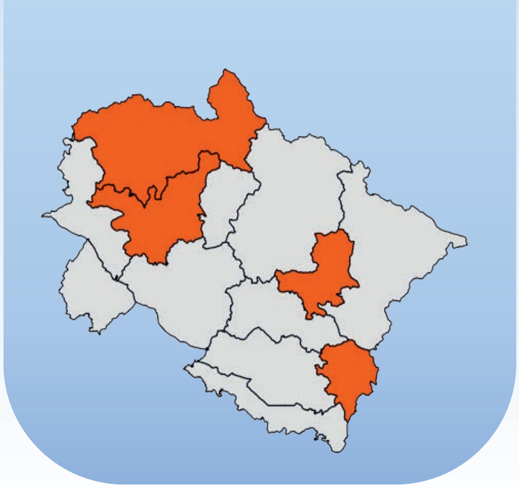

Promising Climate Resilient Technologies for

Jammu & Kashmir and Uttarakhand

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

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VK Singh, G Pratibha, JVNS Prasad, PK Pankaj, Sumanta Kundu, R Rejani,
AS Murai, P Sheoran, M Prabhakar, Rajbir Singh, US Gautam and SK Chaudhari

NICRA
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Indian Council of Agricultural Research (ICAR), New Delhi

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ATARI: Palvi

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सत्यमेव जयते

डॉ. हिमांशु पाठक
Dr. Himanshu Pathak
सचिव (डेयर) एवं महानिदेशक (आईसीएआर)
Secretary (DARE) &
Director General (ICAR)

भारत सरकार
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GOVERNMENT OF INDIA
DEPARTMENT OF AGRICULTURAL RESEARCH AND 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

Jammu & Kashmir and Uttarakhand has a diverse climate due to its varied topography. Agriculture is an important sector in these regions with the majority of the population engaged in farming. The main crops grown in the state include rice, wheat, maize, pulses, oilseeds, fruits, and vegetables. However, the agriculture sector in these regions faces several challenges due to the state's topography and weather conditions. The hilly terrain makes it difficult to cultivate crops, and the state is prone to natural disasters such as floods and landslides. Additionally, these states experiences harsh winters, this can damage crops and make it difficult for farmers to work in the fields.

Combined efforts by Indian Council of Agricultural Research and State Agricultural Universities led to the development of technologies which can enhance resilience to various climatic stresses. As part of Technology Demonstration Component of National Innovations in Climate Resilient Agriculture (NICRA) promising climate resilient technologies are being taken to communities by way of demonstrations to enhance adoption of these technologies in 151 risk prone districts of the country. Efforts were made to forge convergence with the ongoing developmental programmes and partnerships with various development institutions so as to spread the resilient technologies in the NICRA villages. Village institutions such as custom hiring center, seed and fodder production systems, village climate risk management committee are being established to spread the technologies so as to reach every household. Capacities of communities were built on various resilient technologies and on enterprises such as seed production. Efforts lead to enhanced adoption and spread of the climate resilient technologies in the NICRA cluster of villages which helped farmers to minimize yield losses during stress years.

I compliment the authors for bringing out the publication and acknowledge the cooperation of various institutions involved in the program and participating farmers in NICRA villages. I wish that these technologies would be integrated with development programs which will enhance the adaptive capacity of farmers in the region.

With regards,

Yours sincerely,

(Himanshu Pathak)

Dated the 14th March, 2024
New Delhi

PREFACE

Climate change is affecting the agriculture, environment, human health, and livelihoods. Climate change poses a major threat to Indian economy, where agriculture provides a living for a significant proportion of the population. The hilly states of Jammu and Kashmir, Ladakh, and Uttarakhand make substantial contributions to the country's food grain, fruit, and vegetable production. Climate change and variability are affecting the state, and the impact is expected to be larger, more widespread, and long-lasting in the coming years.

National Innovations in Climate Resilient Agriculture (NICRA) is the Indian Council of Agricultural Research's flagship project that addresses multiple aspects of climate change with a focus on the agricultural sector. The Technology Demonstration Component of NICRA aims to identify climate resilient technologies in association with the farming community and improve their ability to face the challenges of climate change. On-farm demonstrations of various technologies for natural resource management, crops and cropping systems, and livestock are being conducted. These strategies were assesed in both normal and stressful years and farmers' perceptions were recorded. In the NICRA villages, community organizations such as seed banks, fodder banks, custom hiring centers, and a local climate risk management committee were established to spread the promising technologies.

The promising resilient technologies were scaled in the NICRA villages in convergence with the ongoing development programs so as to reach as many households in the villages as possible. Several technologies reduced the impact of climate stress while also improved adaptive ability and resilience. This publication on innovative technologies presents evidence on improved production and profitability for the state of Jammu & Kashmir and Uttarakhand. A book containing promising innovations acts as a guide for all stakeholders in scaling climate resilient technologies as part of the state's multiple developmental plans.

In this publication upscaling technologies for each locations, as well as the numerous development projects that can be employed to scale the technologies. Furthermore, promising resilient technologies may be integrated into State Climate Change Action Plans in order to attract extra funding for their expansion. We would like to thank Dr. Himanshu Pathak, Secretary (DARE) and Director General (ICAR), members of the High-Level Monitoring Committee, Zonal Monitoring Committee Chairmen and members, Directors of Extension of the State Agricultural and Veterinary Universities, officials of the state's development Departments and KVKs, and colleagues from ICAR-CRIDA for their constant guidance and support. We gladly recognize the tremendous contributions of farmers, VCRMC members, and other project stakeholders.

Authors

Contributors for this compendium

State	KVK	Name of the PI	Name of the Co-PI	Name of the SRF
---	ATARI, Ludhiana	Dr. Ashish Santosh Murai	---	Ms. Palvi
Jammu & Kashmir, Ladakh	Anantnag	Dr. Ishtiyaq A. Khan	Dr. Ishtiyak Ahmad Mir	Dr. Suheel Ahmad Ganai
	Bandipora	Dr. Tariq Sultan	Dr. Tahir Saleem	Dr. Saba Bukhari
	Kathua	Dr. Vishal Mahajan	Dr. Berjesh Ajrawat	Mr. Sushant Sharma
	Leh	Dr. Feroz Din Sheikh	Dr. Sabiya Asmat Dr. Kunzang Lamo Mr. Sonam Angchuk	Dr. Stanzin Dorjey
	Poonch	Dr. Ajay Gupta	Dr. Muzafar Mir Dr. Mushtaq A Guroo	Dr. Ramandeep Kour
Uttarakhand	Bageshwar	Dr. Kamal Kumar Pande, Dr. RajKuma	Dr. NawalKishor Singh and Mr. Harish Chandra Joshi	Mr. Himanshu Bhatt
	Champawat	Amresh Sirohi, Dr. Deepali T. Pandey	Dr. Sachin Pant, Dr. B.S. Kharayat	Ms. Leema
	Tehri Garhwal	Dr. Aalok Gulabrao Yewale	Ms.Shikha Dr. Sachin Kumar	Mr. Udit Joshi
	Uttarkashi	Dr. Chitrangad Singh Raghav	Mr. Neeraj Joshi	Mr. Pankaj Chauhan

CONTENTS

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 MantriKrishiSinchayeeYojana
PKVY	ParamparagatKrishiVikasYojana
RKVY	RashtriyaKrishiVikasYojana
SAUs	State Agricultural Universities
SFAC	Small Farmers' Agri-Business Consortium
TDC	Technology Demonstration Component
VCRMC	Village Climate Risk Management Committee

1. Introduction

INTRODUCTION

India has a diverse climate due to its vast size and geographical location. The country experiences a range of climatic conditions, from tropical in the south to alpine in the north. One of the most significant impacts of climate change on Indian agriculture is the changing weather patterns. Erratic rainfall, drought, floods, and extreme weather events are becoming more frequent, which are affecting crop yields and productivity. Another impact of climate change on Indian agriculture is the melting of glaciers in the Himalayas. Many rainfed small-scale farmers are dependent on rainfall, hence the changing weather patterns are affecting crop productivity and profitability. The climate change also causes loss of biodiversity, which is affecting the availability of traditional crops and food sources.

a) Jammu and Kashmir

The State of Jammu and Kashmir is situated in the northern part of India, nestled within the greater Himalayas, and shares borders with Pakistan to the West and China to the East. Located between latitudes 32°25' N and 37°07' N and longitudes 72°35' E and 80°14' E (Fig. 1), it is encompassed by the Karakoram Mountain in the north, the Tibetan Plateau in the east, Pakistan in the west, and Punjab in the south.

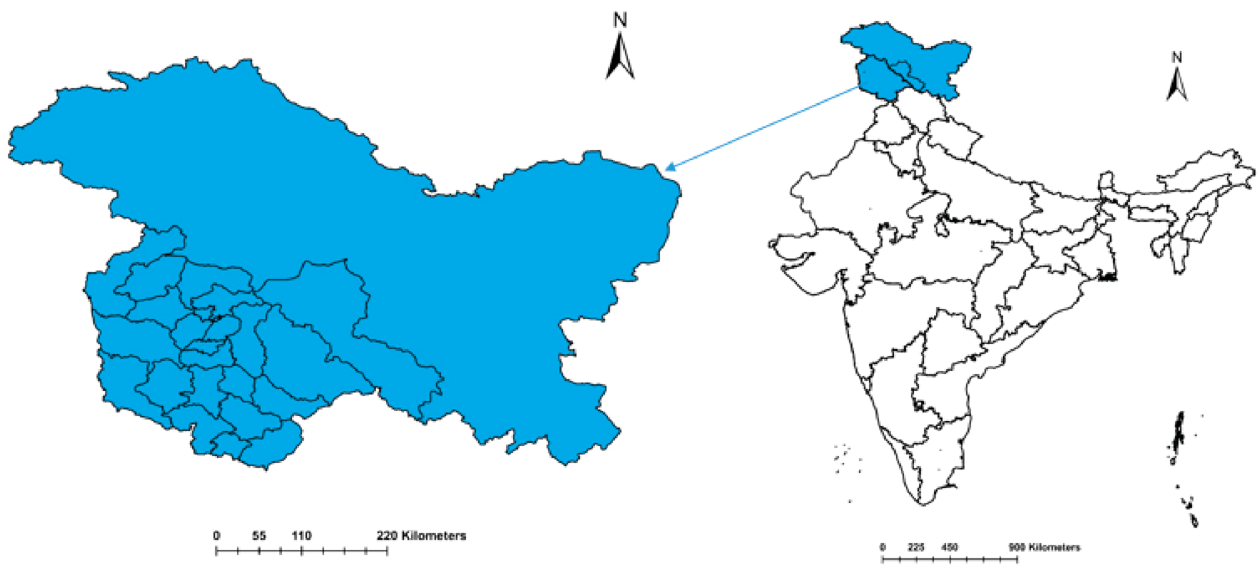


Fig 1. Location map of Jammu & Kashmir, Ladakh

Diverse elevations characterize different parts of Jammu and Kashmir, including the Shivalik and greater Himalayas, as well as the plains of the Kashmir Valley between the inner Himalayas and Karakoram Ranges. The state comprises three distinct regions: the Kashmir Valley, Jammu region, and Ladakh, which stands as the only cold desert in India. Each region possesses a unique resource base, with the majority of the state being mountainous, except for Jammu and Kathua districts.

Ladakh, separated by high mountain ranges, faces unique developmental and communication challenges due to its extensive coverage by glaciers and steep rocks.

Featuring an intricate natural drainage system, the state is traversed by three major river systems Indus, Jhelum, and Chenab flowing from east to west, ultimately draining into the Arabian Sea through Pakistan. These rivers predominantly originate from glaciers in the higher Himalayas. The state is also endowed with numerous natural lakes and wetlands.

Climate

The climate in the state of Jammu and Kashmir can be broadly categorized into tropical, temperate, and alpine based on factors such as elevation, aspects, and rainfall. The major climatic zones include the cold arid desert areas of Ladakh, the temperate climate of the Kashmir Valley, and the humid subtropical region of Jammu. The temperature varies spatially, with Drass being the coldest and Jammu the hottest. January is the coldest period, while June and July are the hottest months. Different climatic zones in Jammu and Kashmir include the windward region (Jammu) with a monsoon climate, the leeward region (Ladakh) experiencing low snowfall.

