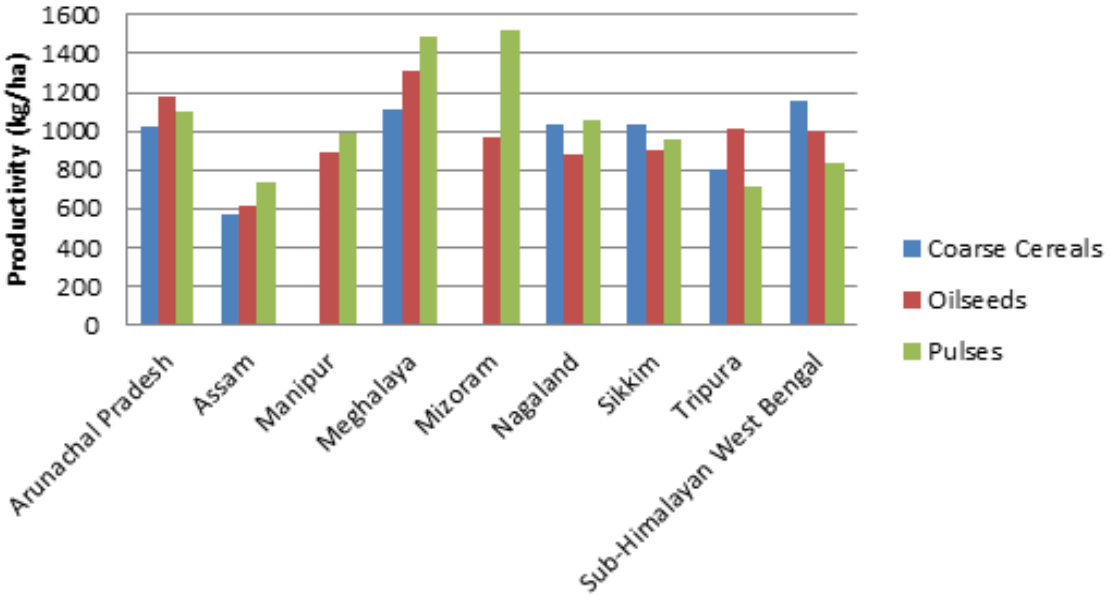

Fig. 11. Productivity of coarse cereals, oilseeds and pulses in EHR

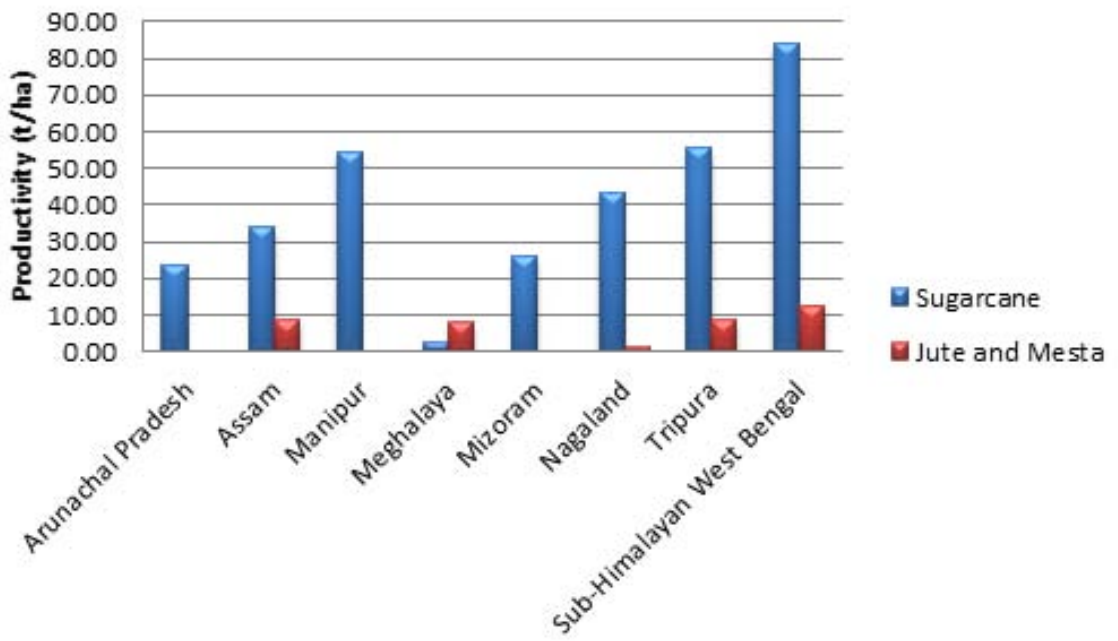

Fig.12. Productivity of fibre crops in EHR

Rainfall and water

Analysis of 78 stations across EHR including Darjeeling and Kalingpong show that there is significantly high variation in rainfall distribution (Table 29). The annual rainfall varies from 962 mm (Dimapur, Nagaland) to 7344 mm (Sohra, Cherrapunji, Meghalaya). The maximum rainfall (85%) is received during South West mansoon during April to September. The average annual rainfall of the region is 2377.70 mm. Once the rain recedes, the region experiences shortage of water for both agricultural and domestic purposes and the period between November to February is critical in terms of water availability.

Table 29. Average Rainfall distribution (in mm) in the EHR

Months	Min	Max	Median	Mean	ET_0
January	1.2	107.0	11.8	28.2	60.8
February	5.8	128.5	23.2	41.1	72.0
March	13.0	176.3	70.3	80.7	109.6
April	51.0	320.9	166.1	169.5	123.7
May	75.8	1090.6	296.0	307.8	129.3
June	130.7	2296.4	351.5	408.7	124.1
July	186.0	2546.0	382.1	448.9	122.2
August	106.8	728.4	328.7	342.3	117.5
September	135.7	868.8	279.7	294.6	106.0
October	86.0	552.8	165.0	178.7	97.1
November	2.8	0.3	32.8	49.1	74.5
December	0.0	107.4	13.1	28.1	60.9
Annual	**962.4**	**7344.6**	**2317.0**	**2377.7**	**1197.7**

The water received through various forms of precipitation drains in to river systems like Bramhaputra, Teesta, Barak etc. The total inland water resources in the region include 43,361 km of rivers and 3.52 lakh ha of water bodies i.e. reservoirs (0.18 lakh ha), tanks and ponds (1.50 lakh ha), beels/oxbow/ lakes/derelict water bodies (1.83 lakh ha) and other than rivers and canals (5.31 lakh ha). The state-wise details of same are furnished in Table 30.

Table 30. Inland water resources

State	Rivers & canals (length in km)	Reservoirs Area (ha)	Area under tanks & ponds (ha)	Beels/Oxbow/ Lakes/ Derelict Water (ha)	Other than rivers & canals (ha)
Arunachal Pradesh	10957	136	29122	3277	56000
Assam	4820	1096	77250	154650	462382
Manipur	14788	2142	11623	24433	0
Meghalaya	4201	718	3465	285	67
Mizoram	1750	8010	5492	-	-
Nagaland	1600	2258	3474	1110	-
Sikkim	1600	850	1466	-	-
Tripura	2976	3049	18530	-	12161
Sub-Himalayan West Bengal (3 districts)	669	-	-	-	-
Total	**43361**	**18259**	**150422**	**183755**	**530610**

Sub-Himalayan West Bengal (Darjeeling including Kalimpong (except Siliguri), Jalpaiguri, Cooch Behar (including Alipurduar)

http://164.100.161.63/sites/default/files/reports_and_publication/statistical_publication/EnviStats/ES1_2021_Comp1.pdf

This region has huge surface and groundwater resources because of high rainfall and presence of vast river system. However, all the water in this region cannot be utilized because of local disadvantage as these sources are highly inaccessible. The information on water resource availability in this region is not adequately documented and as such very little information is available, thus making it difficult to map and properly utilize and to take policy decisions on water resource development. The total surface water potential of the region is 9.65 bm^3. The region, excluding Sikkim, has a total groundwater potential of 33.89 bm^3. All the hilly regions are known to have low groundwater potential and among EHR Sikkim has low groundwater resources.

Land and soil

This region has diverse soil resources and the various soil types include red soils (22.69 m ha), alluvial soils (2.70 m ha), hill soils (0.52 m ha), glacier soils (0.10 m ha), terai soils (0.078 m ha), rock outcrops (0.003 m ha), peat soils (0.002 m ha) and other soil types (0.81 m ha). The state wide distribution of soil types is given Table 31. The landscape in the region is dominated by hilly and sloping terrain i.e. nearly two thirds of total geographical area especially in the states of Arunachal Pradesh, Meghalaya, Sikkim, Nagaland and Mizoram have sloping land with percentage slope ranging between 15-20% thus leading to huge runoff and loss of top soil. Despite huge natural resources in terms of fertile soils, water resources and climate, the region also suffers from varying degree erosion and other infirmities that make land degraded leading to lesser productive use. Among various states, Nagaland (47.05%) has the highest extent of degraded land followed by Manipur (38.29%), Mizoram (34.92%), Meghalaya (28.38%), Arunachal Pradesh (11.74%), Sikkim (10.75%), Tripura (9.80%) and Assam (9.45%).

Table 30. Major soil types in EHR

State	Area ('000 ha)								
	Alluvial soil	Hill soil	Rock outcrops	Peat soil	Red soil	Terai soil	Glacier soil	Other soil	Total
Arunachal Pradesh	251.61	-	-	-	8004.46	-	-	118.23	8374.30
Assam	1204.68	-	-	-	6292.32	-	-	346.80	7843.80
Manipur	318.04	428.44	3.0	-	1432.40	-	-	49.92	2232.70
Meghalaya	167.62	-	-	-	2075.28	-	-	-	2242.90
Mizoram	107.30	-	-	-	1840.44	-	-	160.36	2108.10
Nagaland	-	-	-	-	1604.44	-	-	53.46	1657.90
Sikkim	-	-	-	-	523.16	78.34	101.40	6.70	709.60
Tripura	243.08	90.92	-	2.40	706.69	-	-	5.51	1048.60
Sub-Himalayan West Bengal (3 districts)	416.02	-	-	-	215.61	-	-	77.48	-
Total	2708.35	519.36	3.0	2.4	22694.8	78.34	101.40	818.46	26217.9

Sub-Himalayan West Bengal (Darjeeling including Kalimpong (except Siliguri), Jalpaiguri, Cooch Behar (including Alipurduar)

http://164.100.161.63/sites/default/files/reports_and_publication/statistical_publication/EnviStats/ES1_2021_Comp1.pdf ; https://slusi.dacnet.nic.in/srm/searchsrm.html

Organic farming

Organic farming connotes to a system of agriculture which in principle excludes the use of synthetic inputs viz. fertilizers, pesticides, plant growth substance etc. to the maximum possible extent and advocates system approach in crop production that include incorporation of crop residues, animal based manures, off-farm organic waste, mineral grade rock additives, adoption of system approach to manipulate crop production systems for proper mobilization of resources including nutrient supply and plant protection through biological means. The objective behind the organic farming is developing a unique and self-sustaining production system that promotes over all agro-ecosystem health by excluding the synthetic off-farm inputs.

India is bestowed with vast potential to produce innumerable organic products owing to existence of diverse agro-climatic situations. Realizing the importance of environmental safety and ecosystem health and as a measure of cost minimization, certain Indian states have adopted organic farming as a state tradition and state policy that paved the way for its growth and as on today the organic products could capture 15 to 25 % share in the domestic market besides steady increase in export of organically produced commodities. Today India achieved 8th position in terms of global area under organic farming and 1st position in terms of total number of producers (Source: FIBL & IFOAM Year Book, 2020).

The total area under organic certification process (registered under National Programme for Organic Production) is 4339185 ha (as on 31st March 2021) which include 2657889 ha cultivable area and 1681296 ha for wild harvest collection. Among the states, Sikkim has largest area under organic agriculture.

With regard to export of organic commodities, about 888179.68 MT of organic products were exported with a value proposition of Rs. 70784.9.52 millions (1040.95 million USD) from India during 2020-21. Among various countries, USA stands first in import of organic based products from India followed by European Union, Canada, Great Britain, Korea Republic, Israel, Switzerland, Ecuador, Vietnam, Australia etc. With regard to export value realization processed organic foods, soya meal (57%) stands first among various products followed by oilseeds (9%), cereals and millets (7%), viz. tea and coffee (6%), spices and condiments (5%), medicinal plants(5%), dry fruits (3%), sugar(3%) etc.

Despite practicing low input and indigenous agriculture, EHR is placed poorly among the states with regard to production of organic products in the country except for Sikkim which has achieved remarkable distinction in adopting the entire cultivable land i.e. > 75,000 ha under organic certification. The EHR states have the distinction of indigenous farming practices viz. jhum (present in all NEH states except Sikkim), zoboo (Ngaland), apatani (Arunachal Pradesh) that is organic by default and which highly relies on age old indigenous wisdom as fit for candidates opting for conversion into organic practices with ease. Realizing the immense potential of organic farming in the NEH region, the Ministry of Agriculture and Farmer Welfare has launched a Central Sector Scheme entitled "Mission Organic Value Chain Development for North Eastern Region (MOVCD)" in Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura from the XII Five Year Plan period itself. The main aim is to develop certified organic production in a value chain mode, to link growers directly with consumers and to support the development of a complete value chain by making available seeds, keeping in place certification processess, creating infrastructure for collection, aggregation, processing, marketing and brand of various commodities. These states were selected not only because the land is virgin but because the crops are also grown organically based

on indigenous technical knowledge. The important commodities that originate from EHR includes ginger, turmeric, joha rice (Assam), black rice (Meghalaya), pineapple, Darjeeling tea, khasi mandarine, Arunachal oranges, Sikkim cardamom, Mizo chilli, king chilli, bird eye chilli, manang narang (Meghalaya), Tezpur litchi, kachai lemon (Manipur) etc. Due to concentrated efforts by the then union and state government, organic farming is gaining popularity in the EHR states. State wise area under organic farming is presented in Table 32.

Table 32. State-wise details of area under organic farming (2020-21)

State	Area (ha)		
	Under organic farming	Under conversion	Total
Sikkim	74647.31	1082.34	75729.66
Meghalaya	34816.30	3560.09	38376.39
Assam	6719.27	11751.57	18470.84
Nagaland	7384.96	7405.42	14790.38
Manipur	4419.25	8305.67	12724.92
Arunachal Pradesh	265.37	12848.74	13114.12
Mizoram	40.45	12998.44	13038.89
Tripura	203.56	6317.75	6521.31
Total	**128496.47**	**64270.02**	**192766.51**

The main strengths in this region include the abundant natural resources and rich biodiversity i.e. fauna and flora, existence of 8 mega biodiversity hot spot having indigenous crop germplasm (3000 genera), orchids (1600 species), medicinal plants (9 genera and 119 species), aromatic plants (5 genera), fish germplasm (47 species) gene center for economically important species of rice, citrus, banana, cucumber, brinjal, tea and cotton, rich water resources i.e. rivers (20,050 km) and water bodies (2.08 lakh ha), moderate climate, higher soil organic carbon, apathy of farmer towards usage of external inputs, the shifting cultivated land by default categorized as organic, lower population density, dependence of mid and high altitude farmers on renewable farm resources in crop production, time tested indigenous technical knowledge etc. However, this region is also daunted with various challenges that become the road blocks for growth and development in the region which include no proper documentation on potential areas for organic food production, lack of marketing infrastructure, poor quality of organic commodities both raw and processed commodities, difficulty in aggregation owing to presence of large number of small and marginal farmers and inaccessible hilly terrain, lack of proper road network, lack of refrigerated transport facilities for perishable commodities, lack of processing and postharvest value addition infrastructure etc. However, there exists a big scope for developing this subsector by development location specific package of practices for crops, vegetable, fruits, spices, plantation crops. setting up of location specific Agri-Export Zone (AEZ), policy support for developing logistic, value and supply chain infrastructure for agriculture and allied sectors, creating export potential for niche crops etc.

CHAPTER 3 CHALLENGES

The EHR states have remained backward for centuries together in all the fronts including agriculture. It is being lamented that the legacy of apathy towards enabling development in the region is being debated widely in several socio-economic and political forums from time again and again. In the recent past this region has drawn policy attention for mainstreaming growth and development across all the sectors. Despite coming out with several policies and schemes, the reach of benefits to the end users has remained unsatisfactory as there is lack of understanding of multiplicity of problems and appreciation the perpetuity of constraints. A closer look at the profile of the region and current scenario/status of agriculture, horticulture, livestock and fisheries sector reveals the fact that despite abundant natural resources, diverse agro-ecological and bio-physical resources, the agriculture and allied sectors in the region are at a slow pace of growth whilst the other regions elsewhere in the country are witnessing rapid change in all the sectors including the agriculture and other rural enterprises. It is attributed that sloping and hard terrain and unfavorable climate conditions, apathy of local communities to adopt modern technologies and lack of proper infrastructure hinder the growth and overall development in the region. A brief account of various constraints vis-à-vis impact on various sectors is presented hereunder.

Fragile ecosystem

The land in this region is characterized by hilly and sloping topography that amounts to two thirds of total geographical area. Arunachal Pradesh, Meghalaya, Sikkim, Nagaland and Mizoram have sloping land with percentage slope ranging between 15-20%. In spite of abundant natural resources i.e. fertile soils and water and climatic resources, the region suffers from varying degree erosion and other infirmities that degrades the land leading to lesser productive use. The extent of degraded lands in Nagaland is 47.05% which is highest in the region followed by Manipur, Mizoram, Meghalaya, Arunachal Pradesh, Sikkim, Tripura and Assam. The practice of slash-and-burn agriculture on steep slopes and expansion of agriculture in erosion prone lands results in soil loss as high as 76.60 t ha^{-1} $year^{-1}$. About 42.30 to 59.50 t ha^{-1} $year^{-1}$ of soil is lost from ginger plantation, while it is 21.40 to 37.10 t ha^{-1} $year^{-1}$ and the extent of soil loss in fallow and paddy fields is 69.20 to 88.60 t ha^{-1} $year^{-1}$ during the previous season (Singh et al., 2011). The average sediment load from multi-vegetation hill watershed amounts 22.00 t ha^{-1} $year^{-1}$ which exceeds the maximum permissible limit (6.00 t ha^{-1} $year^{-1}$). It is not the soil alone but also the beneficial plant nutrients that are lost along with sediments and as per a study nitrogen to the extent of 33.00 kg ha^{-1}, phosphorous at 0.30 kg ha^{-1}, potassium at 27.00 kg ha^{-1} and organic carbon at 750.00 kg ha^{-1} are lost annually (Singh, 2010). Thus agriculture is a risky proposition as the crops suffer from severe moisture stress due to low water retention capacity and nutrient stress due to poor fertility results in frequent crop losses. The fragile ecosystem in the region makes the environment to easily succumb to natural and human action and adversely affect the communities. Further, peculiar agro-climatic situation i.e. steep slopes, shallow depth, excess erosion, unpredictable rainfall and short growing seasons makes agriculture as unviable proposition.

Fig. 13. Un-manageable steep slopes

Courtesy:https://www.researchgate.netpublication235945596_Assessing_the_geoindicators_of_land_degradation_in_the_Kashmir_Himalayan_Region_Indiafigureslo=1

Fig. 14. Snow capped human dwelling and cattle sheds in Alpine Zone in Arunachal Pradesh

Climate change

The climate in EHR ranges from tropical at the base of the mountains to permanent ice and snow at the highest elevations. Climatically, the Indian Himalayan Region (IHR) plays an important role in regulating the global weather patterns (Frei et. al., 2012). The climate change phenomenon i.e. extremities of temperature and rainfall events have shown impact on biophysical resources (mountains, rivers and forests, agriculture, animal husbandry) and socio-economic lives of hill communities in the region (Karma *et. al.,* 2010, IPCC 2014). It was reported by Bolch *et. al.,* (2019) that there was a 30% reduction in snowfall due to rise in temperature in the region. Negi *et. al.,* 2012 and Ramesh *et. al.,* 2017 reported that there will be reduced availability of water for drinking and irrigation, frequent incidences of extreme drought and high rainfall events, crash of rainfed production systems, unstable crop yields, and susceptibility of crops to pest, disease and weeds including the invasive species. The hill communities in the region are highly vulnerable to climate change as they have limited livelihood options and higher reliance on rainfed systems therefore they are at risk. Climate change events especially extreme temperature, increased cloud bursts and high rainfall events, increased glacial lake outburst floods and flash floods,

droughts, natural calamities i.e. earth quakes, landslides, drying of perennial water springs, shortening of cropping seasons, agriculture un-sustainability, nutritional insecurity and malnutrition etc. are being observed in EHR states in the recent past leading to changing farming systems and cropping patterns for which the farmers are not well prepared and hence highly vulnerable.

Jhum cultivation

The major constraint for lesser growth in agriculture and horticulture sectors is jhum or shifting cultivation. Jhuming is a type of subsistence cultivation predominant in hilly regions especially in tropical countries where a patch of forest land is cleared off of the vegetation by slash and burn and crops are grown for few years (two or three years). Later the land is abandoned to allow regeneration of natural vegetation and the intervening period is called as fallow whose duration varies depending on the availability of land with the individual household. The period between one slash to next slash is referred as jhum cycle. This system works well if jhum cycle is wider enough to facilitate building of natural vegetation, accumulation of litter etc. However, in case if the jhum cycle is compressed owing to compulsive intensive cultivation would pose a serious threat to fragile hill ecosystem leading to higher erosion, reduced soil fertility and thereby reducing the crops yields. This is being witnessed during recent past especially in EHZ states. The extent of jhum lands as per change analysis based on Temporal Satellite Data between 2008-09 and 2015-16 is presented in Table 33. As per Wastelands Atlas of India - 2019, EHR region contributed 77.52% (3001.904 km^{-2}) of the country's total area under current jhum during 2015-16. There is a decline in current jhum in the region in 2019. Consequently, there was 5.63% increase in the abandoned jhum from 2008-09 to 2015-16. In 2015-16, the area under abandoned jhum was 3764.44 km^{-2} which accounts for 82.27% the total abandoned jhum area in the country.

Table 33. Area under shifting/jhum cultivation

States	Current Jhum (km^{-2})			Abandoned Jhum (km^{-2})		
	2008-09*	2015-16*	2019**	2008-09*	2015-16*	2019**
Arunachal Pradesh	821.67	509.11	133.05	947.5	1204.22	253.54
Assam	82.02	52.6	105.17	83.18	82.09	239.69
Manipur	296.68	499.96	178.63	243.53	298.65	361.34
Meghalaya	281.73	237.87	115.48	275.42	422.68	227.49
Mizoram	602.08	691.55	393.95	1034.28	1011.39	766.35
Nagaland	1414.53	979.33	344.67	903.09	681.21	583.42
Tripura	30.31	30.62	124.01	65.17	64.2	227.71
Sikkim	-	-	-	-	-	-
Sub-Himalayan West Bengal	-	-	-	-	-	-
NEH Total	**3529.02**	**3001.04**	**1394.96**	**3552.17**	**3764.44**	**2659.54**
All India	**4396.85**	**3871.27**	**Not Available**	**4050.8**	**4575.49**	**Not Available**
NEH Share (%)	**80.26**	**77.52**		**87.69**	**82.27**	

*Source: *DoLR and NRSC (2019). Wastelands Atlas of India - 2019 (Change Analysis based on Temporal Satellite Data of 2008-09 and 2015-16). Department of Land Resources, Ministry of Rural Development, Government of India and National Remote Sensing Centre, ISRO, Department of Space, Government of India.*

***Rocky Pebam (2021). Mapping of area under shifting cultivation in North East India. Reflections – Triennial Inhouse Newsletter of North Eastern Space Application Centre, Meghalaya. 14 (3): 10.*

Over the years, the jhum cycle is shortened due to increased demand for food and pressure of population on land, resulting into soil erosion and excessive mining accelerated the deterioration of ecosystem in the jhum lands. With decrease in land holding size in the recent past agriculture alone in jhum land cannot suffice the food and income security of jhumians. According to one study, the contribution of agriculture to income has fallen from 83 to 63 per cent in the eastern Himalaya (Mukerjee *et. al.*, 2018). Despite abundant natural resources, the EHR states did not achieve self-sufficiency in food grain productions. This is mainly due to low input jhum cultivation preventing growth of agriculture and horticulture sectors in the region. The following are the main drawbacks for optimizing the productivity of crops in the jhum lands:

- Shortening the length of Jhum cycle (from >10 years to 4-5 years)
- The shortening of the cropping phase (1 or 2 years) within a jhum cycle and frequent burning of slashed biomass
- Lack of appropriate low-cost soil and water conservation measures
- Lack of location specific soil management technology
- Non-adoption of adequate moisture conservation practice during dry months (*rabi* season)
- Non-adoption of scientific approach or improper combination of crops including horticultural species with livestock and fisheries in the farming systems
- Lack of optimal scientific information on appropriate length of jhum cycle i.e. cropping phase and fallow management with regard to building of soil fertility and continuous income generation during fallow phase
- Poor adoption of improved technologies in Jhum fields due to apathy and ignorance of Jhummias
- Lack of knowledge on suitable crop combination for managing soil fertility
- Lack of proper infrastructure i.e. logistic, supply chain and marketing infrastructure for timely sale and assured price for jhum products

Small land holding size

The operational land holding size of individual household is an important criteria as it decides to take conscious decisions on how and how much and when and where to invest the precious financial resources of the households. The smaller the land holding size, the lesser is the scope for adoption of modern technology especially the farm mechanization, user of improved seeds, fertilizer nutrients and growth promoting substances and it is largely agreed that smaller land holdings are not viable proposition in the present era of agriculture. Small and scattered land holdings are unviable land holdings and are of concern in hill and mountain ecosystems. Population growth couple with breaking of joint family into nuclear families leads to increased number of farming households whilst land available is fixed and therefore leading to unabated land fragmentation causing shrinkage of land holdings per family and manifested further to abandon the farms and migration of farmers leaving the villages behind as ghost villages. The EHR region is no exception and therefore it is attributed that this is the main reason why the growth in this sector is very poor compared to other regions in the country. The average operational land holding in EHR states was 1.70 ha during 2015-16. The maximum average land holding of 5.06 ha was recorded in Nagaland followed by Arunachal Pradesh, Mizoram, Manipur, Sikkim, Assam, Meghalaya, West Bengal and Tripura (Fig.15).

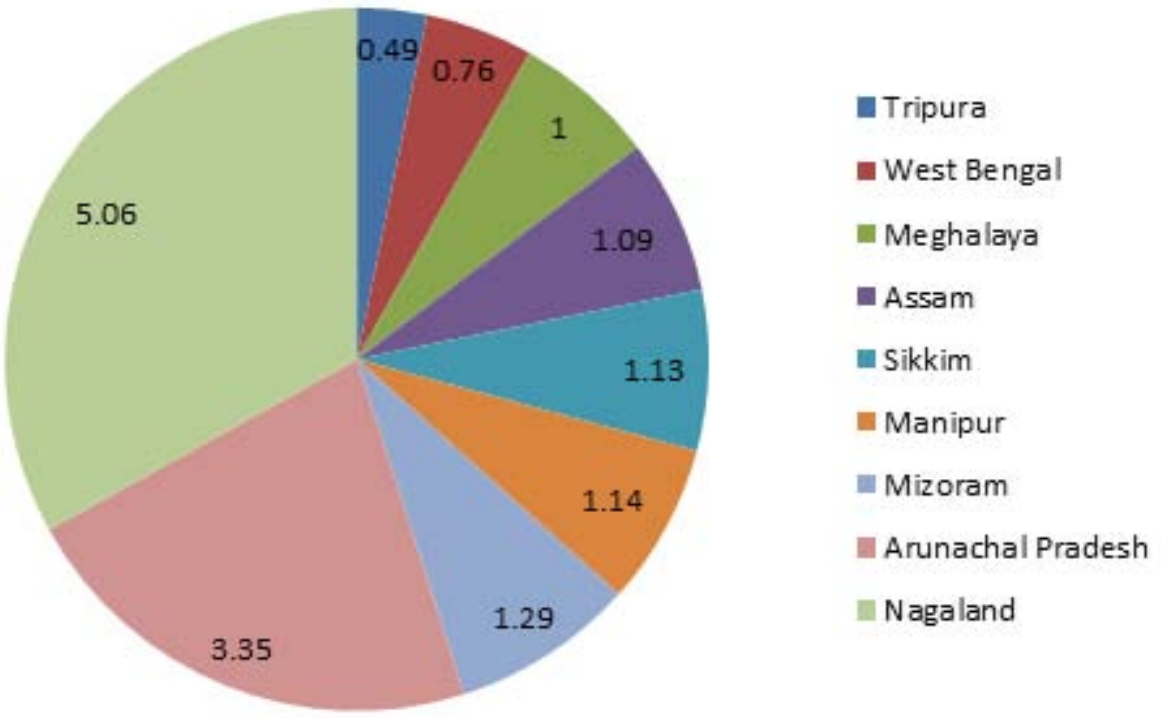

Fig.15. Average operational land holdings (ha) in 2015-16

At present the average land holding size in EHR is highly unviable for food and income security of rural households. Hence a major shift of focus from farming to non-farming professions by the rural households or out migration of families. In view of declining of farm income the educated and younger generation abandoning the non-profit farms and preferring migration to urban areas. This situation results in serious implications to envision a proper policy and strategy for betterment of livelihoods in the EHR for the respective governments.

Gap in base level information

Knowledge is power (Sir Francis Bacon, Meditationes Sacrae 1597) and information is knowledge. As per the standard definition information is processed, organized and structured data and it provides context for data and enables decision making processes. For making policy decisions and enabling prepare plans for respective states, the state administrative machinery largely depend on district level data for all sectors including agriculture, horticulture, animal husbandry, services, manufacturing etc. Whilst the district level data is made available for public domain on worldwide web especially crop production data i.e. area, production and productivity of agricultural crops from 1997-98 until 2020-21, but for horticultural crops, livestock, poultry and fisheries sectors the information is available up to 2016-17 and sometimes even below that. With regard to EHR district level data there are gaps and many gray areas. For example, the data on jhum farming is derived based on satellite imagery and very unsatisfactory ground trouthing. The data collection in EHR is an informidable proposition for the surveyor as he or she has to undergo insurmountable drudgery in reaching the target location as the terrain and climate are highly invincible and one need to prepare for night mares for stay and access to quality food. Further, the road connectivity and public transport are poorly developed that makes the job tougher for data collection at field level. Therefore,

any planning without proper data would end up in debacles.

Poor infrastructure

The EHR communities are highly marginalized with regard to physical infrastructure i.e. roads, transportation system, power supply, communication, supply chain and logistic facilities etc. The state wise allocation of funds for North Eastern Region (NER) states clearly indicate the dismal position of developing road system and a meager of 3.34% of total funds allocated in India during 2017-2018. With regard to railway lines and running track of railways, the situation is very dreadful except Assam as NER states have a meager 4.17 and 3.23% of total routes and total track length of the country (Table 34). A look at the category wise registered motor vehicles in NER states shows that the share of multi-axled/ articulated vehicles/trucks and lorries, light motor vehicles (goods), buses, taxies and light motor vehicles (passenger) is 10.09, 4.15, 3.63, 5.69, and 2.90% which is dismal picture. Except Assam, Nagaland and Meghalaya, the position with regard to number of trucks and lorries is very low which are major means of transport system for bulky goods like farm based commodities. The percentage of light motor vehicles (goods) in NEH region is also very low (meager 4.15%) compared to rest of the country. In view of the poor road system, the goods transportation by light motor vehicles (goods) is the only fair option rather than big transport vehicles. The rail and road and vehicular transport system has pivotal role in overall development of any region as it facilitates quicker and cost effective system of transport of goods especially the bulky and highly perishable agricultural and animal based commodities at affordable prices. The EHR states have distinction of having small land holding size and it is a highly difficulty proposition to aggregate small volume into bigger size marketable quantity especially when there is poor road network and transportation system like that in this region. The majority of agricultural produce is consumed at household level or kept for sale on road side or spoilt during the process. The small quantity left over after keeping aside for home consumption is being carried over the shoulders or heads or hanging behind the back of womenfolk and kept on the roadside for sale or small market places in village. The fate of sale of produce kept on the road side is at the mercy of fortune gods and if the sale happens it is a lucky day and if the sale don't happen or partial produce is sold, it will not be taken back homes, however stored on the roadside itself for tomorrow sale. Hence, the produce don't fetch good price and mostly spoilt and lost in the process.

Fig. 16. The pathetic state of road between Likabali and Along i.e. NH 515

The communication system that include telephone, mobile and internet play a vital role in the economy of the countries. The present day Information and Communication Technology (ICT) has transformed the world as a global village. It plays key role in rural economy as well. It paves the way for easy and quick access to markets and market intelligent in the hand. The telecommunication system in the NER once again a repeat story as that of road, rail and transportation system. A look at the wired telephone networks, number of wired and wireless connection, broad band, internet subscriptions and mobile connections. The situation is very feeble as the per cent share is below four.

The supply power has critical role in growth and development of any regions. The power supply situation is demand and supply figures clearly indicate that the situation is very dismal and there is huge deficit i.e. 10.10% in availability of power (Table 35). Paucity of power is largely agreed as hindrance to development of industries not only agriculture but also in other sectors. This large gap is clearly reflected in poor development of post harvest and processing and industries in secondary agriculture.

