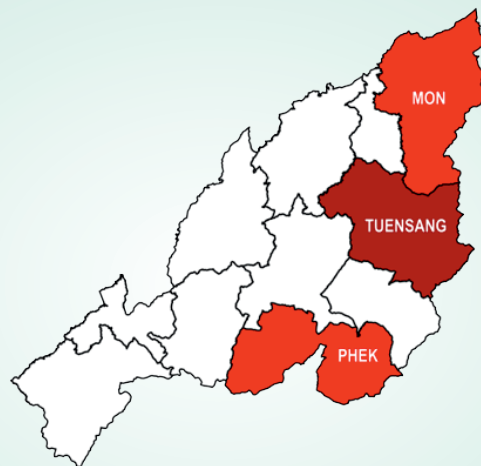


Promising Climate Resilient Technologies for **MANIPUR, NAGALAND and TRIPURA**



National Innovations in Climate Resilient Agriculture
ICAR-Central Research Institute for Dryland Agriculture, Hyderabad
ICAR-Agricultural Technology Application Research Institute, Barapani
Natural Resource Management & Agricultural Extension Divisions
Indian Council of Agricultural Research (ICAR), New Delhi



Promising Climate Resilient Technologies for MANIPUR, NAGALAND and TRIPURA

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Back Cover: 151 districts involved in NICRA and their climatic vulnerabilities

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FOREWORD

The north-eastern states of Manipur, Nagaland, and Tripura are influenced by climatic variability, presenting formidable challenges to agricultural activities. The undulating terrain and diverse ecological makeup render these states susceptible to erratic weather patterns, including unpredictable rainfall and temperature fluctuations. These climatic variations disrupt farming cycles, leading to crop damage, yield losses, and economic instability for farmers. As a result, the agricultural sector in Manipur, Nagaland, and Tripura faces constant adaptation pressures, necessitating innovative strategies to enhance resilience and mitigate the adverse impacts of climate change on agricultural productivity and livelihoods.

In response to these challenges, collaborative efforts between the Indian Council of Agricultural Research and State Agricultural Universities has yielded significant progress in developing technologies tailored to increase resilience to climatic adversities. Through the Technology Demonstration Component of the National Innovations in Climate Resilient Agriculture (NICRA), promising climate-resilient technologies are being demonstrated across 151 vulnerable districts nationwide.

These initiatives involve on-the-ground demonstrations of diverse technologies in various villages, coupled with strategic partnerships with existing developmental programs and institutions to ensure broad adoption. Additionally, the establishment of local village institutions, such as custom hiring centers and climate risk management committees, aims to facilitate the dissemination of these technologies to every household, thereby maximizing their impact on agricultural resilience.

Capacity building activities is important to the success of these efforts through tailored training sessions on resilient technologies and the promotion of enterprises such as seed production and fodder production. Consequently, there has been a notable uptick in the adoption and diffusion of climate-resilient technologies within NICRA cluster villages, equipping farmers with the tools to mitigate yield losses during periods of climatic stress.

My sincere appreciation to the authors for bringing out this publication and to the various institutions and farmers who have contributed to this endeavor. I hope that these technologies will be seamlessly integrated into broader development programs, thereby bolstering the adaptive capacity of farmers across these states.

(Himanshu Pathak)

**Dated the 5th August, 2024
New Delhi**



PREFACE

In the serene landscapes of Manipur, Nagaland, and Tripura, where the harmonious interplay of agriculture, environment, and livelihoods defines the daily rhythm of life, the specter of climate change casts a formidable shadow. Agriculture, deeply entrenched in the cultural and economic fabric of these states, faces unprecedented challenges due to the changing climatic patterns. As we grapple with the harsh realities of a changing climate, the imperative for inventive and resilient solutions tailored to the distinctive challenges of Manipur, Nagaland, and Tripura becomes increasingly urgent.

National innovations in Climate Resilient Agriculture a flagship initiative of the Indian Council of Agricultural Research, New Delhi stands as a beacon of hope in addressing the multifaceted dimensions of climate change in the agricultural sector. The Technology Demonstration Component (TDC) of NICRA, a collaborative initiative involving local farming communities, strives to identify and showcase climate-resilient technologies. This publication extends the narrative by documenting on-farm demonstrations of various technologies related to natural resource management, crops, cropping systems, and livestock in Manipur, Nagaland, and Tripura.

The journey not only involved assessing the performance of these technologies in normal and stress years but also actively engaging with the invaluable perspectives of farmers. Village organizations, such as seed banks, fodder banks, custom hiring centers, and village climate risk management committees, emerged as crucial conduits for disseminating these promising technologies in NICRA villages. This book encapsulates the promising resilient technologies that have proven effective in mitigating climatic stress, enhancing adaptive capacity, and fostering resilience in the unique agro-ecological context of Manipur, Nagaland, and Tripura.

This compilation of promising technologies serves as a guide for policymakers, researchers, practitioners, and local communities, providing insights into the path toward climate resilience. The book discusses potential regions for upscaling each technology, weaving a narrative aligned with development programs specific to the states. By integrating these promising resilient technologies into the State Climate Change Action Plans, our goal is to unlock additional resources for their expansion, ensuring a sustainable and resilient future for Manipur, Nagaland, and Tripura.

We extend our sincere gratitude to Dr. Himanshu Pathak, Secretary (DARE) & Director General (ICAR), the High-Level Monitoring Committee, Zonal Monitoring Committee Chairpersons, Directors of Extension of the State Agricultural and Veterinary Universities, officials of Development Departments and KVKs of the states, and colleagues from ICAR- CRIDA for their unwavering support. Our deepest appreciation also goes to the farmers, Village level Climate Risk Management Committee (VCRMC) members, and various stakeholders whose contributions have enriched the tapestry of this collaborative endeavor.

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LIST OF ACRONYMS

ATMA	Agricultural Technology Management Agency
BCR	Benefit Cost Ratio
CFLDs	Cluster Frontline Demonstrations
CGWB	Central Ground Water Board
CHC	Custom Hiring Centers
FPO	Farmer Producer Organizations
ICAR	Indian Council of Agricultural Research
IFS	Integrated Farming System
IWMP	Integrated Watershed Management Programme
KVK	Krishi Vigyan Kendra
MGNREGS	Mahatma Gandhi National Rural Employment Guarantee Scheme
MIDH	Mission for Integrated Development of Horticulture
NABARD	National Bank for Agriculture and Rural Development
NDDB	National Dairy Development Board
NFSM	National Food Security Mission
NGO	Non-Government Organizations
NHM	National Horticulture Mission
NICRA	National Innovations in Climate Resilient Agriculture
NMSA	National Mission for Sustainable Agriculture
NRM	Natural Resource Management
PMKSY	Pradhan Mantri Krishi Sinchayee Yojana
PKVY	Paramparagat Krishi Vikas Yojana
RKVY	Rashtriya Krishi Vikas Yojana
SAUs	State Agricultural Universities
SFAC	Small Farmers' Agri-Business Consortium
TDC	Technology Demonstration Component
VCRMC	Village Climate Risk Management Committee



1. Introduction



1. INTRODUCTION

Manipur, Nagaland, and Tripura paint a vibrant cultural diversity, lush landscapes, and rich traditions. Manipur, known for its valleys. Nagaland, adorned with hills, is home to indigenous tribes celebrated for their unique traditions and festivals. Tripura, nestled in the foothills, charms with its blend of tribal heritage and historical landmarks. These states not only boast breathtaking natural beauty but also harbour a deep connection to their agrarian roots. Agriculture is not just a source of sustenance; it is woven into the cultural fabric, shaping traditions and livelihoods. However, the looming specter of climate change has cast a profound impact on the agricultural landscape, introducing challenges that threaten the sustainability of these practices. Shifts in precipitation patterns, temperature extremes, and the increasing frequency of extreme weather events have disrupted the delicate balance of these agrarian societies. Farmers in Manipur, Nagaland, and Tripura are grappling with the need to adapt to these changing climatic conditions, prompting a critical examination of resilient agricultural practices and precision climate-resilient technologies that can safeguard their crops, enhance productivity, and ensure the long-term sustainability of agriculture in the face of a rapidly changing climate.

1.1 Manipur

Manipur, situated amidst Nagaland to the North, Mizoram to the South, and Assam to the West, is one of the Northeastern states sharing borders with Myanmar to the East. Spanning an area of 22,347 sq. km. Manipur experiences diverse features such as varied terrain, altitudinal differences, and river patterns, all of which significantly influence its climate. The warmer climate in the Barak basin and lower foothills contrasts with the more temperate conditions in the central valley and surrounding hills. Additionally, the Western part of the state is more humid than the East due to its position on the windward slope of the hills.

Given its location in the Eastern Himalayan periphery, fragile geo-environmental conditions, and economic conditions under development, Manipur is susceptible to water-induced disasters. Surface water resources face threats of water quality deterioration due to high siltation rates, uncontrolled quarrying in catchment areas, and increasing pH in wetlands. Projections for precipitation and evaporation patterns in the 2030s indicate considerable spatial variability in water yield. Manipur, being a rain-fed region, experiences uneven distribution of precipitation throughout the year, with peak rainfall during the monsoon. However, the hilly topography impedes water recharge over an extended period, resulting in frequent floods in the valley areas.

Recent floods in Manipur are attributed to man-made ecological changes in catchment areas, intense rainfall in hilly upper catchments, and runoff issues in degraded watersheds. Flash floods occur within urban settlements during the rainy season, causing damage to agricultural lands and habitats. Flood-related damages include breached bunds, overflowing rivers, landslides, erosion, and depression of river banks. Monsoon season exacerbates siltation in rivers and streams, leading to the gradual disappearance of perennial streams and natural springs (Fig. 1.1).

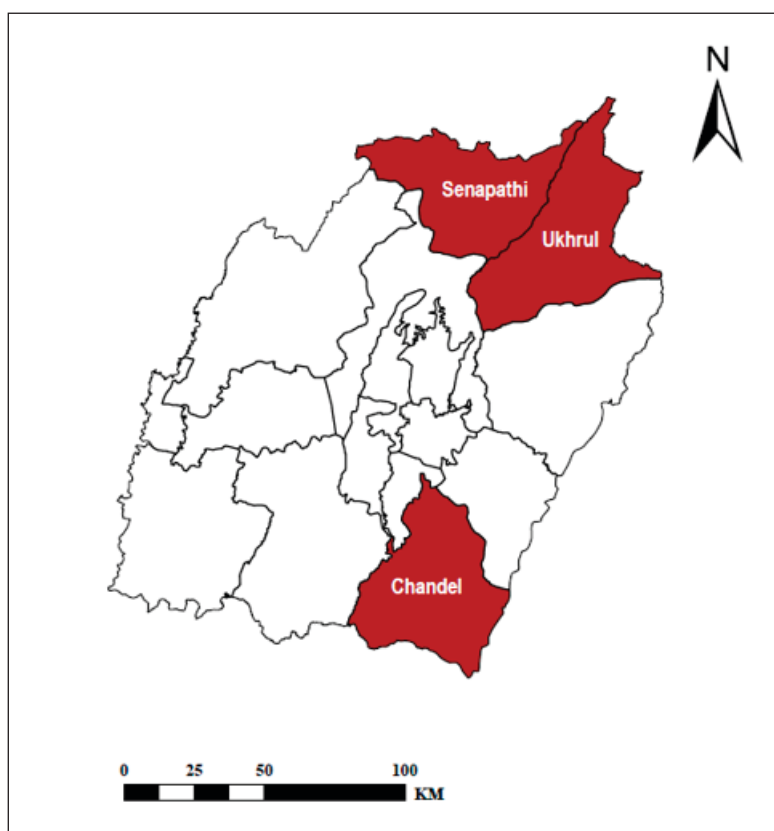


Fig. 1.1. Location map of Manipur with KVKs

Climate

The State Action Plan on Climate Change in Manipur underscores the significance of assessing climate change and vulnerability across various sectors. Agriculture and allied activities, health, water resources, ecosystem, and biodiversity are identified as highly vulnerable to climate change induced by human activities such as deforestation, fossil fuel burning, and waste disposal. Manipur's economy is intricately linked to its natural resource base, with climate-sensitive sectors such as agriculture, water resources, and forestry facing potential threats from anthropogenic climate change.

The impact of climate change is expected to be felt in crucial sectors such as agriculture, water resources, health, sanitation, and forestry. However, poor institutional mechanisms and limited access to resources hinder the vulnerable population's effective coping with the adverse impacts of climate change. The varied vulnerability and adaptive capacities across different sectors and cross-sectoral parameters, including poverty, inequality, social discrimination, access to resources, attrition/migration of the workforce, and competition for scarce natural resources, further complicate the scenario.

Climate variability, encompassing variations in surface temperatures, precipitation, and relative humidity from the mean state, is a key consideration. The project aims to develop adaptation/mitigation measures for climate-sensitive sectors.

This analysis focuses on Manipur’s current mean climate and climate variability at the district level, emphasizing the role of precipitation and temperature as key climate variables. The state’s climate sensitivity is attributed to its fragile ecosystem, resulting in diverse climate types, ranging from near-tropical to temperate and alpine, due to varied physiological features and altitudinal differences.

1.2 Nagaland

Nagaland, one of the eight North-Eastern Hill states in India, is situated between 25° 10’ N and 27° 4’ N Latitude and 93° 15’ E and 95° 20’ E Longitude. The total geographical area of 16,579 km², it is located in the Northern extension of the Arakan Yoma ranges. The state shares an extensive international border with Myanmar to the East and is surrounded by the states of Assam to the West and North, Arunachal Pradesh to the North, and Manipur to the South. Currently, Nagaland comprises 11 districts: Kohima, Dimapur, Kiphire, Longleng, Mokokchung, Mon, Peren, Phek, Tuensang, Wokha, and Zunheboto. The state also includes 114 sub-districts, 26 towns (19 statutory and 7 census towns), and 1428 villages. In terms of physiography, Nagaland features vast undulating terrain and mountainous landscapes, encompassing high hill slopes, hilly dissected terrains, denudational hill slopes, undulating upland, and narrow valleys with perennial streams. This diverse topography supports a rich biodiversity (Fig. 1.2).

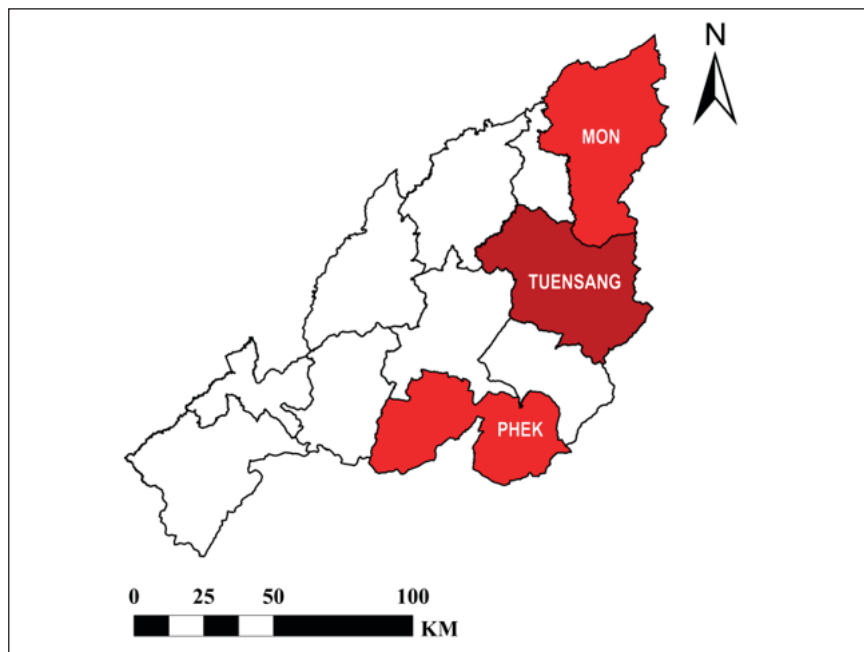


Fig. 1.2. Location map of Nagaland with KVKs

Climate

Nagaland experiences a distinct monsoon climate, characterized by a spectrum of conditions ranging from tropical to temperate. The monsoon season persists for five months, spanning from May to September, with the highest rainfall occurring in May, June, and July. The annual rainfall across different locations within Nagaland varies significantly due to the diverse topography, ranging from 1,000 mm to over 3,000 mm, with an average of 2,000 mm.