The climates of the Kashmir Valley and Chenab Valley in Jammu have unique characteristics, marked by sudden seasonal changes and distinctly divided into four seasons of three months each. These areas experience snowfall and severe winters. In contrast, many parts of the Ladakh region witness heavy snowfall, while others endure severe dry cold and face road closures for about 5-6 months annually. Areas like Pooch, Rajouri, and Uri in the South-West regions of Jammu and Kashmir have a moderately hot climate.

The state's annual rainfall ranges from 600 mm to 800 mm, and temperatures fluctuate between sub-zero levels to 40°C. However, approximately 59% of the geographic area is covered with glaciers, making it unavailable for tree plantation.

Land use pattern

The land utilization pattern in Jammu and Kashmir is depicted in the Fig 2. Over 56% of the area is covered by glaciers or permanent snow, rendering them unsuitable for agriculture and tree planting. In the remaining land, more than 74% is under forests. About 3% of the area is under pasture and grazing with little scope for expansion of area under agriculture. But, there is room for improving agricultural productivity in cultivated and fallow lands. The biodiversity resources present in forests and wildlife areas offer possibilities for non-consumptive utilization,which have the potential to significantly enhance household incomes.

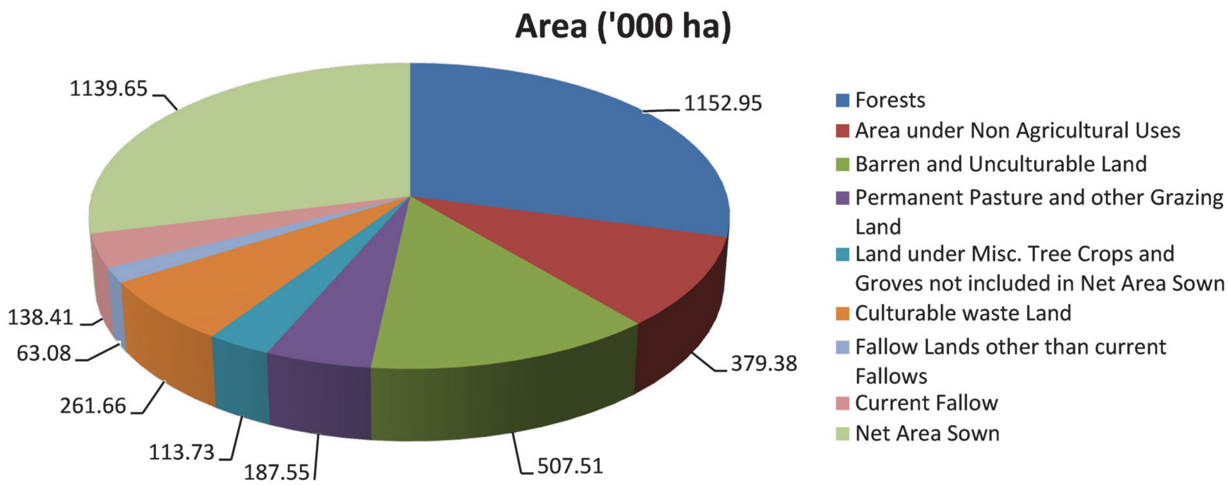


Fig 2. Land Use Pattern

Livestock

Livestock plays very vital role in the economic development of the state and forms an integral part of State Agriculture. About 73% population of J & K State are dependent on agriculture as their main occupation. Livestock rearing is their subsidiary occupation as these two sectors are interdependent. Livestock sector engages sizeable number of work force for in rearing of animals, processing, transportation and sale of the animal products.

Overview of selected districts under NICRA in Jammu and Kashmir

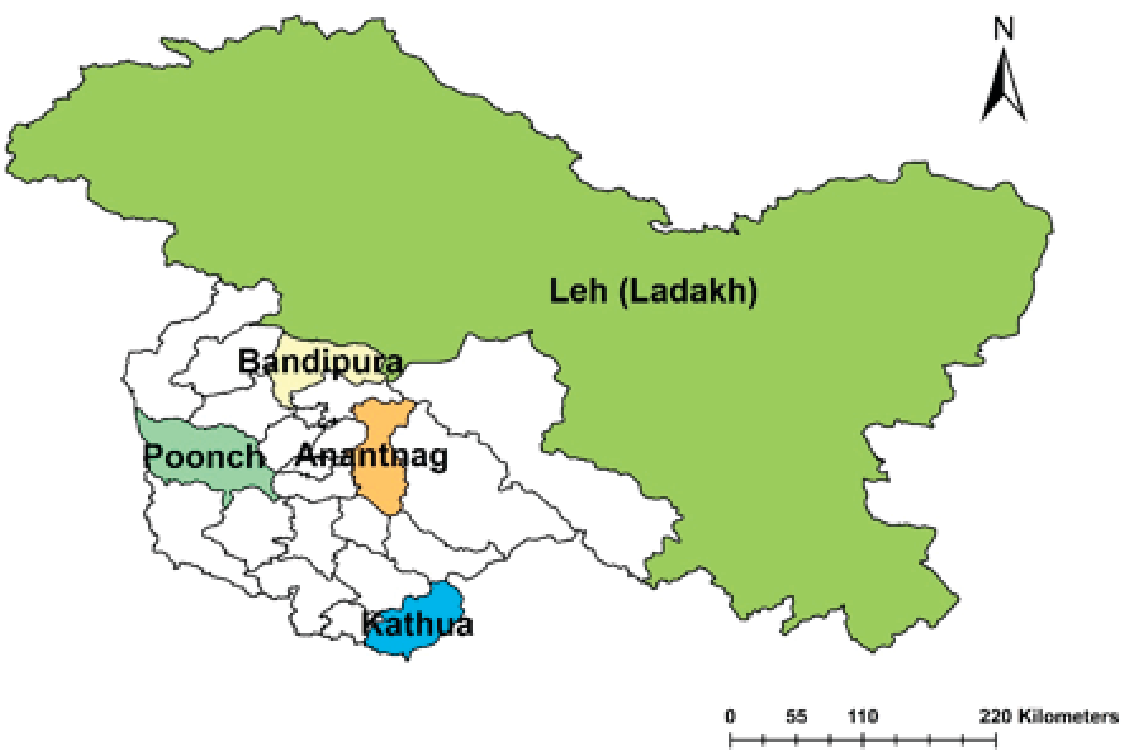


Fig 3. Districts under NICRA Program in Jammu & Kashmir and Ladakh

Anantnag

Anantnag district is located between 33°17'20" and 34°15'30" N latitude and 74°30'15" and 75°35'00" E longitude with an altitude of 5211 ft above mean sea level. The district is bounded by Poonch district in the west, Srinagar district in the North & Kargil district in the North East and Doda district in the East, Pulwama district in the North West, Rajouri & Udhampur districts in the South & South East. The district falls under western himalayas, warm subhumid (to humid with inclusion of perhumid) eco-region (14.2) Agro Eco-sub region (ICAR), Western Himalayan Zone (I) (Planning Commission) and mid to high altitude temperate zone (JK-3) (NARP). The geographical area of the district is 0.72 lakh ha and the land use pattern of the district is indicated Fig. 5. The gross cropped area of the district is 0.67 lakh ha of which 0.44 lakh ha is net sown area and 0.23 lakh ha area is sown more than once. The source of irrigation in the district is canals, tanks, openwells etc. The major crops grown in this district are peas, beans, potato, rapeseed & mustard etc (Table 1.1). Dairy farming, goat and sheep farming are adopted in the district. The average annual rainfall of the district is 713mm. The predominant soils in the district are silty clay loam and sandy to clay loam soils.

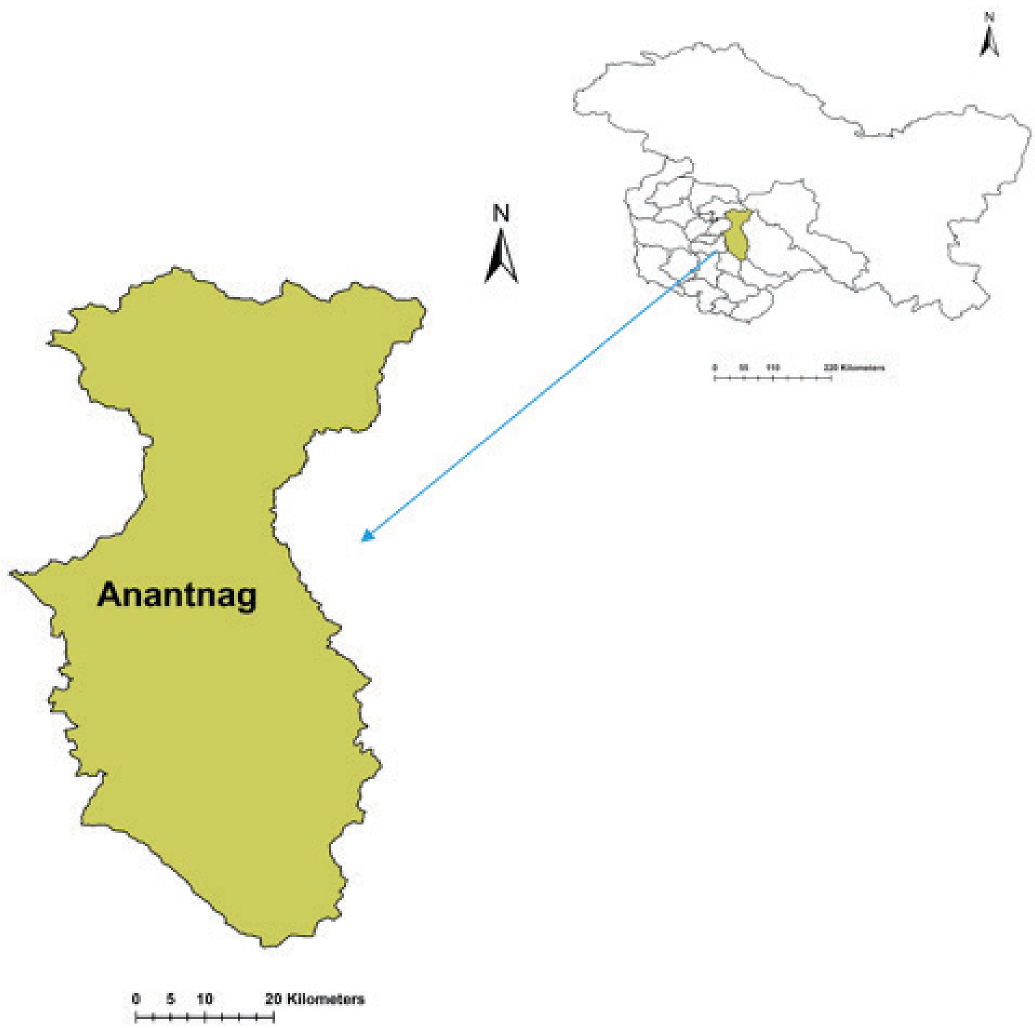


Fig 4. Location map of Anantnag district

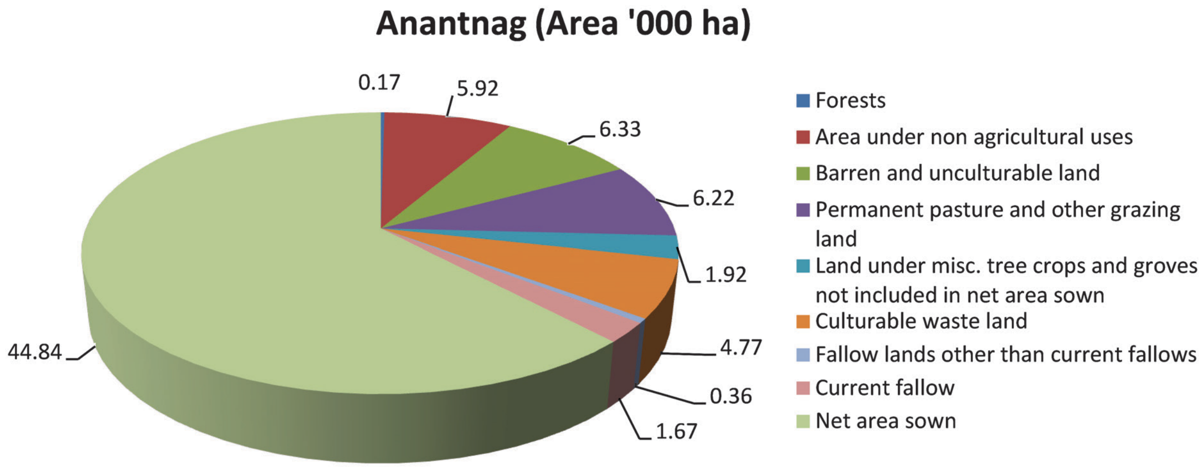


Fig 5. Land use pattern of Anantnag district

Table 1.1 : Area, production and productivity of major crops

Crop	Season	Area (ha)	Production (t)	Yield (t ha^{-1})
Rapeseed and Mustard	*Rabi*	12,764	8,628.8	0.68
Potato	*Rabi*	15	123.1	8.21
Peas and beans (Pulses)	*Rabi*	34	22.7	0.67