Table 34. State-wise Route, Running Track and Total Track of Railway Lines, 2019-20

State	Kilometers		
	Route	Running Track	Total Track
Arunachal Pradesh	12	12	26
Assam	2519	2702	3662
Manipur	13	13	18
Meghalaya	9	9	13
Mizoram	2	2	6
Nagaland	11	11	23
Tripura	265	265	337
NER	**2831**	**3014**	**4085**
All India	**67956**	**99235**	**126366**
Share of NER (%)	**4.17**	**3.04**	**3.23**

https://databank.nedfi.com/content/railways-0

Table. 35. State-wise Power Supply Position in North-East India, 2016-17

State	Energy				Peak			
	Requirement (MU)	Availability (MU)	Surplus (+)/ Deficit (-)		Demand (MW)	Availability (MW)	Surplus (+)/ Deficit (-)	
			(MU)	(%)			(MW)	(%)
Arunachal Pradesh	830	756	-74	-8.9	147	195	48	32.7
Assam	9309	7227	-2082	-22.4	1560	1306	-254	-16.3
Manipur	1008	971	-37	-3.6	184	196	12	6.3
Meghalaya	2215	2065	-150	-6.8	430	482	52	12
Mizoram	533	589	56	10.6	101	123	22	22.1
Nagaland	849	722	-127	-15	140	145	5	3.4
Tripura	1453	2526	1073	73.9	321	391	70	21.8
NER	**16197**	**14858**	**-1339**	**-8.3**	**2801**	**2695**	**-106**	**-3.8**
India	**1214642**	**1227895**	**13252**	**1.1**	**165253**	**169503**	**4250**	**2.6**

https://databank.nedfi.com/content/power-and-energy

Soil infirmities

Soil acidity is foremost important factor that limit the productivity. Higher rainfall and excess leaching of salts due to highly undulating terrain i.e. hilly and mountainous ecosystem, accelerate reduction in soil pH and development of acid soil. The choice of crops in acid soils is very limited and therefore introduction new species is a formidable challenge. A pH value less than 5.5 is more problematic as it limits the availability of major essential plant nutrients i.e. phosphorus, calcium, magnesium and molybdenum. Further reduced pH it poses a threat to crops as it leads to toxicities of aluminium and iron. Hence, it is largely attributed that soil acidity related poor soil resource is one of the major reasons for prevalence of poverty and backwardness in the acid soil regions in NE states. As per one report, about 21 million ha of acid soils are found in NEH region including Sikkim with maximum area under Arunachal Pradesh (6.8 m ha) followed by Assam (4.7 m ha), Meghalaya, (2.24 m ha), Manipur (2.19 m ha) and Mizoram (2.0 m ha) (http://www.kiran.nic.in/pdf/ Extra/acid_soils.pdf). The area covers both arable and non-arable lands. The soils are predominantly acidic in nature in all the states except in Assam where about one-third of soils were non-acidic in nature. A major chunk of area in Arunachal Pradesh (4.8 Mha) falls under the category of strongly acidic soils (pH <4.50). The soils in the region have undulating topography, barren slopes, gravel and coarse textured profile, poor fertility and low moisture retentivity. Further, frequent, intermittent and prolonged dry spells lead to low yield and sometimes total crop failures. Further, increased temperature, decreased rainfall during the winter and spring months makes crop production highly unsustainable.

Poor crop productivity

The average productivity of major crops viz. rice (2193 kg/ha), wheat (1799 kg/ha), maize (2281 kg/ha), rapeseed and mustard (859 kg/ha) and sugarcane (39.87 t/ha) are very low compared to all India average i.e. 2256 kg/ha for rice, 3314 kg/ha for wheat, 2881 kg/ha for maize, 1349 kg/ha for rapeseed and mustard and 76.18 t/ha for sugarcane (Agricultural Statistics at a Glance, 2021, Ministry of Agriculture and Farmers Welfare, Govt. of India). Several studies indicated that the soil moisture stress during post rainy season especially for rabi crops and soil fertility are critical for achieving higher yields.

Even though the average annual rainfall in the region is 2377.70 mm, the wet regime last for few monthly i.e. from April to September, hence the crops suffer from severe moisture stress from post October especially the *rabi* season crops that lead to frequent crop failures. The irrigation facilities in the region are very meager as only 20% of net sown area is under irrigation in this region. Therefore soil moisture not only lead to crop failures but also the productivity of all the *rabi* crops especially the crops grown on hilly and sloping areas where there is little scope storing the runoff water.

As per a study from Assam, it revealed that the soils in EHR are 78% of sampled locations have high organic carbon while 57, 48, 49 and 40% of the locations were low in available nitrogen, phosphorus, potassium and zinc which is very critical for achieving optimum yields (Padua *et. al*. 2018). Even though the soils in the region have either optimal or higher organic carbon, but it will not suffice the current crops requirement as the available nutrient status that decides the productivity. Whilst the soils are very poor in the nutrient status, the farmers in the region are reluctant to use fertilizer nutrients to optimize the crop yields. The average fertilizer nutrient consumption statistics indicate that the average application of total N, P, K fertilizers nutrients is not even half of the all India average consumption per hectare (Table 36).

Among various biotic factors that affect crop yields, the pests i.e. pests, diseases and

weeds take major share of crop loss annually. It was estimated that losses due to pests was 26-29% in soybean, wheat and cotton and 31, 37, 40% for maize, rice and potato whereas weeds were reported to cause crop losses up to 34%. The NER states are no exception in this regard as farmers are reluctant to use pesticides to protect their crops from losses dues various pests, diseases and weeds. The pesticide consumption patter in NER states clearly reveals that the consumption of all forms of chemical pesticides is not even 0.84% of pesticides consumption at all India level (Table 37).

In the absence of curative measures to save the crops from various forms of stress i.e. deficit soil moisture, poor nutrient status and higher incidence of pests and diseases, the productive performance of agriculture and horticulture sectors would continue to be low compared to other states in the country.

Table 36. State-wise Consumption of Fertilizers (N, P & K) in EHR during 2017-18

State	Consumption (kg/ha)			
	N	P	K	Total
Arunachal Pradesh	-	-	-	-
Assam	50.34	16.08	14.45	80.87
Manipur	31.69	13.54	12.81	58.04
Meghalaya	-	-	-	-
Mizoram	36.83	0	0	36.83
Nagaland	16.42	10.94	7.3	34.66
Sikkim	-	-	-	-
Tripura	16.48	5.8	5.95	28.23
Average EHR	**38.28**	**12.33**	**11.16**	**61.77**
All India (Average)	**81.65**	**33**	**13.38**	**128.02**

https://databank.nedfi.com/content/fertilizer-0

Table. 37. State wise consumption of chemical pesticides (technical grade)

States	Quantity (MT)				
	2017-18	2018-19	2019-20	2020-21	2021-22
Arunachal Pradesh	Not reported	5	5	1.95	2.55
Assam	241	256	410	419.5	427.5
Manipur	27	0	25	45.55	Not reported
Meghalaya	Organic state	Organic state	Organic state	Organic state	Organic state
Mizoram	Not reported	26	27	Not reported	22.71
Nagaland	20	21	19	36	40.97
Sikkim	Organic state	Organic state	Organic state	Organic state	Organic state
Tripura	330	349	364	Not reported	Not reported
EHR	**618**	**657**	**850**	**503**	**493.73**
All India	**63406**	**59669**	**61701**	**62192.63**	**58720.12**
Share of EHR(%)	**0.97**	**1.10**	**1.38**	**0.81**	**0.84**

http://ppqs.gov.in/statistical-database

Lack of improved varieties and seed supply

Whilst the soil moisture and fertility crucial in increasing or optimizing the yield, but it is the genetic potential of variety or species that is critical and that has a major role in deciding the yield of crop for that particular agro-ecosystem in that particular region. The EHR is lagging behind the rest of country with regard to cultivation of improved crops varieties. Whist the farmers in the region are reluctant to grow the improved varieties, but the apathy of various agencies including public sector agencies account for the poor adoption and spread of improved cultivars in the region. There are only two agricultural universities that are engaged in developing improved varieties of crops including horticultural species in the region which include the Central Agricultural University (CAU) and the Assam Agricultural University (AAU). As per the web based information, the AAU, Assam has so far developed 55 varieties that include eight each in sugarcane and toria, seven each in rice, green gram and black gram, two each in sesame, lentil and forage species and 20 in vegetable crops. This clearly shows that despite the region represents one of the global biodiversity hotspots and abode of a several distinctive plant and animal species is however lagging behind many states in the country. Further, of the total 68 breeders seed producing farms under national seed project in the country, only one such agency i.e. the AAU, Jorhat is the only farm has the mandate to multiply and supply breeders seeds needs in the region. In fruits around 80 lakhs planting materials per annum is required and in vegetables, the requirement is about 500 tons of seed per annum. Even though, there are 200 government farms and 44 government and private nurseries are there in this region, unknown pedigree, meager funds and lack of trained manpower is daunting the region to exploit the potential of planting and seed production in horticultural crops. A look at the data on state wise seed requirement and supply position in EHR region (https://seednet.gov.in), there is deficit of 21015 quintal of certified seed during rabi 2019-20. As per the information available on web (http://164.100.24.220/loksabhaquestions/ annex/172/AU335.pdf), the Seed Replacement Rate (SRR) in the region has very low i.e. mere 34.33% in rice, 64.55% in peas, 4.5% in jute, 23.49% in rapeseed and mustard and 43.01% in soybean. However, the SRR in case of hybrid maize is 100% followed by maize improved varieties (83.49%) and lentil (81.29%). This clearly demonstrates the dismal picture of penetration rate of improved crop varieties in the region. Hence, there is low productivity of crops and hence the requisite growth in agriculture sector could not be achieved as expected.

Poor marketing infrastructure

In view the economy of the NER is basically agro-based in nature and about 75 per cent of the working population engaged in agricultural sector, developing a strong agri-based marketing system assumes prime importance and is a key for economy in the region. Even though the total food grain production in the region amounts to 44.16 m tons during 2018-19, most of it is being consumed locally and a very limited quantity reaches the market for sale. According to one estimate, only 28% of paddy could reach the regulated market during 1987-88. Paddy is the principal cereal crop grown in the region that occupies more than 60% of the total area under food grains in the region. Maize is the second important crop grown in the region. The area under oilseeds and pulses is very small and the production is also in meager quantities. In case of horticultural crops the total volumes of orange, pineapple, banana, apple, jackfruit, papaya, Assam lemon, potato and ginger is 324, 434, 1205, 11, 453, 160, 230, 1488 and 989 thousand tones only which is very meager, This clearly indicates that a major share of marketable surplus finds its place in the poorly equipped and periodically held local markets in the villages.

The marketing of agri-based commodities in EHR is highly unorganized and underdeveloped and the issues are multifarious and multidimensional. As per a recent study the marketing infrastructure is poorly developed and seldom have storage facilities notably for perishable goods i.e. fruits and vegetables (Dutta S.K. 2021). Major portion of the produce do not flow through the marketing system at all. Participation of farmers in the marketing hardly exists even in the primary agricultural markets at local level. Majority of the transactions involve very small quantity and major traders are private buyers, middleman, petty retailers and moneylenders who are locally known as 'Mahajans'. As the farmers have small volume at their disposal it limits their bargaining power and therefore the trade is biased towards the buyers who would dictate the price. Traders and middlemen have built their own channels for procuring and disposal of various commodities. Backward and forward and linkages is formed by a long chain of middlemen right from the village level itself. The institutional marketing functionaries are rarely found or eliminated at every stage of marketing. Hence, the markets are dominated by the buyers rather than seller i.e. producer. Therefore, the farmers are forced to sell produce at throwaway price i.e. 16-28% depending on the type of commodity and from the area where it comes from. Middlemen at the backward link frequently change their role in market management owing to the fact trading of agricultural commodities is not the primary occupation of more than 75% of them, hence the incidences of disassociating from the marketing chain is quite often especially during the volatile periods i.e. ups and downs of the market that the push farmers into a most awkward situations. In case of some commodities like ginger and areca nut, pre-harvest and credit linked marketing is also in vogue.

Further, in view of continued indebtedness of the farmers who borrow money from money lender or local trader or petty retailer, the farmers have no choice to approach the regulated market but end up with forced sale with money lenders or middlemen or petty retailers. The supply chain infrastructure that includes storage and warehousing, road links, transportation and communication are poorly developed and hence the local sale has the more predominance in the region. Hence, marketing of agricultural commodities in the NER states, is dominated by the private traders. Further it is attributed that poor implementation of market regulation by the respective state agricultural marketing boards is also the main reason for continued existence of local trading largely vest with the 'Mahajans'. Among the eight states in the region, Assam, Meghalaya and Tripura have enacted market regulation act. In Tripura it was enacted and implemented to certain extent that too in case of non-food grain crops i.e. jute and mesta only. In case of Assam, the implementation process is very poor and dead slow due to several litigations leveled by the local traders. Even though the agricultural produce marketing was acted in Meghalaya but it is yet to be implemented and in Manipur enactment of bill is in the process. Apart from this there are other problems associated with the marketing of agricultural commodities and allied products that include organizational, functional and physical infrastructural issues. The organizational aspect mostly related to intervention by state in enacting and implementation of market regulation whilst the functional aspects involve various issues related to lack of proper grading, weighing, pricing, payment etc. This makes the system very complicated and complex to unravel these issues it is beyond the reach of small and marginal farmers.

Lopsided post harvest processing

This region is known for cultivation varied kind of horticultural commodities i.e. fruits (orange, pineapple, banana, jackfruit, papaya and Assam lemon), vegetables

(potato) and spices (ginger), however sizable volumes of production of these commodities is too low to process them at commercial scale even though sizable area is under cultivation. For example, the total volumes of orange, pineapple, banana, apple, jackfruit, papaya, Assam lemon, potato and ginger is mere 324, 434, 1205, 11, 453, 160, 230, 1488 and 989 thousand tones only, Low volumes couple with too many crops doesn't sound well from the commercialization perspective. Further, the marketable surplus available for post harvest processing for pineapple, orange, jackfruit, apple, kiwi, banana, Assam lemon, passion fruit, grapes, cashew nut, ginger, turmeric, potato and vegetables is 124.45, 24.05, 15.50, 0.50, 0.02, 71.45, 10.00, 8.05, 1.10, 3.20, 59.35, 0.28, 12.00 and114.32 thousand tones only which will not suffice for commercial processing.

The hill and mountain topography and steep slopes in the region is a biggest constraint to develop all-weather motorable road systems in the region. Further, the snowfall, landslides and frequent and heavy rains damage the road system and make the job tough for repairs. Further the lack of dedicated transportation facilities both refrigerated and non-refrigerated transport system, limited availability of proper collection centres, lack of cold chain and pre-cooling infrastructure makes it difficult to bring the produce to nearest connecting road and therefore much of the produce is spoilt enroute. Hence, the post-harvest losses are very high and it is estimated that it ranges between 18-32% during transportation and marketing. In case of vegetables the extent of loss is between 30-40% and in case of fruits the incidences of perishing at field before they are harvested is not uncommon. Dr. D.J. Rajkhowa, ICAR NEH, Nagaland Centre pointed out during "Outreach Awareness Programme on Cold-chain" held at Hotel Jafu, Kohima on 21st April, 2022 that agricultural commodities are subjected to post harvest losses up to extent of 45% in NER compared to 30% losses at all India level which is notable. This amounts to loss of more than Rs. 92600 crores in NER alone which is the double the budget allocated for agriculture sector at national level. Whilst only small volumes of the total production is the marketable surplus that is uneconomic proposition for processing, lack of year round supply, feeble power situation, poor road network, lack of proper transport especially the refrigerated transport adds to the problem and hence these commodities could not be processed where they are produced and it is not only cost effective to transport these commodities to somewhere nearest hub i.e. Assam but also the post harvest losses during transport also limit the processing of fruits and other horticultural commodities.

Farm mechanization

Farm mechanization is crucial for agricultural operations as precision and timeliness decides the growth and productivity of crops including the horticultural species. Further, farm mechanization paves the way for modernization and commercialization of agriculture as it facilitates the timeliness of agriculture operations, optimizes resource use, helps in value addition and ward off the labour shortages. In EHZ, the level of mechanization is very low. The reasons being hilly topography, high transportation cost, lack of state policy support to farm machinery and dearth of agricultural machinery suitable for mechanizing the hill agriculture.

As per Final Report on Monitoring, Concurrent Evaluation and Impact Assessment of Sub-mission on Agricultural Mechnization, 2018, the utilization of farm power in NER state is very low (< 1.0 kW/ha) compared to all India average i.e. 2.50 kW/ha. The data on funds allocation and distribution of various machines by the state governments during 2014-17 indicate that the lackluster of support to farm mechanization as the total amount of support on farm machines and custom hiring centres is mere 5 and 4% of total support at all India level.

Therefore agricultural operations in EHR are still traditional in nature and are highly labour intensive and manually performed. Even though the existing tools evolved over the centuries and do well, but they give low output and involves insurmountable drudgery. In view of hard terrain the use of mechanical power is very limited and at least there is need to introduce improved tool and equipment in a selective manner and improve their availability locally. Even though the tractors and power tillers are already in great demand in Manipur and Assam but the situation in other states very brim. The farm power based timeliness of crop operation in EHR region is very critical to increase agricultural productivity and reduce costs and optimize use of inputs i.e. seed, fertilizer, plant protection chemicals, water, etc.

Logistic and supply chain infrastructure

Logistic infrastructure includes industrial parks, warehouses, cold storages etc., while supply chain consists of the assets and systems that drive the network of suppliers, manufacturers and the logistics functions. The logistic infrastructure drives the growth of various sectors and its role is vital the agriculture sector that includes horticulture and animal husbandry sectors as well. The growth in logistic infrastructure would in turn depend on the availability of supply chain infrastructure in a particular region. In EHZ states the status with regard to logistic and supply chain infrastructure was brim until recently. A look at the godowns and cold storage units clearly reveals the growth in this sector is very much skewed as the % of share of godowns is mere 4% while that of cold storage units is below 1% (Table 38). The NER in the last decade has witnessed a radical change with regard to demand for internet connectivity and e-commerce and thanks for big player viz. Amazon and Flipkart. It was reported a spectacular growth in the ecommerce orders from the NER sates and engagement of north-eastern artisans, tea growers and organic cultivators in the ecommerce business. Still there is much need to be done especially with regard to agriculture and allied sectors.

Table 38 & 39. State wise distribution of Cold Storages as on 31.08.2020

State	Number		Cold storage installed capacity (MT)
	Godowns	Cold storage units	
Arunachal Pradesh	13	2	6000
Assam	40	39	178096
Manipur	6	2	4500
Nagaland	6	3	7150
Meghalaya	6	4	8200
Mizoram	6	3	4001
Sikkim	0	2	2100
Tripura	8	14	46354
EHR Total	**85**	**69**	**256401**
All India	**2123**	**8186**	**37425097**
HER Share (%)	**4.00**	**0.84**	**0.69**

https://pib.gov.in/newsite/PrintRelease.aspx?relid=194875

https://pib.gov.in/PressReleasePage.aspx?PRID=1658114

Low productivity of livestock sector

Even though, agriculture is the major source of livelihood for the rural population in EHR, livestock serve as source of household income and nutritional security in the region. The livestock is an important component of mixed farming system in this region due to higher preference for meat by the people. The region is known of highest meat consuming in India because of social and religious acceptance and the most preferred meat is pork followed by beef, chicken etc. Nagaland is ranked top in meat consuming states of India. The consumption of milk and milk products is lower in this region as compared to other states due to varied food habits and less availability of milk. However due to increase in per capita income and changes in life style the demand for milk and milk products is increasing during the last few years. A study on the projection of demand and supply of milk, meat and eggs in NER shows that the demand is more than supply for all the three animal proteins by 2030.The study revealed that deficit to the extent of 696680 tones of milk, 259440 tones of meat and 85200.90 lakh number eggs by 2030.

Off late the livestock sector in this region is facing several issues in the region. As per recent livestock census (2019), even though cattle and pig population increased by 5.03 and 7.35%, there was significant reduction in buffalo population (41.33%) during 2012 to 2019. Similarly there was considerable reduction in goat and sheep population (36.87 and 26.78% respectively) during 2012-19 in the region. However, the population of yak and mithun increased by 61.87 29.94% during 2012-2019 and similar trend was also observed with regard to poultry sector (60.09%). Even though, the total of production of milk, meat and eggs was 1525.23 MT, 253.51 MT and 1175.06 millions of eggs were produced during 2019-20, it is pertinent to note that there was year wise decline in production of milk, meat and eggs during the last decade. Hence, it is an alarming situation for the livestock sector.

The 90% of the cattle population in the region is non-descript local breed that are kept under open grazing system where the herd is kept loose in the open fields, road sides, forest and jungle with or without attendants. In the evening the cattle return the homes and the household's tie them in the thatched cattle shed made of bamboo. Some farmers do not even bother to bring the cattle back to their homes. In this system the cattle is hardly fed with concentrate feed although some few farmers provide agricultural by products, kitchen waste and spoilt vegetables along with salt during the evening hours. High cost, low availability and dominance of commercial animal feeds, limited local production of conventional feed grains, low availability and low affordability of farmers to buy the animal feeds results in improper nutrition of livestock in the region. Therefore, the average milk productivity of local cattle and buffalo is less than half of national average (NSSO, 2003). Some farmers who rear high yielding cross bred cows i.e. Jersey or Holstein Friesian generally practice stall fed system. The commercial dairies are maintained by *Nepali* or *Behari* communities and the animals are provided with concentrate feed, grasses, fodder, tree leaves, paddy straw etc. without following balanced ration. However, the average milk productivity of cross bread cattle in the region is 4.7 liters per day compared to all India average of 6.5 liters per day.

The indigenous non-descript cattle undergo indiscriminate breeding with preference biased towards male progeny. Cattle are kept under open grazing system there no control over breeding that would facilitate higher inbreeding that ultimately result in poor growth and low milk yield. Even though the Artificial Insemination (AI) was introduced in the fifties, the penetration of AI is very poor.

Apart from the low productive indigenous cattle and lack of balanced nutrition, the livestock sector also faces the challenges of higher incidence of cattle diseases of cattle that include mastitis, repeat breeding, anoestrus, milk fever, calf scours, HS, BQ, foot FMD and parasitic infections. Indeterminate agrarian

climate, unpredictable weather, drought, floods, migration of livestock, scarcity of fodders, and unhygienic zoo-sanitary and healthcare practices have collectively resulted in endemicity of diseases ultimately leading to more incidence and prevalence of livestock and poultry diseases throughout the year. The farmers are ignorant about vaccination against diseases like HS, BQ and FMD. This leads to not only animal mortality but also affects the productivity animals. Due to ever increasing human population, more and more grazing lands are being under either human dwelling or industrial use or to farm lands for production of paddy, mustard, maize, peas, flower, fruits, vegetables etc. As a result, hitherto grazing land used for rearing cattle is reduced to great extent that leads to reduce the number of cattle or to abandon them altogether. Local cattle are mainly reared for producing bullocks that are mainly used for draught purpose. Due to recent mechanization of various farm operations especially the ploughing and harvesting, use of draught animals is greatly reduced during the recent past resulting in to major challenge of rearing these male cattle. Disintegration joint families and emergence of nuclear families in the recent years resulted in hardly finding anybody to look after the cattle even in villages. There is an emerging trend of preferring to buy small quantity of milk i.e. half or one liter of milk from the market rather than undergoing all pains to rear low productive ad highly uneconomical local cows. All the above said issues are pushing livestock sector in EHR region into danger zone.

Poor status of fisheries sector

The NE Region represents approximately 33% of total 2,163 freshwater fish species of India. This region has more than 300 species belonging to 133 genera and 38 families. . The region has several potential indigenous fish species which are in good demand and fetches high price. This region is known for higher fish consumption and about 95% of local population in the region consumes fish. The average per capita annual fish consumption in the region is among the highest in the country and the three northeastern states namely Tripura (29.29 kg), Manipur (14.1 kg) and Assam (11.72 kg) are ranked as 1st, 3rd and 5th in fish consumption in the country. However, the local fish production is markedly low despite recent spur in production in the region. With a geographical coverage of about 8% of the country, its contribution to national inland fish production is meager 0.5%. Hence, large quantity of fish is brought into the region not only from the other states of the country but also from neighboring countries including Bangladesh and Myanmar. The current production in the region is 518.5 thousand tonnes and as per one estimate there is an overall annual deficit of about 419.5 thousand tones. In recent years, this region suffers from drastic reduction in abundance of freshwater fishes due to destruction of habitat, unscrupulous fishing methods, river ranching, and overfishing from natural resources. Increasing human population and pollution exerts tremendous pressure on the aquatic environment of the region. Overexploitation of fishes including juvenile and brood fish is the major factor in depletion of fisheries stocks from aquatic resources. Feed and feeding is the key for enhancing the aquaculture productivity and the world wide aquaculture growth is driven by feed based aquaculture. However, it is important to note that natural productivity also plays important nutritional role in fisheries sector. The natural productivity in the region is also low due to prevalence of acidic environment, deficit in soil organic matter, smaller, shallower and seasonal water bodies, shorter photo period and lower temperature regime during winter. In order to augment the productivity, the role of nutritious feed is even more critical. Despite this, application of artificial feed even by the progressive fish farmers is very low. This is primarily due to higher cost of feed and feed ingredients, deficit in self-production of conventional feed grains (corn, wheat, rice, beans, oil cakes etc.) and higher transportation cost owing to long distances transport. Transport of bulk feed ingredients generate amount to the same cost as that of transport of fish except for loss of gainful employment opportunities in fisheries sector.

CHAPTER 4 TECHNOLOGY INVENTORY

Improved technologies play a very critical role in increasing the productivity of crops, horticultural species, animal species and other biological species having economic value to human beings. The improved technology include improved varieties of crops including horticultural species, improved breeds of animal species and other enterprise species and improved production practices viz. proper nutrition, water, pest and disease and weed management practices while it is improved feeds and fodders, fertility management, pest and disease control etc. in case of animal species. Whilst the improved variety or breed decides the genetic potential while the improved management practices facilitate expression of genes and helps in increasing the growth, development and finally the yield. The technologies that have been developed by NARS and private agencies elsewhere in the country and having relevance and potential for usage in the region has been collated and presented as per the ACZ Sub-Zone wise in Table 40 and 41. It is pertinent to mention that improved varieties of 26 agricultural crops, 37 horticultural species and eight animal species are being mapped in Table 40. Similarly improved production technologies that include nutrient management, water management, pest, disease and weed management, cropping intensification, post-harvest technologies, integrated farming systems, jhum cultivation and improved tools and implements for 14 agricultural crops and 29 horticultural, improved production management technologies i.e. feed and nutrition, fertility and breed improvement, disease management, post-harvest technology and improved tools, equipment and diagnostic kits for 8 animal species and improved production technologies for four other enterprises viz. apiculture, lac culture, mushrooms and vermiculture is mapped and presented in Table 41.

Table 40. Agro-Climatic Sub-Zone wise improved varieties and breeds

Enterprise	Crop	Variety/Breed
Alpine Zone		
Crops	Barley	Pusa Losar (BHS 380)
	Cowpea	Kashi Kanchan
	Fodders	Exotic fodder varieties Amba, Sparta, Porto of cocks foot and Brazilia and Goliath of timothy grass and indigenous species Salixbabylonica, salixhumboltiana, salixpurpeurea of salix
	Potato	Kufri Himalini, Kufri Kanchan, Kufri Sailaja, Kufri Sinduri
	Strawberry	Sweet Charlie
Livestock and Fisheries	Pig	HD-K75
	Poultry	Kadaknath, kamrupa, samrat, vanaraja
	Rabbit	German angora
Temperate Sub-Alpine Zone		
Crops	Barley	Pusa Losar (BHS 380)

	Blackgram	IPU-2-43, WBU-108 SARADA, Tripura Maskolai, Pahelo Dal-3
	Cowpea	Kashi Kanchan
	Field pea	TRCP-8, TRCP-9
	Fodder	CSV-21F, J-1006, NSC French
	Greengram	Bidhan-2, pratap, samrat, SGC-16 andSML-668, Tripura Mung-1
	Groundnut	ICGV 91114
	Maize	C-1921, DRMH-1930, HPQM-1, HQPM-1, HQPM-5 , Pusa-VQPM-5, VQPM-9, RCM 1-1, RCM-76, Megha Maize-1, Megha Maize-2, Mizo Mimpui-1, Mizo Popcorn-1, RC Manichujak-1, RC Manichujak-2, Sikkim Sankul, Makka-1, SKMC-2
	Perilla	RC Manithoiding-1, RC Manithoiding-2
	Rajmash	Sikkim Rajmash-1, Tripura selection-1
	Rapeseed and mustard	B-9, Kranti, M-27, Pant Pili Sarson (PPS-1), Pant Sweta , TS-36, TS-38, Tripura Toria
	Rice	Bhalum-3, Bhalum-4, Bhalum-5, CAU R 1 (Tampha Phou), HPR-2612, PALAM BASMATI 01, R C Maniphou-12, RC Maniphou-13, Sikkim Dhan-1, Gomati Dhan, Khowai, Megha SA1, Megha SA2, NICRA Aerobic Dhan 1, RC Maniphou-10, RC Maniphou-11, RC Maniphou-14, RC Maniphou-15, RC Maniphou-16, RC Maniphou-4, RC Maniphou-5, RC Maniphou-6, RC Maniphou-7, Sikkim Dhan-1, TRC 2014-8, Tripura Aus, Tripura Chikan, Tripura Hakuchuk-1, Tripura Hakuchuk-2, Tripura Jala, Tripura Khara-1, Tripura Khara-2, Tripura Nirog, Tripura Sarat
	Sesamum	Tripura Siping, CUMS-17
	Soybean	JS-335, PS-1368, Sikkim Pahelo Bhatmas-1, Umiam Soybean-1
	Bhendi	Arka Anamika, Kashi Lalima
	Bottle gourd	Narendra Rashmi
	Brinjal	Pant Samrat, TRC Singhnath, TRC Bholanath, RC Manikhamen-1
	Broccoli	PUSA Broccoli KTS-1
	Cabbage	NSC-103B, Pusa Mukta
	Capsicum	Arka Harit

	Carrot	Arka Vrishti, Early Nantes
	Cauliflower	Kenzan 60, Moti, Pusa Snowball K-1
	Elephant foot yam	Tripura Yam Batema
	French bean	Zorin Bean
	Garlic	Bhma Purple, Yamuna Safed-8
	Greater yam	Tripua Tha
	Guava	Megha Magenta, Megha Seedless, Megha Supreme, Megha Wonder
	Large Cardamom	Improved Bhatti
	Onion	Arka Pragati, Bhima shakti
	Papaya	Tripura Papita
	Pea	Aman, AP3, Arkel, Azad, Pusa Ageti
	Pinaapple	Tripura Ananas
	Potato	Kufri Bahar, Kifri Hikalani, Kufri Kanchan, Kufri Mohan, Kurfri Sailaja, Kufri Sindhuri
	Pumpkin	Arjuna F-1
	Taro	Megha Taro-1, Megha Taro-2
	Tomato	Megha Tomato-2, Megha Tomato-3, RC Manikahmenashinba-1, RC Manikahmenashinba-2, Arka Abhed, Arka Alok, Arka Rakshak, Arka Samrat, Arka Sandhya
	Turmeric	Megha Turmeric-1
Livestock and Fisheries	Duck	White pekin
	Fish	Tilapia
	Goat	Black Bengal
	Pig	Lumsniang, Hampshire, HD-K75, New Hampshire, Three breed cross Niang Megha x Hampshire x Duroc
	Poultry	Japanese quail, Kadaknath, Kalinga Brown,Kamrupa, Kuroile, Rainbow Rooster, RIR, Samrat, Shrinidhi, Turkey, Vanaraja
	Rabbit	German Angora
	Sheep	Bonpala
Other enterprises	Misc.	Mushroom (Oyster, Shiitake, Button), Apiculture, Food Procesing, etc.
Sub-Tropical Hill Zone		
Crops	Barley	Pusa Losar (BHS 380)
	Blackgram	Kalindi, PU-31, WBU-108 SARADA, Pahelo Dal-3, Tripura Maskolai
	Cowpea	Kashi Kanchan

	Field pea	TRCP-8, TRCP-9
	Fodder	Guinea grass, Hybrid Napier IGFRI3
	Greengram	Samrat, SGC-16, SML-668, Tripura Mung-1
	Groundnut	ICGV-91114
	Jute	JRO-204
	Lentil	KLS-218
	Linseed	T-497
	Maize	C-1921, DRMH-1930, Pusa VQPMS-5, Pusa VQPMS-9, RCM-101, RCM-76, Megha Maize-1, Megha Maize-2, Mizo Mimpui-1, Mizo Popcorn-1, C Manichujak-1, RC Manichujak-2, Sikkim Sankul Makka-1, SKMC-2, RC Manithoiding-1, RC Manithoiding-2
	Perilla	RC Manithoiding-1, RC Manithoiding-2
	Rajmash	Sikkim Rajmash-1, Tripura Selection-1
	Rapeseed and mustard	T-9, NRCHB-101, Pant Pili Sarson (PPS-1), Pant Sweta, Pusa Mustard-28, TS-36, TS-46, TS-67, Tripura Toria
	Rice	Bhalum-3, Bhalum-4, Bhalum-5, CAU R 1 (Tampha Phou), Gitesh, HPR-2612, Maniphou-10, Maniphou-11, Maniphou-12, Maniphou-13, Maniphou-7, PALAM BASMATI 01, RC Maniphou-12, Swarna Sub-1, Gomati Dhan, Khowai, Megha SA1, Megha SA2, NICRA Aerobic Dhan 1, RC Maniphou-10, RC Maniphou-11, RC Maniphou-12, RC Maniphou-13, RC Maniphou-14, RC Maniphou-15, RC Maniphou-16, RC Maniphou-4, RC Maniphou-5, RC Maniphou-6, RC Maniphou-7, Sikkim Dhan 1, TRC 2014-8, Tripura Aus
	Sesamum	CUMS-17, Koliabor Til, Tripura Siping
	Soybean	JS-335, PS-1368, Sikkim Pahelo Bhatmas-1, Umiam Soybean-1
	Sugarcane	Nambor
	Bhendi	Khasi Lalima
	Bottle grourd	Narendra Rashmi
	Brinjal	RC Manikhamen-1, TRC Bholanath, TRC Singhnath
	Cabbage	Chinese Nepa
	Capsicum	Arka Atulya, Arka Harit