The atmospheric temperature in Nagaland exhibits variations, reaching from 15°C to 30°C in summers and dropping to less than 5°C to 25°C during winters. Altitude play a crucial role in climate and weather patterns. Relief features like high mountains act as barriers to the movement of monsoon winds. This results in low temperatures, substantial rainfall on windward slopes, relatively dry conditions on the leeward side, and considerable precipitation in the form of snow at mountain summits – all contributing to the unique features of Nagaland’s climate.

1.3 Tripura

Extending from 22°56’N to 24°32’N latitude and between 91°10’E to 92°20’E longitude, Tripura covers a total area of 10,491.7 sq. km, constituting approximately 0.32 per cent of the country’s total land area. As a landlocked state in the North-East region, Tripura is bordered by Assam to the Northeast, Mizoram to the East, and Bangladesh to the West, North, and South. This is the third smallest state after Goa and Sikkim, Tripura is characterized by its geographical location and compact size (Fig. 1.3).

The state’s economy is predominantly agrarian, with over 42% of its population relying on agriculture and related activities. The net cropped area of Tripura spans 255 thousand hectares, accounting for 24.31 per cent of the state’s geographical area. The gross cropped area is 487 thousand hectares, representing 46.4 per cent of the state’s geographical expanse. The cropping intensity in Tripura stands at 191 per cent. According to the 2011 census, the state has 5.78 lakh operational landholders, with 2.85 lakh hectares of cultivated land. Small and marginal landholders constitute 96 per cent of the total, operating 76 per cent of the occupied area. Tripura’s average

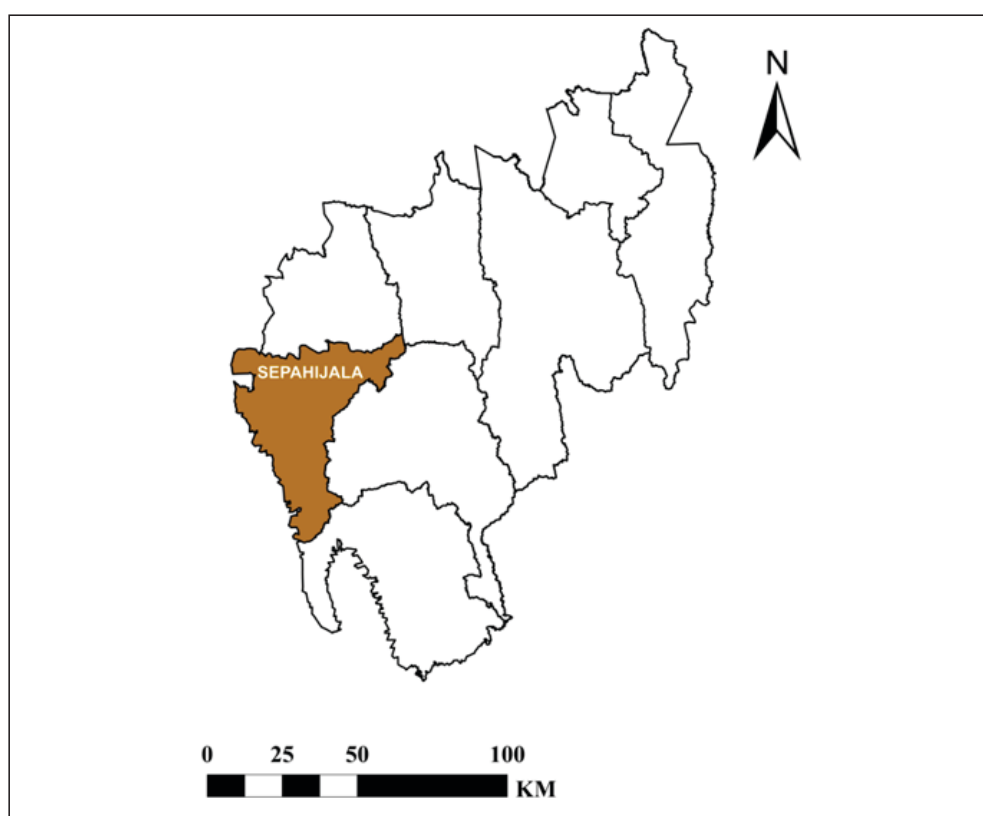


Fig. 1.3. Location map of Tripura with KVKs

landholding size is 0.49 hectares, lower than the national average of 1.15 hectares. With a net irrigated area of 1.17 lakh hectares, Tripura's total food grain production reached 8.4 lakh Metric Tonnes during the fiscal year 2019-20.

Climate

The state of Tripura is situated within the Eastern and Northeastern Himalayan ecology, which faces potential threats due to climate change, including rising temperatures and significant alterations in rainfall patterns. Climate variability and change can exert extreme or prolonged stress on the quality, quantity, and reliability of the services and natural resources provided by the broader ecosystem in this region. These changes, whose timing, location, coverage, and scope are still uncertain, are expected to critically impact food intake, health, and livelihoods, particularly for the impoverished population.

Tripura, being located on the international border with Bangladesh, possesses climate-sensitive and region-specific features that add to its vulnerability. Recognizing Tripura as part of one of the world's most climate-sensitive regions is crucial, considering the anticipated increases in the frequency and intensity of cyclones, storms, sea-level rise, and flooding. Given its extensive international border with Bangladesh, changes in climate undertaken by Bangladesh may also impact Tripura, especially its capital city, Agartala, which is located in close proximity to the border. This situation underscores the significance of addressing the issue of climate migrants or climate refugees as a manifestation of Tripura's vulnerability to climatic changes. The interconnectedness of these environmental factors emphasizes the need for a comprehensive approach to climate resilience in the region.

1.4 Overview of the districts under NICRA - TDC

Recognizing the pressing challenges posed by climate change in the agricultural sector, the NICRA TDC initiative strategically focuses on these risk-prone districts in Manipur, Nagaland, and Tripura. By targeting specific areas susceptible to climate-related uncertainties, the initiative aims to implement and showcase innovative and resilient agricultural technologies. This approach not only addresses the unique challenges faced by farmers in these districts but also serves as a model for climate-resilient practices that can be disseminated and adopted more broadly across the region.

1.4.1 Districts of Manipur

1.4.1.1 Chandel

This district resides in the South-eastern part of Manipur. It is the border district of the state. The neighboring districts are Myanmar (erstwhile Burma) on the South, Ukhrul district on the East, Churachandpur district on the South and West, and Thoubal district on North. Chandel district is located between 23°50'N and 24°48'N, latitude and 93°45'E to 94°125'E longitude (Fig.1.4) with an altitude of 600-1900 m above MSL. The geographical area of the district is 3.31 lakh ha, out of

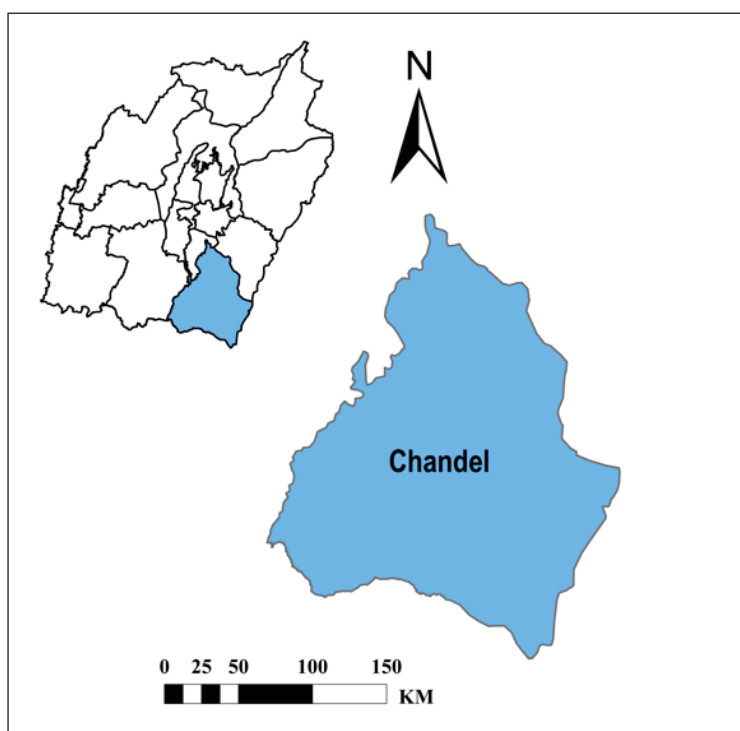


Fig. 1.4. Location map of Chandel

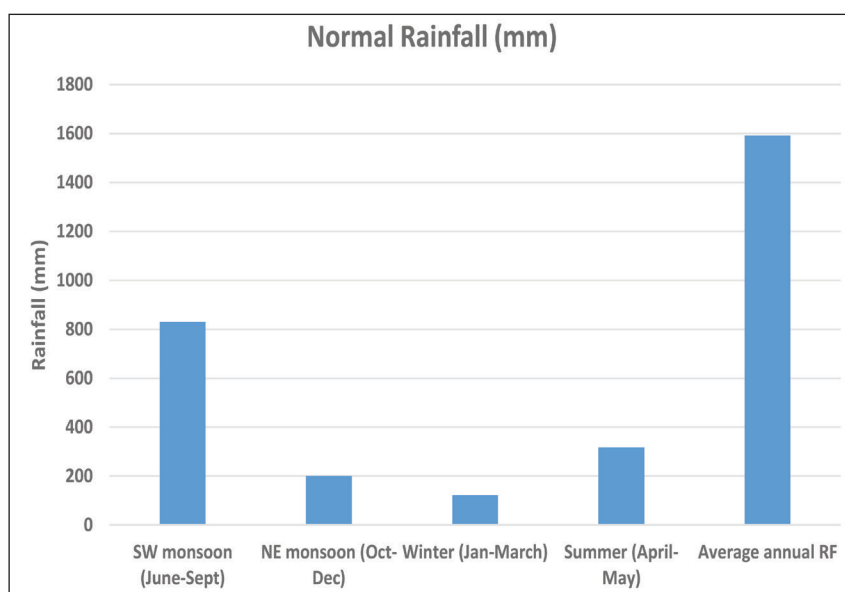


Fig. 1.5. Seasonal rainfall

which cultivable and forest area is 0.62 and 2.32 lakh ha respectively and others. The gross cropped area of the district is 0.139 lakh ha out of which 0.132 lakh ha is net sown area and 0.007 lakh ha area is sown more than once. The area under rainfed situation is 0.13 lakh ha. Rice, maize, millets, barley, soybean and other horticultural crops are the major crops grown in the district. Indigenous cattle, dairy, goat, sheep and pig farming are widely adopted. The average annual rainfall of the district is 1,592 mm and much of the rainfall is received during *kharif* (Fig.1.5). The predominant soils in the district are black soils, sandy loam soils and eroded hill slopes.

1.4.1.2 Ukhrul

Ukhrul district is spread between 24° 29' N and 25° 42' 0" N latitude and 94° 4' 0" E to 94° 47' 0" E longitudes (Fig.1.6) with altitude 2020 m above MSL. Ukhrul district is bounded by Myanmar in the East, Chandel district in the South, Imphal East and Senapati districts in the West and Nagaland in the North. The geographical area of the district is 4.54 lakh ha out of which forest area is 3.63 lakh ha. Majority of the crops grown in the district are under rainfed situation. The normal average annual rainfall of the district is 1,616 mm (Fig. 1.7). Major crops grown in the district are rice, maize, pea, cabbage, squash and chillies. dairy, goat, sheep and pig farming is adopted well in Ukhrul district.

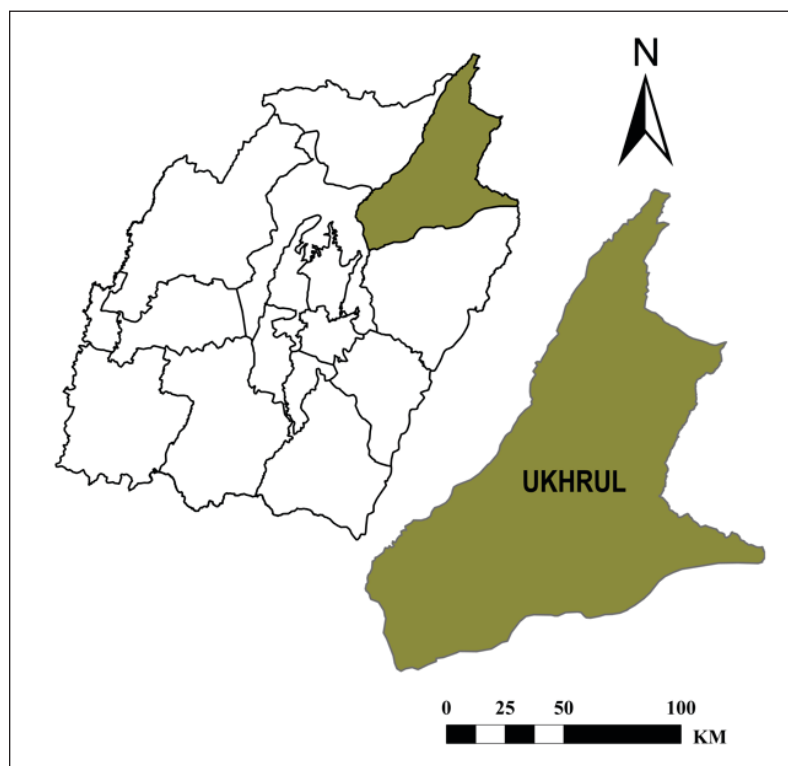


Fig. 1.6. Location map of Ukhrul

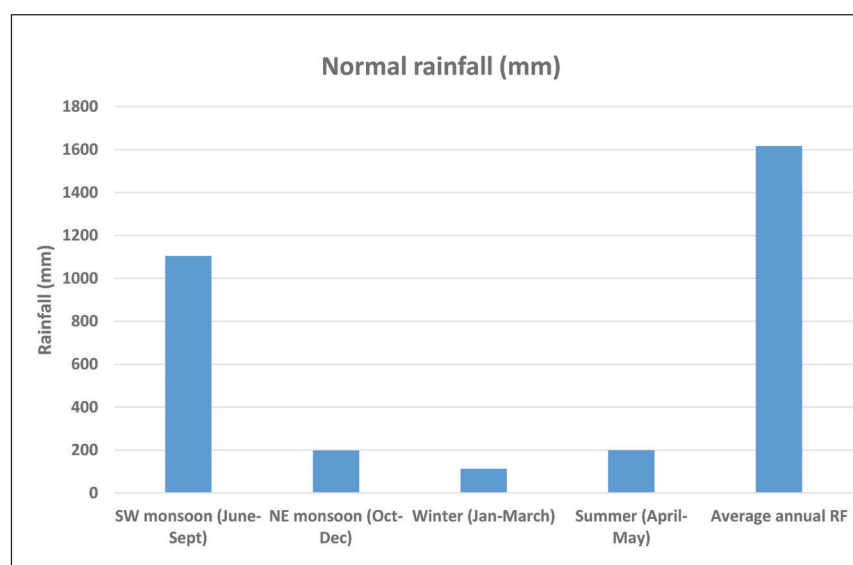


Fig. 1.7. Seasonal rainfall

1.4.1.3 Senapathi

The district is located between 93°29' and 94°15', E longitude and 24°37' to 25°37' N latitude (Fig.1.8) The district is bounded on the South by Imphal East and West districts, on the East by Ukhrul district, on the West by Tamenglong district and on the North by Phek district of Nagaland. The district is under humid sub-tropical climate. The soil is moderately fertile with clay loamy soil with little patches of clay and loam. The main crops are rice, maize, potato, cabbage and tomato. The predominant cropping pattern is single cropping. The cultivation is partly jhumming, partly terraced and wetland cultivation partly. The average annual rainfall is 1,454 mm. Rich varieties of flora and fauna adorn the land. Agriculture is the main occupation of the people and terrace cultivation is practiced by the people. Paddy, maize, cabbage, potato, cereals are the main crops of the district. A total of 80.70% of the area is covered by forest and remaining 20 % is arable land.