Bandipora

Bandipora district is located between 34° 25 'N latitude and 74° 38' E longitude with an altitude of 5541 ft above mean sea level. The district falls under Northern Western Himalayan Agro Eco-sub region (ICAR), Cold Arid Humid (planning commission) and Humid Western Himalayan Region (NARP). The geographical area of the district is 0.34 lakh ha and different land use pattern of the districts are indicated (Fig. 7). The gross cropped area of the district is 0.29 lakh ha out of which

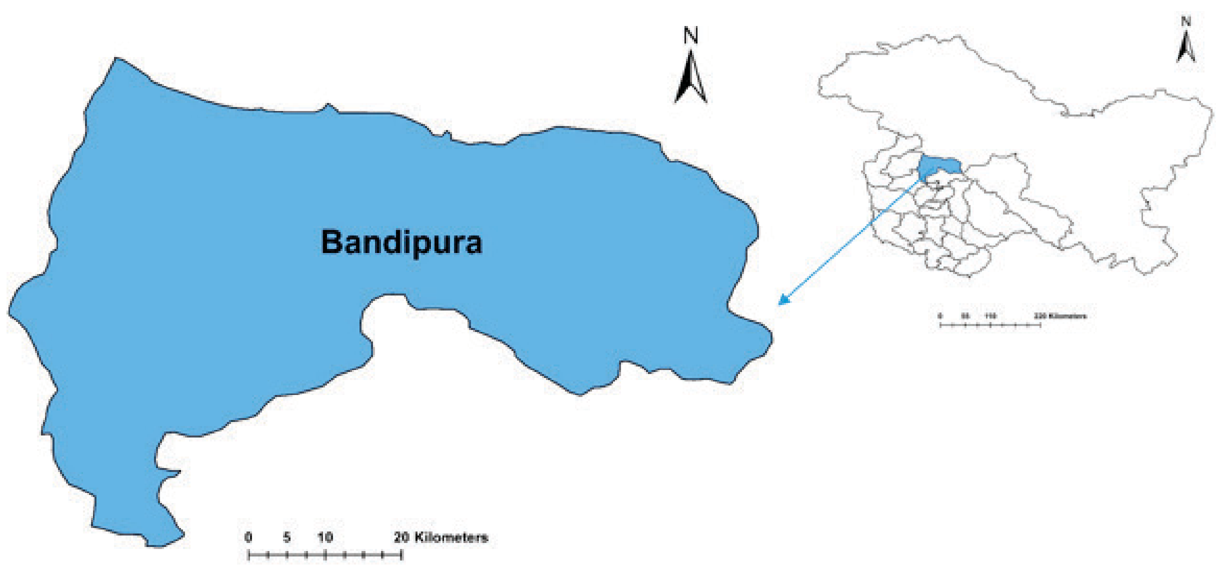


Fig 6. Location map of Bandipora district

0.25 lakh ha is net sown area sown once and 0.03 lakh ha area is sown more than once. The source of irrigation in the district is canals, pumpsets and other sources. The major crops grown in this district are rapeseed & mustard, potato, peas & beans (Table 1.2). Dairy farming, Goat and Sheep are adopted in the district. The average annual rainfall of the district is 1476 mm. The predominant soils in the district are silty clay loam and sandy loam.

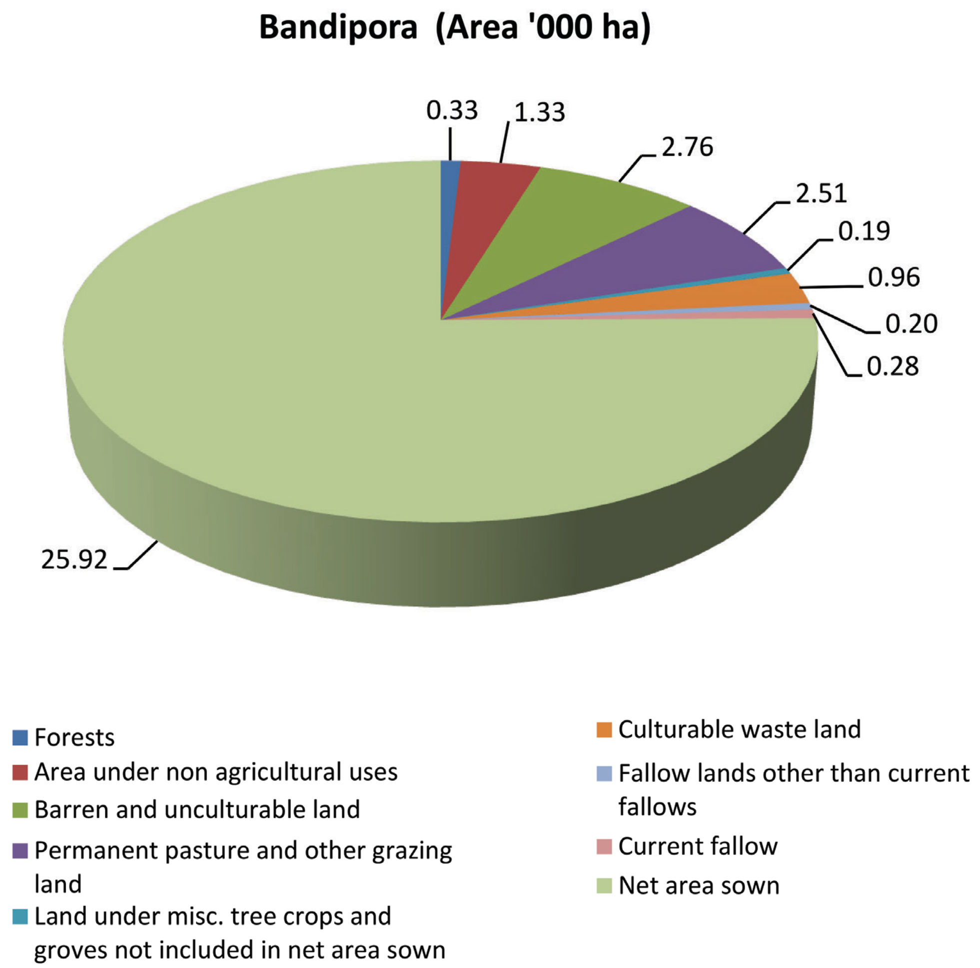


Fig 7. Land use pattern in Bandipora district

Table 1.2: Area, production and productivity of major crops

Crops	Season	Area (ha)	Production (t)	Yield (t ha^{-1})
Peas and beans (Pulses)	*Rabi*	15	10.2	0.68
Potato	*Rabi*	121	1,144.8	9.46
Rapeseed and Mustard	*Rabi*	1,518	1,551.6	1.02

Kathua

Kathua district is located between 34°16'00" and 32°55'00" N latitude and 75°06' and 75°54' E longitude with an altitude of 307 m above mean sea level. The district falls under Western Himalayas, Warm Subhumid (To Humid with inclusion of Perhumid) Eco-sub region (14.2) Agro Eco-sub region (ICAR), Western Himalayan Region (I) (planning commission) and Low Altitude Sub-Tropical Zone (JK-1) (NARP). The geographical area of the district is 2.60 lakh ha and different land use pattern of the districts are indicated (Fig. 8). The gross cropped area of the district is 1.16 lakh ha out of which 0.59 lakh ha is net sown area sown once and 0.56 lakh ha area is sown more than once. The source of irrigation in the district is canals, tanks, open wells, bore wells and other sources. The major crops grown in this district are wheat, rapeseed and mustard, barley, garlic, other *rabi* pulses, potato etc (Table 1.3). Dairy, goat, sheep, pig farming is adopted in the district. The average annual rainfall of the district is 1156 mm and much of the rainfall is received in *kharif* (Fig. 9).

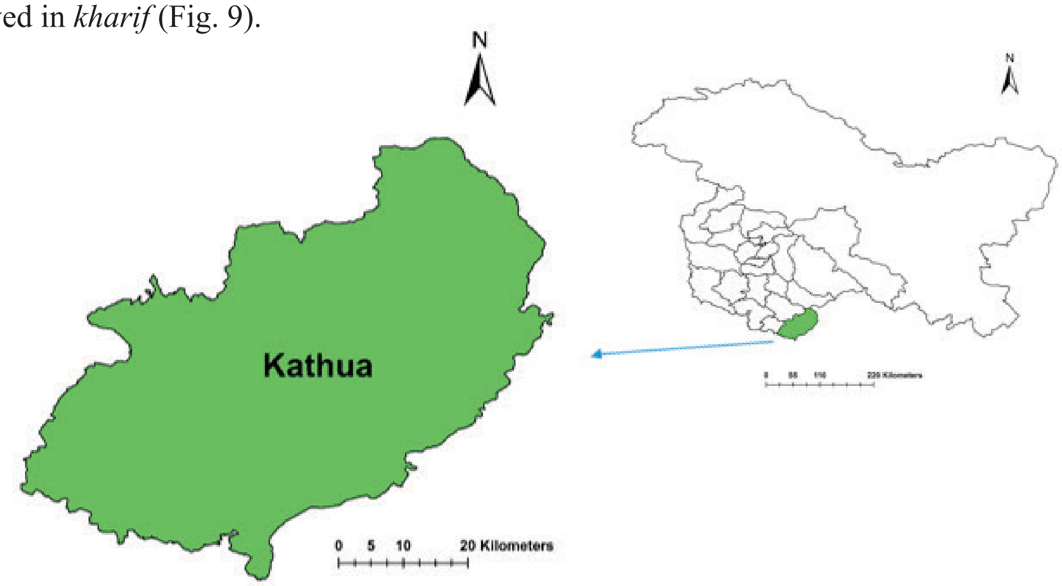


Fig 8. Location map of Kathua district

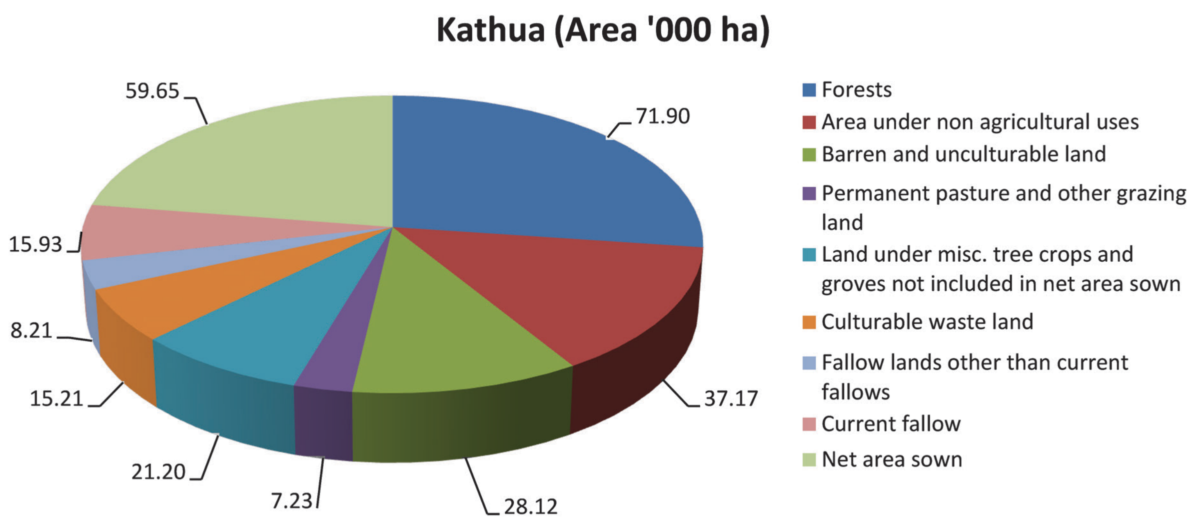


Fig 9. Land use pattern of Kathua district

Table 1.3 : Area, production and productivity of major crops

Crops	Season	Area (ha)	Production (t)	Yield (t ha^{-1})
Wheat	*Rabi*	48,366	1,01,844.3	2.11
Rapeseed and Mustard	*Rabi*	2,592	1,158.5	0.45
Barley	*Rabi*	1,765	1,553.3	0.88
Garlic	*Rabi*	40	29.6	0.74
Other *Rabi* pulses	*Rabi*	30	14.6	0.49
Potato	*Rabi*	29	715.3	24.67
Small millets	*Rabi*	11	7.7	0.7
Other Cereals	*Rabi*	6	1.1	0.18
Linseed	*Rabi*	4	5.2	1.3