	Carrot	Arka Vrishti
	Chilli	Bird eye chilli
	Coconut	Kalpajyothi
	Elephant foot yam	Tripura Yam Batema
	French bean	Zorin Bean
	Garlic	Bhima Purple, Yamuna Safed-8
	Greater yam	Tripua Tha
	Guava	Mega Megenta, Mega Supreme, Mega Wonder, Megha Seedless
	Large Cardamom	Improved Bhatti
	Lemon	Assam Lemon
	Onion	Arka Pragati
	Papaya	Red lady, Tripura Papita
	Pea	Aman, Arkel, Pusa Ageti
	Pinaapple	Tripura Ananas
	Potato	Kufri Himalini, Kufri Kanchan, Kufri Moham, Kufri Sailaja, Kufri Sindhuri
	Pumpkin	Hybrid Arjuna
	Taro	Megha Taro-1, Megha Taro-2
	Tomato	Arka Abhed, Arka Alok, Arka Rakshak, Arka Samrat, Arka Sandhya, Megha Tomato-2, Megha Tomato-3, RC Manikahmenashinba-1, RC, Manikahmenashinba-2
	Turmeric	Megha Turmeric-1
Livestock and Fisheries Other enterprises	Duck	Khaki Campbell
	Fish	Armur Carp, Jayanthi Rohu
	Goat	Black Bengal
	Pig	HD-K75, Lumsniang, New Hampshire, New Yorkshire, Three breed cross (Niang Megha x Hampshire x Duroc)
	Poultry	Japanese Quail, Kadaknath, Kamrupa, Kuroile, Rainbow Rooster, RIR, Samrat, Vanaraja
	Rabbit	German Angora
	Misc.	Mushroom (Milky, Oyster, Paddy straw, Shiitake, Button), Apiculture, Food Procesing, etc.
Sub-Tropical Plain Zone		
Crops	Blackgram	IPU-2-43, PU-31, WBU-108 SARADA, Tripura Maskolai, Pahelo Dal-3
	Field pea	TRCP-8, TRCP-9

	Fodder	Hybrid Napier NB-21 and Co-3
	Greengram	SGC-16, SML-668, Tripura Mung-1
	Jute	JRO-204, Tarun
	Lentil	HUL-57, KLS-218
	Linseed	T-397
	Maize	Bio-9544, HPQM-5, Indam-1202, Megha Maize-1, Megha Maize-2, Mizo Mimpui-1, Mizo Popcorn-1, RC Manichujak-1, RC Manichujak-2, Sikkim Sankul, Makka-1, SKMC-2
	Perilla	RC Manithoiding-1, RC Manithoiding-2
	Rapeseed and mustard	JT-90-1, NRCHB-101, PM-27, TS-29, TS-36, TS-38, TS-46, TS-67, Tripura Toria
	Rice	Bhalum-3, Bhalum-4, Bhalum-5, Gomati Dhan, Khowai, Luit, Arize 6444 Gold, Bahadur Sub-1, CAU R 1 (Tampha Phou), CAUR-4, CR Dhan, Gitesh, Jalashree, Joymati, MTU-1010, Nabin, Naveen, Podumoni, Rajnit Sub-1, RC Maniphou-12, RC Maniphou 13, Shraboni, Swarna Sub-1, TTB-404 (Shravani), Megha SA1, Megha SA2, NICRA Aerobic Dhan 1, RC Maniphou-10, RC Maniphou-11, RC Maniphou-14, RC Maniphou-15, RC Maniphou-16, RC Maniphou-4, RC Maniphou-5, RC Maniphou-6, RC Maniphou-7, Sikkim Dhan 1, TRC 2014-8, Tripura Aus, Tripura Chikan, Tripura Hakuchuk-1, Tripura Hakuchuk-2, Tripura Jala, Tripura Khara-1, Tripura Khara-2, Tripura Nirog, Tripura Sarat
	Sesamum	Tripura Siping
	Soybean	DSB-19, PS-1368, Umiam Soybean-1, Sikkim Pahelo Bhatmas-1
	Sugarcane	Barak
	Wheat	HD-2967
	Banana	Grand Naine, Malbhog
	Bhendi	Arka Anamika
	Black pepper	Penniyur
	Brinjal	RC Manikhamen-1, TRC Singhnath, TRC Bholanath
	Broadean	Pusa Udit
	Broccoli	Green Magic, TSX-0788
	Cabbage	NSC-103B

	Carrot	Rudhira
	Cauliflower	Mothi
	Chilli	Bhut Jolokia
	Coconut	Kamarupa
	Colacasia	Ahina Kachu
	Elephant foot yam	Tripura Yam Batema
	French bean	Zorin Bean
	Ginger	Nadia
	Greater yam	Tripua Tha
	Guava	Megha Magenta, Megha Seedless, Megha Supreme, Megha Wonder
	Large Cardamom	Improved Bhatti
	Merigold	Ceracole,
	Papaya	Red Lady, Sapna, Tripura Papita
	Pea	Arkel, Prakesh
	Pineapple	Tripura Ananas, Kew
	Potato	Aber Chaibi, Kufri Himalini, Kurfri Jyothi, Kurfri Kanchan, Kufri Pokhraj, Kufri Sailaja, Kufri Sindhuri
	Pumpkin	Arjuna F-1
	Strawberry	Sweet Charlie
	Taro	Megha Taro-1, Megha Taro-2
	Tomato	Arka Rakshak, Arka, Samrat, Bioveer, Megha Tomato-2, Megha Tomato-3, RC Manikahmenashinba-1, RC Manikahmenashinba-2
	Turmeric	Lakadang, Megha Turmeric-1
Livestock and Fisheries	Duck	Chara Chembell, Khaki Chambell, Vigova Suprem
	Fish	Armur Carp, Jayanthi Rohu, Tilapia, Ornamental fish
	Goat	Black Bengal
	Pig	Ghungroo, Hampshire, HDK-75, New Hampshire, Rani, Three breed cross Niang Megha x Hampshire x Duroc
	Poultry	Japanese Quail, Kadaknath, Kamarupa, Rainbow Rooster, Samrat, Srinishi, Vanaraja
Other enterprises	Misc.	Mushroom (Milky, Oyster, Paddy straw, Shiitake, Button), Apiculture, Food Procesing, etc.

Mild-Tropical Hill Zone		
Crops	Blackgram	Pahelo Dal-3, Tripura Maskolai, WBU-108 SARADA
	Field pea	TRCP-8, TRCP-9
	Fodder	Anupam, BD-1, BD-2, Guinea grass
	Greengram	Tripura Mung-1
	Jute	JRO-204
	Kesar	Ratan
	Maize	RCM1-76, RC-76, Megha Maize-1, Megha Maize-2, Mizo Mimpui-1, Mizo Popcorn-1, RC Manichujak-1, RC Manichujak-2, Sikkim Sankul, Makka-1, SKMC-2
	Perilla	RC Manithoiding-1, RC Manithoiding-2
	Rapeseed and mustard	Kranti, Tripura Toria
	Redgram	TS3R
	Rice	Bhalum-3, Bhalum-4, Bhalum-5, CAU R 2 (Tomthin Phou), Dishang, Maniphou-10, Maniphou-11, Maniphou-12,, Maniphou-13, Maniphou-7, Rajnit Sub-1, Gomati Dhan, Gomati Dhan, Khowai, Megha SA1, Megha SA2, NICRA Aerobic Dhan 1, RC Maniphou-10, RC Maniphou-11, RC Maniphou-12, RC Maniphou-13, RC Maniphou-1, RC Maniphou-15, RC Maniphou-16, RC Maniphou-4, RC Maniphou-5, RC Maniphou-6, RC Maniphou-7, Sikkim Dhan 1, TRC 2014-8, Tripura Aus, Tripura Chikan, Tripura Hakuchuk-1, Tripura Hakuchuk-2, Tripura Jala, Tripura Khara-1, Tripura Khara-2, , Tripura Nirog, Tripura Sarat
	Sesamum	Tripura Siping
	Soybean	Sikkim Pahelo Bhatmas-1, Umiam Soybean-1, JS-335
	Bottle gourd	Narendra Rashmi
	Brinjal	RC Manikhamen-1, TRC Bholanath, TRC Singhnath
	Broccoli	Green Magic
	Cabbage	Chinese Napa, Green Hero
	Chilli	Arka Meghna, Bird Eye Chilli, Kahsi Anmol

	Cowpea	Kashi Kanchan
	Elephant foot yam	Tripura Yam Batema
	French bean	Zorin Bean
	Greater yam	Tripua Tha
	Guava	Megha Megenta, Megha Supreme, Megha Wonder, Megha Seedless
	Large Cardamom	Improved Bhatti
	Lemon	Assam Lemon
	Marigold	Pusa Narangi
	Papaya	Red lady, Tripura Papita
	Pea	Arka Priya, Arkel
	Pineapple	Tripura Ananas
	Taro	Megha Taro-1, Megha Taro-2
	Tomato	Arka Abhed, Arka Rakshak, Arka Samrat, Pusa Rakshak
	Turmeric	Megha Turmeric-1
	Water-melon	Pusa Bedana
Livestock and Fisheries	Duck	Khaki Campbell, White Pekin
	Fish	Amur Carp, Giant Fresh Water Prawn
	Pig	Lumsniang, New Hampshire, New Yorkshire, Three breed cross Niang Megha x Hampshire x Duroc for lean meat production in pig
	Poultry	Dahlem Red X Tripura Black, RIR, Samrat, Srinidhi, Vanaraja
Other Enterprises	Misc.	Mushroom (Milky, Oyster, Paddy straw, Shiitake), Apiculture, Food Procesing, etc.
Mild-Tropical Plain Zone		
Crops	Banana	Mulbhog
	Ber	Apple Ber
	Blackgram	Kalindi, PU-31, Tripura Moskolai, Pahelo Dal-3, Tripura Maskolai
	Chilli	Arka Lohit
	Coconut	Kalpajyothi
	Field pea	TRCP-8, TRCP-9
	Fodder	BD-1, BD-2, CSH-24MF, Hybrid Napier IGFRI3
	Greengram	Tripura Mung-1
	Kesar	Ratan
	Lentil	KLS-218, PL-406

	Maize	Megha Maize-1, Megha Maize-2, Mizo Mimpui-1, Mizo Popcorn-1, PAC-751 ELITE, RC Manichujak-1, RC Manichujak-2, Sikkim Sankul, Makka-1, SKMC-2
	Marigold	Pusa Narangi, Pusa Narangi Gainda, Seracole
	Oat	Kent
	Papaya	Red lady, Tripura Papita
	Pea	Aman, Arkel, Rachna
	Perilla	RC Manithoiding-1, RC Manithoiding-2
	Pumpkin	Arjun F-1, Araka Suryamukh, Leela
	Rapeseed and mustard	NRCHB-101, Tripura Toria, TS-36, TS-38, TS-67, Tripura Toria
	Rice	Bhalum-3, Bhalum-4, Bhalum-5, Dishang, Gitesh, Kanaklata, KDML-105 (Padumoni), Khara Dhan-1, Khara Dhan-2, Luit, Ranjit Sub-1, Shraboni, Swarna Sub-1, Gomati Dhan, Khowai, Megha SA1, Megha SA2, NICRA Aerobic Dhan 1, RC Maniphou-10, RC Maniphou-11, RC Maniphou-12, RC Maniphou-13, RC Maniphou-14, RC Maniphou-15, RC Maniphou-16, RC Maniphou-4, RC Maniphou-5, RC Maniphou-6, RC Maniphou-7, Sikkim Dhan 1, TRC 2014-8, Tripura Aus, Tripura Chikan, Tripura Hakuchuk-1, Tripura Hakuchuk-2, Tripura Jala, Tripura Khara-1, Tripura Khara-2, Tripura Nirog, Tripura Sarat
	Sesamum	Bohuwa Bheti, Tripura Siping
	Soybean	Sikkim Pahelo Bhatmas-1, Umiam Soybean-1
	Tomato	Arka Rakshak, Pusa Rakshak
	Tube rose	Calcutta Double
	Watemelon	Pusa Bedana
	Brinjal	RC Manikhamen-1, TRC Bholanath, TRC Singhnath, Arka Keshav
	Elephant foot yam	Tripura Yam Batema
	French bean	Zorin Bean
	Greater yam	Tripua Tha
	Guava	Megha Magenta, Megha Seedless, Megha Supreme, Megha Wonder
	Pineapple	Tripura Ananas

	Taro	Megha Taro-1, Megha Taro-2
	Tomato	Megha Tomato-2, Megha Tomato-3, RC Manikahmenashinba-1, RC Manikahmenashinba-2
	Turmeric	Megha Turmeric-1
Livestock and Fisheries	Duck	Khaki Campbell, Vigova Super
	Fish	Amur Carp, Giant Fresh Water Prawn, Jayanthi Rohu, Tilapia
	Goat	Black Bengal
	Pig	Lumsniang, New Yorkshire, Three breed cross Niang Megha x Hampshire x Duroc for lean meat production in pig
	Poultry	Colour Broiler, Dahlem Red X Tripura Black, Japanese Quail, Kamrupa, Kuroiler, Turkey, Vanaraja
Other Enterprises	Misc.	Mushroom (Milky, Oyster, Paddy straw), Apiculture, Food Procesing, etc.

Table 41. ACZ Sub-Zone wise improved technologies

Zone name	Enterprise sub-cat.: Technology
Alpine Zone	Improved technology for agricultural crops • Improved production practices for finger millet • Improved production practices for quinoa
	Improved technology for horticultural crops • Improved production technology for strawberry
	Improved technology for animal species • A novel polymerase spiral reaction (PSR) assay for rapid and visual detection of *Staphylococcus aureus* in meat • A novel and rapid polymerase spiral reaction assay to detect Salmonella in pork and pork products • A novel in-situ methodology for visual detection of Clostridium perfringens in pork harnessing saltatory rolling circle amplification • A Novel Isolation Method For Classical Swine Fever Virus (Csfv) In Rabbit Kidney 13 (Rk-13) Cell Line With Potential Use As A Diagnostic Reagent And Vaccine • A novel polymerase spiral reaction (PSR) assay for rapid and visual detection of Clostridium perfringens in meat • A novel visual detection technique for Campylobacter jejuni in chicken meat and caecum using polymerase spiral reaction (PSR) with pre-added dye • Coarse roughages of local dry grass, paddy straw, maize silage, finger millet straw for yak • Complete feed blocks with non-conventional material (maize stover and molasses) for yak • Exotic fodder varieties Amba, Sparta, Porto of cocks foot and Brazilia and Goliath of timothy grass for yak

	• In-House Indirect Elisa For Detection Of Csfv Antibodies In Serum And Plasma From Pigs Using Rk 13 Adapted Cell Cultured Viral Antigen • Isothermal Rna Amplification Method And Detection Of Classical Swine Fever Virus • Mineral mixtures for yak • Salixbabylonica, salixhumboltiana, salixpurpeurea of salix for yak • Urea treated finger millet straw for yak
	Tools, implements and diagnostic kits • RC seed bin - A low cost medium term seed storage technology for small and marginal farmers of NEHR • Preparation method for coagulated milk (Paneer) sausage
Temperate Sub-Alpine Zone	**Natural resource management** • Improving productivity of maize based system through agronomic management practices in Jhum Land • Integrated farming system model with crops/horticulture/forestry species with fish, pig, poultry, dairy, goat • Multiple use of pond water for crop/horticulture/forestry cum pig/fish/poultry/duck farming • Natural farming • Organic production technology of various agri-horticultural crops for NEHR of India • Integrated farming system model of crops/horticulture/forestry species with dairy, goat, fish, pig, poultry etc. • Rice Fish Farming Under Mid Hill Condition • Organic cultivation of ginger and mandarin • Organic production package for kiwi fruit under high altitude areas in Manipur • Organic production package for pineapple under hill slopes Manipur **Improved technology for agricultural crops** • Biochar As A Potential Liming Material and Moisture Conserving Material For Enhancing Yield Of Winter Crops In Rice And Maize Fallow • Biological control of maize pests • Improved production technology for buckwheat, finger millet, maize, quinoa, rice, sugarcane, rapeseed and mustard, sesamum, soybean, blackram, greengram, rajmash • improving soil health through conservation tillage for maize-rapeseed and mustard system • Innovative resource conservation approaches for sustaining the productivity of rice-rice system • IPM and IDM in rapeseed and mustard and soybean • IPM and IDM in rice • Land use model for sloping land for soil and water conservation towards climate resiliance • Light Weight Power Paddy Thresher Cum Cleaner • Maize intercropping with rajmash • Maize sheller • Management of fall army worm

	• No till system for maize fallow french bean • Package of practices for mitigating abiotic stress in lentil in rice fallow uplands • Perennial forage crops and use of organic amendments to rehabilitate degraded lands in NEHR • Rain water harvesting through Jalkund • Raised bed and sunken beds for cultivation of vegetables and rice-pulse system • Roof water harvesting for homestead vegetable production • Rotary crop planter • Seed weed sap application as an organic bio-stimulant for improving productivity and quality of crops in NEHR India • Seeder cum planter • Sowing Attachment For Light Weight Power Tiller • Technology for double cropping of rice in mid altitudes of NEHR • Yellow sticky traps in rice • Zero tillage in maize • Zn and Bo application in rice
	Improved technology for horticultural crops • Biological control of pests and diseases in ginger • Blight management in large cardamom • Control of diamond back moth in cabbage • Disease management in chillies • Fruit harvester in apple • Gerbera cultivation open field conditions in the mid hills of Meghalaya • High sensitive and robust diagnostic kits for detection of potyvirus associated with yellow mottle and fruit deformation disease of passion fruit • Improved production technology for alstomeria, gladiolus, marigold, apple, dragon fruit, fig, kiwi, mandarin, orange, pineapple, strawberry, tea, black pepper, large cardamom, broccoli, capsicum, cauliflower, cherry pepper, chilli, pea and potato • Integrated nutrient management in marigold, mandarin, orange, ginger, cauliflower • IPM and IDM in lemon, orange, ginger, large cardamom and potato • Late blight management in tomato • Leafy vegetable production in poly tunnels • Low cost plastic shelters for high value organic vegetable production in NEHR • Low cost plastic tunnels for year round intensive organic vegetable production in NEHR • Management o f fruit fly in orange • Management of bacterial wilt in tomato • Management of rhizome rot and soft rot in ginger • Manually Operated Turmeric/ Ginger Slicer • Novel diagnostic kits for detection of viral complex in chilli • Organic mulching in pea • Partial protection of kiwi fruit for organic production in NEHR

	• Production of chillies in polyhouse • Red ants management in potato • Rhizome treatment in ginger • Seed potato production • Single bud transplantation in ginger and turmeric • Vegetable production in poly houses
	Improved technology for animal species • µthimin (class 5), mineral Mixture • A novel polymerase spiral reaction (PSR) assay for rapid and visual detection of Staphylococcus aureus in meat • A novel and rapid polymerase spiral reaction assay to detect Salmonella in pork and pork products • A novel in-situ methodology for visual detection of Clostridium perfringens in pork harnessing saltatory rolling circle amplification • A Novel Isolation Method For Classical Swine Fever Virus (Csfv) In Rabbit Kidney 13 (Rk-13) Cell Line With Potential Use As A Diagnostic Reagent And Vaccine • A novel polymerase spiral reaction (PSR) assay for rapid and visual detection of Clostridium perfringens in meat • A Novel Polymerase Spiral Reaction-Based Testing Technique For Same-Day Visual Detection Of Campylobacter Coli In Pork • A Novel Saltatory Rolling Circle Amplification Assay For Rapid And Visual Detection Of Campylobacter Jejuni In Chicken Meat • A novel visual detection technique for Campylobacter jejuni in chicken meat and caecum using polymerase spiral reaction (PSR) with pre-added dye • An improved low cost portable dummy sow assembly unit with mating grunt voice system • Area specific mineral mixtures for dairy animals • Area-Specific mineral mixture for mithun • Automatic Solar-Operated Mini Egg Incubator • Azolla as poultry feed • Backyard poultry • Balanced feed in dairy animals • Balanced nutrition in pig • Desi magur production in cement tanks • De-worming in mithun, dairy and goat • Disease management in goat • Estrus synchronization • Feed blocks: preparation of low-cost nutritious feed blocks for mithun • Improved production and management of dairy cattle, fisheries, duck, poultry, mithun, pig, goat and sheep • In-House Indirect Elisa For Detection Of Csfv Antibodies In Serum And Plasma From Pigs Using Rk 13 Adapted Cell Cultured Viral Antigen • Isothermal Rna Amplification Method And Detection Of Classical Swine Fever Virus • Low cost high Nutritious feed block for mithun • Low-cost climate resilient environment-affinitive pigpen model

	• Pelleted fish feed • Pig waste water recycling model • Semi-intensive mithun farming • Simple Protocol For Seed Production Of Improved Variety Of Common Carp (Cyprinus Carpio) – Amur Variety (Hungarian Strain) And Pengba (Ostebrama Belangeri)- An Endangered Endemic Fish Species Of Northeast India • Standardization of cryopreservation protocol for mithun embryos • Standardization of embryo transfer protocol in mithun • Standardization of semen preservation and artificial insemination in Mithun • Urea treated paddy straw for dairy and goat • Utilization Of Jalkund (Water Harvesting Pond) For Fish Seed Raising • Standardization of boar semen collection and processing techniques • Popularization of Artificial Insemination technology in pig • Standardization of Good Management Practices of scientific pig production • Formulation of feed for different stages of pigs by using conventional and unconventional feed resources • Ration for modification of body fat composition in pigs • Standardization of package of practices for swine health care • Development of health calendar for pig • Designing of model retail pork shop and portable insulated container for packaged meat • Standardization of technologies for value addition of pork
	Tools, implements and diagnostic kits • RC seed bin - A low cost medium term seed storage technology for small and marginal farmers of NEHR • Zero Energy Cool Chamber • µeef (class 29), Meat of mithun • µLEDER, (class 18) Leather product: jacket, shoes, wallet, handbags, suitcase, belt, and key ring • µlk (class 29), Lassi, barfi, rasgulla, paneer • µyum (class 29), Meat patties, smoke meat, meat sauces, meat block, seasoned dried mithun meat • A method for bio-preservation of mithun hides • A method for processing rabbit pelts and fur • A method of processing rabbit fur on leather • A method of removal of chromium from chrome liquor obtained after processing of mithun hides • A novel method of chrome tannage of mithun hides with Glyoxalic Acid • A process of making leather without any large machinery • An energy-efficient post tanning process for mithun hides • An improved method for chrome Tanning mithun hides • Functional pork and chicken products incorporated with blood fruit, chameleon leaves and perilla seeds • Logo of mithun head (class 5, 18, 29) • Preparation method for coagulated milk (Paneer) sausage • Ready to eat retorted pork curry with bamboo shoot

	• Development of value products from horticultural crops of NEHR • Improving food value and storability of tomato, pineapple and banana through application of exogenous melatonin
	Other enterprises management practices • A location specific modified Zero Energy Poly Tunnel Technology of compost preparation and cultivation of button mushrooms • Enriched compost production technology from farm wastes • Feeding bees with sugar solution during lean periods • Improved management in apiculture • Low cost mushroom production • Low cost oyster mushroom production • Low cost vermin composting in bamboo shed or poly bags or HDPE pipes
Sub-Tropical Hill Zone	**Natural resource management** • Improving productivity of maize based system through agronomic management practices in Jhum Land • Integrated farming system of crop and or horticulture crops with pig, fish, poultry, dairy, goat etc. • Multiple use of pond water for crop/horticulture/forestry cum pig/fish/poultry/duck farming • Organic cultivation of mustard and greengram • Organic production technology of various agri-horticultural crops for NEHR of India • Fish in jalkund • Integrated farming with fish, pig or duck • Rice Fish Farming Under Mid Hill Condition • Organic production package for ginger for hilly areas Manipur • Organic production of mandarin, large cardamom, king chilly and ginger • Organic production package for kiwi fruit under high altitude areas in Manipur • Organic production package for passion fruit based system under foot hill condition of Manipur • Organic production package for pineapple under hill slopes Manipur • Organic production package of turmeric for agro-climatic condition of Manipur
	Improved technology for agricultural crops • Biochar As A Potential Liming Material and Moisture Conserving Material For Enhancing Yield Of Winter Crops In Rice And Maize Fallow • Fall army worm management in maize • Improved production technology in buckwheat, finger millet, maize, quinoa, millets, rice, wheat, sugarcane, jute, groundnut, mustard, soybean, blackgram, greengram, lentil and rajmash • improving soil health through conservation tillage for maize-rapeseed and mustard system • Innovative resource conservation approaches for sustaining the productivity of rice-rice system • Integrated nutrient management in rice, mustard and cowpea

	• Integrated pest and disease management in rice, jute, lentil, mustard, redgram and fodder crops • Intercropping of maize with soybean or rajamash • Land use model for sloping land for soil and water conservation towards climate resilience • Light Weight Power Paddy Thresher Cum Cleaner • Line sowing in fodder crops • Maize sheller, multi-crop thresher, paddy drum seeder, rice transplanter, rotary planter • Modified system of rice intensification • No till system for maize fallow french bean • Package of practices for mitigating abiotic stress in lentil in rice fallow uplands • Perennial forage crops and use of organic amendments to rehabilitate degraded lands in NEHR • Raised bed and sunken beds for cultivation of vegetables and rice-pulse system • Roof water harvesting for homestead vegetable production • Seed production in wheat • Seed weed sap application as an organic bio-stimulant for improving productivity and quality of crops in NEHR India • Sowing Attachment For Light Weight Power Tiller • Stemphylum blight control in lentil • Sustainable and environmentally clean/safer cropping systems for rainfed rice fallow lands of Tripura • Technology for double cropping of rice in mid altitudes of NEHR • Water harvesting using Jalkund • Weed management in rice • Zero tillage in maize • Zn and Bo application in rice
	Improved technology for horticultural crops • Apple fruit harvester • Bacterial wilt management in tomato • Double row planting in pineapple • Drip irrigation in tomato • Ecological engineering based integrated viral disease management module for King Chilli • Fruit borer management in tomato • Fruit fly management in mandarin and pumpkin • Gerbera cultivation open field conditions in the mid hills of Meghalaya • Grape based organic intercropping model under naturally ventilated polyhouse for Manipur condition • Hedge row planting in pineapple • High sensitive and robust diagnostic kits for detection of potyvirus associated with yellow mottle and fruit deformation disease of passion fruit

	• Improved production technology for alstomeria, gladiolus, marigold, apple, banana, dragon fruit, fig, mandarin, strawberry, coconut, tea, broccoli, cabbage, capsicum, cucumber cucurbits, pea, potato and tomato • Integrated nutrient management in marigold, mandarin, water melon and ginger • IPM and IDM in large cardamom • Leaf miner management in tomato • Low cost plastic shelters for high value organic vegetable production in NEHR • Low cost plastic tunnels for year round intensive organic vegetable production in NEHR • Management of diamond back moth in cabbage • Manually Operated Turmeric/ Ginger Slicer • Novel diagnostic kits for detection of viral complex in chilli • Novel isothermal recombines polymerase amplification assay for detection of citrus tristiza virus and Candidatus liberibacter asiaticus - associated with hunglongbing disease of citrus • Nursery management in tomato • Partial protection of kiwi fruit for organic production in NEHR • Pest and disease management in king chilli, pea • Poly house and or poly tunnels for production of vegetables especially chilly, tomato, leafy vegetables • Polythene mulching in watermelon and pea • Red ants management in potato • Rejuvenation of old mandarin gardens • Rhizome rot and soft rot management in ginger • Rice fallow cultivation of pea • Seed potato production • Single bud transplantation in tuberose
	Improved technology for animal species • µthimin (class 5), mineral Mixture • A novel polymerase spiral reaction (PSR) assay for rapid and visual detection of Staphylococcus aureus in meat • A novel and rapid polymerase spiral reaction assay to detect Salmonella in pork and pork products • A novel in-situ methodology for visual detection of Clostridium perfringens in pork harnessing saltatory rolling circle amplification • A Novel Isolation Method For Classical Swine Fever Virus (Csfv) In Rabbit Kidney 13 (Rk-13) Cell Line With Potential Use As A Diagnostic Reagent And Vaccine • A novel polymerase spiral reaction (PSR) assay for rapid and visual detection of Clostridium perfringens in meat • A Novel Polymerase Spiral Reaction-Based Testing Technique For Same-Day Visual Detection Of Campylobacter Coli In Pork • A Novel Saltatory Rolling Circle Amplification Assay For Rapid And Visual Detection Of Campylobacter Jejuni In Chicken Meat

	• A novel visual detection technique for Campylobacter jejuni in chicken meat and caecum using polymerase spiral reaction (PSR) with pre-added dye • An improved low cost portable dummy sow assembly unit with mating grunt voice system • Area specific mineral mixtures in dairy animals • Area-Specific mineral mixture for mithun • Automatic Solar-Operated Mini Egg Incubator • Azolla as poultry feed • Backyard poultry • Backyard rabbbitry • Balanced feed in milch cattle • Composite fish culture • Deep litter management in pigs • Desi magur production in cement tanks • Deworming in milch cattle, pig and goat • Disease management in poultry • Estrus synchronization • Feed blocks: preparation of low-cost nutritious feed blocks for mithun • Feeding of pig with house hold waste • Improved production and management of milch cattle, goat, sheep, pig, poultry, duck, fisheries • In-House Indirect Elisa For Detection Of Csfv Antibodies In Serum And Plasma From Pigs Using Rk 13 Adapted Cell Cultured Viral Antigen • Isothermal Rna Amplification Method And Detection Of Classical Swine Fever Virus • Low cost high Nutritious feed block for mithun • Low-cost climate resilient environment-affinitive pigpen model • Pelleted feed in fisheries • Pig waste water recycling model • Semi-intensive mithun farming • Simple Protocol For Seed Production Of Improved Variety Of Common Carp (Cyprinus Carpio) – Amur Variety (Hungarian Strain) And Pengba (Ostebrama Belangeri)- An Endangered Endemic Fish Species Of Northeast India • Stall feeding in goat • Standardization of cryopreservation protocol for mithun embryos • Standardization of embryo transfer protocol in mithun • Standardization of semen preservation and artificial insemination in Mithun • Urea treated paddy straw in milch cattle and goat • Utilization Of Jalkund (Water Harvesting Pond) For Fish Seed Raising • Standardization of boar semen collection and processing techniques • Popularization of Artificial Insemination technology in pig • Standardization of Good Management Practices of scientific pig production • Formulation of feed for different stages of pigs by using conventional and unconventional feed resources • Ration for modification of body fat composition in pigs • Standardization of package of practices for swine health care

	• Development of health calendar for pig • Designing of model retail pork shop and portable insulated container for packaged meat • Standardization of technologies for value addition of pork
	Tools, implements and diagnostic kits • Hermitic storage of food grains • Low cost oil expeller • Production Technology Of Beehive Charcoal Briquette From Waste Biomass For Cooking And Space Heating In Rural Areas • RC seed bin - A low cost medium term seed storage technology for small and marginal farmers of NEHR • Zero Energy Cool Chamber • µeef (class 29), Meat of mithun • µLEDER, (class 18) Leather product: jacket, shoes, wallet, handbags, suitcase, belt, and key ring • µlk (class 29), Lassi, barfi, rasgulla, paneer • µyum (class 29), Meat patties, smoke meat, meat sauces, meat block, seasoned dried mithun meat • A method for bio-preservation of mithun hides • A method for processing rabbit pelts and fur • A method of processing rabbit fur on leather • A method of removal of chromium from chrome liquor obtained after processing of mithun hides • A novel method of chrome tannage of mithun hides with Glyoxalic Acid • A process of making leather without any large machinery • An energy-efficient post tanning process for mithun hides • An improved method for chrome Tanning mithun hides • Functional pork and chicken products incorporated with blood fruit, chameleon leaves and perilla seeds • Innovative value addition to pig bristles • Logo of mithun head (class 5, 18, 29) • Preparation method for coagulated milk (Paneer) sausage • Ready to eat retorated pork curry with bamboo shoot • Wealth from waste: Bioconverstion of chicken feather waste into agriculturally important product using native bacterium • Development of value products from horticultural crops of NEHR • Improving food value and storability of tomato, pineapple and banana through application of exogenous melatonin • Microcontroller Based Solar Tunnel Drier Suitable For Heavy Rainfall Region Of Northeast India • Motorized Cutter For Trimming Cinnamon Quills
	Other enterprises management practices • A location specific modified Zero Energy Poly Tunnel Technology of compost preparation and cultivation of button mushrooms • Enriched compost production technology from farm wastes • Improved management of apiculture • Improved technology for lac culture