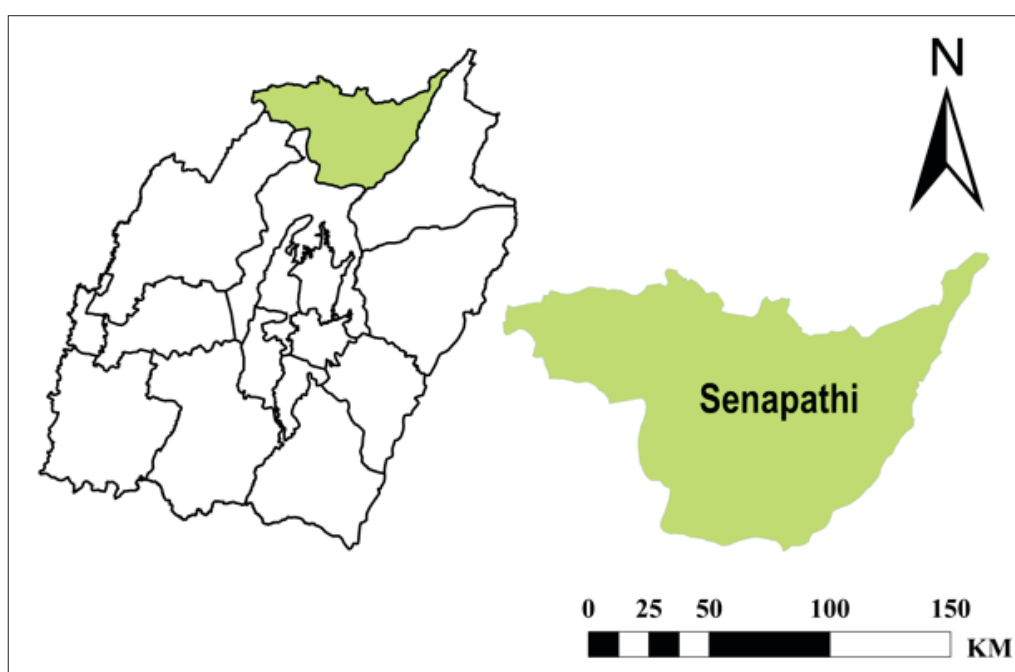


Fig. 1.8. Location map of Senapati

1.4.2 Districts of Nagaland

1.4.2.1 Mon

Mon district is located between 26° 43' N, latitude and 95° 01' E longitude (Fig.1.9) with an altitude of 180-1,625 m above MSL. The district is categorized into Eastern Range Nagaland Hills, Warm to hot pre- humid ecosystem with red and laterite soils Agro Ecological Sub Region (ICAR), Eastern Himalayan Region Agro-Climatic Zone (Planning Commission) and Upper Brahmaputra Valley Zone, NEH-3,95.43 Sub Tropical Hill Zone, NEH-3, 4.57 (NARP). The geographical area of the district is 1.78 lakh ha, out of which cultivable area is 0.38 lakh ha, forest area is 0.41 lakh ha and other land use pattern of the districts are indicated (Fig. 1.11). The gross cropped area of the district is 0.33 lakh ha out of which 0.303 lakh ha is net sown area and 0.027 lakh ha area is

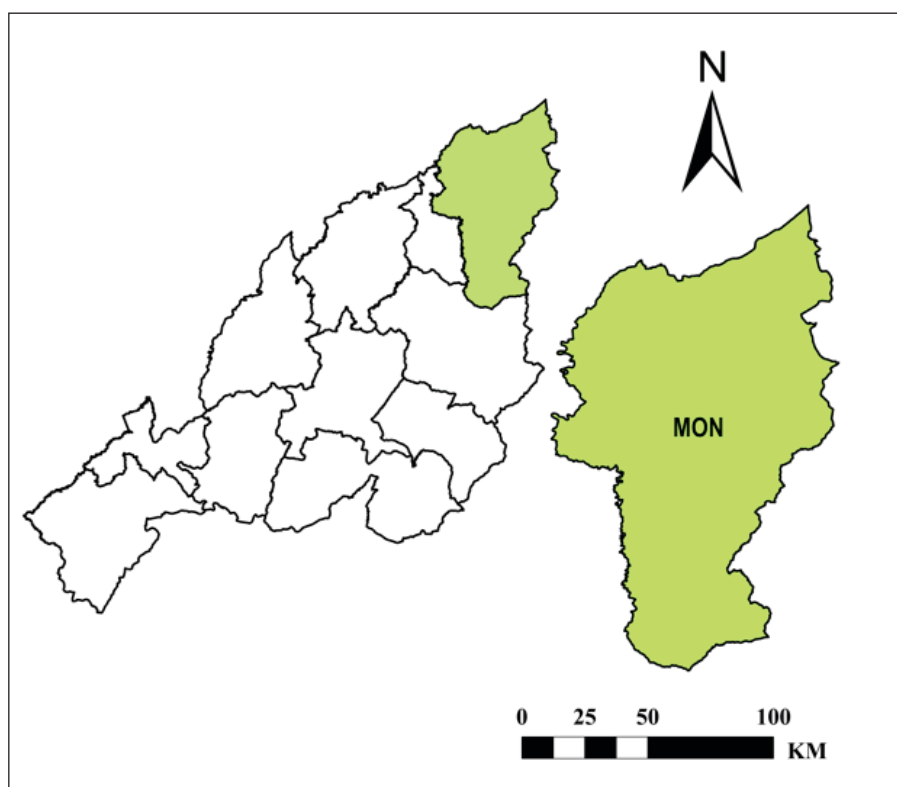


Fig. 1.9. Location map of Mon

sown more than once. The area under rainfed is 0.23 lakh ha whereas irrigated area is 0.05 lakh ha. The source of irrigation in the district are stream flow, pumpsets and other sources. Rice, maize, millets, rapeseed & mustard and other horticulture crops are the major crops grown in the district (Table 1.1). Indigenous cattle, improved / crossbred cattle, buffaloes (local low yielding), improved buffaloes, goat, sheep, pig farming is widely adopted. The average annual rainfall of the district is 2,554 mm and much of the rainfall is received during *kharif* (Fig. 1.10). The predominant soils in the district are black soils, sandy loam soils and eroded hill slopes (Fig. 1.12).

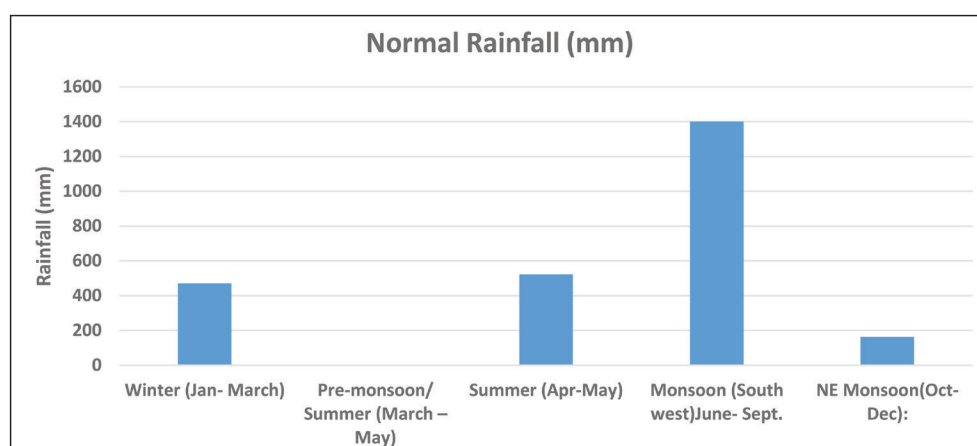


Fig. 1.10. Seasonal rainfall

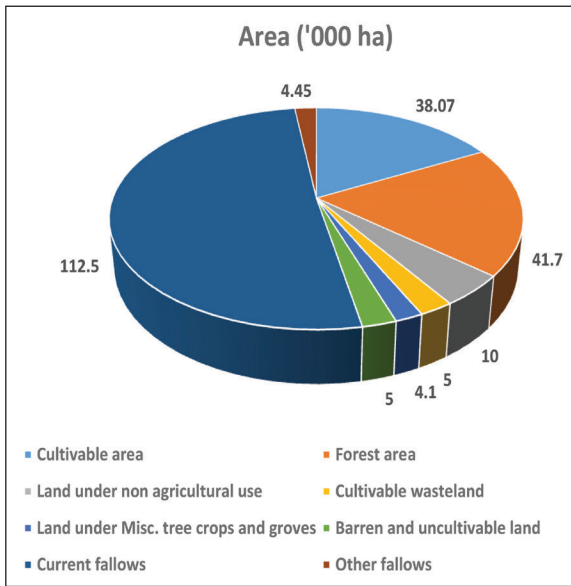


Fig. 1.11. Land use pattern

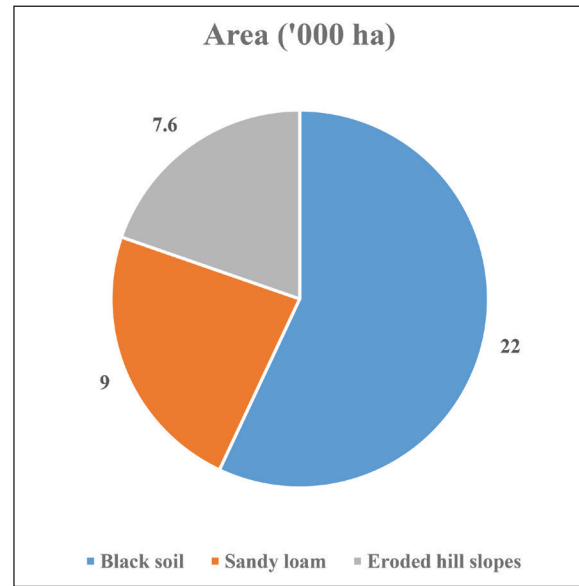


Fig. 1.12. Major soils

Table 1.1 : Area, production and productivity of major crops

Crop	Season	Area (ha)	Production (t)	Productivity (t ha ⁻¹)
Rice	<i>Kharif</i>	15,650	25,978	1.66
Maize	<i>Kharif</i>	3,900	6,045	1.55
Rapeseed & Mustard	<i>Rabi</i>	1,900	1,400	0.74
Soybean	<i>Kharif</i>	1,900	2,301	1.21
Small millets	<i>Kharif</i>	1,556	1,277	0.82
Other <i>kharif</i> pulses	<i>Kharif</i>	960	1,190	1.24
Potato	<i>Rabi</i>	895	3,850	4.3
Peas & beans (Pulses)	<i>Rabi</i>	750	836	1.11
Ginger	<i>Kharif</i>	558	2,984	5.35
Tapioca	<i>Kharif</i>	360	3,850	10.69
Sugarcane	Whole Year	309	4,635	15
Other oilseeds	<i>Kharif</i>	220	135	0.61
Linseed	<i>Rabi</i>	195	166	0.85
Cowpea (Lobia)	<i>Kharif</i>	150	188	1.25
Sweet potato	<i>Kharif</i>	139	597	4.29
Wheat	<i>Rabi</i>	111	172	1.55
Arhar/Tur	<i>Kharif</i>	100	90	0.9
Sesamum	<i>Kharif</i>	90	50	0.56
Groundnut	<i>Kharif</i>	60	54	0.9
Bajra	<i>Kharif</i>	40	29	0.73
Jowar	<i>Kharif</i>	40	34	0.85
Jute	<i>Kharif</i>	32	0.08 bales	-
Moong (Green gram)	<i>Kharif</i>	30	29	0.97
Chickpea	<i>Rabi</i>	25	21	0.84

1.4.2.2 Phek

Phek district is spread between 25°37'37" and N 25°39'47" N latitude and 94°35'18" – E 94°38'09" E longitudes (Fig.1.13) with altitude 1,326 m above mean sea level. The district falls under tropical to temperate Agro Ecological Sub Region (ICAR), Eastern Himalayan Region Agro-Climatic Zone (Planning Commission), Sub – Tropical Hill Zone (98.10) & Mid Tropical Hill Zone (1.90) Agro Climatic Zone (NARP). The geographical area of the district is 2.02 lakh ha out of which cultivable area is 0.38 lakh ha and forest area is 0.88 lakh ha. The land use pattern of the district is shown in Fig. 1.15. Majority of the crops grown in the district are rainfed which covers 0.57 lakh ha. The normal average annual rainfall of the district is 1,606 mm (Fig. 1.14). The district is predominantly covered with black, red, alluvial and sandy soils (Fig. 1.16). Major crops grown in the district are paddy, wheat, maize, soybean, pulses, other millets and other horticulture crops (Table 1.2). Dairy, goat, sheep and pig farming is adopted well in Phek district.