Leh (Ladakh)

Leh is located between 32° to 36° N latitude and 75° to 80° E longitude with an altitude of 11782 ft above mean sea level. The district falls under Western Himalayas, Cold Arid Eco-Regions (1.1) Agro Eco-sub region (ICAR), Western Himalayan Region (I) (Planning Commission) and Cold Arid Region (JK-4) (NARP). The geographical area of the district is 0.45 lakh ha, cultivable area is 0.10 lakh ha and other land use pattern of the districts are indicated (Fig. 11). The gross cropped area of the district is 0.10 lakh ha. The whole area is under irrigation i.e. 0.10 lakh ha. The source of irrigation in the district is canals and small canals. The major crops grown in this district are barley, wheat, pulses, apricot, pear, apple. Dairy farming, goat and sheep farming are adopted in the district. The average annual rainfall+snowfall of the district is 86 mm and much of the rainfall is received in *kharif*. The predominant soils in the district are sandy loam, silty loam and clay loam.

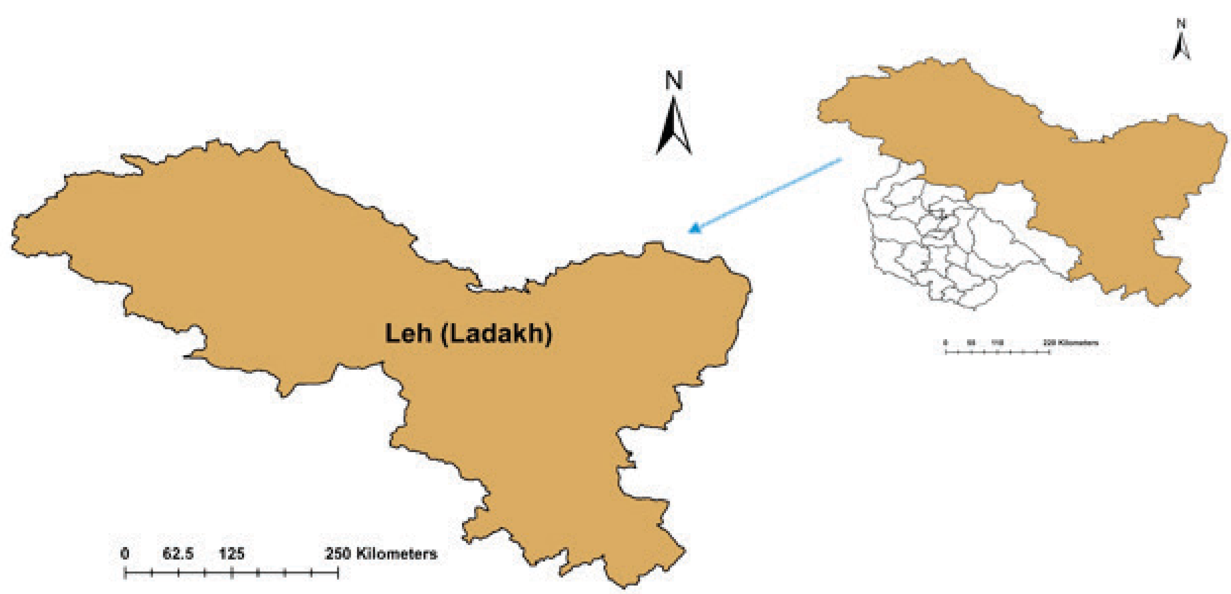


Fig 10. Location map of Leh (Ladakh)

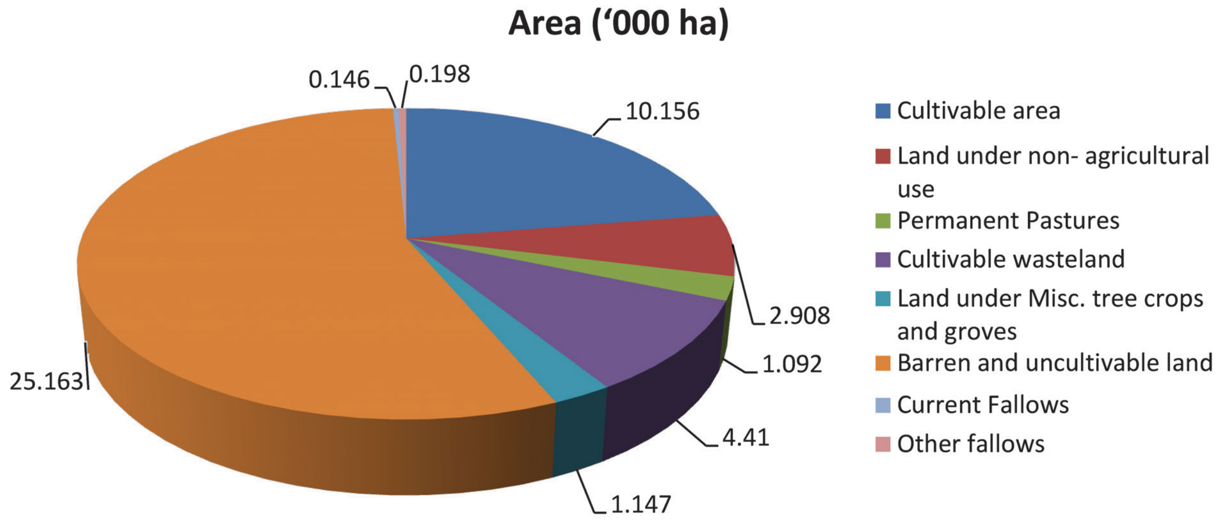


Fig 11. Land use pattern of Leh

Poonch

Poonch district is located between 33°25' to 34º01' N latitude and 73°58' to 74º35' E longitude with an altitude of 1007 m near Poonch town to 4700 m above mean sea level on high hill ranges towards north eastern part of the district. The district falls under Western Himalayas, Warm Subhumid (To Humid With Inclusion of Perhumid) Eco-sub region. (14.2) Agro Eco-sub region (ICAR), Western Himalayan Region (I) (planning commission) and Mid to High Altitude Intermediate Zone (JK-2) & Mid to High Altitude Temperate Zone (JK-3) (NARP). The geographical area of the district is 1.14 lakh ha and other land use pattern of the districts are indicated (Fig. 13). The gross cropped area of the district is 0.44 lakh ha out of which net area sown once is 0.25 lakh ha and area sown more than once is 0.18 lakh ha. The major crops grown in this district are garlic, peas and beans (pulses), rapeseed &mustard and wheat (Table 1.4). Dairy farming, goat, sheep, poultry farming are adopted in the district.

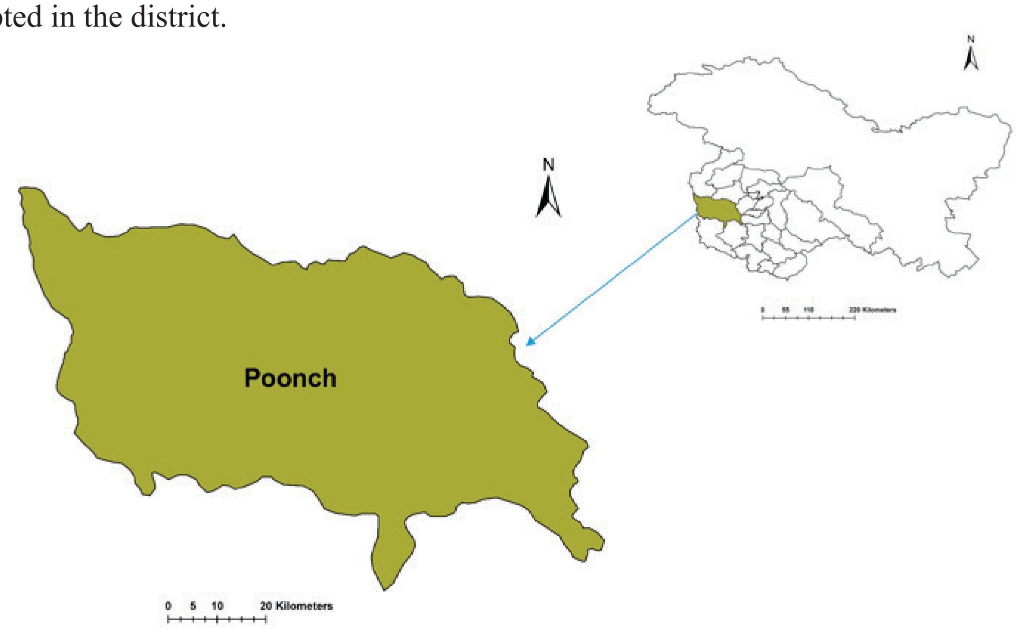


Fig 12. Location map of Poonch district

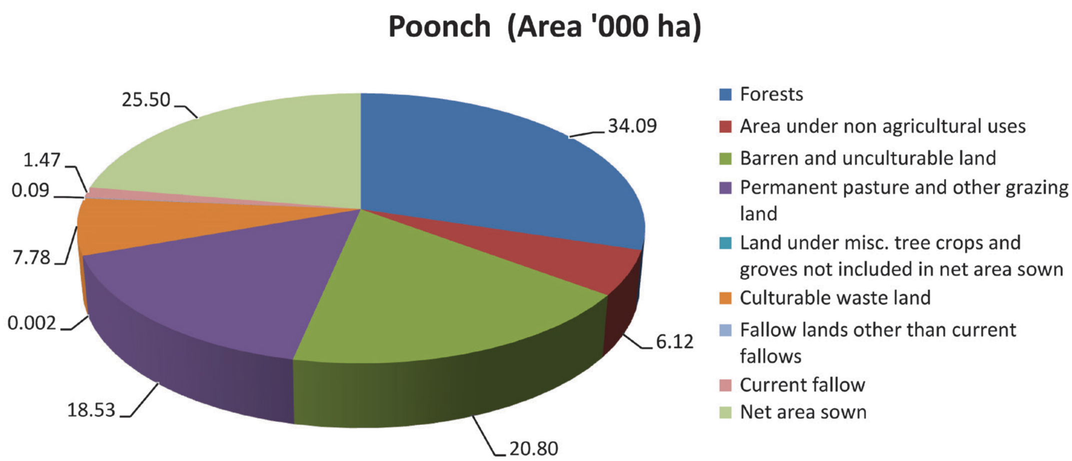


Fig 13. Land use pattern of Poonch district

Table 1.4 : Area, production and productivity of major crops

Crop	Season	Area (ha)	Production (t)	Yield (t ha^{-1})
Wheat	*Rabi*	15,327	35,325.5	2.3
Garlic	*Rabi*	95	81.6	0.86
Rapeseed and Mustard	*Rabi*	30	23.6	0.79
Peas and beans (Pulses)	*Rabi*	1	0.6	0.6

b) Uttarakhand

Uttarakhand is one of the hilly states of the Indian Himalayas. Uttarakhand, originally known as Uttaranchal, was established as the 27th state of the Indian Union. It was once a part of Uttar Pradesh (UP). Situated in northern India, it is bounded by latitudes 28°43′ N and 31°27′ N and