	• Low cost mushroom production • Low cost vermicomposting including production in poly bags or HDPE pipes
Sub-Tropical Plain Zone	**Natural resource management** • IFS of rice cum fish culture • Improving productivity of maize based system through agronomic management practices in Jhum Land • Integrated farming system model with crop/horticulture/forestry species with fish, duck, poultry, pig, dairy, goat, sheep etc. • Multiple use of pond water for crop/horticulture/forestry cum pig/fish/poultry/duck farming • Natural farming • Organic production technology of various agri-horticultural crops for NEHR of India • Integrated farming system model with agriculture/horticulture/forestry species with dairy, sheep or goat, pig, fish, duck and poultry • Rice Fish Farming Under Mid Hill Condition • Organic production package for ginger for hilly areas Manipur • Organic cultivation of cabbage • Organic production package for kiwi fruit under high altitude areas in Manipur • Organic production package for passion fruit based system under foot hill condition of Manipur • Organic production package for pineapple under hill slopes Manipur • Organic production package of turmeric for agro-climatic condition of Manipur
	Improved technology for agricultural crops • Biochar As A Potential Liming Material and Moisture Conserving Material For Enhancing Yield Of Winter Crops In Rice And Maize Fallow • Boron application in wheat and mustard • Direct seeding equipment in rice • Fall army worm management in maize • Foliar nutrition in lentil • IDM in rice • Improved production technology for buckwheat, finger millet, millets, maize, rice, wheat, jute, groundnut, niger, rapeseed and mustard, soybean, blackgram, greengram and lentil • Improved sickle for paddy harvesting • improving soil health through conservation tillage for maize-rapeseed and mustard system • INM in maize and rapeseed and mustard • Innovative resource conservation approaches for sustaining the productivity of rice-rice system • IPM in rice • Jalkund for harvesting of rainwater • Land use model for sloping land for soil and water conservation towards climate resilience • Light Weight Power Paddy Thresher Cum Cleaner

	• No till system for maize fallow french bean • Package of practices for mitigating abiotic stress in lentil in rice fallow uplands • Perennial forage crops and use of organic amendments to rehabilitate degraded lands in NEHR • Raised bed and sunken beds for cultivation of vegetables and rice-pulse system • Relay cropping of kesar crop variety Ratan in rice fallows • Rice thresher, power thresher, rice transplanter, self-propelled eight row transplanter, treadle pump • Roof water harvesting for homestead vegetable production • Sali rice production • Seed weed sap application as an organic bio-stimulant for improving productivity and quality of crops in NEHR India • Sowing Attachment For Light Weight Power Tiller • Stemphylum blight management in lentil • Sustainable and environmentally clean/safer cropping systems for rainfed rice fallow lands of Tripura • Technology for double cropping of rice in mid altitudes of NEHR • Water management in rice • Zn and Bo application in rice
	Improved technology for horticultural crops • Black polythene mulching in tuberose, pineapple, watermelon • Blight management in large cardamom • Cultivation of watermelon on sand and silt deposited soils • Drip irrigation in tomato • Ecological engineering based integrated viral disease management module for King Chilli • Gerbera cultivation open field conditions in the mid hills of Meghalaya • Grape based organic intercropping model under naturally ventilated polyhouse for Manipur condition • High sensitive and robust diagnostic kits for detection of potyvirus associated with yellow mottle and fruit deformation disease of passion fruit • Improved production technology for alstomeria, gladiolus, apple ber, banana, dragon fruit, orange, papaya, strawberry, coconut, black pepper, ginger, broccoli, cabbage, capsicum, cauliflower, pea, potato and tomato • Integrated nutrient management in marigold • IPM and IDM in banana and potato • Leaf miner management in tomato • Low cost plastic shelters for high value organic vegetable production in NEHR • Low cost plastic tunnels for year round intensive organic vegetable production in NEHR • Manually Operated Turmeric/ Ginger Slicer • Novel diagnostic kits for detection of viral complex in chilli • Novel isothermal recombines polymerase amplification assay for detection of citrus tristiza virus and Candidatus liberibacter asiaticus - associated with hunglongbing disease of citrus

	• Partial protection of kiwi fruit for organic production in NEHR • Pheromone traps for fruit fly control in fruits and vegetables • Poly house cultivation of chilli and other vegetables • Poly tunnel cultivation of leafy vegetables • Prevention of fruit scaring beetle in banana • Protective clothing for women for fruit harvesting in bhendi • Rejuvenation of old arecanut plantations • Rhizome seed treatment in ginger • Seed treatment in carrot • Soft rot and rhizome rot management in ginger • Zero tillage in potato
	Improved technology for animal species • µthimin (class 5), mineral Mixture • A novel polymerase spiral reaction (PSR) assay for rapid and visual detection of Staphylococcus aureus in meat • A novel and rapid polymerase spiral reaction assay to detect Salmonella in pork and pork products • A novel in-situ methodology for visual detection of Clostridium perfringens in pork harnessing saltatory rolling circle amplification • A Novel Isolation Method For Classical Swine Fever Virus (Csfv) In Rabbit Kidney 13 (Rk-13) Cell Line With Potential Use As A Diagnostic Reagent And Vaccine • A novel polymerase spiral reaction (PSR) assay for rapid and visual detection of Clostridium perfringens in meat • A Novel Polymerase Spiral Reaction-Based Testing Technique For Same-Day Visual Detection Of Campylobacter Coli In Pork • A Novel Saltatory Rolling Circle Amplification Assay For Rapid And Visual Detection Of Campylobacter Jejuni In Chicken Meat • A novel visual detection technique for Campylobacter jejuni in chicken meat and caecum using polymerase spiral reaction (PSR) with pre-added dye • AI in pigs • An improved low cost portable dummy sow assembly unit with mating grunt voice system • Area specific mineral mixtures in dairy animals and pigs • Area-Specific mineral mixture for mithun • Automatic Solar-Operated Mini Egg Incubator • Azolla as poultry feed • Estrus synchronization • Feed blocks: preparation of low-cost nutritious feed blocks for mithun • Improved production and management in dairy, fishery, duckery, poultry, piggery and goatry • In-House Indirect Elisa For Detection Of Csfv Antibodies In Serum And Plasma From Pigs Using Rk 13 Adapted Cell Cultured Viral Antigen • Isothermal Rna Amplification Method And Detection Of Classical Swine Fever Virus • Low cost high Nutritious feed block for mithun • Low-cost climate resilient environment-affinitive pigpen model

	• Pelleted feed in fishery • Pig waste water recycling model • Semi-intensive mithun farming • Simple Protocol For Seed Production Of Improved Variety Of Common Carp (Cyprinus Carpio) – Amur Variety (Hungarian Strain) And Pengba (Ostebrama Belangeri)- An Endangered Endemic Fish Species Of Northeast India • Standardization of cryopreservation protocol for mithun embryos • Standardization of embryo transfer protocol in mithun • Standardization of semen preservation and artificial insemination in Mithun • Utilization Of Jalkund (Water Harvesting Pond) For Fish Seed Raising • Standardization of boar semen collection and processing techniques • Popularization of Artificial Insemination technology in pig • Standardization of Good Management Practices of scientific pig production • Formulation of feed for different stages of pigs by using conventional and unconventional feed resources • Ration for modification of body fat composition in pigs • Standardization of package of practices for swine health care • Development of health calendar for pig • Designing of model retail pork shop and portable insulated container for packaged meat • Standardization of technologies for value addition of pork **Tools, implements and diagnostic kits** • Cabinet solar dryer • Production Technology Of Beehive Charcoal Briquette From Waste Biomass For Cooking And Space Heating In Rural Areas • RC seed bin - A low cost medium term seed storage technology for small and marginal farmers of NEHR • Zero Energy Cool Chamber • µeef (class 29), Meat of mithun • µLEDER, (class 18) Leather product: jacket, shoes, wallet, handbags, suitcase, belt, and key ring • µlk (class 29), Lassi, barfi, rasgulla, paneer • µyum (class 29), Meat patties, smoke meat, meat sauces, meat block, seasoned dried mithun meat • A method for bio-preservation of mithun hides • A method for processing rabbit pelts and fur • A method of processing rabbit fur on leather • A method of removal of chromium from chrome liquor obtained after processing of mithun hides • A novel method of chrome tannage of mithun hides with Glyoxalic Acid • A process of making leather without any large machinery • An energy-efficient post tanning process for mithun hides • An improved method for chrome Tanning mithun hides • Functional pork and chicken products incorporated with blood fruit, chameleon leaves and perilla seeds • Innovative value addition to pig bristles

	• Logo of mithun head (class 5, 18, 29) • Preparation method for coagulated milk (Paneer) sausage • Ready to eat retorated pork curry with bamboo shoot • Wealth from waste: Bioconverstion of chicken feather waste into agriculturally important product using native bacterium • Development of value products from horticultural crops of NEHR • Improving food value and storability of tomato, pineapple and banana through application of exogenous melatonin • Microcontroller Based Solar Tunnel Drier Suitable For Heavy Rainfall Region Of Northeast India • Motorized Cutter For Trimming Cinnamon Quills
	Other enterprises management practices • A location specific modified Zero Energy Poly Tunnel Technology of compost preparation and cultivation of button mushrooms • Enriched compost production technology from farm wastes • Feeding of sugar solution during off season • Improved production and management in apiculture • Low cost vermicomposting including production in bamboo structures, poly bags and HDPE Pipes • Production and management in mushroom cultivation • Span production
Mild-Tropical Hill Zone	Natural resource management • IFS of rice, maize, cowpea, fruits, vegetables, pig, goat, fish etc • Improving productivity of maize based system through agronomic management practices in Jhum Land • Jhum cultivation for sustainable production • Multiple use of pond water for crop/horticulture/forestry cum pig/fish/poultry/duck farming • Natural farming of crops and horticultural species • Organic production technology of various agri-horticultural crops for NEHR of India • Soybean (Dsb-19) in abandoned Jhumland under Agrisilvi farming system • Rice Fish Farming Under Mid Hill Condition • Organic production package for ginger for hilly areas Manipur • Organic cultivation of cauliflower, ginger, king chilly • Organic production package for kiwi fruit under high altitude areas in Manipur • Organic production package for passion fruit based system under foot hill condition of Manipur • Organic production package for pineapple under hill slopes Manipur • Organic production package of turmeric for agro-climatic condition of Manipur
	Improved technology for agricultural crops • Biochar As A Potential Liming Material and Moisture Conserving Material For Enhancing Yield Of Winter Crops In Rice And Maize Fallow • Cono weeder in rice • Drum seeder in rice

	• Improved production technologies for greengram, blackgram, rajmash, buck wheat, groundnut, finger millet, maize, rice, mustard, sesamum, soybean • improving soil health through conservation tillage for maize-rapeseed and mustard system • Innovative resource conservation approaches for sustaining the productivity of rice-rice system • Integrated nutrient management in rice, soybean, cowpea • Integrated pest management in maize, rice, mustard, lentil etc. • Intercropping of maize with rajmash • Land use model for sloping land for soil and water conservation towards climate resilience • Light Weight Power Paddy Thresher Cum Cleaner • Management of fall army worm in maize • Mize sheller • Modified system of rice intensification • Mulching with black ploythene paper in chilles • No till system for maize fallow french bean • Package of practices for mitigating abiotic stress in lentil in rice fallow uplands • Paddy thresher • Paddy transplanter • Perennial forage crops and use of organic amendments to rehabilitate degraded lands in NEHR • Polythene mulching in watermelon • Raised bed and sunken beds for cultivation of vegetables and rice-pulse system • Roof water harvesting for homestead vegetable production • Seed weed sap application as an organic bio-stimulant for improving productivity and quality of crops in NEHR India • Sowing Attachment For Light Weight Power Tiller • Sustainable and environmentally clean/safer cropping systems for rainfed rice fallow lands of Tripura • Technology for double cropping of rice in mid altitudes of NEHR • Zero Energy Cool Chamber, mini oil expeller, hermitic grain storage • Zero tillage in maize
	Improved technology for horticultural crops • Apple harvester • Biological control of pests in cabbage and potato • Biological control of root grub in potato • Control of diamond back moth in cabbage • Double row planting in pineapple • Drip irrigation in tomato • Ecological engineering based integrated viral disease management module for King Chilli • Fruit fly management in orange • Gerbera cultivation open field conditions in the mid hills of Meghalaya

	• Grape based organic intercropping model under naturally ventilated polyhouse for Manipur condition • High sensitive and robust diagnostic kits for detection of potyvirus associated with yellow mottle and fruit deformation disease of passion fruit • Improved production technology for alstromeria flowers, banana, black pepper, broccoli, cabbage, capsicum, cauliflower, coconut, dragon fruit, fig, kiwi, gladiolus, knolkhol, bhendi, marigold, orange, Darjeeling mandarin, Khasi mandarin, papaya , pea, potato, strawberry, tomato, tea, • Integrated nutrient management in pea, colacasia, orange, watermelon • Integrated pest management in banana, cabbage, ginger, orange, potato, tomato • Late blight management in tomato • Leaf miner management in tomato and chilli • Low cost plastic shelters for high value organic vegetable production in NEHR • Low cost plastic tunnels for year round intensive organic vegetable production in NEHR • Manually Operated Turmeric/ Ginger Slicer • Mulching with black polythene paper in chill and watermelon • Novel diagnostic kits for detection of viral complex in chilli • Novel isothermal recombines polymerase amplification assay for detection of citrus tristiza virus and Candidatus liberibacter asiaticus - associated with hunglongbing disease of citrus • Partial protection of kiwi fruit for organic production in NEHR • Rejuvenation of Khasi mandarin gardens • Rhizome rot and soft rot management in ginger • Rice fallow cultivation of pea • Seed and seedling production in black pepper and tomato • Seed potato production in potato
	Improved technology for animal species • µthimin (class 5), mineral Mixture • A novel polymerase spiral reaction (PSR) assay for rapid and visual detection of Staphylococcus aureus in meat • A novel and rapid polymerase spiral reaction assay to detect Salmonella in pork and pork products • A novel in-situ methodology for visual detection of Clostridium perfringens in pork harnessing saltatory rolling circle amplification • A Novel Isolation Method For Classical Swine Fever Virus (Csfv) In Rabbit Kidney 13 (Rk-13) Cell Line With Potential Use As A Diagnostic Reagent And Vaccine • A novel polymerase spiral reaction (PSR) assay for rapid and visual detection of Clostridium perfringens in meat • A Novel Polymerase Spiral Reaction-Based Testing Technique For Same-Day Visual Detection Of Campylobacter Coli In Pork • A Novel Saltatory Rolling Circle Amplification Assay For Rapid And Visual Detection Of Campylobacter Jejuni In Chicken Meat

	• A novel visual detection methodology for Salmonella in meat using saltatory rolling circle amplification • An improved low cost portable dummy sow assembly unit with mating grunt voice system • Area specific mineral mixtures for fertility management in dairy animals • Area-Specific mineral mixture for mithun • Automatic Solar-Operated Mini Egg Incubator • Disease management in goat, pig, dairy cattle, • Estrus synchronization • Feed blocks: preparation of low-cost nutritious feed blocks for mithun • Feed management in dairy, goat and fishery • Improved management practice for milch animals, poultry, duck, fishery, goat, pig • In-House Indirect Elisa For Detection Of Csfv Antibodies In Serum And Plasma From Pigs Using Rk 13 Adapted Cell Cultured Viral Antigen • Isothermal Rna Amplification Method And Detection Of Classical Swine Fever Virus • Low cost high Nutritious feed block for mithun • Low-cost climate resilient environment-affinitive pigpen model • Pig waste water recycling model • Semi-intensive mithun farming • Simple Protocol For Seed Production Of Improved Variety Of Common Carp (Cyprinus Carpio) – Amur Variety (Hungarian Strain) And Pengba (Ostebrama Belangeri)- An Endangered Endemic Fish Species Of Northeast India • Standardization of cryopreservation protocol for mithun embryos • Standardization of embryo transfer protocol in mithun • Standardization of semen preservation and artificial insemination in Mithun • Utilization Of Jalkund (Water Harvesting Pond) For Fish Seed Raising • Standardization of boar semen collection and processing techniques • Popularization of Artificial Insemination technology in pig • Standardization of Good Management Practices of scientific pig production • Formulation of feed for different stages of pigs by using conventional and unconventional feed resources • Ration for modification of body fat composition in pigs • Standardization of package of practices for swine health care • Development of health calendar for pig • Designing of model retail pork shop and portable insulated container for packaged meat • Standardization of technologies for value addition of pork
	Tools, implements and diagnostic kits • Production Technology Of Beehive Charcoal Briquette From Waste Biomass For Cooking And Space Heating In Rural Areas • RC seed bin - A low cost medium term seed storage technology for small and marginal farmers of NEHR • µeef (class 29), Meat of mithun

	• µLEDER, (class 18) Leather product: jacket, shoes, wallet, handbags, suitcase, belt, and key ring • µlk (class 29), Lassi, barfi, rasgulla, paneer • µyum (class 29), Meat patties, smoke meat, meat sauces, meat block, seasoned dried mithun meat • A method for bio-preservation of mithun hides • A method for processing rabbit pelts and fur • A method of processing rabbit fur on leather • A method of removal of chromium from chrome liquor obtained after processing of mithun hides • A novel method of chrome tannage of mithun hides with Glyoxalic Acid • A process of making leather without any large machinery • An energy-efficient post tanning process for mithun hides • An improved method for chrome Tanning mithun hides • Functional pork and chicken products incorporated with blood fruit, chameleon leaves and perilla seeds • Innovative value addition to pig bristles • Logo of mithun head (class 5, 18, 29) • Preparation method for coagulated milk (Paneer) sausage • Ready to eat retorted pork curry with bamboo shoot • Wealth from waste: Bioconverstion of chicken feather waste into agriculturally important product using native bacterium • Development of value products from horticultural crops of NEHR • Improving food value and storability of tomato, pineapple and banana through application of exogenous melatonin • Microcontroller Based Solar Tunnel Drier Suitable For Heavy Rainfall Region Of Northeast India • Motorized Cutter For Trimming Cinnamon Quills
	Other enterprises management practices • A location specific modified Zero Energy Poly Tunnel Technology of compost preparation and cultivation of button mushrooms • Enriched compost production technology from farm wastes • Low cost vermin compost production
Mild-Tropical Plain Zone	**Natural resource management** • Improving productivity of maize based system through agronomic management practices in Jhum Land • Multiple use of pond water for crop/horticulture/forestry cum pig/fish/poultry/duck farming • Natural farming • Organic production technology of various agri-horticultural crops for NEHR of India • Integrated farming system with crops and or horticultural crops with duck, fish and pig • Rice Fish Farming Under Mid Hill Condition • Organic production package for ginger for hilly areas Manipur • Organic production package for kiwi fruit under high altitude areas in Manipur

	• Organic production package for passion fruit based system under foot hill condition of Manipur • Organic production package for pineapple under hill slopes Manipur • Organic production package of turmeric for agro-climatic condition of Manipur • Single bud transplantation in ginger and turmeric
	Improved technology for agricultural crops • Biochar As A Potential Liming Material and Moisture Conserving Material For Enhancing Yield Of Winter Crops In Rice And Maize Fallow • Improved production technology for rice, maize, lentil, rapeseed and mustard and sesamum • improving soil health through conservation tillage for maize-rapeseed and mustard system • Innovative resource conservation approaches for sustaining the productivity of rice-rice system • Land use model for sloping land for soil and water conservation towards climate resilience • Light Weight Power Paddy Thresher Cum Cleaner • No till system for maize fallow french bean • Package of practices for mitigating abiotic stress in lentil in rice fallow uplands • Paddy drum seeder, rice stripper, Reaper, thresher and combined harvester, vegetable plucker • Paira sowing in lentil and line sowing in fodder crops • Perennial forage crops and use of organic amendments to rehabilitate degraded lands in NEHR • Pest disease management in rice • Phosphorus management in rice • Rainwater harvesting through Jalkund • Raised bed and sunken beds for cultivation of vegetables and rice-pulse system • Roof water harvesting for homestead vegetable production • Seed treatment with Trichoderma in redgram • Seed weed sap application as an organic bio-stimulant for improving productivity and quality of crops in NEHR India • Sowing Attachment For Light Weight Power Tiller • SRI and Modified rice system of intensification • Sustainable and environmentally clean/safer cropping systems for rainfed rice fallow lands of Tripura • Technology for double cropping of rice in mid altitudes of NEHR • Zero tillage in pulses
	Improved technology for horticultural crops • Drip irrigation in tomato • Ecological engineering based integrated viral disease management module for King Chilli • Fruit borer management in tomato • Fruit fly management in watermelon, pumpkin, ridge gourd

	• Gerbera cultivation open field conditions in the mid hills of Meghalaya • Grape based organic intercropping model under naturally ventilated polyhouse for Manipur condition • High sensitive and robust diagnostic kits for detection of potyvirus associated with yellow mottle and fruit deformation disease of passion fruit • Improved production technology in mango, papaya, pineapple, coconut, tea, bitter gourd, chilli, cucumber, cucurbits, pea, potato and pumpkin • Integrated nutrient management in arecanut and coconut • IPM and IDM in banana, chilli, orange, • Late blight management in potato • Low cost plastic shelters for high value organic vegetable production in NEHR • Low cost plastic tunnels for year round intensive organic vegetable production in NEHR • Manually Operated Turmeric/ Ginger Slicer • Novel diagnostic kits for detection of viral complex in chilli • Novel isothermal recombines polymerase amplification assay for detection of citrus tristiza virus and Candidatus liberibacter asiaticus - associated with hunglongbing disease of citrus • Partial protection of kiwi fruit for organic production in NEHR • Plastic mulching in brinjal • Rhizome rot and soft rot management in ginger • Yellow sticky traps for soft bodied insects in tea
	Improved technology for animal species • µthimin (class 5), mineral Mixture • A novel polymerase spiral reaction (PSR) assay for rapid and visual detection of Staphylococcus aureus in meat • A novel and rapid polymerase spiral reaction assay to detect Salmonella in pork and pork products • A novel in-situ methodology for visual detection of Clostridium perfringens in pork harnessing saltatory rolling circle amplification • A Novel Isolation Method For Classical Swine Fever Virus (Csfv) In Rabbit Kidney 13 (Rk-13) Cell Line With Potential Use As A Diagnostic Reagent And Vaccine • A novel polymerase spiral reaction (PSR) assay for rapid and visual detection of Clostridium perfringens in meat • A Novel Polymerase Spiral Reaction-Based Testing Technique For Same-Day Visual Detection Of Campylobacter Coli In Pork • A Novel Saltatory Rolling Circle Amplification Assay For Rapid And Visual Detection Of Campylobacter Jejuni In Chicken Meat • A novel visual detection technique for Campylobacter jejuni in chicken meat and caecum using polymerase spiral reaction (PSR) with pre-added dye • An improved low cost portable dummy sow assembly unit with mating grunt voice system • Area-Specific mineral mixture for mithun • Automatic Solar-Operated Mini Egg Incubator • Creep feeding in pig

	• De-worming in pig and goat • Duck weed feeding in fish • Estrus synchronization • Feed blocks: preparation of low-cost nutritious feed blocks for mithun • Improved production and management in milch cattle, duck, poultry, goat, sheep, pig and fisheries • In-House Indirect Elisa For Detection Of Csfv Antibodies In Serum And Plasma From Pigs Using Rk 13 Adapted Cell Cultured Viral Antigen • Isothermal Rna Amplification Method And Detection Of Classical Swine Fever Virus • Low cost high Nutritious feed block for mithun • Low-cost climate resilient environment-affinitive pigpen model • Mineral mixtures in dairy cattle and goat • Pig waste water recycling model • Semi-intensive mithun farming • Simple Protocol For Seed Production Of Improved Variety Of Common Carp (Cyprinus Carpio) – Amur Variety (Hungarian Strain) And Pengba (Ostebrama Belangeri)- An Endangered Endemic Fish Species Of Northeast India • Standardization of cryopreservation protocol for mithun embryos • Standardization of embryo transfer protocol in mithun • Standardization of semen preservation and artificial insemination in Mithun • Use of pelleted feed in fisheries • Utilization Of Jalkund (Water Harvesting Pond) For Fish Seed Raising • Standardization of boar semen collection and processing techniques • Popularization of Artificial Insemination technology in pig • Standardization of Good Management Practices of scientific pig production • Formulation of feed for different stages of pigs by using conventional and unconventional feed resources • Ration for modification of body fat composition in pigs • Standardization of package of practices for swine health care • Development of health calendar for pig • Designing of model retail pork shop and portable insulated container for packaged meat • Standardization of technologies for value addition of pork • µeef (class 29), Meat of mithun • µLEDER, (class 18) Leather product: jacket, shoes, wallet, handbags, suitcase, belt, and key ring • µlk (class 29), Lassi, barfi, rasgulla, paneer • µyum (class 29), Meat patties, smoke meat, meat sauces, meat block, seasoned dried mithun meat • A method for bio-preservation of mithun hides • A method for processing rabbit pelts and fur • A method of processing rabbit fur on leather • A method of removal of chromium from chrome liquor obtained after processing of mithun hides • A novel method of chrome tannage of mithun hides with Glyoxalic Acid

	• A process of making leather without any large machinery • An energy-efficient post tanning process for mithun hides • An improved method for chrome Tanning mithun hides • Functional pork and chicken products incorporated with blood fruit, chameleon leaves and perilla seeds • Innovative value addition to pig bristles • Logo of mithun head (class 5, 18, 29) • Preparation method for coagulated milk (Paneer) sausage • Ready to eat retorted pork curry with bamboo shoot • Wealth from waste: Bioconverstion of chicken feather waste into agriculturally important product using native bacterium
	Tools, implements and diagnostic kits • Mini dhal mill • Portable rice mill • Production Technology Of Beehive Charcoal Briquette From Waste Biomass For Cooking And Space Heating In Rural Areas • RC seed bin - A low cost medium term seed storage technology for small and marginal farmers of NEHR • Solar dryer • Zero Energy Cool Chamber • Development of value products from horticultural crops of NEHR • Improving food value and storability of tomato, pineapple and banana through application of exogenous melatonin • Microcontroller Based Solar Tunnel Drier Suitable For Heavy Rainfall Region Of Northeast India • Motorized Cutter For Trimming Cinnamon Quills
	Other enterprises management practices • A location specific modified Zero Energy Poly Tunnel Technology of compost preparation and cultivation of button mushrooms • Enriched compost production technology from farm wastes • Improved management in apiculture • Lac farming on host Flemingiasemialata • Low cost vermicomposting including production in poly bags and HDPE pipes

CHAPTER 5 INSTITUTIONAL MECHANISMS

The foundation for growth story of Indian economy since independence is laid on fundamental principles of creating basic infrastructure i.e. transportation (roads, rail, water ways and airways), communications and power so as to attract investments and establish and strengthen industries in manufacturing sector which in turn foster the growth and strengthen the service sector. Though the industrial and manufacturing sector are the key of economy of any particular nation, it is science and technology that drives manufacturing and other industrial establishment which goes without saying that it is the technology that drives all the sectors including the industrial and manufacturing. Agriculture sector is no exception in this regard as science and technology has a pivotal role in manufacturing of modern day agricultural inputs viz. fertilizers, pesticides including herbicides, plant growth substances etc. Though science and technology drives most of the industries, it is the Research and Development (R & D) that gives life to science and technology sector including the agriculture, animal husbandry and allied rural based enterprises. Owing to existence of diverse bio-physical and environmental regimes in India especially the EHR regions, it is imperative to harness these vast natural resources and understand location specific condition to make tailor made solutions to various agro-ecological farming situations. Thus technology generation, assessment or refinement and demonstration of improved technologies assume utmost importance especially conserving scarce human and financial resources. In recently held several meetings, it was emphasized that it is not the dearth of technology alone that hinder in bringing the desired changes in the agriculture and allied sectors, but is the lack of understanding on the nature and magnitude of constraints to production across various agro-ecological region lack of research priorities on such issues and lack of unified effort and strategy among various R & D institutions that is costing heavy on public exchequer.

In order to harness the fruits of research and bring much needed improvements in the farming sectors it is imperative not only for the number of R & D institutions to devise a centralized action plan and strategy, but also having an institution-wise action plan is the need of the day. Hence, an attempt has been made to collect and collate the necessary information and map various research and extension agencies in EHR states to achieve the above said objectives. The NARS system consisting of research, teaching and extension wings of ICAR institutions and State Agricultural Universities has a vast presence in this region and the network is mapped and presented in Table 42. There are about 61 institutions and agencies that have the presence in the region. Krishi Vigyan Kendras (KVK) are the front line extension agencies having presence in most of the districts and have the mandate of technology assessment, assessment and refinement, demonstration and skilling of farmers and farm women, rural youth and extension functionaries. Since KVKs have presence in every district and function at grass root level, it was thought that these institutions are of utmost importance and deserve a special reference and mention and the network of KVKs was mapped and presented in Table 43. There are as many as 93 KVKs in the region. Apart from the NARS and KVKs, the other institution working at district level is Agricultural Technology Management Agency (ATMA) which has a mandate developing strategic research extension plans for the respective district and a total of 29 ATMA districts are available in EHR jurisdiction (Table 44).

Table 42. Research, teaching and extension network of NARs agencies

ACSZ	District	Type of Institution
Alpine zone	West kameng, East district, West district, Kalimpong	ICAR, CAU
Temperate-sub alpine zone	West Kameng, Pasighat, East District, West Sikkim, Kalimpong, Zunheboto	ICAR, CAU, NERIST
Sub-tropical hill zone	West Kameng, Leparada, Karbi Anglong, Ri-Bhoi, Shillong, Serchhip, Kolasib, Aizawl, Cooch Behar, East district, West district, Peren, Kalimpong	ICAR, CAU, SAU, NEHU, NEGRL
Sub-tropical plain zone	Barpeta, Kamrupa, Dispur, Biswanath, Gogamukh, Kokrajhar, Lakhimpur, Biswanath Chariali, Rangamati, North Lakhimpur, Nalbari, Imphal West	ICAR, SAU
Mild tropical hill zone	Dimapur, West Tripura, Kamrupa Metropolitan, Jorhat, Nagaon, West Tripura,West Garo Hills	ICAR, SAU, CIH
Mild tropical plain zone	Kamrupa Metropolitan, Jorhat, West Tripura	ICAR, SAU

Table 43. ACZSZ wise network of KVKs in EHR

ACSZ	District
Alpine Zone	Anjaw, East Kameng, Tawang, Upper Siang, West KAmEng, East District, North District, West District, Darjeeling, Kalimpong
Temperate Sub-Alpine Zone	Anjaw, East Kameng, East Siang, Lohit, Lower Dibang Valley, Papumpare, Tawang, Upper Siang, Upper Subansiri, West Kemang, West Siang, Senapati, Ukhrul, East Khasi, Champhai, Lawngtlai, Saiha, Kiphire, Mokokchung, Phek, Wokha, Zunheboto, East District, North District, South District, West District, Darjeeling, Jalpaiguri, Kalimpong
Sub-Tropical Hill Zone	Anjaw, Changlang, East Kameng, Kurung Kumey, Longding, Lower Dibang Valley, Lower Subansiri, Namsai, Papumpare, Tirap, Upper Siang, West Kameng, West Siang, Dima Hasao (North Cachar Hills), Karbi Anglong, Tamenglong, Ri-Bhoi, South Garo Hills, West Garo Hills, West Jaiantia Hills, Aizawl, Champhai, Kolasib, Lawngtlai, Lunglei, Mamit, Saiha, Serchhip, Kohima, Mokokchung, Mon, Peren, Tuensang, Wokha, East District, North District, South District, West District, Cooch Behar, Darjeeling, Jalpaiguri, Kalimpong
Sub-Tropical Plain Zone	Changlang, Kurung Kumey, Longding, Namsai, Barpeta, Baska, Bongaigaon, Chirang, Darrang, Dhemaji, Dhubri, Goalpara, Kamrup,Kokrajhar, Lakhimpur, Nalbari, Sonitpur,Udalguri, Bishnupur, Imphal East, Imphal West, Thoubal, Mokokchung, Cooch Behar, Darjeeling, Kalimpong
Mild-Tropical Hill Zone	West Kemeng, Cachar, Hailakandi, Karimganj, Chandel, Churachandpur, East Garo Hills, Ri-Bhoi, West Jaiantia Hills, West Khasi Hills, Aizawl, Lunglei, Dimapur, East District, North Tripura, Cooch Behar, Darjeeling, Jalpaiguri,

ACSZ	District
Mild-Tropical Plain Zone	East Siang, Lohit, Tirap, Dibrugarh, Golaghat, Jorhat, Marigaon, Nowgoan, Sivasagar, Tinsukia, West Garo Hills, Aizawl, Kolasib, Mamit, Dhalai, Gomati, Khowai, North Tripura, Sepahijala, South Tripura, Unakoti, West Tripura

Table 44. Agro-Climatic Sub-Zone wise list of districts with ATMA

ACSZ	ATMA District
Temperate Sub-Alpine Zone	East Siang, Lohit, Senapati, Champhai
Mild-Tropical Hill Zone	Lower Subansiri, Papum Pare, Cachar, Karimganj, Aizwal, Lungei, Cooch Bihar
Mild-Tropical Plain Zone	East Siang, Lohit, Tirap, Golaghat, Morigaon, Sivsagar, Tinsukia, Aizwal, Kolasib
Sub-Tropical Hill Zone	Tirap, Dima Hasao (North Cachar Hills), Aizwal, Champhai, Kolasib, Lungei, Cooch Bihar
Sub-Tropical Plain Zone	Bongaigaon, Darrang, Goalpara, Kokrajhar, Lakhimpur, Imphal East, Imphal West, Thoubal, Cooch Bihar

Further there are some R & D centers of commodity boards/corporation i.e. Coconut Development Board, Tea Board, Tea Board of India, Coffee Board, Rubber Board, Spices Board and Cotton Corporation of India that has the mandate of in-house R & D and extension in the EHR operational area.