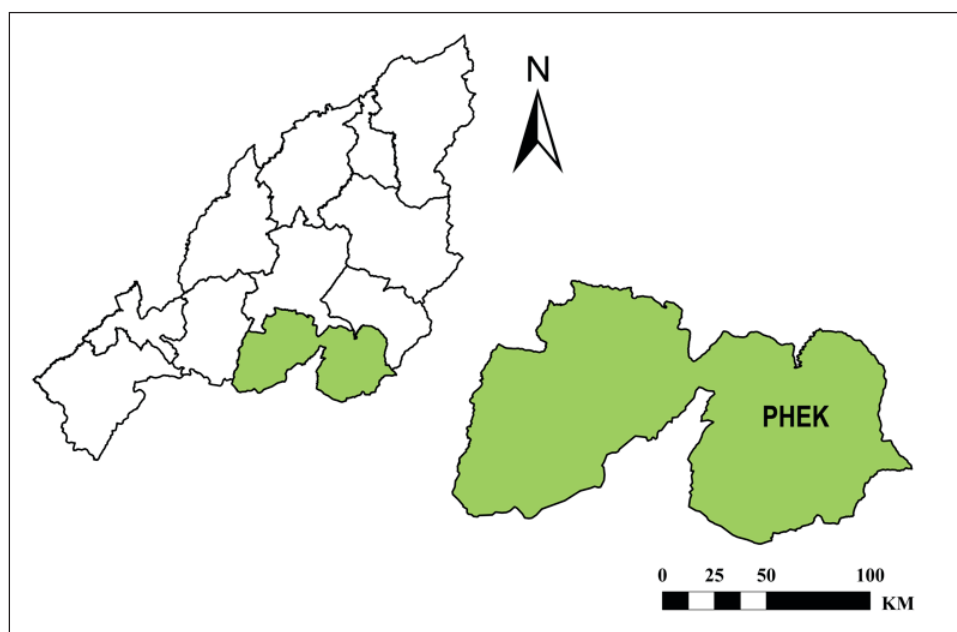


Fig. 1.13. Location map of Phek

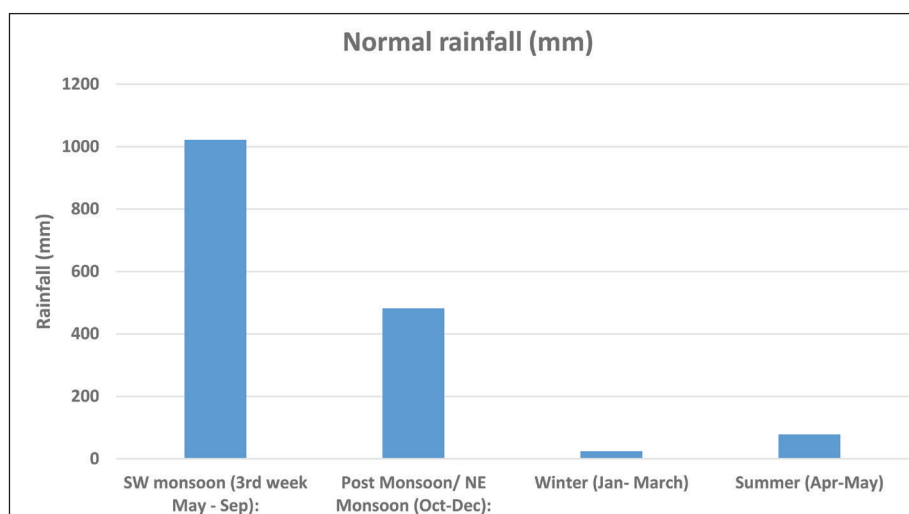


Fig. 1.14. Seasonal rainfall

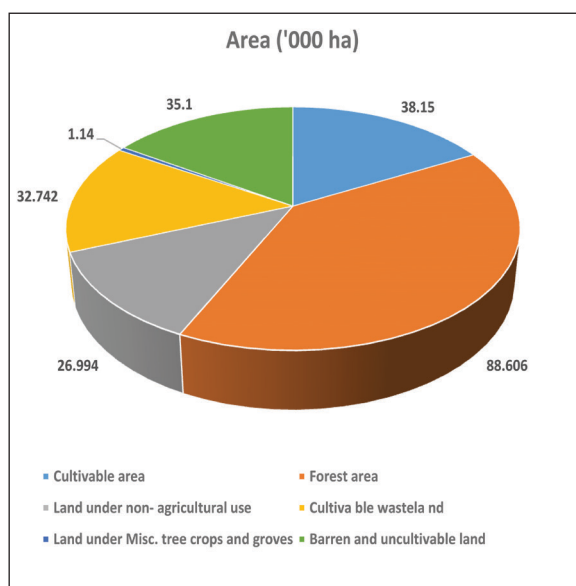


Fig. 1.15. Land use pattern

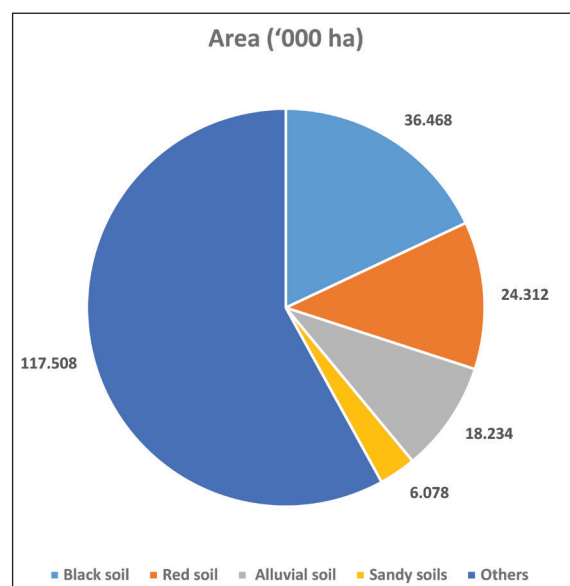


Fig. 1.16. Major soils

Table 1.2 : Area, production and productivity of major crops

Crop	Season	Area (ha)	Production (t)	Productivity (t ha ⁻¹)
Rice	<i>Kharif</i>	9,754	21,763	2.23
Maize	<i>Kharif</i>	3,979	6,227	1.56
Other <i>kharif</i> pulses	<i>Kharif</i>	1,153	1,342	1.16
Ginger	<i>Kharif</i>	860	6,880	8
Small millets	<i>Kharif</i>	627	564	0.9
Potato	<i>Rabi</i>	530	5,300	10
Soybean	<i>Kharif</i>	374	374	1
Peas & beans (Pulses)	<i>Rabi</i>	300	335	1.12
Sugarcane	Whole Year	280	6,720	24
Other oilseeds	<i>Kharif</i>	194	98	0.51
Tapioca	<i>Kharif</i>	172	1,969	11.45
Cowpea (Lobia)	<i>Kharif</i>	136	191	1.4
Groundnut	<i>Kharif</i>	87	89	1.02
Wheat	<i>Rabi</i>	76	114	1.5
Bajra	<i>Kharif</i>	70	53	0.76
Sweet potato	<i>Kharif</i>	67	297	4.43
Rapeseed & Mustard	<i>Rabi</i>	66	59	0.89
Jowar	<i>Kharif</i>	40	39	0.98
Chickpea	<i>Rabi</i>	22	18	0.82
Arhar/Tur	<i>Kharif</i>	19	19	1
Sesamum	<i>Kharif</i>	18	9	0.5
Moong (Green Gram)	<i>Kharif</i>	15	12	0.8
Maize	<i>Rabi</i>	4	6	1.5

Sunflower	<i>Kharif</i>	4	3	0.75
Cotton (lint)	<i>Kharif</i>	2	1	0.5
Mesta	<i>Kharif</i>	2	3	1.5
Castor seed	<i>Kharif</i>	1	1	1

1.4.2.3 Tuensang

Tuensang district is located between 26°14' N latitude and 94°48' E longitude (Fig.1.17) The district falls in warm to hot moist (humid to per humid eco sub region) Agro Ecological Sub Region (ICAR), North Eastern Hill Region Agro-Climatic Zone (Planning Commission), Mid Tropical Hill (AZ52) Agro Climatic Zone (NARP). The geographical area of the district is 2.50 lakh ha out of which, cultivable area is 1.27 lakh ha, forest area is 0.70 lakh ha and other land use pattern of the districts are indicated below (Fig. 1.18). The area under rainfed and irrigation is 0.16 and 0.07 lakh ha respectively. Major crops grown in the district are rice, maize, millets, rajmah, ginger and horticulture crops (Table 1.3). Dairy, goat, sheep and pig farming is adopted. The average annual rainfall of the district is 1,700-2,300 mm. The predominant soils in the district are black soils, sandy soils and others (Fig.1.19).

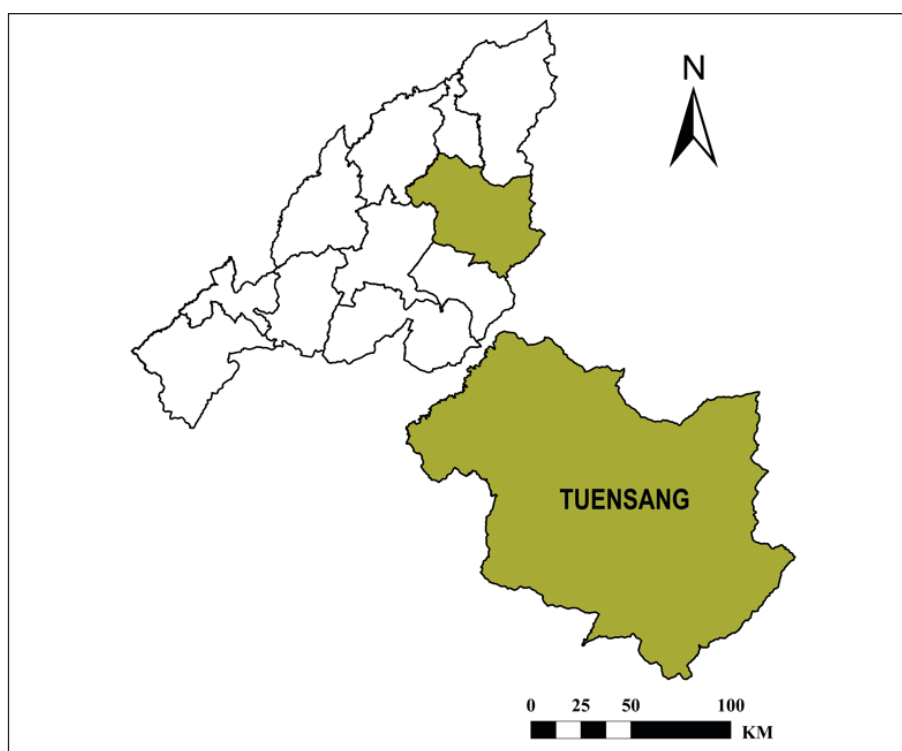


Fig. 1.17. Location map of Tuensang

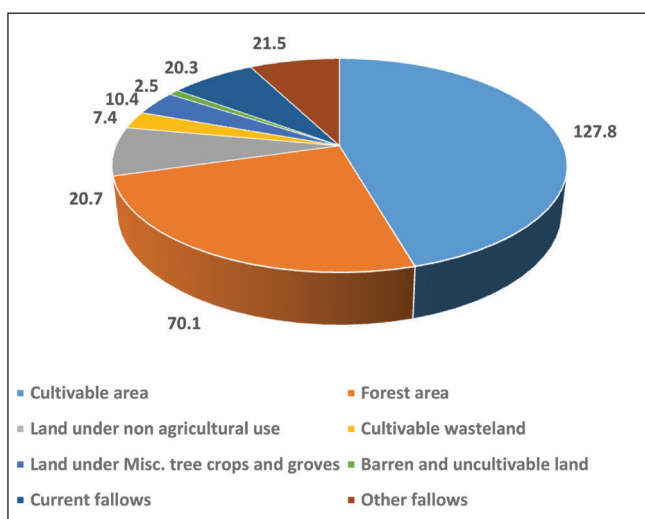


Fig. 1.18. Land use pattern

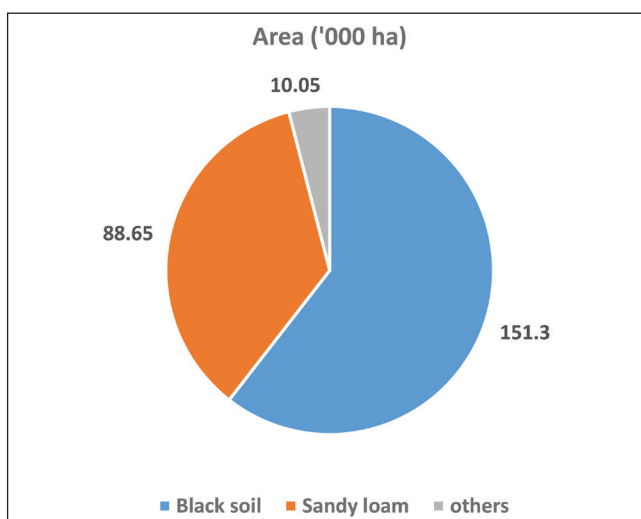


Fig. 1.19. Major soils

Table 1.3 : Area, production and productivity of major crops

Crop	Season	Area (ha)	Production (t)	Productivity (t ha ⁻¹)
Rice	<i>Kharif</i>	10,060	1,7130	1.7
Maize	<i>Kharif</i>	7,700	1,1897	1.55
Other <i>kharif</i> pulses	<i>Kharif</i>	2,775	3474	1.25
Small millets	<i>Kharif</i>	1,146	1,031	0.9
Tapioca	<i>Kharif</i>	550	6,069	11.03
Ginger	<i>Kharif</i>	500	4,500	9
Sugarcane	Whole Year	350	14,700	42
Peas & beans (Pulses)	<i>Rabi</i>	322	316	0.98
Soybean	<i>Kharif</i>	206	253	1.23
Other oilseeds	<i>Kharif</i>	198	86	0.43
Sesamum	<i>Kharif</i>	164	92	0.56
Linseed	<i>Rabi</i>	146	110	0.75
Wheat	<i>Rabi</i>	135	216	1.6
Rapeseed & mustard	<i>Rabi</i>	121	102	0.84
Bajra	<i>Kharif</i>	100	77	0.77
Ragi	<i>Kharif</i>	80	52	0.65
Groundnut	<i>Kharif</i>	74	74	1
Sunflower	<i>Kharif</i>	55	71	1.29
Gram	<i>Rabi</i>	30	25	0.83
Moong (Green gram)	<i>Kharif</i>	20	15	0.75
Mesta	<i>Kharif</i>	1	1	1

1.4.3 Districts of Tripura

1.4.3.1 Sepahijala

Sepahijala district is located between 22° 56' and 24° 32' N, latitude and 91° 0' and 92° 20'E longitude (Fig.1.20) with an altitude of 16 m above MSL. The district is categorized into Humid Eastern Himalayan Region (17.2) Agro Ecological Sub Region (ICAR), Eastern Himalaya Region (II) Agro-Climatic Region (Planning Commission) and Humid subtropical climate Agro Climatic Zone (NARP). The geographical area of the district is 1.03 lakh ha, out of which cultivable area is 0.31 lakh ha, forest area is 0.24 lakh ha and other land use pattern of the districts are indicated (Fig. 1.22). The area under rainfed situation is 0.034 lakh ha and irrigation is 0.024 lakh ha. The source of irrigation in the district are canals, tanks, open wells and other sources. Rice, maize, sesamum, rapeseed & mustard, cowpea, soybean, millets and other horticulture crops are the major crops grown in the district (Table 1.4). Indigenous cattle, improved/crossbred cattle, buffaloes (local low yielding), improved buffaloes, goat, sheep and pig farming are widely adopted. The average annual rainfall of the district is 1,786 mm and much of the rainfall is received in *kharif* (Fig. 1.21). The predominant soils in the district are red soils, alluvial soils, sandysoils laterite soils and acid soils.