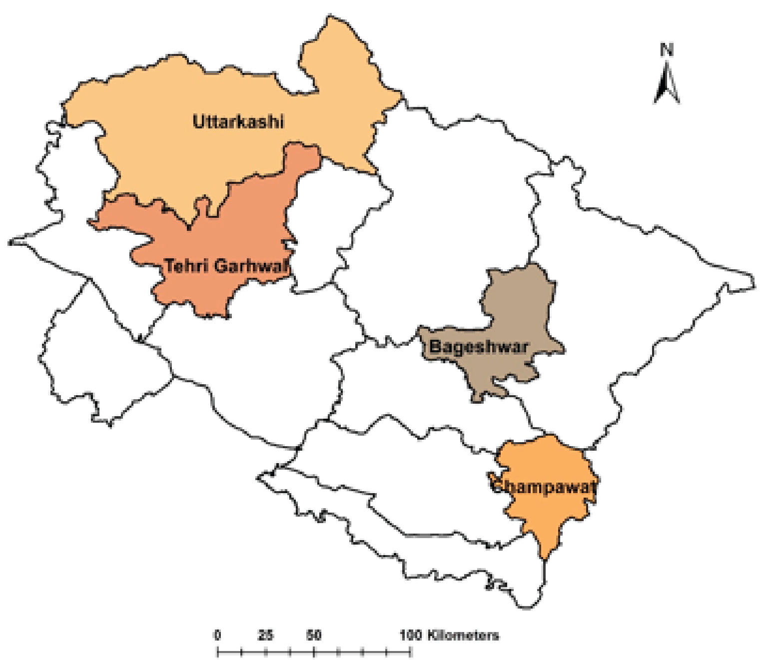


Fig 14. Location map of Uttarakhand

longitudes 77°34′ E and 81°02′ E. Its greatest dimensions are 301 km in the east-west and 255 km in the north-south directions, with a total area of 53,483 km^2. The elevation ranges from 210 to 7817 meters. The state shares border with China (Tibet) in the north, Nepal in the east, Himachal Pradesh in the west and north-west and Uttar Pradesh in the south.

Climate

Uttarakhand has two unique climate regions: Predominantly hilly terrain and the little plain region. Uttarakhand's climatic conditions vary widely due to height and proximity to the Himalayan peaks. The plains' climatic conditions are extremely similar to those of the Gangetic plain, which are tropical. Summers are relatively hot, and winters are frigid, with temperatures dropping below 0° Celsius. The average rainfall across the state ranges from 92 cm in Srinagar to 250 cm in Nainital. However, the spatial distribution of rainfall changes according to the geographical location, slope, and aspect of the area. Rainfall tends to be abundant in low mountainous areas like Nainital and Dehradun, gradually diminishing as elevation increases. Approximately three-quarters of the total rainfall happens during the monsoon season, while the remaining quarter occurs in other seasons due to western disturbances and local orographic effects. Monsoonal patterns typically commence towards the end of June and intensify during July and August.

Climate change

Climate change had a significant impact on agriculture in Uttarakhand. The changing climate has led to alterations in land use and land cover, resulting in a decrease in snow and glacier snow area and an increase in wetlands/waterbodies area. Additionally, there has been a decrease in fallow agricultural land and an increase in cropland area. The built-up area has also increased. These changes, combined with the increasing population and built-up area, have put stress on the region's water resources are jeopardizing the demand and supply of water in the lower regions. The vulnerability of agriculture to climate change is further highlighted by the lower production of wheat, rice, and pulses in years with deficient rainfall and non-seasonal rains. To mitigate the impact of climate change on agriculture in Uttarakhand, a comprehensive land use policy based on integrated management of land, water, and forest resources is necessary. (Dubey et. al. 2022)

Land use pattern

Owing to its mountainous terrain, Uttarakhand possesses distinctive ecosystems. In the north, the state is situated within the vast Himalayan range, characterized by snow-capped peaks and glaciers. Uttarakhand serves as the source of two significant rivers in the Indian subcontinent, the Ganga and the Yamuna are originating from its glaciers. Additionally, dense forests blanket various areas of Uttarakhand, forming a substantial portion of its natural resource wealth.

In Uttarakhand, the land is primarily characterized by its significant forest coverage, occupying 51.88% of the total area, followed by cropped areas at 13.20%. A smaller but notable portion is dedicated to land under miscellaneous tree crops and groves, accounting for 5.36% of the total area, while areas sown more than once constitute 5.11%, net sown area of 8.08%, Culturable waste land occupies 4.74%, and barren and unculturable land make up 2.73%. Additionally, permanent pasture and other grazing land cover 3.40%, with areas under non-agricultural uses accounting for 2.60%. Fallow lands other than current fallows make up 1.47%, while current fallow lands constitute 1.33% (Fig 15). These percentages depict the diverse land use patterns in Uttarakhand, reflecting both its natural landscapes and human activities.

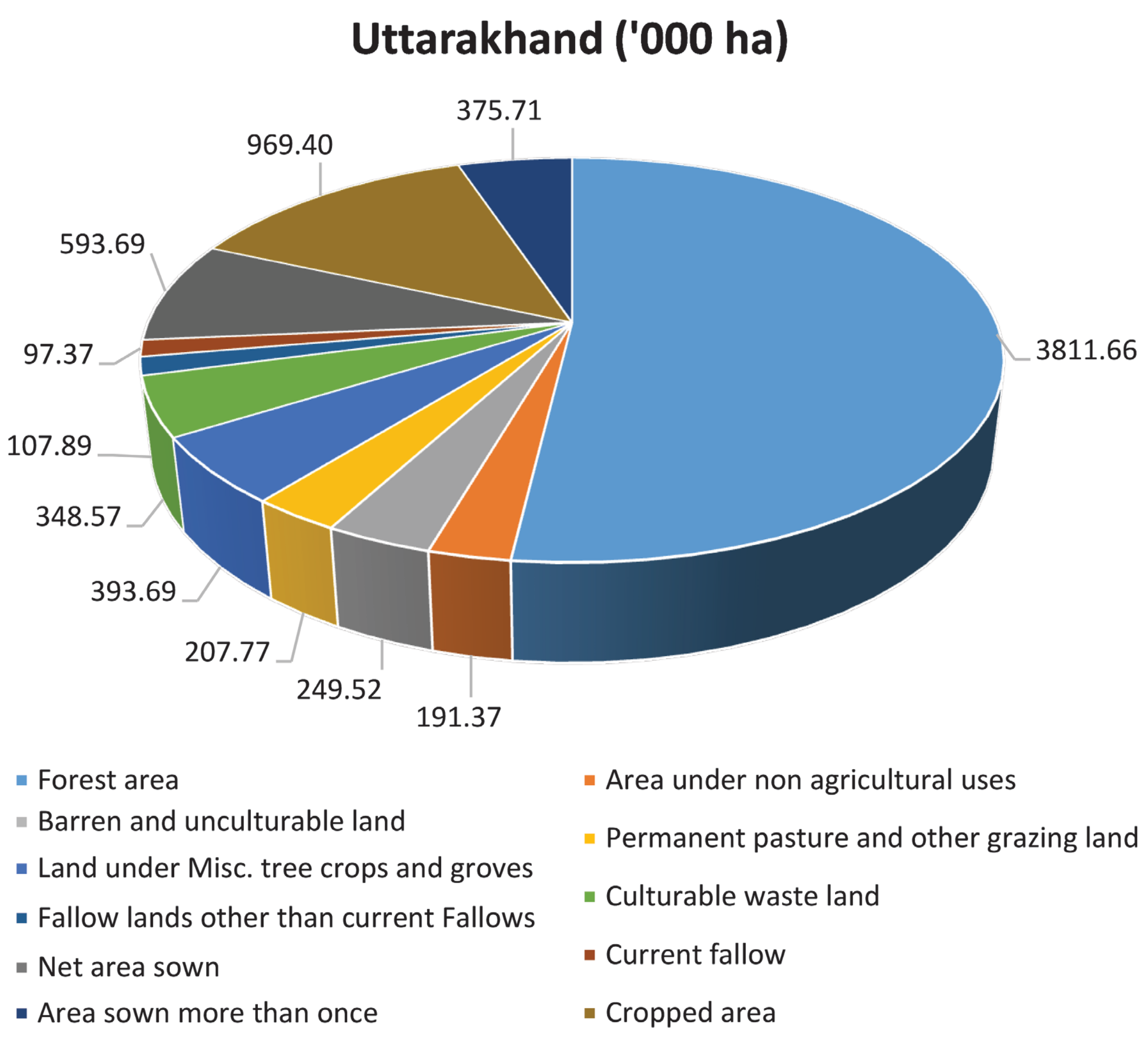


Fig 15. Land use pattern in Uttarakhand

Irrigation

Major sources of irrigation are Gomti, Saryu and Pindar Rivers and some of their tributaries like PungarNadi and LahorNadi. These rivers are main source for Bimola Canal, Mandalsera Canal and Kathayatbara Canal.

Cropping Pattern

In Uttarakhand, food grain production varies across regions, resulting in a mixed agricultural landscape in the state. Farmers have rainfed and irrigated eco system. Irrigated system involves cultivation of cereals and 2 crops per year. Whereas, rainfed production system involves cultivation of millets, pulses, tuber crops, alongside cereals and oilseeds. Mono cropping is prevalent in irrigated regions, while mixed cropping is common in rainfed areas, especially in the hills, to maintain crop diversity and mitigate environmental risks. Weather patterns, particularly precipitation timing and amount, significantly influence crop outcomes in both rainfed and irrigated zones. In rainfed agriculture sowing time, crop duration, and yield directly depends on rainfall, while in irrigated areas, rainfall distribution affects crop germination and harvest.

Overview of the selected districts under NICRA in Uttarakhand

Bageshwar

Bageshwar district is located between 29°40' and 30°20' N latitude and 79°25 and 80°10' E longitude with an altitude of 801 - 2200 m above mean sea level. The district falls under Western Himalayan Region (I) UK Region II- Mid hills (Sub humid- 801-1800 m), UK Region III-High hills (Temperate 1801-2200 m), UK Region IV-Very high hills (> 2200 m) (NARP). The geographical area of the district is 2.07 lakh ha with 1.10 lakh ha area under forest area. The other land use pattern of the district is indicated (Fig 17). The source of irrigation in the district is canals, tanks and other sources. The major crops grown in this district are wheat, rice, ragi, barley, other *kharif* pulses, masoor, small milletsetc (Table 1.5). Dairy, goat, sheep, pig, horse & mule, farming is adopted in the district. The average annual rainfall of the district is 1598 mm and much of the rainfall is received in *kharif* (Fig. 18).