5.1. Aspirational districts of North Eastern Himalaya

The Government of India has launched the 'Transformation of Aspirational Districts' initiative in January 2018 with a vision of a New India by 2022 wherein the focus is to improve India's ranking under the Human Development Index (HDI), raising living standards of its citizens and ensuring inclusive growth of all. A total of 112 Aspirational Districts (AD) across 27 states have been identified by NITI AAYOG based upon composite indicators from Health and Nutrition, Education, Agriculture & Water Resources, Financial Inclusion & Skill development and Basic Infrastructure which have an impact on HDI (Table 45).

Table 45. List of Aspirational districts of NEH India

Sl.No.	State	District
1.	Arunachal Pradesh	Namsai
2.	Assam	Barpeta, Darrang, Dhubri, Udalguri, Goalpara, Hailakandi, Baksa
3.	Manipur	Chandel
4.	Meghalaya	Ri-Bhoi
5.	Mizoram	Mamit
6.	Nagaland	Kiphire
7.	Sikkim	Gyalshing, Gangtok
8.	Tripura	Dhalai

5.2. National Schemes associated with Agriculture and allied sector

1. Input Management Schemes/ Programmes/ Missions

Soil and Fertilizers

- Soil Health Card Scheme (SHC)
- Soil Health Management (SHM)
- Opening of Model Fertilizer Retail Shop
- Policy on Promotion of City Compost
- Direct Benefit Transfer Scheme in Fertilizers
- Neem Coated Urea

Seed

- Sub-Mission on Seed and Planting Material (SMSP)
- Protection of Plant Varieties and Farmers' Rights Authority, India

Water Management-Micro-irrigation

- Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)
- Watershed Development Component of Pradhan Mantri, Krishi Sinchayee Yojana (WDC-PMKSY) (Erstwhile IWMP)

Agricultural Credit

- Kisan Credit Card
- Interest Subvention Scheme
- Joint Liability Group (JLG)

Farm Mechanization

- Sub -Mission on Agricultural Mechanization (SMAM)
- Sub Mission on Plant Protection and Plant Quarantine (SMPP)

2. Production Management Schemes for Higher Productivity

Agriculture

- National Food Security Mission (NFSM)
- Bringing Green Revolution to Eastern India (BGREI)
- National Mission on Oilseeds and Oil Palm (NMOOP)

Horticulture

- Mission for Integrated Development of Horticulture (MIDH)
- Horticulture Mission for North East and Himalayan States (HMNEH)
- National Horticulture Board
- Coconut Development Board Including Technology Mission on Coconut
- Central Institute of Horticulture (CIH)
- Directorate of Cashewnut and Cocoa Development, Kochi
- Directorate of Arecanut and Spices Development, Calicut
- National Centre for Cold-Chain Development
- Prime Ministers' Package for J&K
- Bee Development - National Bee Board (NBB)

Animal Production and Productivity Schemes

- National Programme for Bovine Breeding and Dairy Development (NPBBDD)
- Rashtriya Gokul Mission
- National Kamdhenu Breeding Centre
- National Programme for Bovine Breeding
- National Livestock Mission
- Fodder and Feed Development
- Rural Backyard Poultry Development
- Sheep/Goat Development
- Livestock Health and Disease Control (LH & DC)

Fishery

- Blue Revolution

3. Output Management Schemes-Post Production

- Agricultural Marketing
- National Agriculture Market (e-NAM)
- Small Farmers Agribusiness Consortium (SFAC)

- Price Support and Procurement
- Pradhan Mantri Kisan SAMPADA Yojana
- Mega Food Parks
- Cold Chain
- Scheme for Creation / Expansion of Food Processing / Preservation Capacities
- Agro Processing Cluster
- Scheme for Creation of Backward and Forward Linkages
- Food Safety & Standards Authority of India (FSSAI)
- Detecting Adulteration
- Licensing and Registration of Food Business Operators
- National Cooperative Development Corporation (NCDC)

4. Risk Management in Agriculture

- Pradhan Mantri Fasal Bima Yojna (PMFBY)
- Drought Management Scheme
- Risk Management & Insurance in Animal Husbandry and Dairying
- Mahalanobis National Crop Forecast Centre (MNCFC)
- National Rainfed Area Authority(NRAA)
- Agro-Meteorological Advisory Services (AAS) under Gramin Krishi
- Mausam Seva under Ministry of Earth Science
- Hydro-meteorological Services

5. Extension Management in Agriculture

- Support to State Extension Programmes for Extension Reforms Scheme (ATMA Scheme)
- Mass Media Support to Agricultural Extension
- Establishment of the Agri-Clinics and Agri-Business Centres (ACABC)
- Kisan Call Centers (KCC)
- MANAGE
- Extension Education Institutes (EEIs)
- Model Training Courses (MTCs)
- Diploma in Agricultural Extension Services for Input Dealers (DAESI)
- Exhibitions/ Melas
- Mera Gaon- Mera Gaurav (ICAR)
- Use of Information and Communication Technology in Agriculture
- National e-Governance Plan – Agriculture
- MKisan-Use of basic mobile telephony
- Farmers' portal (www.farmer.gov.in)
- Development of Mobile Apps

6. Management of Allied Activities-Generation of Additional Employment and Income

- Rashriya Krishi Vikas Yojana (Rkvy)
- National Programme for Dairy Development (NPDD)
- Intensive Dairy Development Programme (IDDP) Component of NPDD
- Strengthening Infrastructure for Quality & Clean Milk Production (SIQCMP)
- Assistance to Cooperative Component of NPDD
- National Dairy Plan
- Dairy Entrepreneurship Development Scheme
- Attracting and Retaining Youth in Agriculture (ARYA)
- Pandit Deen Dayal Upadhyay Unnat Krishi ShikshaYojna
- Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS)
- Deen Dayal Upadhyaya Grameen Kaushalya Yojana (DDU-GKY)
- Deendayal Antyodaya Yojana-National Rural Livelihoods Mission (DAY-NRLM)
- Mahila Kisan Sashaktikaran Pariyojana (MKSP)

7. Sustainable Agriculture Management

- Paramparagat Krishi Vikas Yojana (PKVY)
- Mission Organic Value Chain Development for North Eastern Region (MOVCDNER)
- National Mission for Sustainable Agriculture (NMSA)
- Primary Agricultural Cooperative Society (PACS) Computerization
- Sub-Mission on Agroforestry
- Climate Change & Agriculture
- Rashtriya Krishi Vikas Yojana (RKVY)
- Agri-Market Infrastructure Fund (AMIF)
- Long Term Irrigation Fund (LTIF)

5.3. One District-One product (ODOP)

The ODOP initiative is aimed at manifesting the vision of the Hon'ble Prime Minister of India to foster balanced regional development across all districts of the country.

The idea is to select, brand, and promote One Product from each District of the country

- For enabling holistic socioeconomic growth across all regions
- To attract investment in the District to boost manufacturing and exports
- To generate employment in the District
- To provide ecosystem for Innovation/ use of Technology at District level to make them competitive with domestic as well as International market

Table 46. List of One District One Product of Arunachal Pradesh

Sl. No.	District	Product
1	Changlang	Arecanut
2	East Kameng	Orange
3	Kamle	Orange
4	Kra Dadi	Large Cardamom
5	Kurung Kumey	Large Cardamom
6	Leparada	Pickle
7	Lohit	Sesumum
8	Longding	Ginger
9	LowerDibang Valley	Turmeric
10	Lower Subansiri	Kiwi
11	Namsai	Ginger
12	Papum Pare-(Yupia)	Turmeric
13	Siang	Large Cardamom
14	Tawang	Walnut
15	Tirap	Millet Based-products
16	Upper Siang	Orange
17	Upper Subansiri	Orange
18	East Siang	Orange
19	West Siang	Pineapple

Table 47. List of One District One Product of Meghalaya

Sl. No	District	Product
1	East Khasi Hills	Sohiong
2	SouthWestKhasiHills	Honey
3	Ri-Bhoi	Pineapple
4	East Jantia Hills	Turmeric
5	West Jantia Hills	Turmeric
6	North Garo Hills	Banana
7	East Garo Hills	Pineapple
8	South Garo Hills	Jackfruit
9	Southwest Garo Hills	Pineapple
10	West Khasi Hills	Ginger
11	West Garo Hills	Cashewnut Products

Table 48. List of One District One Product of Mizoram

Sl. No	District	Product
1	Aizawl	Mizo Chilli
2	Champhai	Passion Fruit
3	Hnahthial	Turmeric
4	Khawzawl	Pineapple
5	Kolasib	Turmeric
6	Lawngtlai	Mango
7	Lunglei	Turmeric
8	Mamit	Turmeric
9	Saiha	Turmeric
10	Saitual	Ginger
11	Serchhip	Pineapple

Table 49. List of One District One Product of Nagaland

Sl. no	District	Product
1	Dimapur	Pineapple products
2	Kiphire	Kholar products
3	Kohima	Pickle products
4	Longleng	Ginger products
5	Mokokchung	Coffee products
6	Mon	Large cardamom products
7	Peren	Naga King chilly products
8	Phek	Kiwi products
9	Tuensang	Kholar products
10	Wokha	Fish products
11	Zunheboto	Soya bean products

Table 50. List of One District One Product of Sikkim

Sl. No	District	Product
1	North District	Large Cardamom
2	South District	Ginger
3	West District	Minimally processed Vegetables
4	East District	Redcherry Pepper (Dalley Khorsani)

Table 51. List of One District One Product of Assam

Sl. No.	District	Product
1	Baksa	Honey
2	Barpeta	Milk Products
3	Biswanath Charali	Potato
4	Bongaigaon	Turmeric
5	Cachar	Pineapple
6	Charaideo	Rice (soft rice) based products (Pitha,puffed rice,flaked rice)
7	Chirang	Lemon
8	Darrang	Mustard Products
9	Dhemaji	Mustard Products
10	Dhubri	Chilli
11	Dibrugarh	Mustard Products
12	Dima Hasao	Ginger
13	Goalpara	Banana
14	Golaghat	Black Rice
15	Hailakandi	Arecanut
16	Hojai	Sugarcane (Jaggery, Wine)
17	Jorhat	Chilli
18	Kamrup(R)	Banana
19	Kamrup (M)	Fruits and Vegetables (Pickles)
20	Karbi-Anglong	Ginger
21	Karimganj	Arecanut/ Betelnut
22	Kokrajhar	Mushroom
23	Lakhimpur	Piggery (smoked meat)
24	Majuli	Mustard Oil/ Seed
25	Morigaon	Groundnut Products
26	Nagaon	Fruits and Vegetables (PicklesEnterprises)
27	Nalbari	Rice (Soft and Sticky rice) based products (Pitha,puffed rice, flaked rice)
28	Sivasagar	Rice (Red rice) based products (Pitha, puffed rice,flaked rice)
29	Sonitpur	Jackfruit
30	South Salmara	Cashewnut Processing
31	Tinsukia	Citrus Products
32	Udalguri	Potato
33	West Karbi Anglong	Ginger

Table 52. List of One District One Product of Tripura

Sl. no	District	Prodcuct
1	Dhalai	Multiple Fruit Processing
2	Gomti	Multiple Fruit Processing
3	Khowai	Rice based products (puffed rice, chira, snacks etc)
4	North Tripura	Tea Products
5	Sipahijala	Dairy based product
6	South Tripura	Bakery products
7	Unakoti	Multiple Fruit Processing
8	West Tripura	Bakery products
9	Dhalai	Multiple Fruit Processing
10	Gomti	Multiple Fruit Processing
11	Khowai	Rice Products (puffed rice, chira, snacks etc)

Table 53. List of One District One Product of Manipur

Sl.No.	District	Product
1.	Chandel	Ginger
2.	Churachandpur	Pineapple
3.	Imphal East	Pineapple
4.	Imphal West	Fish products
5.	Kakching	Black Rice Products
6.	Bishnupur	Fish products
7.	Pherzawl	Ginger
8.	Noney	Banana
9.	Senapati	Kiwi
10.	Tamenglong	Orange
11.	Tengnoupal	Bamboo Shoot
12.	Thoubal	Pineapple
13.	Kangpokpi	Turmeric
14.	Ukhrul	Kachai Lemon
15.	Kamjong	King Chilli
16.	Jiribam	Coconut

CHAPTER 6 STRATEGIES

The success of modern day business i.e. manufacturing, service, trade and transportation is largely dependent on inventions of new product or process, innovations in the existing product or process, vertical and horizontal expansion and position of the right product in the right location. While the inventions and innovations decide the nature and type of product, the size and quantum of business is dependent on demand and supply matrix, the driving force behind these two factors is business intelligence that decides the success and sustainability of business in a particular sector. Therefore the private sector entities attach utmost importance to the business intelligence and have setup their own R & D with dedicated mechanism to gather business intelligence to devise strategy for launch of new product or process, bring innovations in the existing product or process, identifying areas/sectors for vertical and horizontal expansion, to build partnerships and networks and to expand business in the new sectors and segments. This is true with private entities in the realm of agriculture i.e. the firms engaged in manufacturing of agricultural inputs viz. fertilizers, pesticides, herbicides, growth substances, soil amendments, seed sector, veterinary medicines, animal feeds, production and sale of poultry chicks and fish fingerlings especially the shrimp and prawn, trading entities handling livestock products i.e. milk, meat, eggs etc.

However, such business intelligence and strategy for demand driven public R & D especially in agriculture and animal husbandry sector is lacking to cope up with emerging challenges especially the climate change issues, increased demand for higher food production in the wake of growing population, diversified food needs of consumers especially in the recent era of increased health conscious general public and need for increased income security of farmers and creating employment opportunities for youth in the rural sector. Therefore, the public sector research in agriculture is highly vulnerable and therefore subjected to frequent criticism as huge investments are going into public sector R & D. In the light of this there is need to build the strategy for flow of business intelligence while formulation of research projects and setting research priorities, devise multi-disciplinary and multi-sector projects, building networks and strong partnership including the private sector in the ecosystem and develop technology inventory, create extrapolation domains and deploy suitable technologies across various micro-farming situations.

It is imperative to devise appropriate strategies for strengthening the development of agriculture and allied sector with economic, institutional, participatory, infrastructure and human resource development perspective. The strategies for developing agriculture and allied sectors need to be prepared with the following objectives.

1. To ensure food security by enhancing the area, quantity and quality production and productivity of major crops, livestock and fishery through modern agricultural technology.
2. To meet nutritional demands while providing affordable choices across the food value chain.
3. To conserve or enhance the quality and quantity of natural resources and meet the challenges of changing climate.
4. To drive rural economic development around the state with well-targeted investments especially on critical inputs, processing, packaging, storage, transport and marketing infrastructure.
5. To upgrade the skill and capacity building of various stakeholders on

latest farm technologies through conventional approach as well as using modern communication tools and create quality job opportunity for the educated youths.

Mapping of Constraints and Research Priorities

Analysis of resources situation of EHR, constraints and roadblock for growth and development in agriculture and allied sectors, research priorities and target R & D agencies for need based action in the forgoing sections revealed that despite the existence of a vast network of public R & D institutions i.e. NARS institutions (61), KVKs (93) and development extension agencies i.e. line departments in the region, there is big gap in flow of requisite feedback from the end user of technologies i.e. farmers and lack of information and appreciation of consumer priorities and food choices. Therefore research output is lacking in end users acceptance. This is partly because of paucity of resources to reach out to vast geographical area and lack of standalone two way feedback mechanisms at gross root level. Owing to the paucity of resources and infrastructure especially the manpower available within NARS network, there is need to devise a suitable strategy to identify the common constraints and research priorities to bring necessary improvement in the NARS research system as given below:

- The line department's viz. agriculture, horticulture, forestry, animal husbandry, fisheries, soil conservation etc. being engaged in development activities at gross root level, these agencies are the most appropriate institutions that could help aid in mapping the common and specific constraints across the various micro-farming situations.
- There is a need for an intermediary agency with proper mandate of two way information flow and overseeing functions as well in more or less similar manner as that of Agricultural Technology Management Agency (ATMA).
- Developing Standard Operating Procedures (SOPs) and delineate micro-farming situations and target ecologies.
- Develop a survey instrument with proper data attributes so as to elicit problems at each of micro-farming situations for various enterprises, schedule of activities with timelines and frequency of data collection.
- Training and capacity building of field, mid and high level functionaries
- Data enumeration, validation and ground truthing
- Developing classified content for use by research agencies, development department, extension agencies and policy personnel.

Change Initiatives for Agricultural Development

Planning for agricultural development should fully take into account of the differentiated local realities and local potentialities, local geo-physical features, local resource endowments and local core competencies. The planning profile must respond to different situations, conditions and felt needs of the people and be integrated into holistic regional planning. Initiaing social/community mobilization will help people to act in groups for the planning and implementation of all developmental programmes. A dedicated effort is urgently required to assess the actual production status and natural resources (forest, water resources etc.) using extensive survey, modern information technology, space technology, remote sensing and geographical information system. Without reliable database, the very objective of formulating roadmap will fail miserably.

Sustaining food production will depend on continued high levels of investments in research and technology development.

Applied research is also playing an important role in developing agriculture sector in EHR. It is essential that research capacity has to be increased substantially. More funding needs to be ensured for the research institutions to take up multi-disciplinary research programme. This will ensure the development of cutting-edge environment-friendly production and post-harvest technologies and will bring an agro-technology revolution. Development of agro-ecology specific sustainable production systems for small holdings that protect the natural resource base should be emphasized to promote ecosystem based adaptation. There is also a need for undertaking action research for seamless blending of traditional wisdom and modern scientific technologies to develop locally suited adaptive strategies for agriculture under global climate disruption. To ensure 'Climate Compatible Development', more financial support should be provided for research and innovations.

Quality seed and planting material is the key to the growth of agricultural sector. Varietal recommendations for various crops are also available. But there is huge gap between demand and supply for the quality seed and planting material. Most of states in EHR do not have any organized seed production, seed processing, seed certification and seed supply chain. Hence, establishment of seed industry or accredited nursery (either public or private) as well as installation of proper seed certification mechanism is the need of the hour.

The success of agricultural sector depends on reliable and timely availability of quality inputs at reasonable prices. Establishment of agro-input delivery mechanism at block level through PPP mode is urgently required. Intensification of agriculture without the use of external inputs, is leading to a serious problem of mining soil fertility.

Non-availability of irrigation water during lean period is the main reason of low cropping intensity. Creation and conservation of water resources is another important aspect of agricultural development. Year-round availability of water can play a great role in increasing resilience of mountain agriculture against the changing climatic scenario. Water and energy efficient integrated participatory watershed development, water harvesting and water saving techniques will have far reaching implications in increasing agricultural production and raising calorie intake in the rainfed ecosystem. The concept 'One Farmer - One Jalkund' should be popularized for rainwater harvesting. Roof water harvesting is quite common in EHR. For multiple use of this harvested water, after household utilization, the water should be made available for agricultural purposes. The extent of soil erosion is very high in hilly areas. Hence, low cost easily adoptable soil conservation measures should be popularized in these areas. Government should launch one Mission Mode Project on Soil and Water Conservation in EHR.

Besides popularizing technologies for promoting crop intensification, the region must give greater attention to agricultural diversification particularly towards intensive production of pulses, oilseeds, fruits, vegetables, flowers and other high value crops that are expected to increase income growth and generate effective demand for food. Diversification towards these high value and labour intensive commodities can provide adequate income and employment to the farmers dependent on small size of farms. Due importance should be given to quality and nutritional aspects as well.

So far the magic of globalization has not been felt in EHR. The globalization of agricultural sector will bring will bring to the farmers access to markets and new opportunities for employment and income generation. It will force the adoption of new technologies, shift production functions upwards and attract new capital into the deprived sector. In this context, organic farming is a viable option for keeping pace

with globalisation. EHR, especially NEH region has enormous scope for production and export of signature organic products, especially pineapple, turmeric, ginger, chilli and black rice. For development of organic sector in the state, emphasis should not only be given on formation of FPCs and promotion of the cluster based organic farming; but also on the establishment of organic nurseries, establishment of agri-preneurship for mass production of bio-organic inputs, inclusion of post harvest food safety in organic crop management plan, development of agri-export zone for identified organic products, promotion of Public-Private-People Partnership (PPPP) for production-processing-marketing (PPM) of organic produces under regional branding and development of dedicated infrastructure like storage, transport and packing stations for organic produces. Special attention should be given on organic production of GI tagged crops. More accent should be given on development of customized end-to-end supply chain capable of handling the organic produce from the farm gate to the end customer to eliminate wastage by integrating all activities from pre and post-harvest management to storage and logistics for the organic foods as well as management of demand supply imbalances in a better manner and elimination of inefficiency along the supply chain by reducing the number of intermediaries.

Climate Change has the potential to seriously derail the food production targets of the country. Assessing vulnerabilities of villages for climate variations is essential for building resilience of the people and their livelihoods. Hence, agriculture in a climate change context requires a multi-sectoral and multi-agency approach. Government policies, and the various departments and development agencies need to synchronize their efforts towards achieving sustainable agriculture productivity and food and nutrition security, particularly for the small and marginal farmer. 'Climate Proof Planning (CPP)' with greater integration with disaster preparedness or risk reduction is required for mainstreaming climate change action.

Effective climate smart technologies like climate-ready crop varieties, changing planting date, growing resistant/tolerant crops varieties, intensifying crop production, crop diversification, conservation agriculture, bio-organic management, nitrogenous fertilizer management, intercropping / multi-tier cropping, organic farming, integrated farming system, precision farming, protected cultivation, water-saving technologies, rain water harvesting, multiple use of water and soil conservation measures need to be demonstrated in larger scale. Integrated farming system and integrated watershed development should be the focal point for any climate change action, especially in hill regions. IFS approach can lead to a quantum jump in the productivity on a sustainable basis and ensure better livelihood securities to the people in fragile ecosystems. Such kind of approaches need to be undertaken with community involvement.

There is an urgent need to identify, conserve and characterize the indigenous crop varieties or livestock breed and reverse the loss of agro-biodiversity caused due to market drivers. Indigenous crops are more resilient to climate variations, generally meet the food preferences of communities and farmers having better knowledge of handling them, that make it more important to create measures to promote and revive such crops. 'National Seed Programme on Climate Resilient and Indigenous Varieties/Breeds of Crops and Livestock' therefore needs to be undertaken. Besides, dedicated funding is required on development of 'Contingent Seed Bank' in each and every district.

Current jhum area needs to be improved with site specific "Jhum Improvement Module (JIM)". Major emphasis should be given on suitable cropping system, introduction of

suitable varieties and scientific land use system to increase the jhum cycle. Residue management should be emphasized to maintain the soil fertility in jhum areas. Traditional institutions can be involved in this process. Central Government should launch a 'Jhum Improvement Project for North East India'.

Market driven secondary agricultural activities are of prime importance for sustaining the livelihood of the farming community through additional income generation. Various options for secondary agricultural activities include mushroom production & processing, bee-keeping & honey production, primary processing of horticultural crops, etc. All of these activities should be cluster based and integrated with suitable packaging facility and marketing network. However, such activities should be demand-driven, location-specific and participatory manner, considering gender specific needs as well as the priorities of indigenous communities. The role of biotechnology and nanotechnology in post-harvest management and value addition deserves special attention. Contract farming may be encouraged especially for medicinal herbs and signature horticultural crops and explore the possibilities of setting up farm-get processing plants.

For livestock sector, characterisation of indigenous livestock and poultry resources and their conservation need to be emphasised as there are many valuable genes for adaptability and disease resistance available in these animals. Besides, emphasis should be given on introduction of high yielding livestock and popularization of 'Participatory Livestock Breeding Unit'. There is a need for establishing District Level Artificial Insemination Facility, especially for pigs. Climate resilient breeds should be popularized with special emphasis on climate smart breeding strategies, production adjustment, herd management, grazing management, housing and feed management. Emphasis should be given towards on-farm manuring not only to minimize the emission of GHGs but also to increase the availability of organic source of nutrients for the crop husbandry. Non-availability of feed and fodder in sufficient quantity is one of the major bottlenecks for growth of the livestock sector. To ensure the year-round fodder availability, locally available feed and fodder resources need to be identified. Establishment of 'Community Fodder Farm' (CFF) and 'Dry Fodder Bank' (DFB) would not only be helpful to meet the fodder demand during lean period but will also minimize the free grazing problem during winter months.

Emergence of new diseases or trans-boundary diseases are gaining importance in recent time. Disease surveillance, monitoring and early warning system is one of the important steps for detection of trans-boundary and emerging diseases in livestock. 'Disease Referral Laboratory' or 'Disease Surveillance and Monitoring Laboratory' should be established in the state. Similarly, establishment or strengthening of Quarantine Stations is required at Check Gates in the border areas to restrict the movement of livestock.

In fishery, area which is unsuitable for crop production should be brought under fish farming. Participatory fish breeding unit and establishment of cold-water fish hatchery needs to be popularized. Protection and conservation measures for potential fish stocks are indispensable, especially for indigenous fish species. Establishment of 'Fish Seed Bank' (FSB) is another option for safeguarding the aquatic resources and popularizing the fish farming in the state. Special emphasis should be given on cold water fishery and species diversification. Paddy cum fish culture is already popular in the region. Composite fish culture and cage culture is also gaining momentum. Besides, studies on hydrobiology of different stretches of hill streams and lakes of upland need to be undertaken in addition to physiological changes and emerging diseases of fish in

relation with climate change.

The importance of circular economy or bioeconomy is increasing in agriculture and allied sector. Reduction of agricultural waste, produced at all stages from farm to plate, is essential, especially during the post-harvest stage. Decentralizing the storage facilities and improving storage possibilities along with localised value addition to perishable goods is essential and will reduce the carbon and water footprint simultaneously. Priority should be given on efficient waste recycling process to convert agricultural waste into productive resources.

Disaster Management is also closely related with agricultural development. The frequency and intensity of disasters such as floods, droughts, cyclones and landslide have increased in the recent years. Special effort should be made to generate appropriate technologies for increasing preparedness to predict and to manage the disasters. Effective and reliable information and communication systems, contingency planning, national and international mobilization of technologies and resources are a must. Dissemination of Community Based Disaster Management (CBDM) skills can play a crucial role. Experiences of other state/countries in prevention and management of the disasters should be shared. Formulation of contingent crop plan and establishment of contingent seed bank should be given prior importance.

Information is power and will underpin future progress and prosperity. Efforts must be made to strengthen the informatics in agriculture by exploiting the cyberspace through development of new databases, linking state databases with national databases and adding value to information to facilitate decision making at various levels. Development of production models for various agro-ecological regimes to forecast the production potential should assume greater importance. Using the remote sensing and GIS technologies, natural and other agricultural resources should be mapped at micro and macro levels and effectively used for land and water use planning as well as agricultural forecasting, market intelligence and e-business, contingency planning and prediction of disease and pest incidences. During COVID-19 pandemic, the entire world witnessed the power of digital platforms. To harness the still untapped potential of digital tools, dedicated focus is required on mobile or web-based ICT tools.

In hilly terrains, weather varies with altitude, location of the hills etc. and establishment of weather station at one location cannot represent the weather of entire district/zone. But preparedness for weather variations is critical. To better equip farmers to respond appropriately to climate variations and minimize risks, local automated weather stations at appropriate distances will help to generate locale-specific crop-weather advisories more efficiently; together with contingent crop plans specific to the district/sub-agri-climatic zone, they will increase the response capacity of farmers and will minimize losses. Dedicated 'National Programme on Climate Information and Early Warning Systems' would be helpful for decision making by the small and marginal farmers.

Small-mechanised tools, which minimize drudgery and do not reduce employment, but only add value to the working hours are needed to enhance labour productivity. There is also an urgent need for developing or popularizing women friendly tools and implements.

Improved institutional and credit support always increases rural employment opportunities. Expansion of micro credit programmes or SHG-Bank Linkage Programme should be encouraged among the small and marginal farmers including farm women for income-generation activities. More farmers should be brought under KCC coverage. Absence of proper land tenure system is one of the major constraints for the hill farmers to access the credit facility. Hence, codification

of customary land tenure system and recognition should be done in hills; whereas a land bank should be created in plain area to promote agro-industries. Investment (public or private) should be increased by many fold in agriculture and allied infrastructures, especially on irrigation, transport, storage and market infrastructure for sustaining the productivity and profitability of food crop production.

Institutions, Linkages and Monitoring Mechanisms

There are several agencies i.e. research, teaching and extension institutions in the realm of agriculture and allied enterprises functioning under the aegis of NARS in the EHR jurisdictional area, there exists a kind of functional relationships and linkages, however it is limited only to the extent of sharing of resources, infrastructure and upgrading of skill and knowledge through capacity building of low and middle level functionaries. However, there seems to be very feeble linkages among the networking institution with regard to sharing of information i.e. constraints and research priorities and conducting research by proposing joint research projects with an exception of AICRPS and AINPs within the EHR area. The major reason for this situation is lack of proper linkages with regard to exchange of information among the networking institutions. The present day research policy at each of these networking institutions is mostly project based budget for research projects and project is proposed individually by a scientist or individual scientist with one or two co-associates from within the same institution. Therefore, the research priorities are highly biased towards one's own line of work and commodity where one has already worked upon during post graduation and other higher studies, evincing interest in the field which can reward and bring name and fame to individual or line of work suitable and acceptable to a targeted journals with high impact factor, rather than appreciating real time constraints existing in the micro-farming situations that impact the farmers in terms of income, productivity, quality etc. To quote a few examples from the recent past there is a spurt multiplicity of research projects on carbon sequestration, molecular mapping and genomics in plant and animal genetics and molecular markers in plant and animal pest and disease management. The scientists fall prey and come under fallacy that such work is a flagship research and work on these lines always fetches him or her social esteem and elevate his or status in the peer group in the industry. Unfortunately the present system of evaluation of scientist is also a culprit in not setting priorities as per the problems at gross roots and hardly giving any weightage for a publication of popular article in vernacular language in local news paper or exclusive farmer's journal that has more relevance to target clientele and wider circulation and can reach farmers with much ease.

Looking into these issues and drawing clues from the preceding section the following interventions could be of immense use for fostering proper linkages among various institutions:

- It is necessary to create an exclusive network that could gather gross root level information on constraints, setting research priorities and set agenda and conduct research so as to avoid duplicity of projects and reduce the wastage of resources within the respective ACZ
- Once the network is created it is necessary to run the network by setting a proper frame work for fostering linkages, establish a vibrant monitoring and coordinating mechanism
- Major step in this direction could be constitution of various steering committees at EHR, ACZ, district and block levels by appropriately drawing human resources from research, extension and administration wings of the lead technology department of respective state governments at EHR, ACZ, district and block levels.

- There is a need to develop a work plan for individual functionary and in the similar manner there would be a plan of work for monitoring i.e. appraisal or work through obtaining of periodical reports, work plan for schedule of review meetings with precise timelines, arranging visits to project sites at periodical intervals, preparation of inventory of constraints and researchable areas and technology inventory with such attributes to match with micro-farming situations and farmers resource situation.
- Set agenda for frontline extension i.e. assess and/or assess and refine and demonstrate high impact and flagship technologies
- Backstop the development extension in line department of respective state governments by transferring high impact technologies along with transfer of skills, knowledge and improve the capacities of mid and low level department officials

Extension Mechanism

The extension mechanism in the realm of agriculture and allied sectors comprise of

1. Direct extension by the commodity institutions of NARs system, entities working under commodity boards (union and state governments) and bureaus
2. Front line extension through assessment, assessment and refinement of technologies, front line demonstration on various crops, skilling programmes for farmers, farm women, rural youth and extension functionaries and conducting outreach programmes viz. kisan mela, field days, etc. by KVKs
3. Direct or development or regular extension by conducting demonstrations, skilling programmes for farmers and farm women, organizing field days, kisan melas, farmers rallies, exhibitions, publishing leaflets and pamphlets, and outreach programmes through electronic media by the respective line departments in the field of agriculture, horticulture, animal husbandry, fisheries, poultry, sericulture, forestry etc.
4. In addition to above there is midwifery institution i.e. ATMA existing if not in all districts has the mandate to prepare and implement strategic research and extension plans.

It is pertinent to mention that ATMA is the only specialist agency having presence in district level and has the access and control over the line department to prepare and implement extension plans, coordinate and oversee the research and extension activities at district level and provide feedback to research agencies about the research priorities in the district. The ATMA has its own manpower and infrastructure to coordinate and oversee the extension activities at district, block and village level and has the some control on Village Level Workers (VLW). Hence ATMA can play a pivotal role for strengthening and coordinating the extension activities in the district as either District Collector or Project Director, DRDA or District Head, Dept. of Agriculture as the Chairman with all the heads of line department at district level as the members. Further, the KVK Head, SMS from ZARS of SAU, Manager, lead bank in the district and representatives from small scale industry, lead farmers from agriculture, animal husbandry and allied sectors etc. are also the members in ATMA Committee. Hence, it play a big role not only in preparing district level extension and research plans, oversee the activities right from gross root level, but also play pivotal role in obtaining much needed feedback from across various sectors and villages. However, as stated earlier the ATMA is present in only few districts (29 only) in the EHR states and there are four states Meghalaya, Sikkim, Tripura and Nagaland where ATMA is not in existence till date.