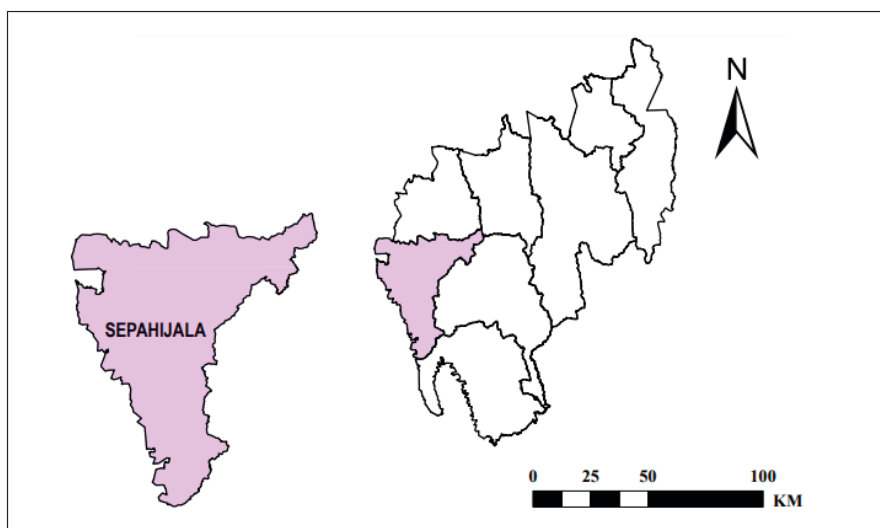


Fig. 1.20. Location map of Sepahijala

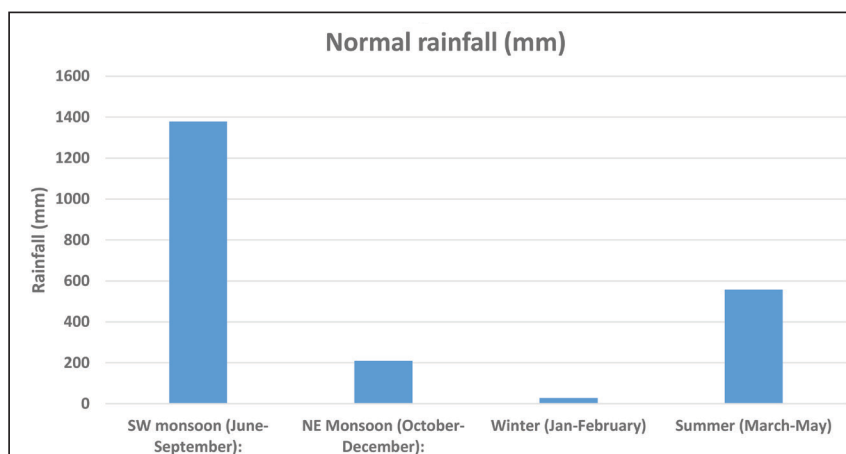


Fig. 1.21. Seasonal rainfall

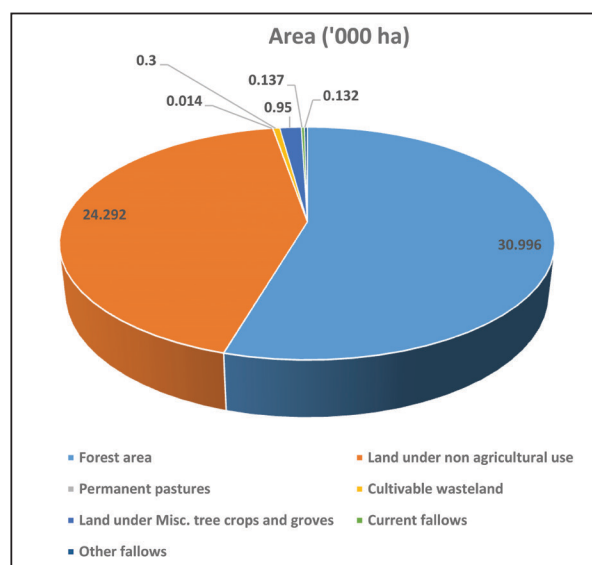


Fig. 1.22. Land use pattern

Table 1.4 : Area, production and productivity of major crops

Crop	Season	Area (ha)	Production (t)	Productivity (t ha ⁻¹)
Rice	<i>Kharif</i>	397	409	1.03
	Winter	27,985	93,881	3.35
	Summer	19,327	67,285	3.48
	Autumn	1,062	3,001	2.83
Maize	<i>Kharif</i>	1,232	2,489	2.02
	<i>Rabi</i>	885	2,368	2.68
Sesamum	<i>Kharif</i>	494	337	0.68
Rapeseed & mustard	<i>Rabi</i>	450	367	0.82
Urad	<i>Kharif</i>	356	262	0.74
	<i>Rabi</i>	350	271	0.77
Cowpea (Lobia)	<i>Kharif</i>	259	192	0.74
Other <i>rabi</i> pulses	<i>Rabi</i>	245	205	0.84
Arhar/Tur	<i>Kharif</i>	194	146	0.75
Sugarcane	Whole Year	117	7233	61.82
Small millets	<i>Rabi</i>	66	57	0.86
	<i>Kharif</i>	57	43	0.75
Groundnut	<i>Kharif</i>	55	76	1.38
Moong (Green gram)	<i>Kharif</i>	55	34	0.62
	<i>Rabi</i>	38	24	0.63
Jute	<i>Kharif</i>	18	149 bales	8.28 bales ha ⁻¹
Other <i>kharif</i> pulses	<i>Kharif</i>	14	14	1
Mesta	<i>Kharif</i>	6	48	8
Cotton (lint)	<i>Kharif</i>	5	5.8	1.16
Chickpea	<i>Rabi</i>	1	1	1



2. Promising Climate Resilient technologies

2.1 Promising Natural Resource Management Technologies

Paddy straw mulching in field pea

Climate vulnerability: Moisture stress

Background: Mon district of Nagaland receives 1776mm of annual rainfall but yet the agricultural crops in this district face the moisture stress due to erratic rainfall distribution i.e. sometimes heavy intense rainfalls in a single day and sometimes long dry spells which affect the crop growth and yield significantly.

Resilient technology

Paddy straw mulching is a sustainable practice for rainfed *rabi* crops as it has significant benefits and improve soil health, conserve moisture, control weeds, and enhance crop yields. After harvesting the paddy crop, the straw is collected and chopped into small pieces. This chopped straw is then spread on the field. The recommended thickness of the paddy straw mulch layer is 3-5 inches. The chopped straw is evenly distributed across the field to provide uniform coverage. Paddy straw mulch acts as a protective layer, reduces evaporation and conserves soil moisture. This is crucial for *rabi* crops that are grown during the dry season. The mulch layer helps to regulate soil temperature, protect crops from extreme temperature fluctuations, reduces weed infestation and reduces soil erosion by reducing the impact of rainfall and wind on the exposed soil. Hence paddy straw mulch can lead to increased crop yields in rainfed conditions. Paddy straw mulch is an eco-friendly and cost-effective method for improving soil quality and sustainable crop yields in *rabi* crops.

Performance and impact of technology

Paddy straw mulching in field pea in an area of 8.5 ha involving 7 farmers during 2022-23 was conducted. The availability of the soil moisture to the crop increased by 15-20 % and could reduce one hand weeding. The yield in local variety and improved variety Aman with straw mulch was 13.4 and 14.2 q ha⁻¹ respectively. Where as local variety without mulch is 10.5 q ha⁻¹. The straw mulching in Aman and local variety increased the yields by 81% and 36% respectively (Table 2.1.1).

Table 2.1.1: Impact of paddy straw mulching for cultivation of Field Pea, Aman variety

Intervention	Yield (q ha ⁻¹)	Cost of cultivation (₹ ha ⁻¹)	Gross returns (₹ ha ⁻¹)	Net Returns (₹ ha ⁻¹)	B:C ratio
Farmer's practice (local pea variety without mulching)	10.5	26,500	63,000	36,500	2.38
Use of paddy straw mulching in field pea (Local variety)	13.4	30,500	80,400	49,900	2.64
Use of paddy straw mulching in field pea (Aman)	14.25	33,500	99,750	66,250	

Scope for upscaling

This technology can be scaled up by providing more trainings and inputs through convergence with various programmes conducted by the state and the central government.



Paddy straw mulching in field pea cultivation

Straw mulching in garden pea for *in-situ* moisture conservation

Climate vulnerability: Moisture stress

Background: Phek district of Nagaland receives 1400mm of rainfall but yet the rainfall distribution is not uniform in addition to this the sloppy lands of the mountainous terrain does not hold moisture and it causes the crop to suffer from moisture stress. Hence, in-situ moisture conservation is vital for the survival of the crop.

Resilient technology

Garden pea is one of the important vegetable crops in Phek district, Nagaland. In 2020-21, garden pea was grown in an area of 122 hectare with a production of 756 MT. The yields of the pea in Thipuzu village are low due to drought. Straw is burnt after the harvest. Therefore, a demonstration on paddy straw mulching in garden pea var. Arkel was conducted at Thipuzu village and other villages.

Performance and impact of technology

The yield of pea with straw mulching in garden pea was 78.57 q ha⁻¹ whereas, under the control it was 44.8 q ha⁻¹ (Table 2.1.2). Before KVK intervention in the village, the total area under garden pea cultivation was 1.4 ha and after the intervention there was horizontal spread of this crop cultivation of garden pea increased the cropping intensity. This technology was well accepted by the farmers in the village and other neighboring villages. The straw mulching can be done in crops like cabbage, potato etc.

Table 2.1.2 : Yield and economics of garden pea

Particulars	Straw mulching in garden pea	Without straw mulching
Average yield (q ha ⁻¹)	78.57	44.28
Gross cost (₹ ha ⁻¹)	139200	136000
Gross income	382850	221185
Net income	253650	85185
Benefit Cost Ratio	2.82	1.63

Scope for upscaling

The technology can spread more to the entire farming communities through convergence with the state departmental activities, central programmes, ATMA and other NGOs.



In-situ moisture conservation through straw mulching in garden pea

Jalkund: Low-cost water harvesting structure

Climate vulnerability: Moisture stress

Background: Phek district of Nagaland receives intense rainfalls on a single day and due to the hilly terrain all the rainwater is lost in the form of runoff. Hence, rainwater harvesting and storage in Jalkund helps in supplemental irrigation water during dryspells.

Resilient technology

Surface runoff is effectively collected during the periods when enough rainfall occurs. Harvested rain water can be used for irrigation in rainfed agriculture or water supply for households. Hence, to overcome this water deficit during winter season, KVK Phek introduced a low cost rain water harvesting structure Jalkund to harvest and use the harvested water during winter/lean season. The intervention was taken up in Gidemi village during 2018. In Jalkund 30,000 litres of water could be stored.

Performance and impact of technology

Winter crops such as cabbage, broccoli, pea etc. were introduced using the harvested water. During the winter season, farmers cultivated cabbage and recorded a yield of 299.9 q ha⁻¹ and broccoli 128.4 q ha⁻¹ (Table 2.1.3). Whereas before the intervention in the village second crop was not cultivated after paddy and maize crop during the *rabi* season due to lack of water. Apart from irrigation to crops the water from the Jalkund was also utilized for livestock, nurseries and other purposes. After Jalkund intervention the area under winter vegetable expanded and the farmers could realize an additional net returns of ₹ 10660.

Table 2.1.3: Performance of winter vegetable by using water harvested in jalkhund

Technology demonstrated	Avg. yield (q ha ⁻¹)	Avg. gross cost (₹ ha ⁻¹)	Avg. gross return (₹ ha ⁻¹)	Avg. net return (₹ ha ⁻¹)
Winter vegetables	Cabbage:299.95 q ha ⁻¹ Broccoli:128.40 q ha ⁻¹	65,200	17,1800	10,660

Scope for upscaling

The technology can be upscaled to the entire farming communities through convergence with the state departmental activities, central programmes, ATMA and other NGOs.



Water harvesting through jalkund for winter season crops

Paddy straw mulching

Climate vulnerability : Moisture stress

Background: Sepahijala district of Tripura state faces frequent dry spells due to erratic rainfall. Hence conservation of moisture is vital for the crop growth and yield.

Resilient technology

After rice harvesting farmer immediately plough the field and the cut tubers are placed in soil at 5-7 cm and are covered by paddy-straw mulch uniformly throughout the field. The mulch helped in better germination, growth, maintain soil moisture, better weed control, higher yields.

Performance and impact of technology

Potato cultivation with paddy straw mulching was conducted at Golaghati GP of Sepahijala district, Tripura during 2022-2023. The irrigation water was reduced by 30-35% as compared to farmers practice. The mulching increased soil moisture and also reduced the weed growth. The technology has helped the farmers to improve yield by 29% and realize an additional income of ₹ 70,911 ha⁻¹ (Table 2.1.4).

Table 2.1.4: Performance of potato under paddy straw mulching

Intervention	Yield (q ha ⁻¹)	Cost of cultivation (₹ ha ⁻¹)	Net return (₹ ha ⁻¹)	B:C Ratio
Kufri Jyoti under paddy straw mulching	212.5	1,12,500	2,06,250	2.83
Farmer's practice	164.13	1,10,856	1,35,339	2.2

Scope for upscaling : The technology can be scaled up in convergence with the other programmes implemented by KVK Sepahijala, CAU (I).



Paddy straw mulching in potato cultivation

Capsicum cultivation under poly-mulching

Climate vulnerability: Moisture stress

Background: Sepahijala district of Tripura faces frequent dry spells, in situ moisture conservation is necessary for moisture conservation and crop growth and yield.

Resilient technology

Normally, 5 to 6 seed beds with each size of 300 cm x 60 cm x 15 cm are required to cover 1 hectare cultivation. Seeds should be sown in rows at 10 cm apart to get healthy germination (seedlings). 1 to 2 kg seeds are required for sowing in one hectare land depending on the cultivar. Bed size of 100 m long and 1.5 m width and 60 cm space between two beds were formed. Before, transplanting the seed bed was covered with poly mulch. Two rows are planted on each bed with optimum spacing of 40 cm x 60 cm.

Performance and impact of technology

Capsicum cultivation under poly-mulching was cultivated in 0.8 ha area involving 10 farmers at Golaghati GP of Sepahijala district, Tripura. The irrigation water requirement was reduced by 25-30% compared to normal practices. The effect of moisture stress also reduced and weed growth was reduced. The technology helped the farmer to improve yield by 73% and additional income of ₹ 207451 ha⁻¹ respectively (Table 2.1.5).

Table 2.1.5 : Impact of capsicum cultivation under poly-mulching

Intervention	Yield (q ha ⁻¹)	Cost of cultivation (₹ ha ⁻¹)	Net return (₹ ha ⁻¹)	B:C Ratio
Capsicum under poly- mulching	85.1	1,54,704.0	4,40,926	3.8
Farmer's practice	49.2	1,11,275	2,33,475.0	3.1

Scope for upscaling : The technology can be scaled up by providing mulching and various demonstration programme implemented by KVK Sepahijala, CAU (I) in convergence with state department of agriculture.



Cultivation of capsicum with poly-mulching

Slurry method of phosphorus management in paddy

Climate vulnerability: Moisture stress

Background: Acidic soils of Sepahijala pose challenges of phosphorus availability. Hence conventional phosphorus management methods have limitations in acid soils. This conventional method have low phosphorus use efficiency and recovery use efficiency.

Resilient technology

A mud slurry is prepared in one corner of the field (45 sq. m) for 1 ha area. An amount of 7 kg single super phosphate is mixed thoroughly with the mud. Roots of up-rooted seedlings are washed properly and soaked in the prepared SSP slurry overnight (minimum 10 hrs.). The optimum dose of P applied is 112.5 mg per kg soil mud. Another similar size of mud bed (45 sq. m) is prepared another corner of the field. Approximately 5 kg well grinded cow dung along with 4 kg MC bio-fertilizers or 500 ml MC bio-fertilizers is mixed and paddy seedlings are dipped for another 2 hr in that prepared mud slurry prior to transplanting of SSP-MC treated paddy seedlings. A dose of 50 kg/ha rock phosphate (50% of the recommended dose of P) and 44 kg Urea (1/3rd of nitrogen) and 66.4 kg MOP (Full dose of K) are applied.

Performance and impact of technology

Slurry method of phosphorus management in paddy was demonstrated in 2.57 ha area involving 20 farmers at Golaghati GP of Sepahijala District, Tripura. The phosphatic fertilizer requirement was reduced by 50% compared to normal practices by adopting this technology along with saving in cost of cultivation by ₹ 1238 ha⁻¹. The technology helped the farmer to improve the yield by 36% and additional income of ₹ 32785 ha⁻¹ respectively (Table 2.1.6).

Table 2.1.6 : Performance of paddy under slurry method of Phosphorous management

Intervention	Yield (q ha ⁻¹)	Cost of cultivation (₹ ha ⁻¹)	Net return (₹ ha ⁻¹)	B:C ratio
Slurry Method of Phosphorus Management in Paddy	57.5 (Grain) 62.5 (Straw)	59,325	1,24,625	2.12
Farmers practice	42.4 (Grain) 45.8 (Straw)	60,563	91,840	1.51

Scope for upscaling

The technology can be scaled up by providing various demonstration programme implemented by KVK Sepahijala, CAU (I).

Jalkund- water harvesting structure

Climate vulnerability: Moisture stress

Background: Chendang village, like many other villages in Nagaland faces challenges due to erratic rainfall during monsoon and water scarcity during the lean season. The period from July to September received substantial amount of the annual rainfall, but a significant quantity of rainfall is lost as runoff due to the undulated topography. In contrast, with the retreating monsoon, the period from November to March usually remains dry, aggravating the water scarcity.