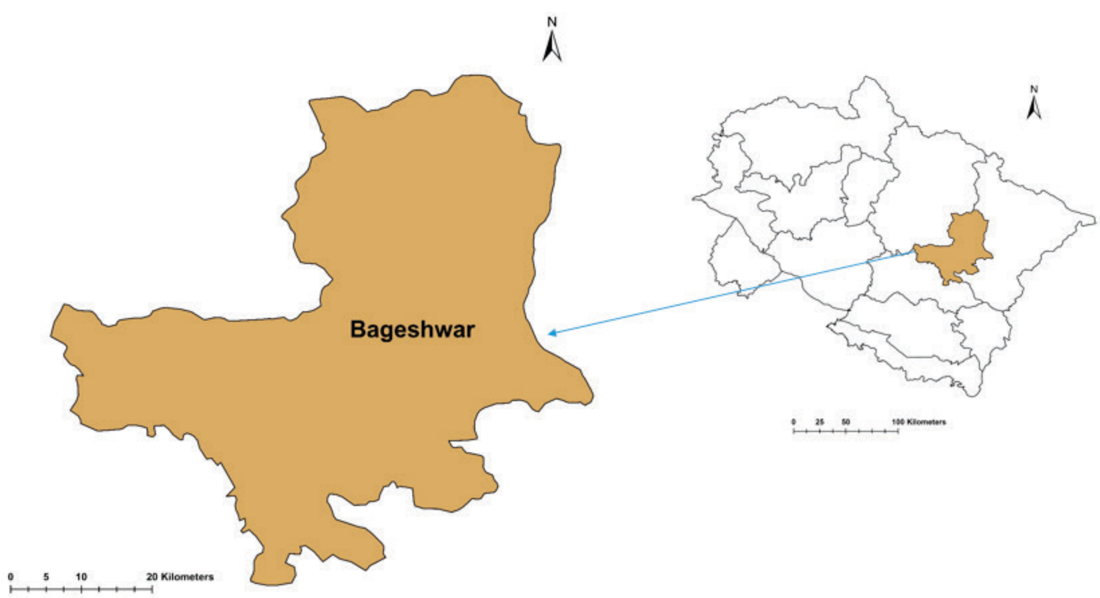


Fig 16. Location map of Bageshwar district

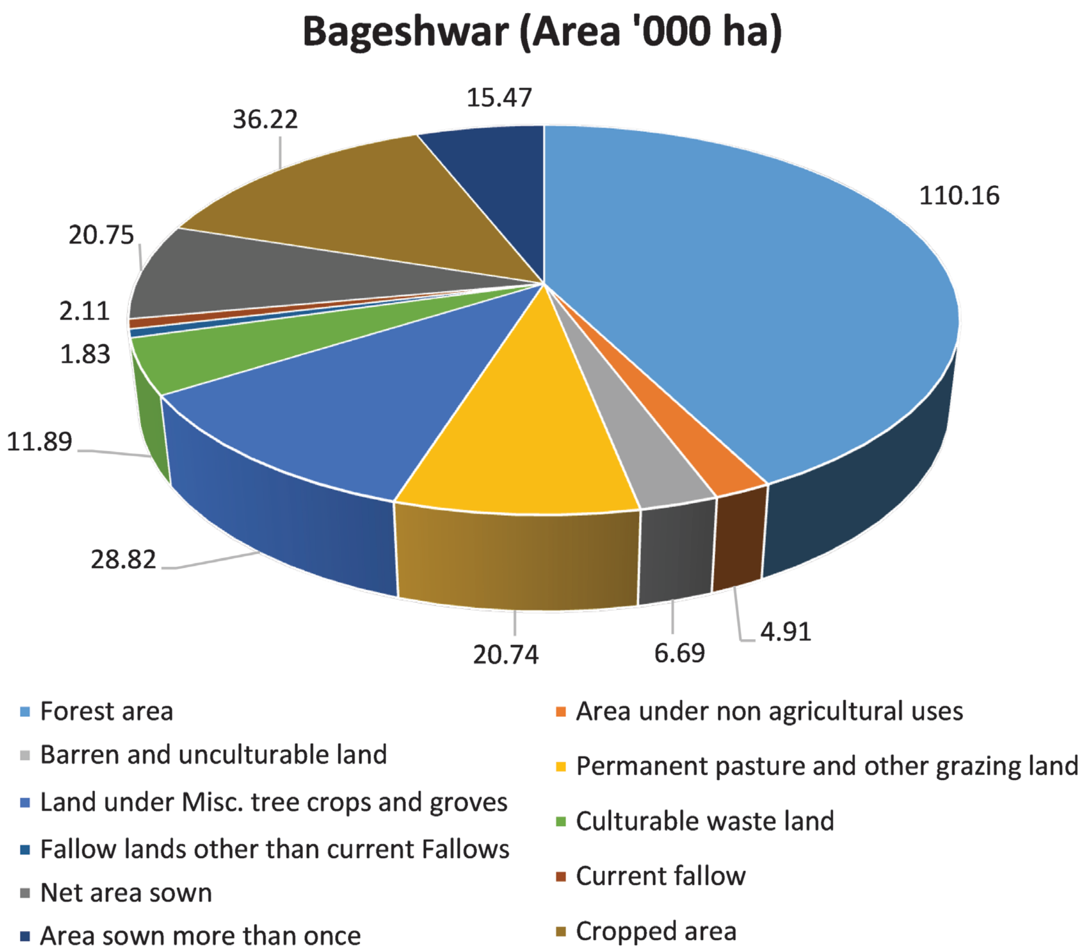


Fig 17. Land use patternof Bageshwar district

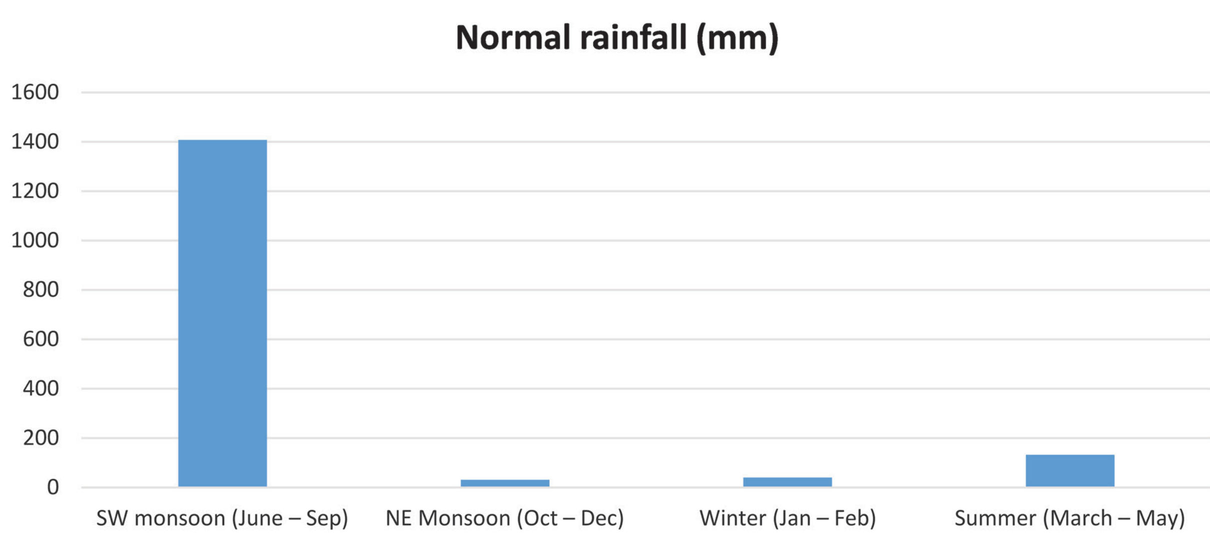


Fig 18. Season wise rainfall distribution

Table 1.5 : Area, production and productivity of major crops 2021-2022

Crop	Season	Area (ha)	Production (t)	Yield (t ha^{-1})
Rice	*Kharif*	12,925	20,802	1.61
Ragi	*Kharif*	4,841	7,571	1.56
Other *Kharif* pulses	*Kharif*	1,054	1,023	0.97
Small millets	*Kharif*	591	791	1.34
Maize	*Kharif*	269	487	1.81
Horse-gram	*Kharif*	121	150	1.24
Wheat	*Rabi*	13,035	23,935	1.84
Barley	*Rabi*	1,077	1,691	1.57
Masoor	*Rabi*	1,018	920	0.9
Rapeseed and Mustard	*Rabi*	143	84	0.59
Potato	*Rabi*	110	838	7.62
Onion	Whole Year	154	1,786	11.6
Garlic	Whole Year	85	228	2.68
Ginger	Whole Year	36	292	8.11

Champawat

Champawat district is located at 29°5' & 29° 30'N latitude and 79° 59' & 80° 3' E longitude with an altitude of 1615 m above MSL. The district is categorized into Western Himalayas, warm subhumid (to humid with inclusion of perhumid) ecoregion (14.2) Agro ecological Sub Region (ICAR), Western Himalayan Region (I) (Planning Commission) and Hill Zone- 105 NARP clarification (Brown hills seslsup/R AZ 25) western Hills (4) of ACRP (NARP). The geographical area of the district is 2.33 lakh ha, The gross cropped area of the district is 0.19 lakh ha out of which 0.12 lakh ha is area sown once and 0.07 lakh ha area sown more than once. Different land use pattern of the

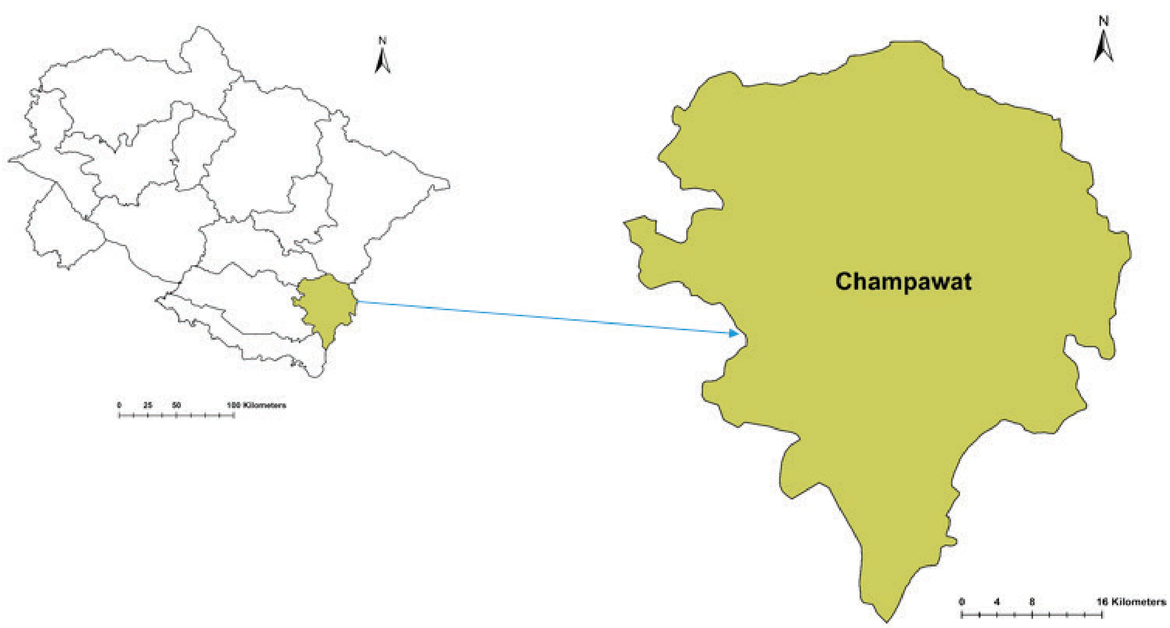


Fig 19. Location map of Champawat district

district are indicated (Fig. 20). The source of irrigation in the district are canals, tanks, borewells and other sources. Wheat, rice, ragi, small millets, horse-gram, barley, other *kharif* pulsesare the major crops grown in the district (Table 1.6).