In order to strengthen extension system and make it vibrant in the EHR, it is imperative to consider the following policy measures on urgent basis:

- Establish ATMA in every district and give responsibility and function as lead technology agency to take stock of improved technologies available with research agencies
- Strengthening of the KVKs with modern tools/equipments for hill development in agriculture and allied sectors
- Deploy the flagship and high impact technologies in various micro-farming situations across the district through line departments
- Develop mobile and web based applications for use by KVKs, line department officials and farmers to **pave the way** for **farm and farmer specific expert advisory** instead of generalized advisory
- Arrange to collect and provide much needed feedback to researcher on the location specific problems across various micro-farming situations to provide better solutions
- Foreseeing the delay in establishing ATMA, the KVKs in the respective districts can be assigned with the responsibilities and functions of ATMA in the districts where ATMA is not present
- Capacity building programme should be crux of any developmental activity. Upgradation of skills of poor farmers in the areas of attitudinal changes to switch from a subsistence mindset towards commercialization, techno-managerial skills to enhance the productivity of agriculture and allied activities as well as to enhance production of non-conventional land based items like aromatic and medicinal plants, cane and bamboo cultivation, ornamental fish culture, pig breeding, minor forest products etc.
- Development of entrepreneurial skills particularly among the educated unemployed youth is necessary in the areas of secondary agriculture, processing and packaging, marketing and business, repair and maintenance, banking and insurance and eco-tourism at school and college level. Specific human resource and skill development programmes will make them better decision-makers and highly productive. Human resource development for increasing productivity of the farmers and rural youth should get high priority. Thus, knowledge and skill development of rural people in agriculture and allied sectors is essential for achieving economic and social goals.

Policy Perspectives

Formulation or improvement of state agricultural policy is of utmost importance. Many of the states in Eastern Himalayan Region do not have policy for agricultural and allied sector. The existing policies need to be revisited and reformulated to articulate a clear and long term vision on basic parameters of the agricultural sector like sustainability and natural resource management, institutional change, investment priorities, incentives and risk management, around which a policy framework must be developed and an inter-sectoral linkages are explicit. Policy document must spell out new approaches. There is a need to develop a consensus on investment themes, priorities and policies. Policy document must lend strength to the claim for greater investment in rural areas, and also re-examine its programmes in the light of complementarities. Farmers must be provided the necessary support, encouragement and incentives. It must focus both on income and greater on-farm and off-farm job and livelihood opportunities. Private investment in agriculture in the region has been slow and

must be stimulated with appropriate policy. Instead of crop-based programme, it is the high time to formulate policy for promoting 'System Based Programme'. The agriculture policy must accelerate all-round development and economic viability of agriculture in comprehensive terms.

Risk and uncertainty management is the emerging areas of modern agriculture. The design of insurance products should be such that they contribute to climate change adaptation. In other words, risk reduction should be rewarded upfront. Hence, instead of yield-based index for crop insurance, 'Weather Index Based Crop Insurance' should be introduced. For this, the crop insurance policy should be changed, and innovative approaches need to be adopted to link the farmer with insurance companies.

District headquarters/towns should be developed as 'Agri Growth Centre'. The block headquarters should be made as 'Rural Business Hub'. This includes connectivity improvement (all weather rural roads, agricultural link roads), storage infrastructure (warehouse, rural godown, cold chain), market (rural market, community pack house), power improvement (solar, hydro), farmers' field school (training centre), common service centre (information kiosk) and block level resource centre etc. This lays emphasis on the development of necessary socio-economic infrastructure for providing backward and forward linkages for production, value addition/processing and marketing of rural products thereby integrating the rural community with the rest of society. This, while facilitating the process of modernization of production sectors, would also pave the way for the promotion of a rural-urban continuum.

Above all, it is necessary to bridge the gap between expectations and performance by mobilizing social energies, forging and fostering creative and collaborative partnerships with civil society, target groups, stakeholders and grassroots institutions to induct people into the planning and implementation process in a participatory mode. Fortunately, most of the indigenous communities in EHR exhibit substantial social cohesion and the communities are willing to work in teams and groups. These social dynamics can and must be harnessed to accelerate the socio-economic development. Community mobilization envisages making the poor and the community at large aware of development programmes, organizing the poor to act in groups and nurturing group action. Therefore, social and community mobilization needs to be made mandatory both at the policy and implementation levels for all agricultural development programmes, backed by adequate funds and functionaries.

CHAPTER 7 RESEARCHABLE ISSUES

The R & D institutions play a key role in developing the economy of any country. These institutions have the mandate to identify the constraints to optimize the method of production and or process of production or both by prioritizing the researchable issues. Every R & D institutions has its own instrument of intelligence to devise the methods and means of formulating research projects and conduct research accordingly so as to bring innovation in product or process to optimize resource and increasing the production. In the similar manner, the R & D in agriculture domain in India is highly broad with network of commodity based institutions, research centers/regional stations, in the realm of National Agricultural Research System (NARS) comprising of ICAR institutions, State Agricultural Universities, Central Agricultural Universities, Deemed Universities and traditional universities with faculty in agriculture, horticulture and animal sciences. As enunciated in institutional mechanism there is vast network of institutions and gross root level agencies in EHR working relentlessly for the welfare and wellbeing of farmers, farm women and other rural based artisans by collating and prioritizing the research researchable issues and developing technologies accordingly. A look at the technology inventory discussed elsewhere in this document makes it very clear that there is no dearth of technologies to address the issues of each of the biophysical and socio-economic situation in the EHR region. However, there are some grey areas where not much work has been done and there exists tremendous scope to bring much needed improvements in agro-ecosystem in the region. An attempt has been made to collate and identify the researchable issues or grey areas and the same presented in Table 54.

Table 54. Agro-Climatic Sub-Zone wise and constraints wise researchable issues and target audience

ACSZ	Constraints	Researchable issues/ grey areas	Target group			
			Researcher	Extension worker	Policy maker	Development department
Alpine Zone	Continued moisture stress during the crop growth period	Characterization of moisture stress vis-à-vis crop lifecycle and yield loss estimation due to early, mid-season and terminal stress of various crops	Identifying the micro-farming situations and conducting the crop wise studies	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Nil **Development department:** Survey and data collection on agri-intelligence		
Alpine Zone	Rocky and undulating terrain with very less soil depth and poor nutrient status limits the yield and choice of crops	Characterization of agro-ecosystem with regard to nature of slope and extent and spread of rocky and steep slopes	Devise and standard protocol for hydrological studies and suggest suitable land shaping structures and standardize soil and land management practices including agro-forestry interventions to prevent generation of excess run off, increase the infiltration of water and safe disposal of runoff water, developing sustainable Integrated Farming System models	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to land shaping, land reclamation and rejuvenation **Development department:** Assessing the nature, extent and spread of rocky and steep slopes and develop infrastructure for land shaping and creating recreation facilities i.e. tourism		

Alpine Zone	Snow coverage and very low rainfall limit the choice of crops	Agro-ecosystem analysis on characterizing the climatic, bio-physical and socio-economic and cultural factors and assessing the length of growing season and possible introduction of suitable species, varieties and improved technology	Identification of crops and cropping systems and varieties, introduction of new crops and varieties and devising breeding programmes to develop new varieties	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create research facilities to support agriculture and allied sectors **Development department:** Creating necessary infrastructure at village level
Alpine Zone	Uncongenial temperature regime that limits agricultural and animal husbandry activities	Agro-ecosystem analysis on characterizing the climatic, bio-physical and socio-economic and cultural factors and assessing the length of growing season and possible introduction of suitable species, varieties and improved technology	Identification of crops and cropping systems and varieties, introduction of new crops and varieties and devising breeding programmes to develop new varieties	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create research facilities to support agriculture and allied sectors **Development department:** Creating necessary infrastructure at village level
Alpine Zone	Unique land tenure system that makes it difficult for brining the improvement in the agriculture and horticultural systems	Developing protocol and standardizing the soci-econometric study and scoping study on introducing the contract farming	Developing socio-econometric protocol and devise, test and standardize the survey instrument for assessment of land tenure system and suggest policy measures and developing Standard Operating Systems for Community/contract farming	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support and legislation and enactment of law for effective utilization of common property land for developing pastures, fodder, silvi-pastorial system etc. and contract/ community farming **Development department:** Crating village level infrastructure and building social capital for contract farming
Alpine Zone	Very short length of growing season and highly suitable for pastures and fodder grasses	Agro-ecosystem analysis on characterizing the climatic, bio-physical and socio-economic and cultural factors and assessing the length of growing season and possible introduction of suitable species, varieties and improved technology	Identification of crops and cropping systems and varieties, introduction of new crops and varieties and devising breeding programmes to develop new varieties	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create research facilities to support agriculture and allied sectors **Development department:** Creating necessary infrastructure at village level
Temperate Sub-Alpine Zone	Cool, moist and humid climate and continued wet regime leads higher incidences of pest and diseases leading high mortality	Characterization and quantification of yield and economic loss across different agro-climatic and farmers resource use regimes and devise and standard protocols for disease surveillance	Identifying target locations and conduct studies, develop protocol on survey and reporting to develop Animal Health Intelligence	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to develop Animal Health Intelligence and create infrastructure for veterinary health care **Development department:** Periodic disease surveillance for animal health intelligence

Temperate Sub-Alpine Zone	Infertility and anestrous leading to poor reproductive efficiency	Farmer resource based characterization of various factors by conducting bio-physical and socio-economic analysis	Delineation of factors and formulate preventive and curative measures to improve reproductive performance of various categories of animal species	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support through special scheme or project or programme **Development department:** Establishing social and physical infrastructure at village level
Temperate Sub-Alpine Zone	Lack of availability of improved seeds	Farmers resource based characterization of target ecosystem and identification of suitable varieties and breeding needs	Identification suitable varieties or developing strategy for varietal improvement by prioriting crops	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support for certified seed production by public and private agencies through special scheme or project or programme and enabling farmers to access for easy and quick institutional credit **Development department:** Estimating seed requirement at village, block and district level and establishing physical infrastructure at village level
Temperate Sub-Alpine Zone	Lack of green fodder and poor nutrition especially no feeding of concentrate feeds and poor milk, meat and egg production	Estimation of green fodder and concentrate feed requirements across various categories, identification of locally available agricultural and other commodities and devising balanced ration formula as per the resource situation of farmers	Devising balanced feed combination of green and dry fodder and locally available agri-based commodities at minimum cost	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support i.e. subsidy on readymade feeds and institutional credit **Development department:** Establishing social and physical infrastructure at village level
Temperate Sub-Alpine Zone	Lack of organized marketing and storage infrastructures viz. godowns, warehouses, pre-cooling, cold storage etc.	Socio-econometric analysis on channels of marketing i.e. individuals and institutions involved in trading of agricultural and livestock commodities and quantification of marketable surplus and volume of business involved and study on existing storage infrastructure at individual farmer and community level	Formation of farmers group viz, FPOs	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Addressing the policy issues through appropriate legislation and empowering regulatory agencies, policy support to build village level storage infrastructure **Development department:** Implementing and execution of programmes and projects and setting of social and physical infrastructure at village level
Temperate Sub-Alpine Zone	Lack of post harvesting infrastructure, lack of grading, packing etc.	Socio-econometric analysis on marketable surplus and volume of business involved and study on existing post harvest processing, grading and packing infrastructure at block level	Scoping study and market chain analysis, preparation of socio-metric analysis feasibility report with nature and quantum of processed foods and revenue generation	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to build necessary infrastructure in PPP model **Development department:** Implementing and execution of programmes and projects and setting of social and physical infrastructure at village level

Temperate Sub-Alpine Zone	Lack of suitable tools, implements and equipment for hill agriculture and horticulture	Crop/enterprise and cropping system based socio-metric and bio-physical analysis on nature and quantity energy needs, drudgery involved, availability of labour needs, requirement of improved tools, implements and equipment to optimize the labour needs and reduce drudgery	Establishment of Custom Hiring Centre (CHC) and providing implements	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support for establishment of custom hiring centers in PPP mode **Development department:** Setting of social and physical infrastructure for custom hiring centers
Temperate Sub-Alpine Zone	Lack of suitable varieties of crops and horticultural species and animals	Farmers resource based characterization of target ecosystem and identification of suitable varieties and breeding needs in crops and animal species	Identification suitable varieties and animal breeds or developing strategy for varietal or breed improvement by prioriting crops and animal species	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support for certified seed production and animal breeding farms by public and private agencies through special scheme or project or programme and enabling farmers to access for easy and quick institutional credit **Development department:** Estimating seed and improved animal breed requirements at village, block and district level and establishing physical infrastructure at village level
Temperate Sub-Alpine Zone	Lack of supply chain and logistic infrastructure i.e. roads, communication including telecommunication, power, transportation system, processing units, marketing etc.	Socio-metric analysis on quantum of flow of agricultural inputs and trade in agricultural commodities, impact of on loss to individuals, community at village, block and district level due to poor road, transportation system and poor power situation	Scoping study on supply chain management	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create necessary infrastructure in PPP model **Development department:** Appraising the policy makers and assisting the researcher on conducting socio-metric analysis
Temperate Sub-Alpine Zone	Mansoon recession, low water retention in soil profile, lack of irrigation leads to continued moisture stress for post rainy crops and rabi season crops	Bio-physical and socio-economic analysis on seasonality of rainfall, soil profile moisture retention characterization i.e. quantum and duration of availability of profile water, devising or modifying in-situ rainwater harvesting structures i.e. Jalkunds	Conducting hydrological studies on most viable models of low cost Jalkund as per the land and socio-economic resource profile of target farmers	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create necessary infrastructure i.e. build small to medium irrigation dams and subsidy support to farmer on creating Jalkunds **Development department:** Assessing the jalkund needs at village level and implement the subsidy schemes

Temperate Sub-Alpine Zone	Moderate rainfall, landslides, very high soil erosion, loss of top soil leading to land degradation	Bio-physical and socio-economic analysis on seasonality of rainfall, soil profile moisture retention characterization i.e. quantum and duration of availability of profile water, devising or modifying in-situ rainwater harvesting structures i.e. Jalkunds	Conducting hydrological studies on most viable models of low cost Jalkund as per the land and socio	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create necessary infrastructure i.e. build small to medium irrigation dams and subsidy support to farmer on creating Jalkunds **Development department:** Assessing the jalkund needs at village level and implement the subsidy schemes
Temperate Sub-Alpine Zone	Moderate snow coverage and short length of growing season limit the choice of crops	Agro-ecosystem analysis on characterizing the climatic, bio-physical and socio-economic and cultural factors and assessing the length of growing season and possible introduction of suitable species, varieties and improved technology	Identification of crops and cropping systems and varieties, introduction of new crops and varieties and devising breeding programmes to develop new varieties	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create research facilities to support agriculture and allied sectors **Development department:** Creating necessary infrastructure at village level
Temperate Sub-Alpine Zone	Poorly developed agricultural and veterinary extensions system	Assessing the agro-ecosystem and develop and or standardize methodology and survey instrument to identify the training and capacity building needs at gross root levels	Devise and standardize survey instrument and protocol to assess training and capacity building needs, social engineering to develop community based organizations to aid in agriculture and veterinary extension system	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create necessary infrastructure at gross root level **Development department:** To establish infrastructure at gross root level
Temperate Sub-Alpine Zone	Prevalence of high level of inbreeding and lack of artificial insemination leading poor breed improvement of indigenous species	Assessment on nature, extent and distribution animal inbreeding in cattle, small ruminants and other animal species and developing protocol and portable AI kits	Standardizing survey protocol and instrument on assessment of inbreeding in animals and AI needs in the region and suggest preventive and curative measures for reducing the inbreeding and AI for improving the indigenous breeds	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support for establishment of cattle breeding stations and AI infrastructure **Development department:** Village level estimation of AI requirements and conduct AI camps at frequent intervals
Temperate Sub-Alpine Zone	Rocky and undulating terrain with steep slopes, very less soil depth and poor nutrient status limits the yield and choice of crops	Characterization of agro-ecosystem with regard to nature of slope and extent and spread of rocky and steep slopes	Devise and standard protocol for hydrological studies and suggest suitable land shaping structures and standardize soil and land management practices including agro-forestry interventions to prevent generation of excess run off, increase the infiltration of water and safe disposal of runoff water, developing sustainable Integrated Farming System models	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to land shaping, land reclamation and rejuvenation **Development department:** Assessing the nature, extent and spread of rocky and steep slopes and develop infrastructure for land shaping and creating recreation facilities i.e. tourism

Temperate Sub-Alpine Zone	Subsistence farming, small volumes, no grading, no primary processing and poor quality of produce	Market chain analysis on farm and famer level, village, block and district level volumes of agricultural and horticultural commodities and prepare village, block and district level estimates on the quantum of volumes, manpower and infrastructure for grading, processing, storing, transportation and marketing and suggest measures for demand driven supply of agricultural and horticultural commodities	Research on market chain analysis and scoping study to suggest short, medium and long term strategy for establishment of supply chain and logistic infrastructure to facilitate fair trade and bring transparency in the marketing system	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create infrastructure for primary and secondary processing, improving storage including pre-cooling and refrigerated storage, transportation and marketing system and market intelligence **Development department:** Creating infrastructure and execute and implement the programmes/projects/ schemes
Temperate Sub-Alpine Zone	Unique land tenure system that makes it difficult for brining the improvement in the agriculture and horticultural systems	Developing protocol and standardizing the soci-econometric study and scoping study on introducing the contract farming	Developing socio-econometric protocol and devise, test and standardize the survey instrument for assessment of land tenure system and suggest policy measures and developing Standard Operating Systems for Community/contract farming	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support and legislation and enactment of law for effective utilization of common property land for developing pastures, fodder, silvi-pastorial system etc. and contract/ community farming **Development department:** Crating village level infrastructure and building social capital for contract farming
Sub-tropical Hill Zone	Apathy of farmers towards modern technologies	Socio-econometric study of target ecosystem and delineation of socio-economic, gender and cultural and religions factors leading to responsible for lack of response to use modern technologies	Assess behavioural biases for apathy of farmers towards modern technologies	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Nil **Development department:** Survey and data collection on agri-intelligence
Sub-tropical Hill Zone	Continued wet regime leading to higher incidences of pests, diseases and weeds	Individual pest and crop wise and bio-physical climatic situation wise characterization of frequency, intensity and nature and quantum of economic loss studies	Identifying micro-farming situations in each agro-ecological zone and conduct studies and surveys, develop the protocol and devise, test and standardize the survey instrument for developing Agri-intelligence	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Nil **Development department:** Survey and data collection on agri-intelligence
Sub-tropical Hill Zone	Cool, moist and humid climate and continued wet regime leads higher incidences of pest and diseases leading high mortality	Characterization and quantification of yield and economic loss across different agro-climatic and farmers resource use regimes and devise and standard protocols for disease surveillance	Identifying target locations and conduct studies, develop protocol on survey and reporting to develop Animal Health Intelligence	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to develop Animal Health Intelligence and create infrastructure for veterinary health care **Development department:** Periodic disease surveillance for animal health intelligence

Sub-tropical Hill Zone	Dominance of private traders in agricultural marketing and lack of market regulation or poor implantation of marketing acts	Socio-econometric analysis on channels of marketing i.e. individuals and institutions involved in trading of agricultural and livestock commodities and quantification of marketable surplus and volume of business involved	Scoping study and market chain analysis, preparation of socio-metric analysis feasibility report with nature and quantum of processed foods and revenue generation	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Addressing the policy issues through appropriate legislation and empowering regulatory agencies **Development department:** Implementing the market regulation at gross root level
Sub-tropical Hill Zone	Fragile ecosystem with rocky and undulating terrain with steep slopes, very less soil depth and poor nutrient status limits the yield and choice of crops	Seasonal analysis and characterization of agro-ecosystem with precise analysis on intensity, frequency and magnitude of problem and quantification of damage to crops and livestock	Preparation of comprehensive report by quantifying loss and recommendations for preventive and curative measures	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Devising a policy and devise a special programme/project **Development department:** Planning and execution of programme/project and handholding of beneficiaries through building/strengthening of community based organizations
Sub-tropical Hill Zone	Heavy rainfall, landslides, very high soil erosion, loss of top soil leading to land degradation	Seasonal analysis and characterization of agro-ecosystem with precise analysis on intensity, frequency and magnitude of problem and quantification of damage to crops and livestock	Preparation of comprehensive report by quantifying loss and recommendations for preventive and curative measures	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Devising a policy and devise a special programme/project **Development department:** Planning and execution of programme/project and handholding of beneficiaries through building/strengthening of community based organizations
Sub-tropical Hill Zone	High incidences of crop damage by wild animals	Bio-physical and socio-economic analysis and crop loss estimation studies`	Identifying representative locations and conducting the studies and devise preventive and curative measures and long term strategy	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy changes and modification of legislation on management of wildlife **Development department:** Planning and execution of programme/project and handholding of beneficiaries through building/strengthening of community based organizations
Sub-tropical Hill Zone	High level of indebtedness and poorly developed or lack of access to institutional credit systems	Socio-metric and bio-physical studies on indebtedness, sources of credit and quantification of credit requirements	Identifying the reasons of indebtness and less accessability to instutional credit systems	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy formulation through appropriate legislation to strengthen public sector agencies and increase the flow of institutional credit **Development department:** Setting of social and physical infrastructure and enabling the farmers to have easy and quick access to institutional credit
Sub-tropical Hill Zone	High prevalence of primitive agriculture i.e. jhum cultivation leading to land degradation	Socio-economic and bio-physical characterization of jhum farming systems and estimation of jhum area and characterization of jhum cycle	Identification of types jhum farming systems, quantification and estimation of loss due to biotic and abiotic stress i.e. excess and deficit moisture, nutrient stress, stress due pest, diseases, wildlife, weeds etc. and identifying most appropriate jhum-fallow cycles for sustainable production	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy formulation through appropriate legislation to recognize sustainable jhum system and institutional support to build resilience to the jhum ecosystem **Development department:** Implementing and execution of schemes/ projects/programmes

Sub-tropical Hill Zone	Infertility and anestrous leading to poor reproductive efficiency	Farmer resource based characterization of various factors by conducting bio-physical and socio-economic analysis	Delineation of factors and formulate preventive and curative measures to improve reproductive performance of various categories of animal species	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support through special scheme or project or programme **Development department:** Establishing social and physical infrastructure at village level
Sub-tropical Hill Zone	Lack of access to vaccination in animals	Identifying vaccination needs of various categories of animal species	Nil	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Formulation of state level policies for massive vaccination programme **Development department:** Establishing social and physical infrastructure at village level and conduct vaccination camps at frequent intervals
Sub-tropical Hill Zone	Lack of availability of improved seeds	Farmers resource based characterization of target ecosystem and identification of suitable varieties and breeding needs	Identification suitable varieties or developing strategy for varietal improvement by prioriting crops	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support for certified seed production by public and private agencies through special scheme or project or programme and enabling farmers to access for easy and quick institutional credit **Development department:** Estimating seed requirement at village, block and district level and establishing physical infrastructure at village level
Sub-tropical Hill Zone	Lack of green fodder and poor nutrition especially concentrate feeds leading to poor milk, meat and egg production	Estimation of green fodder and concentrate feed requirements across various categories, identification of locally available agricultural and other commodities and devising balanced ration formula as per the resource situation of farmers	Devising balanced feed combination of green and dry fodder and locally available agri-based commodities	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support i.e. subsidy on ready-made feeds and institutional credit **Development department:** Establishing social and physical infrastructure at village level
Sub-tropical Hill Zone	Lack of improved technologies especially in jhum areas i.e. sustainable cropping system, land management practices and length of jhum – fallow cycles	Socio-economic and bio-physical characterization of jhum farming systems and estimation of jhum area and characterization of jhum cycle	Deification of types jhum farming systems, quantification and estimation of loss due to biotic and abiotic stress i.e. excess and deficit moisture, nutrient stress, stress due pest, diseases, wildlife, weeds etc. and identifying most appropriate jhum-fallow cycles for sustainable production	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy formulation through appropriate legislation to recognize sustainable jhum system and institutional support to build resilience to the jhum ecosystem **Development department:** Implementing and execution of schemes/ projects/programmes

Sub-tropical Hill Zone	Lack of organized marketing and storage infrastructures viz. godowns, warehouses, pre-cooling, cold storage etc.	Socio-econometric analysis on channels of marketing i.e. individuals and institutions involved in trading of agricultural and livestock commodities and quantification of marketable surplus and volume of business involved and study on existing storage infrastructure at individual farmer and community level	Scoping study and market chain analysis, preparation of socio-metric analysis feasibility report with nature and quantum of processed foods and revenue generation	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Addressing the policy issues through appropriate legislation and empowering regulatory agencies, policy support to build village level storage infrastructure **Development department:** Implementing and execution of programmes and projects and setting of social and physical infrastructure at village level
Sub-tropical Hill Zone	Lack of post harvesting infrastructure, lack of grading, packing, secondary processing etc.	Socio-econometric analysis on marketable surplus and volume of business involved and study on existing post harvest processing, grading and packing infrastructure at block level	Scoping study and market chain analysis, preparation of socio-metric analysis feasibility report with nature and quantum of processed foods and revenue generation	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to build necessary infrastructure in PPP model **Development department:** Implementing and execution of programmes and projects and setting of social and physical infrastructure at village level
Sub-tropical Hill Zone	Lack of suitable tools, implements and equipment for hill agriculture and horticulture	Crop/enterprise and cropping system based socio-metric and bio-physical analysis on nature and quantity energy needs, drudgery involved, availability of labour needs, requirement of improved tools, implements and equipment to optimize the labour needs and reduce drudgery	New innovations or designing, testing of suitable tools, implements, equipment for hill and plain land agro-ecosystems	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support for establishment of custom hiring centers in PPP mode **Development department:** Setting of social and physical infrastructure for custom hiring centers
Sub-tropical Hill Zone	Lack of suitable varieties of crops and horticultural species and animals	Farmers resource based characterization of target ecosystem and identification of suitable varieties and breeding needs in crops and animal species	Identification suitable varieties and animal breeds or developing strategy for varietal or breed improvement by prioriting crops and animal species	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support for certified seed production and animal breeding farms by public and private agencies through special scheme or project or programme and enabling farmers to access for easy and quick institutional credit **Development department:** Estimating seed and improved animal breed requirements at village, block and district level and establishing physical infrastructure at village level

Sub-tropical Hill Zone	Lack of supply chain and logistic infrastructure i.e. roads, communication including telecommunication, power, transportation system, processing units, marketing etc.	Socio-metric analysis on quantum of flow of agricultural inputs and trade in agricultural commodities, impact of on loss to individuals, community at village, block and district level due to poor road, transportation system and poor power situation	Scoping study and market chain analysis, preparation of socio-metric analysis feasibility report with nature and quantum of processed foods and revenue generation	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create necessary infrastructure in PPP model **Development department:** Appraising the policy makers and assisting the researcher on conducting socio-metric analysis
Sub-tropical Hill Zone	Leaching of base salts and prevalence of high soil acidity	Characterization and quantification on leaching of bases and impact on soil acidity	Pilot project on soil acidity and recommendation of short, medium and long term preventive and curative measures	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to devise special scheme or programme or project **Development department:** Village level estimation of soil acidity problem and assessing the liming and or other reclamation input needs, establishing infrastructure at village level
Sub-tropical Hill Zone	Low productive indigenous cattle, goat, sheep, pig and apathy of farmers to introduce improved and exotic breeds	Farmers resource based characterization of target ecosystem and socio-econometric studies on reasons for lack of acceptance of local communities on improved breeds	Identification suitable animal breeds or developing strategy for breed improvement by prioriting needs	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support through special scheme or project or programme and enabling farmers to access for easy and quick institutional credit **Development department:** Creating necessary infrastructure at village level
Sub-tropical Hill Zone	Non-application of fertilizer nutrients and pesticides to control pests, diseases and weeds	Agro-ecosystem analysis to assess the fertility status with regard to soil physical and chemical characters, standardizing a protocol to collect soil samples i.e. number and frequency of soil samples and minimum distance between sampling locations across various agro-ecosystems and production systems and characterization of crop wise pest, disease and weed complexes and standardize a protocol for survey on frequency, intensity and incidence of native and invasive species and develop INM and IPM packages	Devise and standardize soil sampling protocol for physical and chemical parameters and incidence, frequency and intensity of occurrence of native and invasive species of pests and devise short, medium and long term preventive and curative measures to improve soil fertility and reduce incidence of pest, disease and weeds	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create permanent infrastructure at block level for agri-intelligence **Development department:** To collect soil, plant and water samples and analyze them at periodic intervals and to conduct pest, disease and weed incidences to aid in developing appropriate agri-intelligence at village level

Sub-tropical Hill Zone	Poorly developed agricultural and veterinary extensions system	Assessing the agro-ecosystem and develop and or standardize methodology and survey instrument to identify the training and capacity building needs at gross root levels	Devise and standardize survey instrument and protocol to assess training and capacity building needs, social engineering to develop community based organizations to aid in agriculture and veterinary extension system	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create necessary infrastructure at gross root level **Development department:** To establish infrastructure at gross root level
Sub-tropical Hill Zone	Poorly developed veterinary primary health care	Assessing the agro-ecosystem and mapping the existing veterinary health care system and devising a protocol for establishing a veterinary care system for a given number of animal population for a given square kilometers area	Develop and standardize a protocol for animal population density based number of veterinary health care system	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to establish requisite infrastructure **Development department:** To establish infrastructure at gross root level
Sub-tropical Hill Zone	Prevalence of high level of inbreeding and lack of artificial insemination leading poor breed improvement of indigenous species	Assessment on nature, extent and distribution animal inbreeding in cattle, small ruminants and other animal species and developing protocol and portable AI kits	Standardizing survey protocol and instrument on assessment of inbreeding in animals and AI needs in the region and suggest preventive and curative measures for reducing the inbreeding and AI for improving the indigenous breeds	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support for establishment of cattle breeding stations and AI infrastructure **Development department:** Village level estimation of AI requirements and conduct AI camps at frequent intervals
Sub-tropical Hill Zone	Quick mansoon recession, low water retention in soil profile, lack of irrigation facilities leads to continued moisture stress in post rainy season and rabi season crops	Bio-physical and socio-economic analysis on seasonality of rainfall, soil profile moisture retention characterization i.e. quantum and duration of availability of profile water, devising or modifying in-situ rainwater harvesting structures i.e. Jalkunds	Conducting hydrological studies on most viable models of low cost Jalkund as per the land and socio	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create necessary infrastructure i.e. build small to medium irrigation dams and subsidy support to farmer on creating Jalkunds **Development department:** Assessing the jalkund needs at village level and implement the subsidy schemes
Sub-tropical Hill Zone	Subsistence farming, small land holdings, small volumes, no grading, no primary processing and poor quality of produce	Market chain analysis on farm and famer level, village, block and district level volumes of agricultural and horticultural commodities and prepare village, block and district level estimates on the quantum of volumes, manpower and infrastructure for grading, processing, storing, transportation and marketing and suggest measures for demand driven supply of agricultural and horticultural commodities	Research on market chain analysis and scoping study to suggest short, medium and long term strategy for establishment of supply chain and logistic infrastructure to facilitate fair trade and bring transparency in the marketing system	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create infrastructure for primary and secondary processing, improving storage including pre-cooling and refrigerated storage, transportation and marketing system and market intelligence **Development department:** Creating infrastructure and execute and implement the programmes/projects/ schemes

Sub-tropical Hill Zone	Subsistence system of animal husbandry	Characterization of animal husbandry eco-system with regard to bio-physical, socio-economic and cultural and environmental traits and develop sustainable models for commercialization of animal husbandry in the region	Developing protocol for resource chain analysis and survey instrument and evolve suitable models for commercialization of animal husbandry in the model of cooperative dairy enterprise	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create enabling environment for fostering cooperative farming models in animal husbandry **Development department:** Creating village/block level chilling centers
Sub-tropical Hill Zone	Unique land tenure system that makes it difficult for bringing the improvement in the agriculture and horticultural systems	Developing protocol and standardizing the soci-econometric study and scoping study on introducing the contract farming	Developing socio-econometric protocol and devise, test and standardize the survey instrument for assessment of land tenure system and suggest policy measures and developing Standard Operating Systems for Community/contract farming	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support and legislation and enactment of law for effective utilization of common property land for developing pastures, fodder, silvi-pastorial system etc. and contract/ community farming **Development department:** Crating village level infrastructure and building social capital for contract farming
Sub-tropical Plain Zone	Alternate long wet and dry regimes leads to higher incidences of pests, diseases and weeds	Individual pest and crop wise and bio-physical climatic situation wise characterization of frequency, intensity and nature and quantum of economic loss studies	Identifying micro-farming situations in each agro-ecological zone and conduct studies and surveys, develop the protocol and devise, test and standardize the survey instrument for developing Agri-intelligence	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Nil **Development department:** Survey and data collection on agri-intelligence
Sub-tropical Plain Zone	Apathy of farmers towards modern technologies	Socio-econometric study of target ecosystem and delineation of socio-economic, gender and cultural and religions factors leading to responsible for lack of response to use modern technologies	Identifying micro-farming situations in each agro-ecological zone and conduct studies and surveys, develop the protocol and devise, test and standardize the survey instrument for developing Agri-intelligence	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Nil **Development department:** Survey and data collection on agri-intelligence
Sub-tropical Plain Zone	Cool, moist and humid climate and continued wet regime leads higher incidences of pest and diseases leading high mortality	Characterization and quantification of yield and economic loss across different agro-climatic and farmers resource use regimes and devise and standard protocols for disease surveillance	Identifying target locations and conduct studies, develop protocol on survey and reporting to develop Animal Health Intelligence	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to develop Animal Health Intelligence and create infrastructure for veterinary health care **Development department:** Periodic disease surveillance for animal health intelligence
Sub-tropical Plain Zone	Dominance of private traders in agricultural marketing and lack of market regulation or poor implantation of marketing acts	Socio-econometric analysis on channels of marketing i.e. individuals and institutions involved in trading of agricultural and livestock commodities and quantification of marketable surplus and volume of business involved	Scoping study and market chain analysis, preparation of socio-metric analysis feasibility report with nature and quantum of processed foods and revenue generation	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Addressing the policy issues through appropriate legislation and empowering regulatory agencies **Development department:** Implementing the market regulation at gross root level