Resilient technology

Jalkund is a practical and a sustainable solution for addressing water scarcity problem. The Jalkund of 24 ft × 14 ft, depth 4 ft dimension and capacity of 38,000 L was made. The sides and the bottom were then plastered with mixture of clay and cow dung and made into a smooth surface. Dry leaves of pine trees of about 2 inches were used for cushioning the sides and the bottom of the pit to avoid damages to the lining material. The film of 250 micron silpaulin was then laid carefully ensuring uniform placement and coverage while the outer edges of the film were covered with soil to keep it tightly binded. The water stored in the structure was used for life saving irrigation to the crops in the nearby low-cost poly-house constructed for off season vegetable production.

Performance and impact of technology

Jalkhund construction has enabled the farmers to cultivate off season crops in low cost polyhose through supplemental irrigation from the Jalkhund. The technologies have helped the farmer to achieve a yield improvement of the vegetable crops. The supplemental irrigation from Jalkund resulted in increasing the cabbage yield and returns by 117% and 156% respectively over farmers practice (Table 2.1.7).

Table 2.1.7 : Impact of jalkhund at Chendang village, Tuensang district

Intervention	Yield (q ha ⁻¹)	Cost of cultivation (₹ ha ⁻¹)	Gross return (₹ ha ⁻¹)	B: C ratio
Jalkund + Low cost polyhouse	2500kg /1000m ²	25,500/1000 m ²	62,500	2.45
Control	1150 kg/1000 m ²	14,250/1000 m ²	24,280	1.70

Scope for upscaling

This technology can be scaled through convergence with the District Agriculture, Horticulture and Soil and Water Conservation Department.



Jalkund and low-cost polyhouse

Use of paddy straw mulch in garlic production

Climate vulnerability : Moisture stress

Background: Frequent dry spells occur in *rabi* hence the yields of garlic are low. Moreover the paddy straw is burnt.

Resilient technology

Mulching with chopped paddy straw for 3-5 inches. This mulch layer acts as a protective straw layer, conserves soil moisture, regulate soil temperatures and reduces erosion. Reduces soil loss and nutrient loss by reducing the impact of rainfall and wind on the exposed soil, reduces weed growth. Hence paddy straw mulch is an eco-friendly and cost-effective method for improving soil quality and enhancing crop yields in *rabi* crops and is more sustainable and resilient practice.

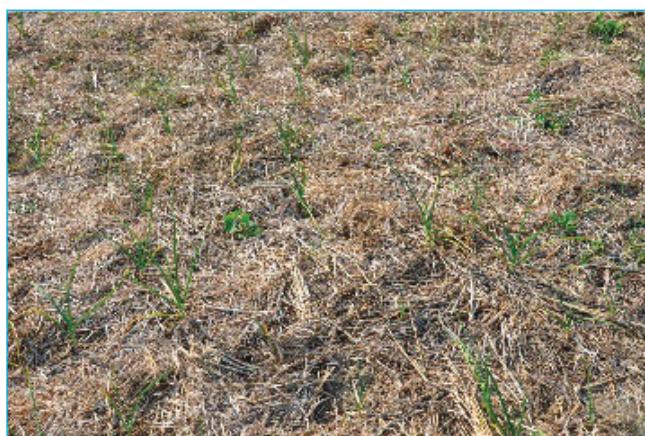
Performance and impact of technology

Five demonstrations were carried out for paddy straw mulch for cultivation of locally available garlic variety in an area of 6 ha involving 5 farmers during the year 2022-23. Yield from the farmers practice and paddy straw mulch in garlic were 19.67 and 23.45 q ha⁻¹ respectively. The use of paddy straw mulch in cultivation of garlic also gave higher gross returns (₹ 1,05,525), net returns (₹ 67,925) and benefit cost ratio (2.81) (Table 2.1.8).

Table 2.1.8: Use of paddy straw mulching for cultivation of garlic

Intervention	Yield (q ha ⁻¹)	Cost of cultivation (₹ ha ⁻¹)	Gross returns (₹ ha ⁻¹)	Net returns (₹ ha ⁻¹)	B:C ratio
Farmer's practice	10.5	26,500	63,000	36,500	2.38
Use of paddy straw mulching in Field Pea (Local variety)	13.4	30,500	80,400	49,900	2.64
Use of paddy straw mulching in Field Pea (Aman)	14.25	33,500	99,750	66,250	2.98

Scope for upscaling : This technology can be upscaled and practiced at larger scale through convergence with the state department.



Paddy straw mulch in garlic production

Cultivation of chilli under polymulching to conserve soil moisture

Climate vulnerability: Moisture stress

Background: Chilli is the major crop of Sepahijala district, frequent dryspells in the district reduces the chilli growth leading to low yield and income.

Resilient technology

Chilli, in Golaghati GP, Sepahijala district of Tripura, is one of the major vegetable crop. Most of the farmers follow normal cultivation practices which is less profitable. In Golaghati GP village, NICRA farmers cultivate chilli under polymulching which is profitable to the farmer. In this technique farmer's prepare bed with 1 m width and length according to field. Before polymulching the farmer applies nutrient and level the bed. Planting is done at a spacing of 50 cm. Polymulching increased the crop yield by 18.4%. Thus, polymulching appears to be a viable tool to increase the farmer's income. This is a labour, moisture, and water-saving technology.

Performance and impact of technology

Polymulching of chilli performs well in the dry season of the year. Polymulching saved 30-40, 15-20 and 25-30 % of irrigation, labour and fertilizer application respectively in chilli. Polymulching recorded 81 per cent higher yield than the normal method and farmer earned a net return of ₹ 1,27,686 ha⁻¹ (Table 2.1.9)

Table 2.1.9: Impact of polymulching technology in NICRA village

Intervention	Yield (q ha ⁻¹)	Cost of cultivation (₹ ha ⁻¹)	Gross return (₹ ha ⁻¹)	Net return (₹ ha ⁻¹)	BC ratio
Farmer's practice	19.50	41365	1,07,250	85,885	2.89
Polymulching technology	35.44	63234	1,94,920	1,27,686	2.47

Scope for upscaling

The technology can be spread to entire district through convergence with state governmental activities and central programmes.



Poly-mulching in chilli to conserve soil moisture

Cultivation under polymulching to conserve soil moisture

Climate vulnerability: Moisture stress

Background: Sepahijala district of Tripura faces dry spells and moisture stress in order to cultivate the vegetables *in-situ* moisture conservation is required.

Resilient technology

Bed of 1 m width and length can be made. Before covering the bed with silpaulin, nutrients are applied and later the bed is levelled. Planting is done at a spacing of 60 cm. Polymulching had the maximum number of fruits and higher yields. It's extensively used for brinjal production because it control weeds, soil moisture, increase soil temperature, crop yield and quality. This is a labour, moisture, and water-saving technology.

Performance and impact of technology

Polymulching in brinjal performed well in the dry season. During the year 2021-2022, KVK Sepahijala conducted 6 demonstrations covering 15 ha land with brinjal under polymulching at NICRA village, which yielded 62.3 per cent more than that of the normal method and farmer earned a net return of ₹ 2,43,631 ha⁻¹ (Table 2.1.10). Besides this the farmer could save 15-20% labour, 30-40% and 25-30% irrigation and fertilizer respectively.

Table 2.1.10 : Impact of polymulching technology in NICRA village

Intervention	Yield (q ha ⁻¹)	Cost of cultivation (₹ ha ⁻¹)	Gross return (₹ ha ⁻¹)	Net return (₹ ha ⁻¹)	BC ratio
Farmer's practice	70.09	76,523	2,10,270	1,33,747	2.74
Polymulching technology	113.78	1,09,782	3,53,340	2,43,631	3.22

Scope for upscaling

The technology can be spread to entire districts through convergence with state governmental activities and central programmes.



Brinjal cultivation under polymulching

Conserving soil health: Minimum tillage in pea cultivation

Climate vulnerability: Moisture stress

Background: Excessive tillage in hilly terrain of Senapati district in Manipur leads to loss of top fertile surface soil.

Details of the technology

After harvesting of paddy crop, the field is fallow due to moisture constraint. Hence minimum tillage was demonstrated in Senapati district for pea cultivation. This helps farmers to upgrade their household income improving quality of life and motivated for better farm income activities. Presently the minimum tillage has become an eye opener amongst the farmers from NICRA village as well as the neighboring farmers of the NICRA village.

Performance and impact of technology

The improved pea variety Prakash with minimum tillage recorded 28.7 and 66.1% higher yield and net returns when compared to the local check (Table 2.1.11). This underscores the potential of enhanced agricultural practices to boost economic viability, suggesting that farmers may benefit from adopting such interventions for improved financial outcomes.

Table 2.1.11 : A comparative study of demo crop (Prakash) and local check crop

Interventions	Gross cost (₹)	Yield (q ha ⁻¹)	Gross returns (₹ ha ⁻¹)	Net returns (₹ ha ⁻¹)	B:C ratio
Improved (Pea var. Prakash)	63540	43.4	130200	66,660	2.04:1
Local check	60990	33.7	1,01100	40,110	1.65:1

Scope for upscaling

The technology can be scaled up or spread to the entire districts through convergence with the state department activities.



Minimum tillage in pea cultivation



2.2 Promising Crop Production Technologies

Early planting in garden pea : Avoid moisture stress

Climate vulnerability: Moisture stress

Background: Ukhrul district of Manipur receives most of the monsoon rain from June to August months *rabi* crops like garden pea suffers from terminal drought.

Resilient technology

Ukhrul district is not economically feasible to irrigate throughout the season. An alternative ways for efficient use of rain water is early planting for escaping moisture stress in garden pea in the village.

Performance and impact of technology

Early planting of field pea recorded 30.2- 36.5% moisture content (August) as compared to farmers' practice (19.3-25.4%) late sown (October). Early sown gives the maximum yield of 34.3 q ha⁻¹ on average as compared to late sown (28.4 q ha⁻¹), and return per rupee investment is 3.2 and 1.8 in early sown and late sowing respectively (Table 2.2.1).

Table 2.2.1: Impact of early planting in garden pea to escape moisture stress

Intervention	Crop yield (q ha ⁻¹)	Cost of cultivation (₹ ha ⁻¹)	Gross return (₹ ha ⁻¹)	Net return (₹ ha ⁻¹)	B:C ratio
Early planting in garden pea	36.2	60,000	2,17,200	1,57,200	3.62
Farmer's practice	26.4	60,000	1,58,400	98,400	2.64

Scope for upscaling : The technology can be scaled through field demonstrations and knowledge sharing



Early planting in garden pea to escape moisture stress

Intercropping of groundnut and maize

Climate vulnerability: Moisture stress

Background: Sole cropping is risky records lower yields and incomes. Further it may also lead to soil erosion. Maize being the erosion permitting crop the sole crop of maize increases soil erosion and nutrient loss. In addition to this in appropriate farming practices such as Jhum cultivation and deforestation aggravates the situation and results in severe soil degradation

Resilient technology

To minimise or to check soil erosion and degradation, maize intercropped with groundnut as cover crop is recommended for soil and moisture conservation and nutrient recycling. Maize: groundnut system was planted in 1:2 and 1:3.

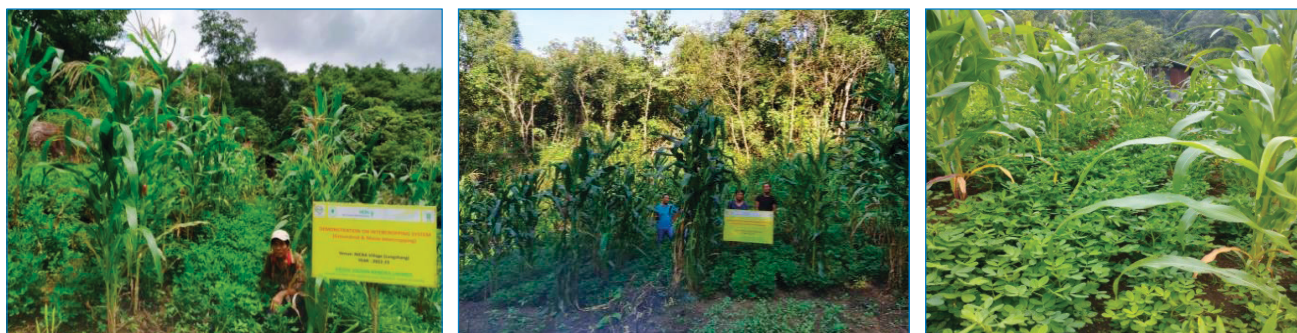
Performance and impact of technology

The yield, gross return, and B:C ratio of maize/groundnut intercrop were found higher than that sole crop maize. Sole cropping system recorded lower B:C ratio (2.5) than intercropping system (3.1). Maize Equivalent Yield (MEY) in intercropping was 49.5 q ha⁻¹ whereas sole crop of maize recorded 31.5 q ha⁻¹ (Table 2.2.2). Besides yield advantage intercropping helps in conservation of soil moisture, reduce erosion and thereby conserves soil resources, suppression of weeds and increase in crop yields.

Table 2.2.2: Impact of groundnut and maize intercropping system at Ukhrul

Technology Demonstrated	Equivalent yield (q ha ⁻¹)	Variety	Economics of demo (₹ ha ⁻¹)		
			Gross return (₹ ha ⁻¹)	Net Return (₹ ha ⁻¹)	B:C ratio
Groundnut + Maize	49.5	ICGS 76 and Composite variety	1,27,600	87,600	3.1:1
Farmer practice - Sole Maize	31.5	Composite	76,250	46,250	2.5

Scope for upscaling : The technology can be scaled through convergence with the district agriculture departments and ATMA.



Groundnut and maize intercropping

Rare ball- a high yielding cabbage variety

Climate vulnerability: Moisture stress

Background: Cabbage is the most widely cultivated commercial vegetable in the Tuensang district, Local varieties are low yielding, susceptible to diseases and moisture stress.

Resilient technology

Cabbage is one of the most important and widely cultivated vegetable crop in the NICRA village of Chendang and Tuensang. The majority of the farmers were engaged in large scale cabbage cultivation. However, with unpredictable rainfall patterns followed by prolonged dry period, water logging and drought stress have affected the growth and quality of cabbage. Availability and procuring high quality and suitable cabbage varieties also pose a challenge. Cabbage var. Rareball coupled with climate resilient practices such as seedling raised in polypropylene trays, polythene mulching or locally available mulches performs very well in stress prone areas.

Performance and impact of technology

Cabbage variety Rareball was demonstrated in the NICRA village of Chendang in 3 ha of land. The farmers in the adopted village cultivated the Rareball cabbage variety. This variety recorded 18% higher productivity over local variety. Incidences of disease and pest infestation were also minimal. It helped in achieving higher net return of ₹ 1,19,500 ha⁻¹ comparatively to that of the local variety (Table 2.2.3).

Table 2.2.3 : Impact of cultivation of high yielding cabbage variety Rareball at Chendang village, Tuensang district

Intervention	Year	Yield (q ha ⁻¹)	Cost of cultivation (₹ ha ⁻¹)	Net returns (₹ ha ⁻¹)	B:C ratio
Cabbage var. Rareball	2022-23	262	1,90,500	1,19,500	1.6
Farmer's practice	Stress year	176	1,65,000	55,000	1.3

Scope for upscaling

The technology can be scaled through convergence with the district agriculture, horticulture departments and ATMA.



Cultivation of high yielding cabbage variety Rareball

Short duration paddy variety RC-Maniphou-12

Climate vulnerability: Moisture stress

Background: Chandel district of Manipur faces moisture stress.

Resilient technology

RC-Maniphou-12 is a short duration paddy variety suitable for early summer and pre-*kharif* crop. This variety matures in 90-105 days in summer (March-April sowing) season in Manipur. This variety can successfully be cultivated after the main *kharif* crop. RCM-12 bears about 150-200 spikelet's per panicle and yield about 4.0-5.0 t ha⁻¹ under good management. It has soft cooking quality. This variety is suitable to system of rice intensification practice too.