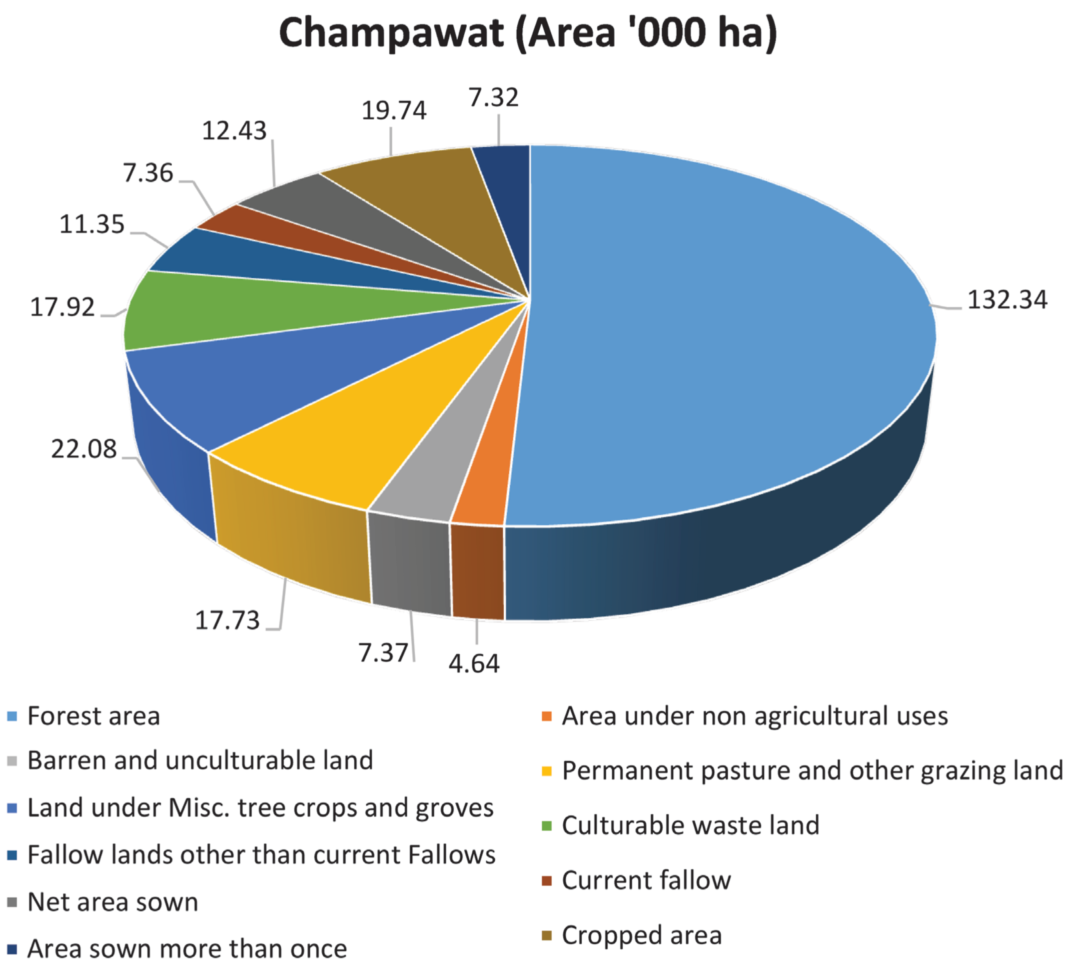


Fig 20. Land use patternof Champawat district

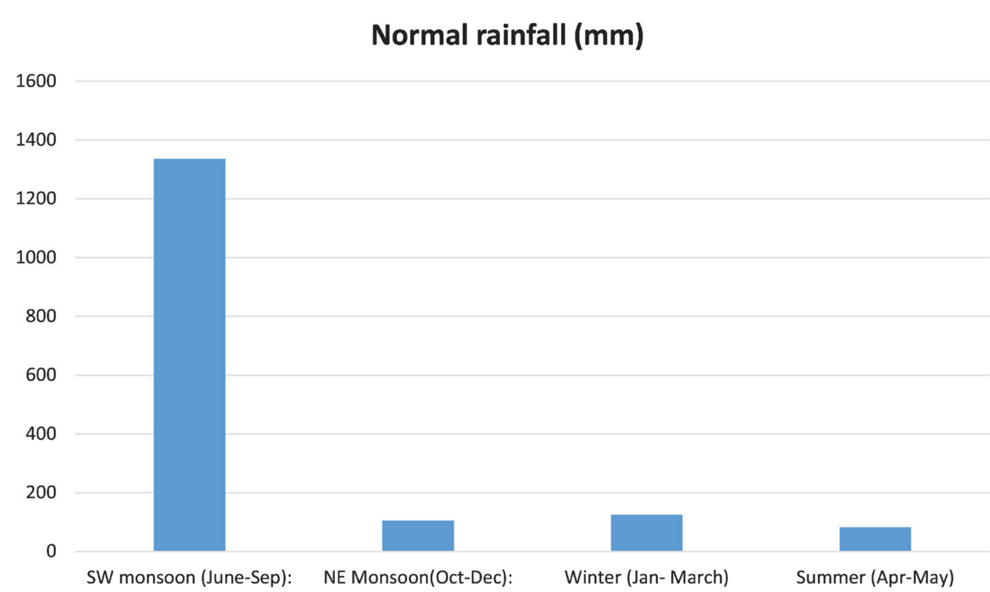


Fig 21. Season wise rainfall distribution

Table 1.6 : Area, production and productivity of major crops 2021-2022

Crop	Season	Area (ha)	Production (t)	Yield (t ha^{-1})
Rice	*Kharif*	3,695	4,844	1.31
Ragi	*Kharif*	3,006	4,573	1.52
Small millets	*Kharif*	784	1,128	1.44
Horse-gram	*Kharif*	770	890	1.16
Other *Kharif* pulses	*Kharif*	691	1,056	1.53
Soyabean	*Kharif*	560	902	1.61
Maize	*Kharif*	556	1,495	2.69
Urad	*Kharif*	374	532	1.42
Wheat	*Rabi*	4,167	9,534	2.29
Barley	*Rabi*	715	1,124	1.57
Masoor	*Rabi*	677	590	0.87
Rapeseed and Mustard	*Rabi*	628	364	0.58
Potato	*Rabi*	304	7,315	24.06
Peas and beans (Pulses)	*Rabi*	129	96	0.74
Ginger	Whole Year	369	4,808	13.03
Garlic	Whole Year	281	976	3.47
Onion	Whole Year	273	5,808	21.27
Turmeric	Whole Year	187	761	4.07

Tehri Garhwal

Tehri Garhwal district is located between 30°3' and 30°53' N latitude and 77°56' and 79°04' E longitude with an altitude of 1550 m above MSL. The district is categorized into Western Himalayas, Warm Subhumid (To Humid with Inclusion of Perhumid) Eco-Region 14.2 Agro ecological Sub Region (ICAR), Western Himalayan Region (I) agro climatic zone (Planning Commission) and Hill zone (UP-1) (NARP). The geographical area of the district is 4.85 lakh ha. The gross cropped

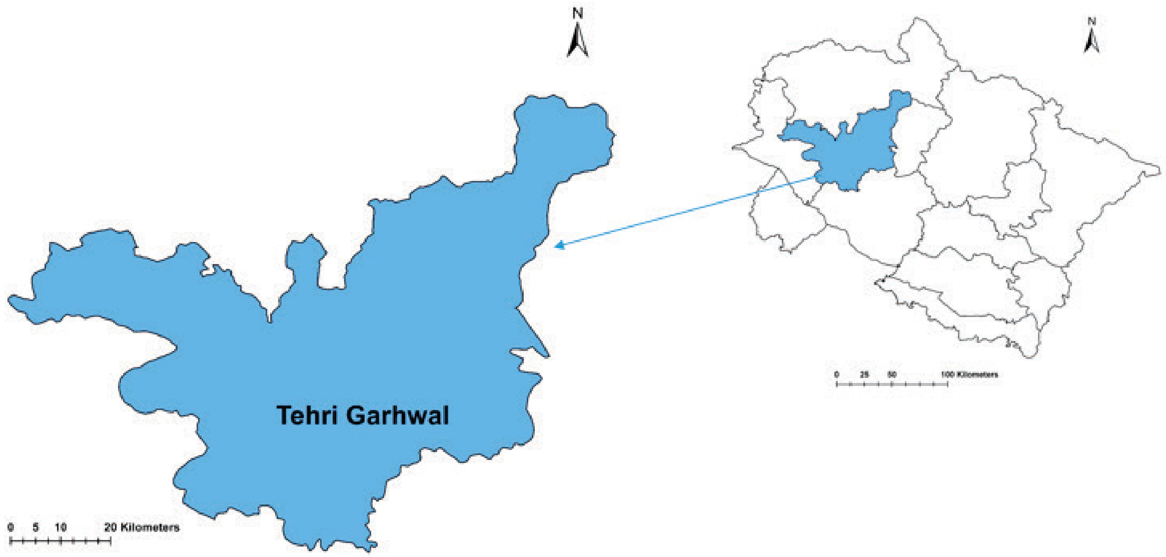


Fig 22. Location map of TehriGarhwal district

area of the district is 0.61 lakh ha out of which 0.43 lakh ha is are sown once and 0.18 lakh ha area is sown more than once. The sources of irrigation in the district are canals, borewells, open wells and other sources. Wheat, small millets, rice, ragi, horse-gram, urad and maize are the major crops grown in the district.