Sub-tropical Plain Zone	Fragile ecosystem with poorly developed soils profile, sand and mud deposition, very less soil depth and poor nutrient status limits the yield and choice of crops	Seasonal analysis and characterization of agro-ecosystem with precise analysis on intensity, frequency and magnitude of problem and quantification of damage to crops and livestock	Preparation of comprehensive report by quantifying loss and recommendations for preventive and curative measures	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Devising a policy and devise a special programme/project **Development department:** Planning and execution of programme/project and handholding of beneficiaries through building/strengthening of community based organizations
Sub-tropical Plain Zone	Heavy rainfall and poor drainage leading to frequent floods and submergence of agricultural fields leading to land degradation	Seasonal analysis and characterization of agro-ecosystem with precise analysis on intensity, frequency and magnitude of problem and quantification of damage to crops and livestock	Preparation of comprehensive report by quantifying loss and recommendations for preventive and curative measures	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Devising a policy and devise a special programme/project **Development department:** Planning and execution of programme/project and handholding of beneficiaries through building/strengthening of community based organizations
Sub-tropical Plain Zone	High incidences of crop damage by wild animals	Bio-physical and socio-economic analysis and crop loss estimation studies`	Identifying representative locations and conducting the studies and devise preventive and curative measures and long term strategy	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy changes and modification of legislation on management of wildlife **Development department:** Planning and execution of programme/project and handholding of beneficiaries through building/strengthening of community based organizations
Sub-tropical Plain Zone	High level of indebtedness and poorly developed or lack of access to institutional credit systems	Socio-metric and bio-physical studies on indebtedness, sources of credit and quantification of credit requirements	Identifying representative locations and conducting studies and estimating credit needs village, block and district level using socio-metric formula	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy formulation through appropriate legislation to strengthen public sector agencies and increase the flow of institutional credit **Development department:** Setting of social and physical infrastructure and enabling the farmers to have easy and quick access to institutional credit
Sub-tropical Plain Zone	Infertility and anestrous leading to poor reproductive efficiency	Farmer resource based characterization of various factors by conducting bio-physical and socio-economic analysis	Delineation of factors and formulate preventive and curative measures to improve reproductive performance of various categories of animal species	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support through special scheme or project or programme **Development department:** Establishing social and physical infrastructure at village level
Sub-tropical Plain Zone	Lack of access to vaccination in animals	Identifying vaccination needs of various categories of animal species	Nil	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Formulation of state level policies for massive vaccination programme **Development department:** Establishing social and physical infrastructure at village level and conduct vaccination camps at frequent intervals

Sub-tropical Plain Zone	Lack of availability of improved seeds	Farmers resource based characterization of target ecosystem and identification of suitable varieties and breeding needs	Identification suitable varieties or developing strategy for varietal improvement by prioriting crops	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support for certified seed production by public and private agencies through special scheme or project or programme and enabling farmers to access for easy and quick institutional credit **Development department:** Estimating seed requirement at village, block and district level and establishing physical infrastructure at village level
Sub-tropical Plain Zone	Lack of green fodder and poor nutrition especially concentrate feeds leading to poor milk, meat and egg production	Estimation of green fodder and concentrate feed requirements across various categories, identification of locally available agricultural and other commodities and devising balanced ration formula as per the resource situation of farmers	Devising balanced feed combination of green and dry fodder and locally available agri-based commodities	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support i.e. subsidy on ready made feeds and institutional credit **Development department:** Establishing social and physical infrastructure at village level
Sub-tropical Plain Zone	Lack of organized marketing and storage infrastructures viz. godowns, warehouses, pre-cooling, cold storage etc.	Socio-econometric analysis on channels of marketing i.e. individuals and institutions involved in trading of agricultural and livestock commodities and quantification of marketable surplus and volume of business involved and study on existing storage infrastructure at individual farmer and community level	Scoping study and market chain analysis, preparation of socio-metric analysis feasibility report with nature and quantum of processed foods and revenue generation	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Addressing the policy issues through appropriate legislation and empowering regulatory agencies, policy support to build village level storage infrastructure **Development department:** Implementing and execution of programmes and projects and setting of social and physical infrastructure at village level
Sub-tropical Plain Zone	Lack of post harvesting infrastructure, lack of grading, packing, secondary processing etc.	Socio-econometric analysis on marketable surplus and volume of business involved and study on existing post harvest processing, grading and packing infrastructure at block level	Scoping study and market chain analysis, preparation of socio-metric analysis feasibility report with nature and quantum of processed foods and revenue generation	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to build necessary infrastructure in PPP model **Development department:** Implementing and execution of programmes and projects and setting of social and physical infrastructure at village level
Sub-tropical Plain Zone	Lack of suitable tools, implements and equipment for commercial agriculture and horticulture	Crop/enterprise and cropping system based socio-metric and bio-physical analysis on nature and quantity energy needs, drudgery involved, availability of labour needs, requirement of improved tools, implements and equipment to optimize the labour needs and reduce drudgery	New innovations or designing, testing of suitable tools, implements, equipment for hill and plain land agro-ecosystems	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support for establishment of custom hiring centers in PPP mode **Development department:** Setting of social and physical infrastructure for custom hiring centers

Sub-tropical Plain Zone	Lack of suitable varieties of crops and horticultural species that withstand excess moisture and deficit moisture stress	Farmers resource based characterization of target ecosystem, seasonal analysis of crop and cropping system based excess and deficit moisture i.e. early, late and mid season stress and identification of suitable varieties and breeding needs in crops including horticultural species	Identification crops and cropping systems and identification and prioritization of breeding needs and developing new varieties as per the nature of stress	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support for certified seed production by public and private agencies through special scheme or project or programme and enabling farmers to access for easy and quick institutional credit **Development department:** Estimating seed requirements at village, block and district level and establishing physical infrastructure at village level
Sub-tropical Plain Zone	Lack of supply chain and logistic infrastructure i.e. roads, communication including telecommunication, power, transportation system, processing units, marketing etc.	Socio-metric analysis on quantum of flow of agricultural inputs and trade in agricultural commodities, impact of on loss to individuals, community at village, block and district level due to poor road, transportation system and poor power situation	Scoping study and market chain analysis, preparation of socio-metric analysis feasibility report with nature and quantum of processed foods and revenue generation	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create necessary infrastructure in PPP model **Development department:** Appraising the policy makers and assisting the researcher on conducting socio-metric analysis
Sub-tropical Plain Zone	Low productive indigenous cattle, goat, sheep, pig and apathy of farmers to introduce improved and exotic breeds	Farmers resource based characterization of target ecosystem and socio-econometric studies on reasons for lack of acceptance of local communities on improved breeds	Identification suitable animal breeds or developing strategy for breed improvement by prioriting needs	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support through special scheme or project or programme and enabling farmers to access for easy and quick institutional credit **Development department:** Creating necessary infrastructure at village level
Sub-tropical Plain Zone	Non-application of fertilizer nutrients and pesticides to control pests, diseases and weeds	Agro-ecosystem analysis to assess the fertility status with regard to soil physical and chemical characters, standardizing a protocol to collect soil samples i.e. number and frequency of soil samples and minimum distance between sampling locations across various agro-ecosystems and production systems and characterization of crop wise pest, disease and weed complexes and standardize a protocol for survey on frequency, intensity and incidence of native and invasive species and develop INM and IPM packages	Devise and standardize soil sampling protocol for physical and chemical parameters and incidence, frequency and intensity of occurrence of native and invasive species of pests and devise short, medium and long term preventive and curative measures to improve soil fertility and reduce incidence of pest, disease and weeds	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create permanent infrastructure at block level for agri-intelligence **Development department:** To collect soil, plant and water samples and analyze them at periodic intervals and to conduct pest, disease and weed incidences to aid in developing appropriate agri-intelligence at village level

Sub-tropical Plain Zone	Poorly developed agricultural and veterinary extensions system	Assessing the agro-ecosystem and develop and or standardize methodology and survey instrument to identify the training and capacity building needs at gross root levels	Devise and standardize survey instrument and protocol to assess training and capacity building needs, social engineering to develop community based organizations to aid in agriculture and veterinary extension system	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create necessary infrastructure at gross root level **Development department:** To establish infrastructure at gross root level
Sub-tropical Plain Zone	Poorly developed veterinary primary health care	Assessing the agro-ecosystem and mapping the existing veterinary health care system and devising a protocol for establishing a veterinary care system for a given number of animal population for a given square kilometers area	Develop and standardize a protocol for animal population density based number of veterinary health care system	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to establish requisite infrastructure **Development department:** To establish infrastructure at gross root level
Sub-tropical Plain Zone	Prevalence of acid and saline and alkali soils	Characterization and quantification nature, extent and distribution of acid, saline and alkali soils	Pilot project on soil infirmities and recommendation of short, medium and long term preventive and curative measures	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to devise special scheme or programme or project **Development department:** Village mapping of nature, extent coverage and area under acidic, saline and alkali soils and liming and or other curative and soil amendments requirements and establishing infrastructure at village level
Sub-tropical Plain Zone	Prevalence of high level of inbreeding and lack of artificial insemination leading poor breed improvement of indigenous species	Assessment on nature, extent and distribution animal inbreeding in cattle, small ruminants and other animal species and developing protocol and portable AI kits	Standardizing survey protocol and instrument on assessment of inbreeding in animals and AI needs in the region and suggest preventive and curative measures for reducing the inbreeding and AI for improving the indigenous breeds	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support for establishment of cattle breeding stations and AI infrastructure **Development department:** Village level estimation of AI requirements and conduct AI camps at frequent intervals
Sub-tropical Plain Zone	Quick mansoon recession, low water retention in soil profile, lack of irrigation facilities leads to continued moisture stress in post rainy season and rabi season crops	Bio-physical and socio-economic analysis on seasonality of rainfall, soil profile moisture retention characterization i.e. quantum and duration of availability of profile water, devising or modifying in-situ rainwater harvesting structures i.e. Jalkunds	Conducting hydrological studies on most viable models of low cost Jalkund as per the land and socio	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create necessary infrastructure i.e. build small to medium irrigation dams and subsidy support to farmer on creating Jalkunds **Development department:** Assessing the jalkund needs at village level and implement the subsidy schemes

Sub-tropical Plain Zone	Subsistence farming, small land holdings, small volumes, no grading, no primary processing and poor quality of produce	Market chain analysis on farm and famer level, village, block and district level volumes of agricultural and horticultural commodities and prepare village, block and district level estimates on the quantum of volumes, manpower and infrastructure for grading, processing, storing, transportation and marketing and suggest measures for demand driven supply of agricultural and horticultural commodities	Research on market chain analysis and scoping study to suggest short, medium and long term strategy for establishment of supply chain and logistic infrastructure to facilitate fair trade and bring transparency in the marketing system	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create infrastructure for primary and secondary processing, improving storage including pre-cooling and refrigerated storage, transportation and marketing system and market intelligence **Development department:** Creating infrastructure and execute and implement the programmes/projects/ schemes
Sub-tropical Plain Zone	Subsistence system of animal husbandry	Characterization of animal husbandry eco-system with regard to bio-physical, socio-economic and cultural and environmental traits and develop sustainable models for commercialization of animal husbandry in the region	Developing protocol for resource chain analysis and survey instrument and evolve suitable models for commercialization of animal husbandry in the model of cooperative dairy enterprise	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create enabling environment for fostering cooperative farming models in animal husbandry **Development department:** Creating village/block level chilling centers
Sub-tropical Plain Zone	Uncontrolled and excess runoff water from hilly areas	Characterization of seasonality of high and moderate intense storms with regard to frequency, intensity and duration and quantification of runoff and its impact on soil erosion and flash floods in lower reaches	Developing protocol for resource analysis and standardizing the survey instrument for hydrological studies and develop predictive models for a given set of climate, soil and bio-physical regimes, suggest suitable site specific land shaping models and soil and land management practices using GIS tools	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create infrastructure for safe disposal of excess runoff, construction of mini and medium water reservoirs **Development department:** Creating village/block level and community based infrastructure for implementation of various projects/programmes/schemes on soil and water conservation
Sub-tropical Plain Zone	Unique land tenure system that makes it difficult for bringing the improvement in the agriculture and horticultural systems	Developing protocol and standardizing the soci-econometric study and scoping study on introducing the contract farming	Developing socio-econometric protocol and devise, test and standardize the survey instrument for assessment of land tenure system and suggest policy measures and developing Standard Operating Systems for Community/contract farming	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support and legislation and enactment of law for effective utilization of common property land for developing pastures, fodder, silvi-pastorial system etc. and contract/ community farming **Development department:** Crating village level infrastructure and building social capital for contract farming

Mild Tropical Hill Zone	Apathy of farmers towards modern technologies	Socio-econometric study of target ecosystem and delineation of socio-economic, gender and cultural and religions factors leading to responsible for lack of response to use modern technologies	Identifying micro-farming situations in each agro-ecological zone and conduct studies and surveys, develop the protocol and devise, test and standardize the survey instrument for developing Agri-intelligence	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Nil **Development department:** Survey and data collection on agri-intelligence
Mild Tropical Hill Zone	Continued wet regime leading to higher incidences of pests, diseases and weeds	Individual pest and crop wise and bio-physical climatic situation wise characterization of frequency, intensity and nature and quantum of economic loss studies	Identifying micro-farming situations in each agro-ecological zone and conduct studies and surveys, develop the protocol and devise, test and standardize the survey instrument for developing Agri-intelligence	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Nil **Development department:** Survey and data collection on agri-intelligence
Mild Tropical Hill Zone	Cool, moist and humid climate and continued wet regime leads higher incidences of pest and diseases leading high mortality	Characterization and quantification of yield and economic loss across different agro-climatic and farmers resource use regimes and devise and standard protocols for disease surveillance	Identifying target locations and conduct studies, develop protocol on survey and reporting to develop Animal Health Intelligence	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to develop Animal Health Intelligence and create infrastructure for veterinary health care **Development department:** Periodic disease surveillance for animal health intelligence
Mild Tropical Hill Zone	Dominance of private traders in agricultural marketing and lack of market regulation or poor implantation of marketing acts	Socio-econometric analysis on channels of marketing i.e. individuals and institutions involved in trading of agricultural and livestock commodities and quantification of marketable surplus and volume of business involved	Scoping study and market chain analysis, preparation of socio-metric analysis feasibility report with nature and quantum of processed foods and revenue generation	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Addressing the policy issues through appropriate legislation and empowering regulatory agencies **Development department:** Implementing the market regulation at gross root level
Mild Tropical Hill Zone	Fragile ecosystem with rocky and undulating terrain with steep slopes, very less soil depth and poor nutrient status limits the yield and choice of crops	Seasonal analysis and characterization of agro-ecosystem with precise analysis on intensity, frequency and magnitude of problem and quantification of damage to crops and livestock	Preparation of comprehensive report by quantifying loss and recommendations for preventive and curative measures	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Devising a policy and devise a special programme/project **Development department:** Planning and execution of programme/project and handholding of beneficiaries through building/strengthening of community based organizations
Mild Tropical Hill Zone	High incidences of crop damage by wild animals	Bio-physical and socio-economic analysis and crop loss estimation studies`	Identifying representative locations and conducting the studies and devise preventive and curative measures and long term strategy	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy changes and modification of legislation on management of wildlife **Development department:** Planning and execution of programme/project and handholding of beneficiaries through building/strengthening of community based organizations

Mild Tropical Hill Zone	High level of indebtedness and poorly developed or lack of access to institutional credit systems	Socio-metric and bio-physical studies on indebtedness, sources of credit and quantification of credit requirements	Identifying representative locations and conducting studies and estimating credit needs village, block and district level using socio-metric formula	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy formulation through appropriate legislation to strengthen public sector agencies and increase the flow of institutional credit **Development department:** Setting of social and physical infrastructure and enabling the farmers to have easy and quick access to institutional credit
Mild Tropical Hill Zone	High prevalence of primitive agriculture i.e. jhum cultivation leading to land degradation	Socio-economic and bio-physical characterization of jhum farming systems and estimation of jhum area and characterization of jhum cycle	Deification of types jhum farming systems, quantification and estimation of loss due to biotic and abiotic stress i.e. excess and deficit moisture, nutrient stress, stress due pest, diseases, wildlife, weeds etc. and identifying most appropriate jhum-fallow cycles for sustainable production	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy formulation through appropriate legislation to recognize sustainable jhum system and institutional support to build resilience to the jhum ecosystem **Development department:** Implementing and execution of schemes/ projects/programmes
Mild Tropical Hill Zone	High rainfall, landslides, very high soil erosion, loss of top soil leading to land degradation	Socio-economic and bio-physical characterization of jhum farming systems and estimation of jhum area and characterization of jhum cycle	Deification of types jhum farming systems, quantification and estimation of loss due to biotic and abiotic stress i.e. excess and deficit moisture, nutrient stress, stress due pest, diseases, wildlife, weeds etc. and identifying most appropriate jhum-fallow cycles for sustainable production	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy formulation through appropriate legislation to recognize sustainable jhum system and institutional support to build resilience to the jhum ecosystem **Development department:** Implementing and execution of schemes/ projects/programmes
Mild Tropical Hill Zone	Infertility and anestrous leading to poor reproductive efficiency	Farmer resource based characterization of various factors by conducting bio-physical and socio-economic analysis	Delineation of factors and formulate preventive and curative measures to improve reproductive performance of various categories of animal species	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support through special scheme or project or programme **Development department:** Establishing social and physical infrastructure at village level
Mild Tropical Hill Zone	Lack of access to vaccination in animals	Identifying vaccination needs of various categories of animal species	Nil	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Formulation of state level policies for massive vaccination programme **Development department:** Establishing social and physical infrastructure at village level and conduct vaccination camps at frequent intervals

Mild Tropical Hill Zone	Lack of availability of improved seeds	Farmers resource based characterization of target ecosystem and identification of suitable varieties and breeding needs	Identification suitable varieties or developing strategy for varietal improvement by prioriting crops	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support for certified seed production by public and private agencies through special scheme or project or programme and enabling farmers to access for easy and quick institutional credit **Development department:** Estimating seed requirement at village, block and district level and establishing physical infrastructure at village level
Mild Tropical Hill Zone	Lack of green fodder and poor nutrition especially concentrate feeds leading to poor milk, meat and egg production	Estimation of green fodder and concentrate feed requirements across various categories, identification of locally available agricultural and other commodities and devising balanced ration formula as per the resource situation of farmers	Devising balanced feed combination of green and dry fodder and locally available agri-based commodities	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support i.e. subsidy on ready made feeds and institutional credit **Development department:** Establishing social and physical infrastructure at village level
Mild Tropical Hill Zone	Lack of improved technologies especially in jhum areas i.e. sustainable cropping system, land management practices and length of jhum – fallow cycles	Socio-economic and bio-physical characterization of jhum farming systems and estimation of jhum area and characterization of jhum cycle	Deification of types jhum farming systems, quantification and estimation of loss due to biotic and abiotic stress i.e. excess and deficit moisture, nutrient stress, stress due pest, diseases, wildlife, weeds etc. and identifying most appropriate jhum-fallow cycles for sustainable production	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy formulation through appropriate legislation to recognize sustainable jhum system and institutional support to build resilience to the jhum ecosystem **Development department:** Implementing and execution of schemes/ projects/programmes
Mild Tropical Hill Zone	Lack of organized marketing and storage infrastructures viz. godowns, warehouses, pre-cooling, cold storage etc.	Socio-econometric analysis on channels of marketing i.e. individuals and institutions involved in trading of agricultural and livestock commodities and quantification of marketable surplus and volume of business involved and study on existing storage infrastructure at individual farmer and community level	Scoping study and market chain analysis, preparation of socio-metric analysis feasibility report with nature and quantum of processed foods and revenue generation	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Addressing the policy issues through appropriate legislation and empowering regulatory agencies, policy support to build village level storage infrastructure **Development department:** Implementing and execution of programmes and projects and setting of social and physical infrastructure at village level

Mild Tropical Hill Zone	Lack of post harvesting infrastructure, lack of grading, packing, secondary processing etc.	Socio-econometric analysis on marketable surplus and volume of business involved and study on existing post harvest processing, grading and packing infrastructure at block level	Scoping study and market chain analysis, preparation of socio-metric analysis feasibility report with nature and quantum of processed foods and revenue generation	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to build necessary infrastructure in PPP model **Development department:** Implementing and execution of programmes and projects and setting of social and physical infrastructure at village level
Mild Tropical Hill Zone	Lack of suitable tools, implements and equipment for hill agriculture and horticulture	Crop/enterprise and cropping system based socio-metric and bio-physical analysis on nature and quantity energy needs, drudgery involved, availability of labour needs, requirement of improved tools, implements and equipment to optimize the labour needs and reduce drudgery	New innovations or designing, testing of suitable tools, implements, equipment for hill and plain land agro-ecosystems	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support for establishment of custom hiring centers in PPP mode **Development department:** Setting of social and physical infrastructure for custom hiring centers
Mild Tropical Hill Zone	Lack of suitable varieties of crops and horticultural species and animals	Farmers resource based characterization of target ecosystem and identification of suitable varieties and breeding needs in crops and animal species	Identification suitable varieties and animal breeds or developing strategy for varietal or breed improvement by prioriting crops and animal species	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support for certified seed production and animal breeding farms by public and private agencies through special scheme or project or programme and enabling farmers to access for easy and quick institutional credit **Development department:** Estimating seed and improved animal breed requirements at village, block and district level and establishing physical infrastructure at village level
Mild Tropical Hill Zone	Lack of supply chain and logistic infrastructure i.e. roads, communication including telecommunication, power, transportation system, processing units, marketing etc.	Socio-metric analysis on quantum of flow of agricultural inputs and trade in agricultural commodities, impact of on loss to individuals, community at village, block and district level due to poor road, transportation system and poor power situation	Scoping study and market chain analysis, preparation of socio-metric analysis feasibility report with nature and quantum of processed foods and revenue generation	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create necessary infrastructure in PPP model **Development department:** Appraising the policy makers and assisting the researcher on conducting socio-metric analysis
Mild Tropical Hill Zone	Leaching of base salts and prevalence of high soil acidity	Characterization and quantification on leaching of bases and impact on soil acidity	Pilot project on soil acidity and recommendation of short, medium and long term preventive and curative measures	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to devise special scheme or programme or project **Development department:** Village level estimation of soil acidity problem and assessing the liming and or other reclamation input needs, establishing infrastructure at village level

Mild Tropical Hill Zone	Low productive indigenous cattle, goat, sheep, pig and apathy of farmers to introduce improved and exotic breeds	Farmers resource based characterization of target ecosystem and socio-econometric studies on reasons for lack of acceptance of local communities on improved breeds	Identification suitable animal breeds or developing strategy for breed improvement by prioriting needs	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support through special scheme or project or programme and enabling farmers to access for easy and quick institutional credit **Development department:** Creating necessary infrastructure at village level
Mild Tropical Hill Zone	Non-application of fertilizer nutrients and pesticides to control pests, diseases and weeds	Agro-ecosystem analysis to assess the fertility status with regard to soil physical and chemical characters, standardizing a protocol to collect soil samples i.e. number and frequency of soil samples and minimum distance between sampling locations across various agro-ecosystems and production systems and characterization of crop wise pest, disease and weed complexes and standardize a protocol for survey on frequency, intensity and incidence of native and invasive species and develop INM and IPM packages	Devise and standardize soil sampling protocol for physical and chemical parameters and incidence, frequency and intensity of occurrence of native and invasive species of pests and devise short, medium and long term preventive and curative measures to improve soil fertility and reduce incidence of pest, disease and weeds	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create permanent infrastructure at block level for agri-intelligence **Development department:** To collect soil, plant and water samples and analyze them at periodic intervals and to conduct pest, disease and weed incidences to aid in developing appropriate agri-intelligence at village level
Mild Tropical Hill Zone	Poorly developed agricultural and veterinary extensions system	Assessing the agro-ecosystem and develop and or standardize methodology and survey instrument to identify the training and capacity building needs at gross root levels	Devise and standardize survey instrument and protocol to assess training and capacity building needs, social engineering to develop community based organizations to aid in agriculture and veterinary extension system	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create necessary infrastructure at gross root level **Development department:** To establish infrastructure at gross root level
Mild Tropical Hill Zone	Poorly developed veterinary primary health care	Assessing the agro-ecosystem and mapping the existing veterinary health care system and devising a protocol for establishing a veterinary care system for a given number of animal population for a given square kilometers area	Develop and standardize a protocol for animal population density based number of veterinary health care system	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to establish requisite infrastructure **Development department:** To establish infrastructure at gross root level
Mild Tropical Hill Zone	Prevalence of high level of inbreeding and lack of artificial insemination leading poor breed improvement of indigenous species	Assessment on nature, extent and distribution animal inbreeding in cattle, small ruminants and other animal species and developing protocol and portable AI kits	Standardizing survey protocol and instrument on assessment of inbreeding in animals and AI needs in the region and suggest preventive and curative measures for reducing the inbreeding and AI for improving the indigenous breeds	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support for establishment of cattle breeding stations and AI infrastructure **Development department:** Village level estimation of AI requirements and conduct AI camps at frequent intervals

Mild Tropical Hill Zone	Quick mansoon recession, low water retention in soil profile, lack of irrigation facilities leads to continued moisture stress in post rainy season and rabi season crops	Bio-physical and socio-economic analysis on seasonality of rainfall, soil profile moisture retention characterization i.e. quantum and duration of availability of profile water, devising or modifying in-situ rainwater harvesting structures i.e. Jalkunds	Conducting hydrological studies on most viable models of low cost Jalkund as per the land and socio-economic resource profile of target farmers	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create necessary infrastructure i.e. build small to medium irrigation dams and subsidy support to farmer on creating Jalkunds **Development department:** Assessing the jalkund needs at village level and implement the subsidy schemes
Mild Tropical Hill Zone	Subsistence farming, small land holdings, small volumes, no grading, no primary processing and poor quality of produce	Market chain analysis on farm and famer level, village, block and district level volumes of agricultural and horticultural commodities and prepare village, block and district level estimates on the quantum of volumes, manpower and infrastructure for grading, processing, storing, transportation and marketing and suggest measures for demand driven supply of agricultural and horticultural commodities	Research on market chain analysis and scoping study to suggest short, medium and long term strategy for establishment of supply chain and logistic infrastructure to facilitate fair trade and bring transparency in the marketing system	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create infrastructure for primary and secondary processing, improving storage including pre-cooling and refrigerated storage, transportation and marketing system and market intelligence **Development department:** Creating infrastructure and execute and implement the programmes/projects/ schemes
Mild Tropical Hill Zone	Subsistence system of animal husbandry	Characterization of animal husbandry eco-system with regard to bio-physical, socio-economic and cultural and environmental traits and develop sustainable models for commercialization of animal husbandry in the region	Developing protocol for resource chain analysis and survey instrument and evolve suitable models for commercialization of animal husbandry in the model of cooperative dairy enterprise	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create enabling environment for fostering cooperative farming models in animal husbandry **Development department:** Creating village/block level chilling centers
Mild Tropical Hill Zone	Unique land tenure system that makes it difficult for brining the improvement in the agriculture and horticultural systems	Developing protocol and standardizing the soci-econometric study and scoping study on introducing the contract farming	Developing socio-econometric protocol and devise, test and standardize the survey instrument for assessment of land tenure system and suggest policy measures and developing Standard Operating Systems for Community/contract farming	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support and legislation and enactment of law for effective utilization of common property land for developing pastures, fodder, silvi-pastorial system etc. and contract/ community farming **Development department:** Creating village level infrastructure and building social capital for contract farming

Mild Tropical Plain Zone	Alternate long wet and dry regimes leads to higher incidences of pests, diseases and weeds	Individual pest and crop wise and bio-physical climatic situation wise characterization of frequency, intensity and nature and quantum of economic loss studies	Identifying micro-farming situations in each agro-ecological zone and conduct studies and surveys, develop the protocol and devise, test and standardize the survey instrument for developing Agri-intelligence	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Nil **Development department:** Survey and data collection on agri-intelligence
Mild Tropical Plain Zone	Apathy of farmers towards modern technologies	Socio-econometric study of target ecosystem and delineation of socio-economic, gender and cultural and religions factors leading to responsible for lack of response to use modern technologies	Identifying micro-farming situations in each agro-ecological zone and conduct studies and surveys, develop the protocol and devise, test and standardize the survey instrument for developing Agri-intelligence	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Nil **Development department:** Survey and data collection on agri-intelligence
Mild Tropical Plain Zone	Cool, moist and humid climate and continued wet regime leads higher incidences of pest and diseases leading high mortality	Characterization and quantification of yield and economic loss across different agro-climatic and farmers resource use regimes and devise and standard protocols for disease surveillance	Identifying target locations and conduct studies, develop protocol on survey and reporting to develop Animal Health Intelligence	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to develop Animal Health Intelligence and create infrastructure for veterinary health care **Development department:** Periodic disease surveillance for animal health intelligence
Mild Tropical Plain Zone	Dominance of private traders in agricultural marketing and lack of market regulation or poor implantation of marketing acts	Socio-econometric analysis on channels of marketing i.e. individuals and institutions involved in trading of agricultural and livestock commodities and quantification of marketable surplus and volume of business involved	Scoping study and market chain analysis, preparation of socio-metric analysis feasibility report with nature and quantum of processed foods and revenue generation	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Addressing the policy issues through appropriate legislation and empowering regulatory agencies **Development department:** Implementing the market regulation at gross root level
Mild Tropical Plain Zone	Fragile ecosystem with poorly developed soils profile, sand and mud deposition, very less soil depth and poor nutrient status limits the yield and choice of crops	Seasonal analysis and characterization of agro-ecosystem with precise analysis on intensity, frequency and magnitude of problem and quantification of damage to crops and livestock	Preparation of comprehensive report by quantifying loss and recommendations for preventive and curative measures	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Devising a policy and devise a special programme/project **Development department:** Planning and execution of programme/project and handholding of beneficiaries through building/strengthening of community based organizations
Mild Tropical Plain Zone	Heavy rainfall and poor drainage leading to frequent floods and submergence of agricultural fields leading to land degradation	Seasonal analysis and characterization of agro-ecosystem with precise analysis on intensity, frequency and magnitude of problem and quantification of damage to crops and livestock	Preparation of comprehensive report by quantifying loss and recommendations for preventive and curative measures	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Devising a policy and devise a special programme/project **Development department:** Planning and execution of programme/project and handholding of beneficiaries through building/strengthening of community based organizations

Mild Tropical Plain Zone	High incidences of crop damage by wild animals	Bio-physical and socio-economic analysis and crop loss estimation studies`	Identifying representative locations and conducting the studies and devise preventive and curative measures and long term strategy	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy changes and modification of legislation on management of wildlife **Development department:** Planning and execution of programme/project and handholding of beneficiaries through building/strengthening of community based organizations
Mild Tropical Plain Zone	High level of indebtedness and poorly developed or lack of access to institutional credit systems	Socio-metric and bio-physical studies on indebtedness, sources of credit and quantification of credit requirements	Identifying representative locations and conducting studies and estimating credit needs village, block and district level using socio-metric formula	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy formulation through appropriate legislation to strengthen public sector agencies and increase the flow of institutional credit **Development department:** Setting of social and physical infrastructure and enabling the farmers to have easy and quick access to institutional credit
Mild Tropical Plain Zone	Infertility and anestrous leading to poor reproductive efficiency	Farmer resource based characterization of various factors by conducting bio-physical and socio-economic analysis	Delineation of factors and formulate preventive and curative measures to improve reproductive performance of various categories of animal species	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support through special scheme or project or programme **Development department:** Establishing social and physical infrastructure at village level
Mild Tropical Plain Zone	Lack of access to vaccination in animals	Identifying vaccination needs of various categories of animal species	Nil	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Formulation of state level policies for massive vaccination programme **Development department:** Establishing social and physical infrastructure at village level and conduct vaccination camps at frequent intervals
Mild Tropical Plain Zone	Lack of availability of improved seeds	Farmers resource based characterization of target ecosystem and identification of suitable varieties and breeding needs	Identification suitable varieties or developing strategy for varietal improvement by prioriting crops	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support for certified seed production by public and private agencies through special scheme or project or programme and enabling farmers to access for easy and quick institutional credit **Development department:** Estimating seed requirement at village, block and district level and establishing physical infrastructure at village level
Mild Tropical Plain Zone	Lack of green fodder and poor nutrition especially concentrate feeds leading to poor milk, meat and egg production	Estimation of green fodder and concentrate feed requirements across various categories, identification of locally available agricultural and other commodities and devising balanced ration formula as per the resource situation of farmers	Devising balanced feed combination of green and dry fodder and locally available agri-based commodities	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support i.e. subsidy on readymade feeds and institutional credit **Development department:** Establishing social and physical infrastructure at village level