Performance and impact of technology

About 700-800 m² of nursery is required for transplanting one-hectare. Preparation of nursery bed starts from November to January (pre *kharif*) and February (summer) depending on the availability of water. The nursery bed is well puddled and levelled to avoid uneven distribution of water. Demonstration of this variety of paddy was done in 7 ha area involving 11 farmers in Lambung village of Chandel district, Manipur. This short duration variety is suitable for early summer and pre- *kharif* crop. This variety matures in 90-105 days in summer (March-April sowing) season under the local conditions. It is found to be tolerant to stem borer and resistant to gall midge biotype-6. It is also resistant to leaf blast and brown spot. It escapes neck blast during pre-*kharif* compared to traditional varieties. The technology has helped the farmers to achieve the yield of 52.3 q ha⁻¹ as compared to 33.6 (q ha⁻¹) in traditional varieties thus achieving a yield increase of 35.7% (Table 2.2.4).

Table 2.2.4: Impact of RC Maniphou-12 in Chandel district of Manipur

Crop	Before inter vention (q ha ⁻¹)	After inter vention (q ha ⁻¹)	% increase	Cost of cultivation (₹ ha ⁻¹)	Gross returns (₹ ha ⁻¹)	Net returns (₹ ha ⁻¹)	B:C ratio
Paddy (var. RCM-12)	33	52	36	74450	167456	93006	2.2

Scope for upscaling

The technology can be scaled up by making available the seeds on time and also in collaboration with the State Agriculture Department.



Cultivation of short duration paddy variety RC-Maniphou-12

Medium duration paddy variety RC Maniphou 12 (RCM-13) for sequential cropping

Climate vulnerability: Moisture stress

Background: Local rice varieties are long duration, late maturing, which reduces the scope for taking up the second crop and also the cropping intensity.

Resilient technology

Introduction of medium duration rice variety RCM - 13 (RC Maniphou-12, 115-120 days) as compared to 150-160 days for local varieties.

Performance and impact of technology

RCM - 13 performs better as compared to long duration local varieties in terms of production and productivity and providing enough scope for the second crops such as toria and other winter vegetables after the harvest of paddy. RCM-13 has a yield of 34.6 (q ha⁻¹) whereas, 22.6 (q ha⁻¹) in terms of local variety (Table 2.2.5). The medium duration paddy RCM - 13 (RC Maniphou-12) of 120 days helps in taking second crop such as toria and winter vegetables after the harvest of the rice.

Table 2.2.5: Impact of mid duration variety of paddy RC Maniphou 12 (RCM-13)

Intervention	Crop yield (q ha ⁻¹)	Cost of cultivation (₹ ha ⁻¹)	Gross return (₹ ha ⁻¹)	Net returns (₹ ha ⁻¹)	B:C ratio
RC Maniphou 12 (RCM-13)	34	50,000	1,03,800	50,000	2.1
Farmer's practice	22	45,000	67,800	35,000	1.5

Scope for upscaling : The technology can be scaled up or spread to the entire districts through convergence with the state department activities. Further field demonstrations help in higher adoption of variety.



Cultivation of medium duration paddy variety RC-MANIPHOU-12 (RCM-13) for sequential cropping

Crop diversification with Soybean for climate resilience

Climate vulnerability: Moisture stress

Background: The tribal farmers of the district traditionally practice mono-cropping. Unfortunately, rice cultivation is subjected to the erratic and uncertain rainfall. To increase crop productivity and improve soil fertility, soybean was introduced. But the area under soybean was very limited in this region due to lack of improved varieties, poor agronomic practices such as higher seed rate, irregular sowing time, defective method of sowing *etc.* which made it a highly unpopular crop in the district.

Resilient technology

To improve farm productivity as well as to retain soil fertility the improved soybean var DSb-19 was introduced. Soybean was found to be possessing a very high nutritional value along with high yield potential. Besides being a good climate resilient crop, it is also a rich source of protein, they are also important for sustainable agriculture enriching the soil through biological nitrogen fixation. These crops fit well in the various cropping systems without disturbing the main cereal crops. Hence, it is important to develop high yielding variety of this crop.

Performance and impact of technology

The soybean cultivation was carried out to demonstrate the production and economic benefit of adopting improved technologies through line sowing at 45 cm x 15 cm spacing in adopted farmer's fields. The crops were harvested at maturity stage. The farmers have greatly benefitted and achieved a yield of 18.58 q ha⁻¹ as compared to 12.80 q ha⁻¹ in traditional varieties thus achieving a yield increase of 31.11 % (Table 2.2.6).

Table 2.2.6 : Impact of soybean (DsB-19) in Chandel district of Manipur

Crop	Before intervention (q ha ⁻¹)	After intervention (q ha ⁻¹)	% increase	Cost of cultivation (₹ ha ⁻¹)	Gross returns ₹ ha ⁻¹	Net returns ₹ ha ⁻¹	B:C ratio
Soybean (var. DSb-19)	13	18	31	1,02,190	35,270	66,920	2.9

Scope for upscaling

The technology can be scaled up by making the seeds available on time and also in collaboration with the State Agriculture Department.



Cultivation of improved climate resilient soybean variety (var. DsB 19)

Crop diversification through climate resilient groundnut variety ICGS-76

Climate vulnerability: Moisture stress

Background: Paddy is the traditional crop cultivated in the fields of the tribal farmers. This is often not sustainable nor profitable. To sustain the food requirement of the burgeoning population in the fragile hilly rainfed uplands, improvement in agricultural productivity through the adoption of improved crop varieties suitable to targeted environments is the need of the hour. Also, crop diversification with oilseed crops such as groundnut in the existing cropping pattern (rice/maize) in the degraded sloppy uplands assures better nutritional security by providing vegetable protein and edible oils.

Resilient technology

Groundnut var. ICGS-76 has shown greater adaptability in the degraded strong acid soils of hilly ecosystems. A proven high yielding variety, it matures in 120 days and is tolerant to bud necrosis disease besides having good recovery from mid-season drought. This crop has been able to withstand several abiotic stresses (soil degradation from Jhuming, acidity) and thus, they could produce up to 60.3% higher mean dry pod yield over local varieties under similar agro-ecosystem management.

Performance and impact of technology

Crop diversification with groundnut has ensured better productivity and profitability with higher net returns without any extra cost to the existing production system. This is also offered a viable alternative to the existing low profit cereal based cropping systems (rice/maize- fallow) in the region, thereby improving sub-optimal cropping intensity (cropping intensity and area diversification in the degraded soils of the district. The farmers have achieved a yield of 20.5 quintals ha⁻¹ as compared to 16.58 (q ha⁻¹) in traditional varieties and achieving a yield increase of 19.12% (Table 2.2.7).

Table 2.2.7 : Impact of groundnut (ICGS-76) in Chandel district of Manipur

Crop/ Yield (q ha ⁻¹)	Before inter vention (q ha ⁻¹)	After inter vention (q ha ⁻¹)	% increase	Gross Cost (₹ ha ⁻¹)	Gross Return (₹ ha ⁻¹)	Net Return (₹ ha ⁻¹)	B:C Ratio
Groundnut (var ICGS76)	16	20	19	55480	184500	129020	3.3

Scope for upscaling

The technology can be scaled up by convincing the farmers on crop diversification and adopt the scientific package of practices.



Cultivation of climate resilient groundnut variety ICGS-76

Advancement of date of sowing in soybean to escape terminal drought

Climate vulnerability: Moisture stress

Background: Phek district of Nagaland receives 1400 mm of annual rainfall but due to ill distribution of rainfall the crops face drought during the crop growth period especially terminal drought in soybean.

Resilient technology

A advancement of date of sowing in soybean was done to escape terminal drought. The demonstration was taken on soybean var. JS 335 in an area of 0.5 ha. in Jhum field during 1st fortnight and 2nd fortnight of May earlier than the conventional time of sowing which is at 1st fortnight of June. The seeds were sown in line at a spacing of 30 x 10 cm and the seed rate was @80 kg ha⁻¹.

Performance and impact of technology

Advancing the date of sowing soybean helped in better and early germination, increased flowering, and improved the pod filling stage. As soybean is a short-day crop with high temperature requirements, it thrived very well with early sowing of the crop and hence achieved satisfactory yield compared to the conventional time of sowing. The farmer could achieve 22.1 q ha⁻¹ and 23.2 q ha⁻¹ during 2015-16 and 2016-17 respectively as compared to the conventional method which was 13.08 q ha⁻¹ and 14.26 q ha⁻¹ (Table 2.2.8).

Table 2.2.8: Yield and economics of soybean

Yield (q ha ⁻¹)		Cost of cultivation (₹ ha ⁻¹)		Gross return (₹ ha ⁻¹)		Net return (₹ ha ⁻¹)		B:C ratio	
Demo	Check	Demo	Check	Demo	Check	Demo	Check	Demo	Check
22.15	13.08	28000	32000	88600	52320	60600	20320	3.16	1.63
23.25	14.26	28000	32000	93000	57040	65000	25040	3.32	1.78

Scope for upscaling : The technology can spread more to the entire farming communities through convergence with the state departmental activities, central programmes, ATMA and other NGOs.



Early sowing of soybean to escape terminal drought



2.3 Promising Livestock/Animal Production Technologies

Khaki Campbell duck breed for improving farm income

Climate vulnerability: Moisture stress

Background: Duck farming is widely practiced in Sepahijala. However the farmers use desi ducks that are low yielding, which may lay only about 70-80 eggs in a year.

Details of technology

Kakhi Campbell breed of duck is known for its high egg laying capacity, multi purpose use and great foragers in paddy fields to eat the pest. In Golaghati Gp most of the farmers rearing only local breed. Krishna shil, Kishore Debbarma and Nirmal Biswas farmer from NICRA village they start scientific rearing of Duckery (Khaki Champbell). Floor space for Duckery is 2.5 sqft/bird/day and feeding management was done 120g concentrated feed/day. These birds are adaptable and tolerant breeds which do not require much vaccination and other health management protocols. They are adapted to rearing under poor ambient conditions.

Performance and impact of technology

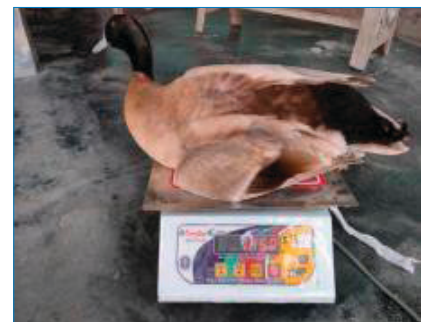
After introducing duckery with Khaki Campbell, it gave additional income to the farmer. Mortality was reduced to 27% and growth rate has enhanced to 26% and egg production was increased by 54 %. During the year 2021-2022, KVK Sepahijala conducted six demonstrations on duckery with NICRA village farmer (30) and providing 15 number Khaki Campbell breed among the farmers, which enhanced farmer income by 100 per cent and BC ratio by 45.33 percent compared to farmer's practices (Table 2.3.1).

Table 2.3.1 : Impact of Duckery (Khaki Champbell) technology in NICRA village

Intervention	Egg yield (No day ⁻¹)	Cost of cultivation (₹ ha ⁻¹)	Gross return (₹ ha ⁻¹)	Net return (₹ ha ⁻¹)	BC ratio
Farmer's practice	6	40	60	20	1.5
Duckery technology	12	55	120	65	2.18

Scope for upscaling

The technology can be spread to entire districts through coming together with state governmental activities and central programmes.



Rearing of Khaki Campbell breed of duck

Composite fish culture technology : For higher productivity

Climate vulnerability: Moisture stress

Background: In Sepahijala district of Tripura the harvested water was utilised supplemental irrigation. In some ponds single species of fish is raised. The productivity and profitability of the pond can be improved by utilizing the space more efficiently *i.e* by adopting composite fish cultivation.

Resilient technology

Composite fish culture is a technique in which five or six different types of fish species are cultured together in a single pond. Fishes with their different food habitats are selected and cultivated so they don't compete with each other for food. Fish used in this fish culture technique were surface (Cattle silver cap), column feeder (Rohu) and bottom feeder (Mrigal and common carp) @ ratio of 30:30:40, 10,000 fingerling ha⁻¹.

Performance and impact of technology

KVK Sepahijala introduced composite fish culture in NICRA village, which increased the farmers income. A higher yield *i.e.* 1200 kg of fish with a net return of ₹ 1,69,798 and B:C ratio of 3.64 was recorded as compared to 650 kg of fish with a net return of ₹ 72,300 and B:C ratio of 2.32 from traditional practice (Table 2.3.2).

Table 2.3.2: Impact of fish culture technology in NICRA village

Intervention	Yield (kg ha ⁻¹)	Cost of cultivation (₹ ha ⁻¹)	Gross return (₹ ha ⁻¹)	Net return (₹ ha ⁻¹)	BC ratio
Farmer's practice	650	54450	126750	72300	2.32
Composite fish culture technique	1200	64202	234000	169798	3.64

Scope for upscaling

The technology can be spread to entire districts through coming together with state governmental activities and central programmes.



Composite fish culture at Golaghati village of Sepahijala

Poultry rearing techniques with poultry breed BND

Climate vulnerability: Moisture stress

Background: Farmers in Golghati of Sepahijala rear local poultry breed with poor housing. It leads to yield lower and affect profitability.

Resilient technology

BND cross (Kamrupa) is a triple cross bred dual purpose variety of poultry developed by ICAR-RC for NEH region, Agartala (Tripura) suited for local conditions. In NICRA village Golaghati of Bishalgarh block, Sepahijala, poultry rearing with improved poultry breed BND with improved techniques were demonstrated. Under improved poultry rearing method, floor space requirement for poultry is 1 sqft/bird and feed management with 12g concentrated feed/day in initial days and latter 30 g concentrated feed/day. BND breed gives 170-185 number egg year⁻¹.

Performance and impact of technology

After introducing BND poultry rearing, the farmer income has increased. With the start of NICRA, farmer recieved high quality poultry breed BND from KVK Sepahijala. KVK conducted 3 demonstrations cum training programme with 30 farmers and provided 20 chicks to everyone. In a poultry house the 1500 BND chicks acre⁻¹ land holding were reared. whereas the local chicks were reared with 650 local chicks acre⁻¹ land holding. The improved breed recorded 148% higher net returns than local practice with a B:C ratio of 2.03 (Table 2.3.3).

Table 2.3.3: Impact of poultry rearing with poultry breed BND technology in Upscaling

Intervention	Area (Nos acre ⁻¹)	Cost of cultivation (₹ ha ⁻¹)	Gross return (₹ ha ⁻¹)	Net return (₹ ha ⁻¹)	BC ratio
Farmer's practice	650	1,54,450	2,22,675	68,225	1.44
Poultry breed BND	1500	1,64,202	3,33,400	1,69,198	2.03

Scope for upscaling

The technology can be spread to entire districts through coming together with state governmental activities and central programmes.



Improved poultry rearing techniques for BND poultry

Paddy cum fish farming for resource recycling

Climate vulnerability: Moisture stress

Background: Paddy is the major crop of Sepahijala. But due to frequent moisture stress paddy crop is affected leading to frequent crop losses.

Resilient technology

To reduce the crop risk and to improve the profitability, Paddy and Fish are cultivated using the same resources in the same unit area. In this integrated farming system, paddy is the main enterprise and fishes are grown to obtain additional income. In this integration, fish like Common carp, Tilapia and Grass carp are reared at the rate of 1500-2000 ha and size ranges from 12 -15 cm.

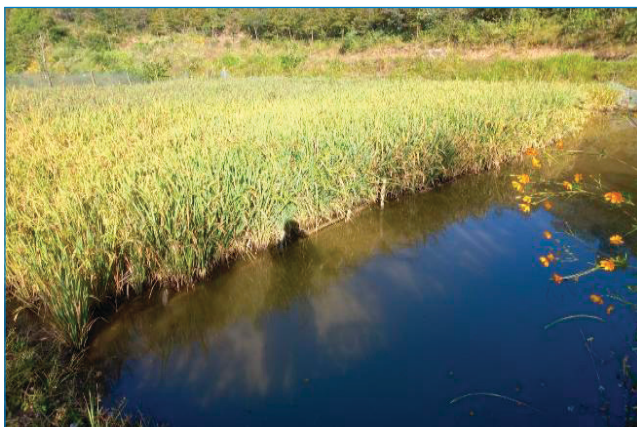
Performance and impact of technology

Paddy cum fish culture is easy, cost effective, sustainable and environmentally friendly. This fish control unwanted filamentous algae which may otherwise compete for the nutrients with the rice and also control the unwanted aquatic weeds which reduce rice yield up to 50%. Moreover, it saves labour cost for weeding and supplemental feeding for fish. Rice yield was increased by 5-10%, which is due to the indirect organic fertilization through the fish excreta. The equivalent yield of rice for the integrated system is 55.5 q ha⁻¹ with a B:C ratio of 2.5 as compared to 25.6 q ha⁻¹ for sole paddy with B:C ratio of 1.66 (Table 2.3.4).

Table 2.3.4: Impact of integrated paddy- cum -fish culture

Technology Demonstrated	Variety	Yield (q ha ⁻¹)	Gross return (₹ ha ⁻¹)	Net return (₹ ha ⁻¹)	B:C ratio
Paddy cum fish farming for resource recycling	RCM-13 and Common carp and grass carp	55.5 (REY)	1,66,500	98,500	2.5
Farmer's practice - Sole paddy	Local	25.6	76,800	30,800	1.66

Scope for upscaling : The technology can be spread to entire districts through convergence with state governmental activities and central programmes.



Composite fish culture at Golaghati village of Sepahijala

Backyard poultry : Gramapriya a sustainable option for landless farmers

Climate vulnerability: Moisture stress

Background: The hilly terrain in Tripura limits the crop production. Farmers in these areas had to depend on other enterprises which require less area for their livelihood.

Resilient technology

Gramapriya, a popular backyard poultry breed, thrives with proper housing, balanced nutrition from commercial feed and green fodder, access to clean water, and adherence to a vaccination schedule and biosecurity measures. Effective breeding management, health monitoring, and economic evaluation ensure successful Gramapriya rearing.

Performance and impact of technology

Farmers in the NICRA village of Sepahijala were demonstrated with backyard poultry rearing using Gramapriya breed. Farmer who had adopted Gramapriya backyard rearing witnessed an income of ₹ 11052 with a B:C ratio of 2.17 (Table 2.3.5).

Table 2.3.5: Economics of egg production of one unit (25 nos. of birds)

Sl No.	Particular	Quantity/ number	Amount (₹)
1	A. Expenditure:- Cost of 3 weeks old Gramapriya chick @ ₹ 64/chick	25	1600
2	Cost of concentrated feed	100	1900
3	Local feeds	-	790
4	Vety. Medicine	-	780
	Total cost		5070
	B. Gross income		
5	Nos. of egg produced	1842 nos, ₹ 6 egg ⁻¹	11052
6	C. Net income	-	5982

Scope for upscaling : Local agricultural extension services or poultry experts can provide region-specific guidance for optimal results.



Backyard poultry rearing with gramapriya poultry breed



3. Climate Resilient Technologies for Risk Prone Districts of Manipur, Nagaland and Tripura and Approaches for Upscaling



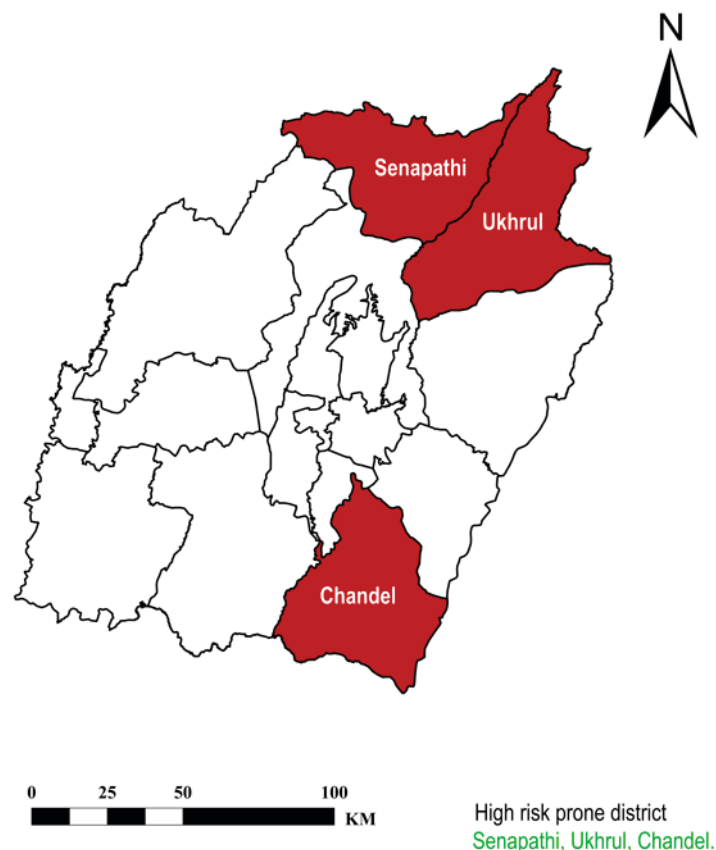
Climate Resilient Technologies for risk prone districts of Manipur, Nagaland and Tripura

Districts in Manipur, Nagaland and Tripura have been classified into various risk categories, including very high risk, high risk, medium risk, and low risk, based on a comprehensive risk assessment conducted by Ramarao *et al.* (2019). The identification of resilient technologies for climate change and variability in these risk-prone districts is informed by on-farm experimentation carried out under the Technology Demonstration Component of NICRA and other relevant studies. The selection of specific technologies is contingent upon the prevailing production systems, available resources, and the production objectives of local farmers. Below are promising resilient technologies recommended for each risk category across different districts of Manipur, Nagaland and Tripura

Risk districts of Manipur

High risk districts of Manipur –Chandel, Churachandpur, Imphal East, Senapati, Thoubal, Ukhurul

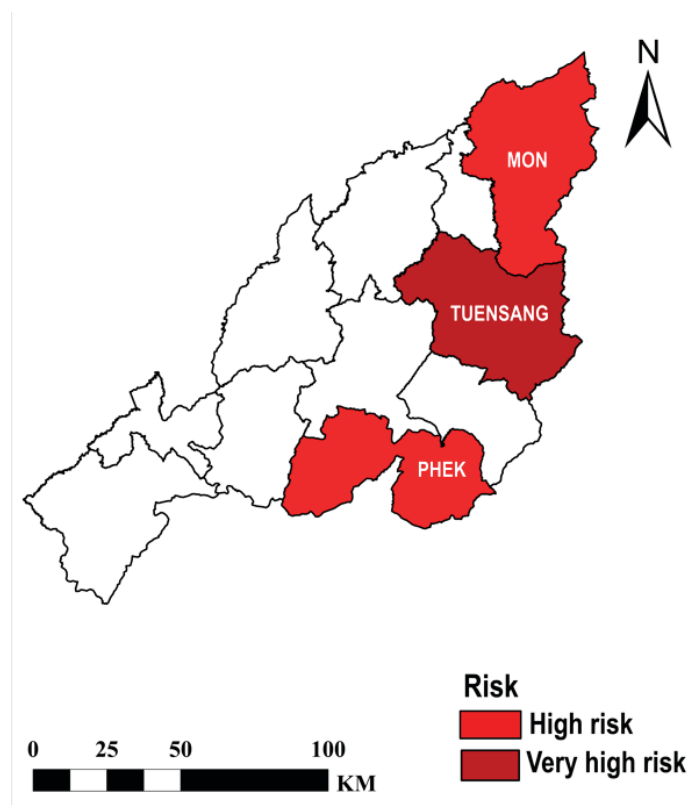
High risk districts of Manipur selected under NICRA



- Construction of low cost water harvesting structure Jalkunds to increase crop intensification and helped to cultivate high value crops by supporting life saving irrigation
- Straw mulching in vegetable crops to conserve moisture thereby increase in crop yield
- Soybean (JS-335) as cover crop for soil and moisture conservation in abounded Jhum land
- Escaping moisture stress through early planting in garden pea
- Intercropping of groundnut and maize
- Medium duration paddy variety RC Maniphou 12 (RCM-13) for sequential cropping
- Paddy cum fish farming for resource recycling
- SRI cultivation under nicra
- Minimum tillage of pea
- Short duration paddy variety RC-Maniphou-12
- Crop diversification through climate resilient crop (groundnut-ICGS-76)
- Gramapriya breed backyard rearing: a suitable option for landless farmers for economic empowerment
- Improved composite fish culture with harvested water

Risk districts of Nagaland

Very high risk and high risk districts selected under NICRA



Very high risk district of Nagaland – Tuensang

- Jalkhund- Water harvesting structure and lowcost polyhouse
- Cultivation of high yielding cabbage variety Rareball.
- Construction of low cost water harvesting structure jalkunds to increase crop intensification and helped to cultivate high value crops after harvest of paddy
- System of rice intensification to overcome dry spells and obtain high yield
- Low cost poly house in vegetable cultivation to get better yield
- Backyard Khaki Campbell layer duck rearing to get additional income
- Mineral mixture feed to the livestock for high yield
- Improved shelter for livestock helps to have better health

High risk district of Nagaland – Mon, Mokokchung, Phek, Wokha, Zunheboto

- Construction of low cost water harvesting structure jalkunds to increase crop intensification and helped to cultivate high value crops after harvest of paddy
- Use of paddy straw mulching for cultivation of field pea, Aman Variety.
- Straw mulching in garden pea for *in-situ* moisture conservation.
- Use of paddy straw mulch in Garlic production.
- Advancement of date of sowing in soybean to escape terminal drought
- Low-cost water harvesting using jalkhund for winter season crop
- Rearing of dual-purpose poultry Kuroiler

Tripura

Risk prone districts of Tripura selected under NICRA



Medium risk districts of Tripura- South Tripura, West Tripura

- Slurry method of phosphorus management in paddy
- Potato cultivation under paddy straw mulching
- Cultivation of french bean variety NRC french under rice fallow
- Capsicum cultivation under poly mulching
- Cultivation of chilli under polymulching to conserve soil moisture
- Cultivation of brinjal under polymulching to conserve soil moisture
- Enhance farmer income to introduce duckerry with the breed Khaki Campbell
- Composite fish culture technology for enhancing productivity
- Poultry rearing techniques with poultry breed BND

Upscaling Promising Climate Resilient Technologies

In the context of the Technology Demonstration Component (TDC) under the National Innovations in Climate Resilient Agriculture (NICRA) initiative, several promising resilient practices have been identified to mitigate the impacts of climate change and variability. Through participatory demonstrations, technologies suitable for 151 districts across the country have been recognized. Scaling up these options and technologies is crucial to effectively minimize the adverse effects of climate change.

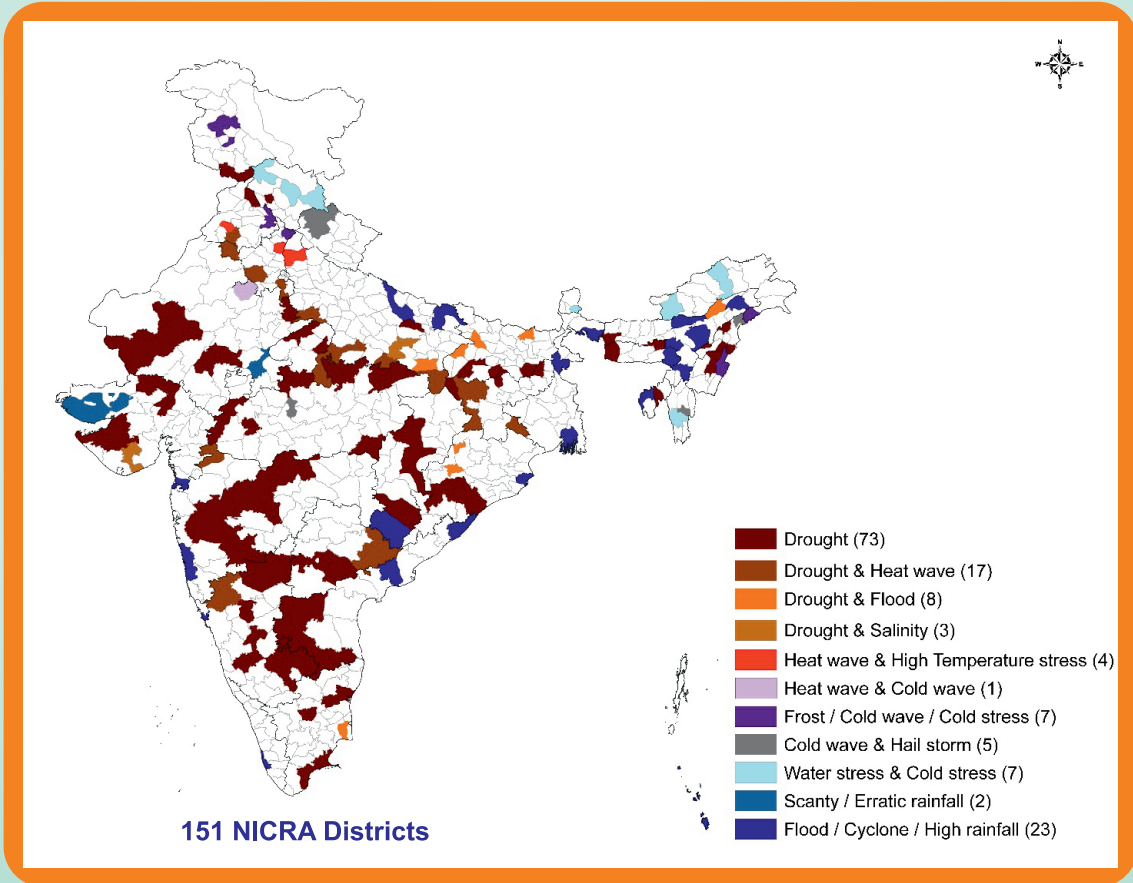
The resilient practices identified in the TDC of NICRA can be seamlessly integrated into the ongoing developmental programs of Manipur, Nagaland, and Tripura. Various existing programs such as the National Mission on Sustainable Agriculture, Mahatma Gandhi National Rural Employment Guarantee Programme, Watershed Development Programme, and others are operational in several districts. Some resilient practices are already integral components of these programs, and additional location-specific resilient technologies need integration to benefit a larger number of farmers.

Certain natural resource management technologies may require significant initial investments to mitigate the adverse impacts of climate change. Given that these programs are piloted by various departments with distinct guidelines and implementation mechanisms, there is a crucial need for convergence at the village level. This convergence will allow farmers in Manipur, Nagaland, and Tripura to avail themselves of the benefits based on their resource endowments and specific farming situations. Proven practices should be targeted based on the biophysical environments, prevailing production systems, and specific vulnerabilities associated with these states.

Resilient practices such as the cultivation of drought-tolerant crop varieties, implementation of intercropping systems, and utilization of improved fodder crop planting materials can be expanded by enhancing community capacities and developing local enabling mechanisms. The creation and nurturing of institutional frameworks at the local level can significantly contribute to the adoption and spread of these practices. It is crucial to establish and support such mechanisms through policies aimed at promoting the dissemination of climate-resilient technologies in Manipur, Nagaland, and Tripura.

4. Literature cited

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