Mild Tropical Plain Zone	Lack of organized marketing and storage infrastructures viz. godowns, warehouses, pre-cooling, cold storage etc.	Socio-econometric analysis on channels of marketing i.e. individuals and institutions involved in trading of agricultural and livestock commodities and quantification of marketable surplus and volume of business involved and study on existing storage infrastructure at individual farmer and community level	Scoping study and market chain analysis, preparation of socio-metric analysis feasibility report with nature and quantum of processed foods and revenue generation	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Addressing the policy issues through appropriate legislation and empowering regulatory agencies, policy support to build village level storage infrastructure **Development department:** Implementing and execution of programmes and projects and setting of social and physical infrastructure at village level
Mild Tropical Plain Zone	Lack of post harvesting infrastructure, lack of grading, packing, secondary processing etc.	Socio-econometric analysis on marketable surplus and volume of business involved and study on existing post harvest processing, grading and packing infrastructure at block level	Scoping study and market chain analysis, preparation of socio-metric analysis feasibility report with nature and quantum of processed foods and revenue generation	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to build necessary infrastructure in PPP model **Development department:** Implementing and execution of programmes and projects and setting of social and physical infrastructure at village level
Mild Tropical Plain Zone	Lack of suitable tools, implements and equipment for commercial agriculture and horticulture	Crop/enterprise and cropping system based socio-metric and bio-physical analysis on nature and quantity energy needs, drudgery involved, availability of labour needs, requirement of improved tools, implements and equipment to optimize the labour needs and reduce drudgery	New innovations or designing, testing of suitable tools, implements, equipment for hill and plain land agro-ecosystems	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support for establishment of custom hiring centers in PPP mode **Development department:** Setting of social and physical infrastructure for custom hiring centers
Mild Tropical Plain Zone	Lack of suitable varieties of crops and horticultural species that withstand excess moisture and deficit moisture stress	Farmers resource based characterization of target ecosystem, seasonal analysis of crop and cropping system based excess and deficit moisture i.e. early, late and mid season stress and identification of suitable varieties and breeding needs in crops including horticultural species	Identification crops and cropping systems and identification and prioritization of breeding needs and developing new varieties as per the nature of stress	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support for certified seed production by public and private agencies through special scheme or project or programme and enabling farmers to access for easy and quick institutional credit **Development department:** Estimating seed requirements at village, block and district level and establishing physical infrastructure at village level

Mild Tropical Plain Zone	Lack of supply chain and logistic infrastructure i.e. roads, communication including telecommunication, power, transportation system, processing units, marketing etc.	Socio-metric analysis on quantum of flow of agricultural inputs and trade in agricultural commodities, impact of on loss to individuals, community at village, block and district level due to poor road, transportation system and poor power situation	Scoping study and market chain analysis, preparation of socio-metric analysis feasibility report with nature and quantum of processed foods and revenue generation	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create necessary infrastructure in PPP model **Development department:** Appraising the policy makers and assisting the researcher on conducting socio-metric analysis
Mild Tropical Plain Zone	Low productive indigenous cattle, goat, sheep, pig and apathy of farmers to introduce improved and exotic breeds	Farmers resource based characterization of target ecosystem and socio-econometric studies on reasons for lack of acceptance of local communities on improved breeds	Identification suitable animal breeds or developing strategy for breed improvement by prioriting needs	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support through special scheme or project or programme and enabling farmers to access for easy and quick institutional credit **Development department:** Creating necessary infrastructure at village level
Mild Tropical Plain Zone	Non-application of fertilizer nutrients and pesticides to control pests, diseases and weeds	Agro-ecosystem analysis to assess the fertility status with regard to soil physical and chemical characters, standardizing a protocol to collect soil samples i.e. number and frequency of soil samples and minimum distance between sampling locations across various agro-ecosystems and production systems and characterization of crop wise pest, disease and weed complexes and standardize a protocol for survey on frequency, intensity and incidence of native and invasive species and develop INM and IPM packages	Devise and standardize soil sampling protocol for physical and chemical parameters and incidence, frequency and intensity of occurrence of native and invasive species of pests and devise short, medium and long term preventive and curative measures to improve soil fertility and reduce incidence of pest, disease and weeds	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create permanent infrastructure at block level for agri-intelligence **Development department:** To collect soil, plant and water samples and analyze them at periodic intervals and to conduct pest, disease and weed incidences to aid in developing appropriate agri-intelligence at village level
Mild Tropical Plain Zone	Poorly developed agricultural and veterinary extensions system	Assessing the agro-ecosystem and develop and or standardize methodology and survey instrument to identify the training and capacity building needs at gross root levels	Devise and standardize survey instrument and protocol to assess training and capacity building needs, social engineering to develop community based organizations to aid in agriculture and veterinary extension system	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create necessary infrastructure at gross root level **Development department:** To establish infrastructure at gross root level

Mild Tropical Plain Zone	Poorly developed veterinary primary health care	Assessing the agro-ecosystem and mapping the existing veterinary health care system and devising a protocol for establishing a veterinary care system for a given number of animal population for a given square kilometers area	Develop and standardize a protocol for animal population density based number of veterinary health care system	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to establish requisite infrastructure **Development department:** To establish infrastructure at gross root level
Mild Tropical Plain Zone	Prevalence of high level of inbreeding and lack of artificial insemination leading poor breed improvement of indigenous species	Assessment on nature, extent and distribution animal inbreeding in cattle, small ruminants and other animal species and developing protocol and portable AI kits	Standardizing survey protocol and instrument on assessment of inbreeding in animals and AI needs in the region and suggest preventive and curative measures for reducing the inbreeding and AI for improving the indigenous breeds	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support for establishment of cattle breeding stations and AI infrastructure **Development department:** Village level estimation of AI requirements and conduct AI camps at frequent intervals
Mild Tropical Plain Zone	Prevalence of soil acidity and salinity of alkalinity	Characterization and quantification nature, extent and distribution of acid, saline and alkali soils	Pilot project on soil infirmities and recommendation of short, medium and long term preventive and curative measures	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to devise special scheme or programme or project **Development department:** Village mapping of nature, extent coverage and area under acidic, saline and alkali soils and liming and or other curative and soil amendments requirements and establishing infrastructure at village level
Mild Tropical Plain Zone	Quick mansoon recession, low water retention in soil profile, lack of irrigation facilities leads to continued moisture stress in post rainy season and rabi season crops	Bio-physical and socio-economic analysis on seasonality of rainfall, soil profile moisture retention characterization i.e. quantum and duration of availability of profile water, devising or modifying in-situ rainwater harvesting structures i.e. Jalkunds	Conducting hydrological studies on most viable models of low cost Jalkund as per the land and socio-economic resource profile of target farmers	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create necessary infrastructure i.e. build small to medium irrigation dams and subsidy support to farmer on creating Jalkunds **Development department:** Assessing the jalkund needs at village level and implement the subsidy schemes
Mild Tropical Plain Zone	Subsistence farming, small land holdings, small volumes, no grading, no primary processing and poor quality of produce	Market chain analysis on farm and famer level, village, block and district level volumes of agricultural and horticultural commodities and prepare village, block and district level estimates on the quantum of volumes, manpower and infrastructure for grading, processing, storing, transportation and marketing and suggest measures for demand driven supply of agricultural and horticultural commodities	Research on market chain analysis and scoping study to suggest short, medium and long term strategy for establishment of supply chain and logistic infrastructure to facilitate fair trade and bring transparency in the marketing system	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create infrastructure for primary and secondary processing, improving storage including pre-cooling and refrigerated storage, transportation and marketing system and market intelligence **Development department:** Creating infrastructure and execute and implement the programmes/projects/ schemes

Mild Tropical Plain Zone	Subsistence system of animal husbandry	Characterization of animal husbandry eco-system with regard to bio-physical, socio-economic and cultural and environmental traits and develop sustainable models for commercialization of animal husbandry in the region	Developing protocol for resource chain analysis and survey instrument and evolve suitable models for commercialization of animal husbandry in the model of cooperative dairy enterprise	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create enabling environment for fostering cooperative farming models in animal husbandry **Development department:** Creating village/block level chilling centers
Mild Tropical Plain Zone	Uncontrolled and excess runoff from hilly areas	Characterization of seasonality of high and moderate intense storms with regard to frequency, intensity and duration and quantification of runoff and its impact on soil erosion and flash floods in lower reaches	Developing protocol for resource analysis and standardizing the survey instrument for hydrological studies and develop predictive models for a given set of climate, soil and bio-physical regimes, suggest suitable site specific land shaping models and soil and land management practices using GIS tools	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support to create infrastructure for safe disposal of excess runoff, construction of mini and medium water reservoirs **Development department:** Creating village/block level and community based infrastructure for implementation of various projects/programmes/schemes on soil and water conservation
Mild Tropical Plain Zone	Unique land tenure system that makes it difficult for brining the improvement in the agriculture and horticultural systems	Developing protocol and standardizing the soci-econometric study and scoping study on introducing the contract farming	Developing socio-econometric protocol and devise, test and standardize the survey instrument for assessment of land tenure system and suggest policy measures and developing Standard Operating Systems for Community/contract farming	**Extension worker:** Social engineering in target ecosystem and awareness building **Policy maker:** Policy support and legislation and enactment of law for effective utilization of common property land for developing pastures, fodder, silvi-pastorial system etc. and contract/community farming **Development department:** Crating village level infrastructure and building social capital for contract farming

CHAPTER 8 RECOMMENDATIONS

The TFC constituted for EHR vide its meeting held under the Chairmanship Dr. Anupam Mishra, Hon'ble Vice-Chancellor, CAU, Imphal and under the stewardship of Dr. V. K. Mishra, the learned Director, ICAR RC NEH, Umiam on 15th February, 2022 had a series of deliberations, gathered some basic information and has worked out strategy on mapping the profile of various ACSZ in the realm of EHR, presenting the information on current scenario of agriculture and allied sectors, analysis of constraints and researchable issues across various ACSZs and mapping of institutional mechanisms within the ACSZ. The committee has left no stone unturned to collate the information and arrange the same as per the ACSZ as hardly any information especially district level is available with any single source with an exception to area production and productivity of major agricultural, horticultural and livestock commodities. The information on constraints and researchable issues presented in the report is based on information presented by various participating institutions in the committee meeting held during February and the information available across various websites of respective NARs network including the KVKs and North East Databank. Having done the analysis on various constraints and institutional mechanisms and the linkages especially the information flow, sharing of resources, inter-organization research project proposal, work-sharing mechanisms on common activities, troubleshooting mechanisms vis-à-vis the common agenda and sharing of responsibilities with regard to role play especially on terms and references of the TFC on ACZ, the **Committee proposes the following recommendation**:

1. Establishment of an independent network institution in the name and style of **AICRP on Agri-business Research Intelligence (AICRP-ABRI)** under the aegis of NARS. It will be a new, independent and autonomous body especially of the status of a **Bureau** or **Commission** at national/ACZ level with **statutory powers** so as to effectively coordinate with state government machinery or else **to establish ATMA in each district with mandate of RBI** in the realm of agriculture and allied sectors. Development of Standard Operating Procedure (**SOP**) with proper attributes and tags for **ABRI** in line with the comments, suggestions, notes and remarks elsewhere in this document and collate and triangulate through ground truthing through periodic surveys, field visits, diagnostic tours, focused group discussions and household surveys and organizing state level, district level and ACZSZ wise meetings, obtaining and appraising quarterly reports etc.
2. There is a dearth of grass root level information with regard to farm and farmer-wise inventory of assets i.e. land, livestock and other animal species, buildings viz. animal sheds, implement sheds, mushrooms unit, sericulture unit, vermi-composting unit, threshing yards, grain storage structures, tools, implements and other farm equipment, tube wells, open wells, water bodies, historical data i.e. farm wise season wise crops and cropping system etc., which is of utmost significance for proper recommendation of improved technologies as per the micro-farming situation and farmer resource situation specific agro-advisory, creation of a web and mobile based software i.e. **Farm and Farmer Inventory** (**FFI**) for the use by researchers, extension workers and line department officials. Further, sending proper directions to respective

state line department to collect and upload the farm and farmer wise data through appropriate higher authority in the respective Union and State Governments is essential.

3. There is no systematic documentation of improved technologies i.e. improved seeds, breeds and species, other improved technologies that augment production, productivity and income across various enterprises i.e. crops, horticulture, livestock, poultry, fisheries and other important enterprises vis-à-vis and its applicability or suitability for a particular micro-farming situation for a particular given constraint. Therfore, **website** on **ABI** for researchers and extension workers and **Agri-business Technology Inventory** (**ABTI**) for extension agents, farmers and other innovator in the domain or agriculture and allied enterprises is necessary.

4. There is need of creating a midwifery interface or network of research, education, AICRPs/AINPs and extension institutes, centre, agencies within the arena of NARS with mandates identification, planning , execution, monitoring and impact evaluation of projects of utmost relevance in each of ACSZ to shun duplicity and redundancy in research. Therefore, creation of a network within the ACSZ in the name and style as **Zonal Interface for Teaching Research and Education for Network Projects** (ZITRENR) to be directly attached to lead state or central agricultural university within the ACZ is essential.

5. There exists strong frontline extension system within NARs and KVKs, however there seems to be some gaps or shortcomings with regard to development extension at grass root level as more than 80% of the districts in the ACZ have not established ATMA which is interfacing and nodal agency of development extension at grass root level. Hence, there is **necessity of establishing ATMA in every district,** sending appropriate directions from the highest authority to respective state governments.

6. Entrusting the mandate of ATMA to the district level Head in the department of agriculture and make the KVKs to participate in the monthly, quarterly, half yearly and annual meetings to facilitate the process of technology delivery at gross root level and a direction to that extent should go to the appropriate authority in the respective state governments.

7. Creation of **Farm and Famers Inventory** (FFI) and ABTI, since the development extension is very feeble and necessary for extensive use of the Information and Communication Technology for outreach activities i.e. farm and farmer specific advisory through FFI and ABTI platform under the aegis of KVKs in the respective district to augment shortage of ATMA, manpower, infrastructure and financial resources.

8. It is necessary to build a module called **Technology Foot Print Interface** (TFPI) to map the spread of technologies across various micro-farming situations and needs to build TFPI module with appropriate attributes to map the technology spread and visualization on GIS platform and a mechanism to upscale the technology usage across various extrapolation domains so as to bring accountability, transparency and visibility to individual and institutions.

9. Formation of **Task Force On Land Degradation** under the aegis of North East Council and by pulling the resource persons from NARS (hydrology, soil and water conservation, forestry, agronomy, soil science etc.) and line departments. Further, the **Task Force** should have

the mandate of characterization of soil erosion in terms of seasonality, quantum, frequency and intensity of erosion with concomitant impact on the production, productivity of ecosystem, loss of man days, loss of income and burden on state exchequer and come out with short, medium and long term preventive and curative measures and come out with a special project/programme with activities that can curtail the land degradation in EHZ states.

10. It is necessary to characterize the rainfall, soil hydrological and physical parameters, natural drains, possible areas to collect and store rain and runoff water and identify and classify areas based on impact into high, medium and low category by using suitable GIS tools by proposing pilot project with the involvement of research and development department personal in the respective disciplines. Proposal for a multi-disciplinary and multi-sector **Pilot Project on Rain Water Harvesting Engineering** under the aegis of North East Council with the above said objectives. Suggest short, medium and long preventive and curative measures to mitigate water stress by construction of small and medium scale water storage reservoirs at suitable and high impact locations.

11. Evaluation of efforts especially the in-situ water conservation technique Jalkund and **Integrated Farming System** (IFS) model by researchers deserves special attention from policy perspective and at the same time guidelines to researchers to develop a mobile based calculator or ready reckoner to specify the size of Jalkund and size and combination of enterprises for a given set of bio-physical and climatic factors and socio-economic resource condition of farmer and by suitably defining and standardizing all the attributes to get final output in the form of nature, size combination and package of practices for sustainable intensification of resource use and productivity. Therefore, formulation of appropriate policy especially in the nature of, if not a project but a scheme or programme with ample built in subsidy component is necessary. Further, a mobile and or web based software application can be developed that has the capability of **geo-fencing** and can also act as calculator or ready reckoner to suggest size and combination of enterprises for Jalkund and IFS Model for a given set of farmers conditions.

12. As water is a precious commodity especially in hill based agro-ecosystems and therefore this aspect deserves special attention of policy makers, researchers and development department officials, there should be extensive use of Jalkund technology to harvest and store runoff and rain water. There is need to introduce sensor based micro-irrigation especially drip and sprinkler systems in hill based agro-ecosystems. Hence, **Feasibility Study** on large scale introducing micro-irrigation in the region by appropriate agency by looping an appropriate suitable private firm so as to give effect to policy support by formulating a special scheme on micro-irrigation to foster overall growth in hill based agriculture can be done.

13. There is necessity to have a special and network projects looking into the massive area covered under jhum in EHZ and elsewhere in other states in India and formation of **AICRP on Jhum Farming** (AICRPOJF) under the aegis of NARS to generate informations and come out with appropriate short, medium and long term preventive and curative measures for sustainable crop intensification. Further, there needs to be **geo-fencing** by appropriate state government agency for mapping of

jhum lands in terms of individual and community centric acreage under jhum land across various villages, blocks and districts and a direction to that effect shall be sent under the signature of appropriate to the respective state governments.

14. Considering existence of immense wetland lands across various EHZ states, however it feels necessary to initially map and characterize wet land in terms of area covered under various categories of wetlands, seasonality of wet, moist and dry regimes including the depth of wetlands, sources of wetness, acreage of wetland across villages, blocks and districts, title and type of ownership, current status and nature of utilization and system of management, input and output flows including flow of revenue etc. by an appropriate agency. Formation of **Task Force on Wetland Ecosystems** under the aegis of North East Council with the mandate of mapping and effective utilization of wetlands and appropriate policy on short, medium and long term strategy for conservation and effective utilization of wetlands. Further, formulation of **Network Project on Wetland Ecosystem** (NPOWE) to generate scientific information and devising of improved management practices for sustainable utilization of wetland is desirable.

15. The Committee is appreciative of progress in organic and natural farming front by the NARS network, however while lamenting on the paucity of information on supply chain analysis with regard to flow of inputs and energy, supply and demand, existing institutional mechanisms in the arena of infrastructure development, capacity building, marketing and trading, regulatory and quality control including product certification and consumer preferences. Therefore, **Scoping Study** and **Supply Chain Analysis** on organically or naturally grown foods by appropriate agency having known requisite expertise to enable demand driven production of organic commodities in the region is essential.

16. The EHZ is an abode of organic farming in the Country and several commodities that have high value as organic products are being grown in the region. However, when it comes to the sale of such products, the farmers face the issue of product quality and certification. The interaction of Committee with various stakeholders in EHZ is revealed that there is hardly any quality testing laboratories in the region. Hence, the Committee strongly recommends for establishment of Quality Testing Laboratories for assessing the residues of various agricultural chemicals and heavy metal in the agricultural produce and agricultural inputs under the aegis of respective state government on priority. Therefore, it is essential to establish quality control laboratory/state of the art facilities for organic, agricultural and livestock produce and inputs since this region has potential for organic faming.

17. The Committee envisages an institution or body or an agency with a mandate of proper and systematic mapping, cataloguing, conserving and needful provisioning service to appropriate R & D agencies in the realm of agriculture, horticulture, forestry, animal husbandry etc. Proper legislation and policy decision on declaring the region as **Niche Global Bio-Diversity Region** (NGBDR) that curtail, prohibit, restrain and fetter certain human activities that pose threat to bio-diversity and at the same time to allow certain activities for effective utilization of genetic resources for the common good. Further, establishment of a **Bureau** or **Commission** or **Board** with statutory and regulatory powers

to implement, monitor, coordinate and oversee various activities and give policy direction to the administrators is necessary.

18. Seed and planting material multiplication and supply by state seed farms and or by private industry in PPP model. **Scoping Study and Supply Chain Analysis on Seed Chain** by an appropriate agency to suggest short, medium and long term measures to overcome shortage of seed and planting material and supply of improved breeds or special of animal and suggest enabling mechanism for community level seed production.

19. The small scale farm mechanization need to be introduced in hill based agriculture and animal husbandry sectors. However, there is paucity of information on type, nature and magnitude of farm activities and also information on the improved tools, implements, equipment and machinery. Further, the small land holding size in hilly areas is also a limitation. In order to augment the paucity of information on farm mechanization, supply chain analysis on farm mechanization in hilly based agro-ecosystems including custom hiring mechanism by appropriate agency to suggest short, medium and long term measures to overcome the issue of labour shortage, reduction of human drudgery and facilitate perform farm operation in timely manner with increased precision. Policy support more in the manner of a scheme or programme or project and policy guidelines for formalizing the **Custom Hiring** of improved tools, implements, equipment, machinery etc. more in the nature of PPP model to perpetuate the benefits at gross root level.

20. It is lamented that lack of employment opportunities in the rural front is the prime reason for such an unabated migration and therefore this aspect warrant special attention of policy personnel, researchers and development departments and private industry. Identifying and creating proper employment opportunities in the near vicinity is need of the day. The primary and secondary processing of agri-based and livestock based commodities can can provide several employment avenues in the region as EHR has several signature commodities i.e. king chilli, bird eye chilli, khasi mandarin, pineapple, large cardamom, ginger, turmeric, jackfruit, bamboo etc. Other enterprises that has the potential of employment generation include seed production, apiculture, fishery, duckery, poultry, goatery, piggery, sericulture, mushrooms, mushroom spwan production, lac farming, grading, packing, marketing, trading, warehousing transportation, pre-cooling, cold-storage etc.

21. Shortage and costly animal feeds especially the concentrate feeds is impacting the production and productivity of livestock based commodities i.e. milk, meat and eggs, the committee feels it necessary to conduct a feasibility study more in nature of Scoping Study and Supply and Value Chain Analysis so as to assess the fodder and feed requirement of various categories of animal species, readiness of farmers to focus on concentrate feeds and readiness of feed industry to produce locally and supply feed and feed supplements at cost effective prices in the region. **Scoping Study** on supply chain and market analysis of feed and feed supplements and suggesting measures for short, medium and long term measures to develop mechanism to produce locally and supply locally and globally. The **Committee** also recommends for **policy support** and evolving a mechanism for manufacturing locally and supply the same to farmers

at cost effective prices more in nature of public private partnership model.

22. Declining trend in population of buffalo, goat, sheep populations during the last decade is of the view that this aspect needs attention policy personnel, researchers and development department in the respective state government. And whilst the livestock census data (20th Livestock Census) reveals only number and not the causes or reasons and factors responsible for this grim situation. Hence, formation of **Task Force on Dwindling Animal Resources** (TFODAR) under the aegis of North East Council with a mandate to have a comprehensive analysis of situation, reasons thereof and to suggest short, medium and long term preventive and curative measures to bring back normalcy in the sector.

23. Since the region has Alpine Zone (>3500 m) and Temperate Sub-Alpine Zone (1500 – 3500 m), there is scope and potential for cold water fisheries in the high alitudue region. Thus the **committee recommends** to stuy the feasiablity of cultivation of cold water fisheries in the selected areas through pilot study and further populatization in collboration with relevant instititutaions.

24. The EHZ province shares about 4500 km of highly sensitive and porous international border with five countries viz. Tibet, Bhutan, China, Myanmar and Bangladesh. This gives scope for intense and close interaction between human beings, domestic and wildlife animals and therefore therein lays a great risk and threat for emergence and spreading of trans-boundary diseases. This is most evident considering the repeated outbreaks of avian influenza, sporadic outbreaks of Nipah, PRRS, SARS, West Nile and Swine flu in the region. Looking into seriousness of the issue the **Committee** therefore **recommends of establishment of a statutory body** with quarantine function more in nature of **Bureau or Board or Commission** with a mandate of assessment, reporting and characterization of etiological agents and suggest short, medium and long term strategy and preventive and curative measures on curtailing the tarns-boundary diseases.

25. Formulation of multi-institutional and multi-agency network project on Climate Change in EHR to characterize the climate change by conducting simulation studies and developing climate models under the aegis of IMD and NEH Council so as to predict the climate change effects on agriculture, horticulture, animal husbandry and economy of in the region and suggest short, medium and long term preventive and curative methods to cope up with climate change.

26. The Committee recognized the need for increasing the living standards of people and ensuring inclusive growth across various sections of citizens with a view to improve India's global ranking with regard to Human Development Index (HDI). By taking clues from the recent initiatives of union government i.e. Transformation of Aspirational Districts, the Committee felt that one way to increase the income from agricultural sector is identifying signature products of EHZ and do value addition that could generate revenue to region. Therefore, the Committee strongly recommends for setting up of requisite logistic and supply chain infrastructure in place for speedy implementation of Hon'ble Prime Minister's initiative i.e. One District-One Product (ODOP) by the respective state governments on urgent basis. The special produce and products specific to the ACZ need to be promoted through entrepreneurship and business networking for national and international markets.

27. The EHZ share borders with several countries that go without saying that there is scope for fostering international and cross border trade with regard to agricultural commodities more specially the organic commodities. In order to compete with the similar products from other countries more particularly the Myanmar and Bangladesh, there is a need to develop massive infrastructure especially the capacity building, secondary and postharvest processing and logistic and supply chain infrastructure in the region. Hence, the Committee strongly recommends for establishment such infrastructure by the respective state government by harnessing the funds provided under Act East Policy of Government Of India

28. In view of paucity of information on quantification and magnitude of economic loss incurred in the regions by virtue of lack of investments, concomitant poor infrastructure development and income revenue loss at village, block and district levels so as to properly appreciate the issue and suggest suitable policy measures in this direction. Hence, **Scoping Study** under the aegis lead SAU and North East Council so as to appraise the policy makers to slightly modify the law by setting in motion legislative process to the extent that at least the new law should make a provision for allocation of land to private sector agencies engaged in infrastructure development on lease for about 50 years or make a provision to develop infrastructure on Build, Operate and Transfer (BOT) model and also providing legal status for contract farming in the region.

29. Government of India came out with a scheme called "Tribal Sub-Plan (TSP)" for enhancing income and livelihood of tribal population in the country through technological intervention. Similarly the Government of India devised a scheme called "Scheduled Caste Sub-Plan (SCSP)" to give a thrust to family oriented schemes for economic development of scheduled caste families below poverty line. Under these two programs, several government agencies (both central and state including ICAR institutes) have been providing various critical inputs and disseminate improved technologies in the agriculture and allied sector so as to increase the productivity of crops and livestock species, reduce drudgery and economic wellbeing of these targeted communities. Accordingly, there are many technologies/varieties/ scientific practice have been demonstrated and popularized, which enhance the income and livelihood of the target populations in the region. However, it is needs to develop mechanism/model through community participatory mode for effective and judicious utilization of allocated funds under the program, besides efficient implementation of the program and self-sustainability and Atma Nirbhar of tribal society in the region.

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CHAPTER 10 ABBREVIATIONS

EHR	Eastern Himalayan Region
NE	North East
NEHR	North East Hilly Region
ACZ	Agro-Climatic Zone
ACSZ	Agro-Climatic Sub-Zone
TFC	Task Force Committee
EHZ	Eastern Himalayan Zone
ITK	Indigenous Technical/Traditional Knowledge
FPO	Farmers Producer Organisation
NER	North Eastern Region
NES	North Eastern States
MSL	Mean Sea Level
AMSL	Above Mean Sea Level
Km	Kilometer
ha	Hectare
m	Metre
mm	Millimeter
ET	Evapotranspiration
t	Tonne
MT	Metric tonne
Mt	Megatonne
MOVCD	Mission Organic Value Chain Development
AEZ	Agri-Export Zone
IHR	Indian Himalayan Region
ICT	Information and Communication Technology
MU	Million Unit
MW	Megawatt
SRR	Seed Replacement Rate
kW	Kilowatt

AI	Artificial Insemination
NARS	National Agricultural Research System
PSR	Polymerase Spiral Reaction
KVK	Krishi Vigyan Kendra
ATMA	Agricultural Technology Management Agency
SOPs	Standard Operating Procedures
VLW	Village Level Workers
RBI	Research Business Intelligence
FFI	Farm and Farmer Inventory
ZITRENR	Zonal Interface for Teaching Research and Education for Network Projects
TFPI	Technology Foot Print Interface
IFS	Integrated Farming System
NPOWE	Network Project on Wetland Ecosystem
NGBDR	Niche Global Bio-Diversity Region
TFODAR	Task Force on Dwindling Animal Resources
BOT	Build, Operate and Transfer

CHAPTER 11 CONTRIBUTORS

1	Dr. D.J. Rajkhowa, ICAR RC for NEH Region, Nagaland
2	Dr. Shaon K. Das, ICAR RC for NEH Region, Sikkim
3	Dr. Deepak Jhajharia, College of Agricultural Engineering & Post-Harvest Technology, CAU, Sikkim
4	Dr. Debasish Chakraborty, ICAR RC for NEH Region, Meghalaya
5	Dr. S. Hazarika, ICAR RC for NEH Region, Meghalaya
6	Dr. Dwipendra Thakuria, College of Post-Graduate Studies in Agril. Sciences, CAU, Meghalaya
7	Dr. L. Nabachandra Singh, College of Agriculture, CAU, Manipur
8	Dr. B.K. Sethy, ICAR RC for NEH Region, Meghalaya
9	Dr. B.C. Kusre, College of Agricultural Engineering & Post-Harvest Technology, CAU, Sikkim
10	Dr. U.S. Saikia, ICAR-NBSS-LUP, Assam
11	Er. K. Ajaykumar, ICAR RC for NEH Region, Meghalaya
12	Dr. A.K. Vashisht, College of Agricultural Engineering & Post-Harvest Technology, CAU, Sikkim
13	Dr. Anup Das, ICAR RC for NEH Region, Tripura
14	Dr. Jayanta Layek, ICAR RC for NEH Region, Meghalaya
15	Dr. Bikram Singh, College of Horticulture & Forestry, CAU, Arunachal Pradesh
16	Dr. Sankar Mayanglangbam, College of Horticulture & Forestry, CAU, Arunachal Pradesh
17	Dr. U.K. Behera, Dean, College of Agriculture, Meghalaya
18	Dr. Vishram Ram, College of Post-Graduate Studies in Agril. Sciences, CAU, Meghalaya
19	Dr. B.U. Choudhury, ICAR RC for NEH Region, Meghalaya
20	Dr. Saurav Saha, ICAR RC for NEH Region, Sikkim
21	Dr. N.S. Chauhan, College of Agricultural Engineering & Post-Harvest Technology, CAU, Sikkim
22	Dr. G.T. Patle, College of Post-Graduate Studies in Agril. Sciences, CAU, Meghalaya
23	Dr. Wricha Tyagi, Dean, College of Post-Graduate Studies in Agril. Sciences, CAU, Meghalaya

24	Dr. K. Noren Singh, College of Post-Graduate Studies in Agril. Sciences, CAU, Meghalaya
25	Dr. S. P. Das, ICAR RC for NEH Region, Tripura
26	Dr. Mayank Rai, College of Post-Graduate Studies in Agril. Sciences, CAU, Meghalaya
27	Dr. I.M. Singh, ICAR RC for NEH Region, Manipur
28	Dr. Lobsang Wangchu, College of Horticulture & Forestry, CAU, Arunachal Pradesh
29	Dr. Pankaj Baiswar, ICAR RC for NEH Region, Meghalaya
30	Dr. Sandip Patra, ICAR RC for NEH Region, Meghalaya
31	Dr. Pranab Dutta, College of Post-Graduate Studies in Agril. Sciences, CAU, Meghalaya
32	Dr. B.N. Hazarika, Dean, College of Horticulture & Forestry, CAU, Arunachal Pradesh
33	Dr. Nangsol Dolma Bhutia, Dr. Lobsang Wangchu, College of Horticulture & Forestry, CAU, Arunachal Pradesh
34	Dr. Deepak Jhajharia, College of Agricultural Engineering & Post-Harvest Technology, CAU, Sikkim
35	Dr. S.K. Pattanaik, College of Horticulture & Forestry, CAU, Arunachal Pradesh
36	Dr. Arun Kumar Phurillatpam, College of Horticulture & Forestry, CAU, Arunachal Pradesh
37	Dr. Tara Singh Mehra, College of Horticulture & Forestry, CAU, Arunachal Pradesh
38	Dr. Nilay Kumar, College of Horticulture & Forestry, CAU, Arunachal Pradesh
39	Dr. N.S. Chauhan, College of Agricultural Engineering & Post-Harvest Technology, CAU, Sikkim
40	Dr. S.K. Satpathy, College of Agricultural Engineering & Post-Harvest Technology, CAU, Sikkim
41	Dr. Ng. Joykumar Singh, Dean, College of Food Technology, CAU, Manipur
42	Dr. Sujata Jena, College of Agricultural Engineering & Post-Harvest Technology, CAU, Sikkim
43	Dr. Said Prashant P, College of Agricultural Engineering & Post-Harvest Technology, CAU, Sikkim
44	Dr. G. Kadirvel, ICAR RC for NEH Region, Meghalaya
45	Dr. L. Hmar, Dean, College of Veterinary Sc. & AH, CAU, Mizoram
46	Dr. Girin Kalita, College of Veterinary Sc. & AH, CAU, Mizoram
47	Dr. S. Doley, ICAR RC for NEH Region, Mizoram

48	Dr. A.K. Samanta, College of Veterinary Sc. & AH, CAU, Mizoram
49	Dr. Joseph Koireng, AICRP, Forage Crops, COA, Manipur
50	Dr. A. Sen, ICAR RC for NEH Region, Meghalaya
51	Dr. S. Ghatak, ICAR RC for NEH Region, Meghalaya
52	Dr. T.K. Dutta, College of Veterinary Sc. & AH, CAU, Mizoram
53	Dr. S.K. Das, ICAR RC for NEH Region, Meghalaya
54	Dr. R.K. Saha, Dean, College of Fisheries, CAU, Tripura
55	Dr. A.B. Patel, College of Fisheries, CAU, Tripura
56	Dr. S. Khogen Singh, College of Fisheries, CAU, Tripura
57	Dr. Pradyut Biswas, College of Fisheries, CAU, Tripura
58	Dr. S.C. Mandal, College of Fisheries, CAU, Tripura
59	Dr. Rajesh Kumar, Director, ATARI, Assam
60	Dr. A. K. Singha, Director, ATARI, Meghalaya
61	Dr. S. Basanta Singh, Director of Instruction, CAU, Manipur
62	Dr. R. J. Singh, School of Social Sciences, CPGS, Meghalaya
63	Dr. A. Roy, ICAR RC for NEH Region, Meghalaya