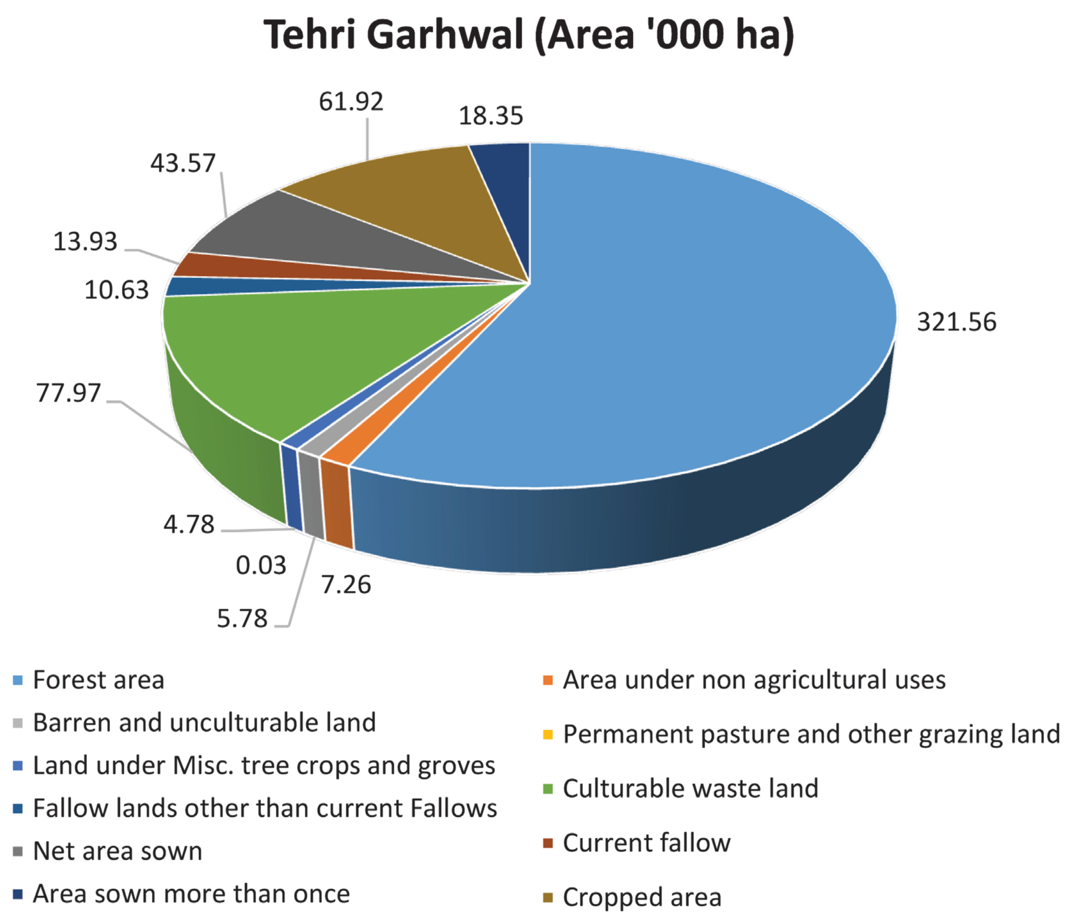


Fig 23. Land use pattern of Tehri Garhwal district

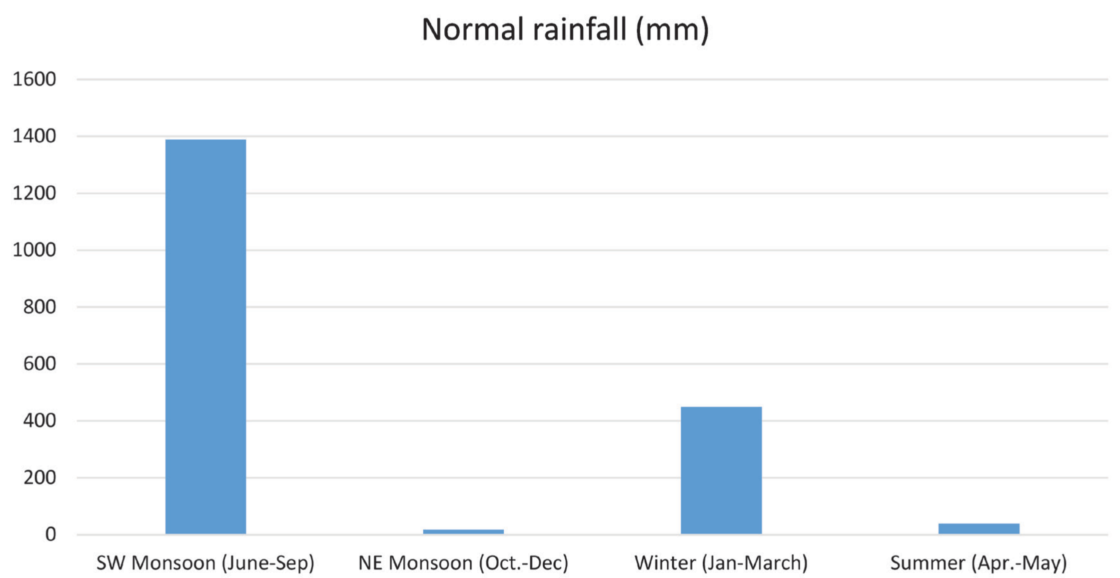


Fig 24. Season wise rainfall distribution

Table 1.7 : Area, production and productivity of major crops 2021-2022

Crop	Season	Area (ha)	Production (t)	Yield (t ha^{-1})
Small millets	*Kharif*	11,509	21,172	1.84
Rice	*Kharif*	9,201	19,183	2.08
Ragi	*Kharif*	7,471	12,889	1.73
Horse-gram	*Kharif*	3,285	3,296	1
Urad	*Kharif*	2,638	2,581	0.98
Maize	*Kharif*	1,879	3,296	1.75
Arhar/Tur	*Kharif*	1,479	1,575	1.06
Other *Kharif* pulses	*Kharif*	1,410	1,456	1.03
Soyabean	*Kharif*	698	781	1.12
Sesamum	*Kharif*	439	119	0.27
Potato	*Kharif*	343	4,669	13.61
Wheat	*Rabi*	14,223	29,399	2.07
Barley	*Rabi*	1,875	2,784	1.48
Rapeseed and Mustard	*Rabi*	912	456	0.5
Masoor	*Rabi*	910	662	0.73
Potato	*Rabi*	442	3,604	8.15

Uttarakashi

Uttarakashi district is located between 30.73 N meters latitude and 78.45E longitude with an altitude of 1140 m above mean sea level. The district falls under Western Himalayan Region (09) (ICAR), Western Himalayan Region (01) (Planning commission) and AZ hill zone (NARP). The geographical area of the district is 8.12 lakh ha and other land use patterm of the district is indicated in Fig. The gross cropped area of the district is 0.40 lakh ha out of which 0.28 lakh ha area is sown only once a year and 0.11 lakh ha area is sown more than once. The source of irrigation in the district is canals and other sources. The major crops grown in this district are

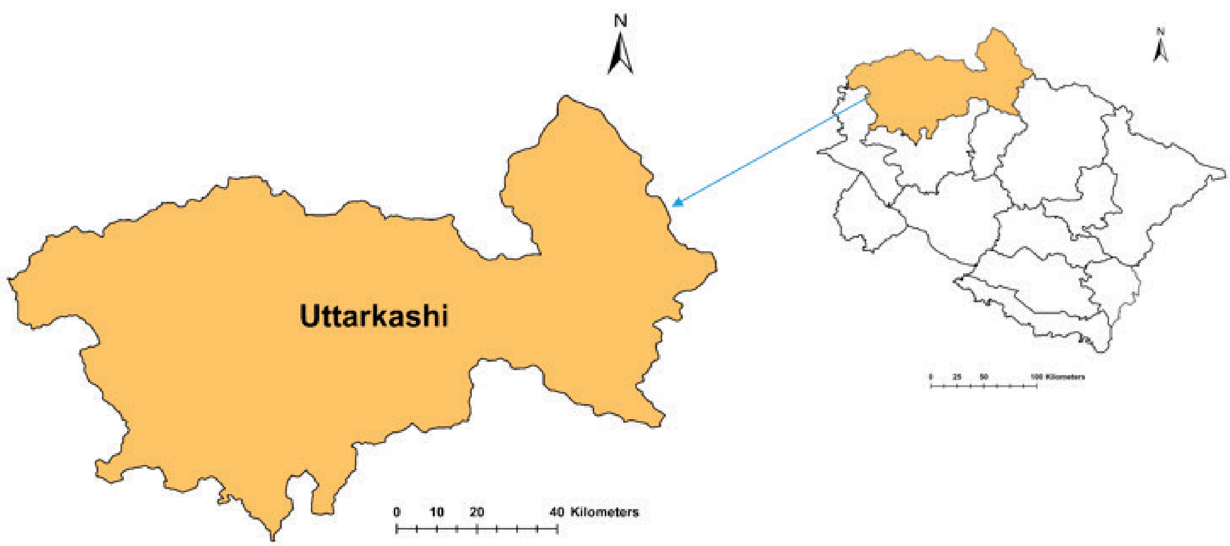


Fig 25. Location map of Uttarkashi district

rice, finger millet, barnyard millet, maize etc (Table 1.8). Dairy, goat, sheep, pig, Equine farming is adopted in the district. The average annual rainfall of the district is 1175 mm and much of the rainfall is received in *kharif* (Fig. 27).

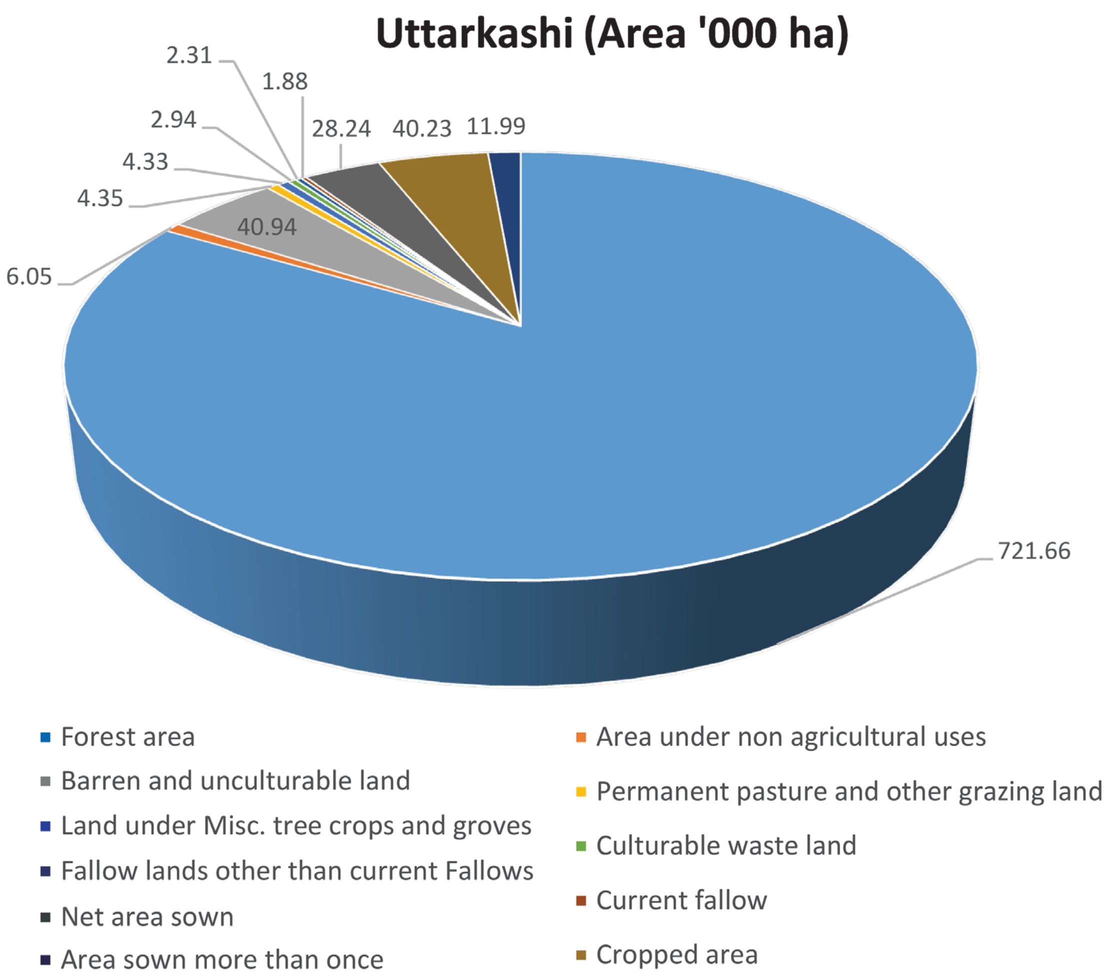


Fig 26. Land use pattern of Uttarkashi district

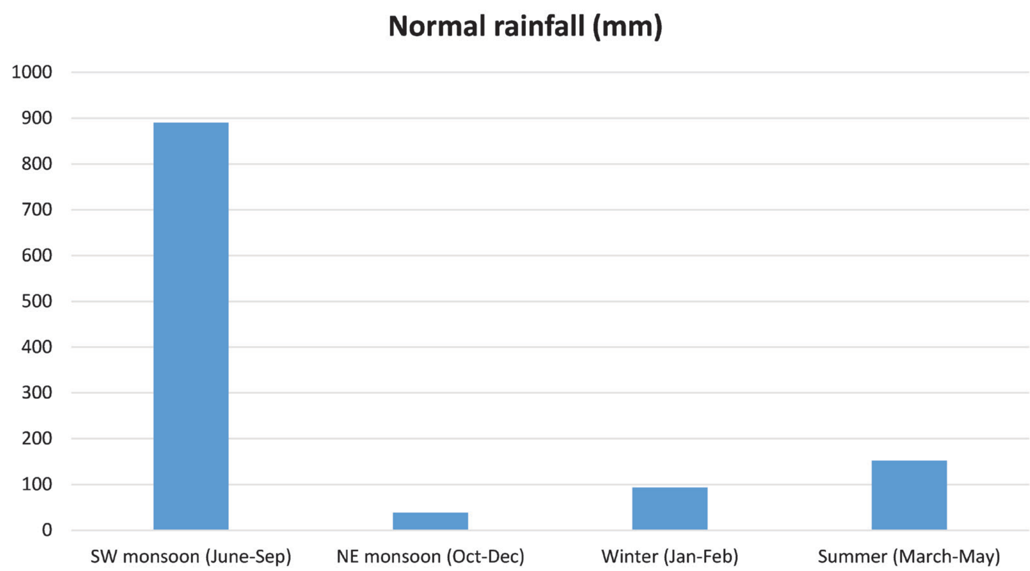


Fig 27. Season wise rainfall distribution

Table 1.8 : Area, production and productivity of major crops 2021-2022

Crop	Season	Area (ha)	Production (t)	Yield (t ha^{-1})
Rice	*Kharif*	9,401	17,416	1.85
Ragi	*Kharif*	4,973	8,183	1.65
Small millets	*Kharif*	3,681	5,889	1.6
Potato	*Kharif*	2,410	25,503	10.58
Other *Kharif* pulses	*Kharif*	2,236	2,365	1.06
Horse-gram	*Kharif*	1,040	991	0.95
Sesamum	*Kharif*	716	190	0.27
Maize	*Kharif*	441	1,348	3.06
Arhar/Tur	*Kharif*	382	424	1.11
Soyabean	*Kharif*	242	271	1.12
Other Cereals	*Kharif*	218	134	0.61
Rapeseed and Mustard	*Rabi*	932	590	0.63
Peas and beans (Pulses)	*Rabi*	699	409	0.59
Masoor	*Rabi*	331	284	0.86
Barley	*Rabi*	329	471	1.43
Potato	*Rabi*	305	1,783	5.85
Gram	*Rabi*	25	18	0.72
Onion	Whole Year	64	867	13.55
Garlic	Whole Year	32	54	1.69

2.1 Promising Natural Resource Management Technologies

Mulching : To minimize moisture stress

Climatic vulnerability: Moisture stress/Heat wave/Cold wave

Background: The Anantnag region receive 713 mm rainfall and is uncertain hence the soil moisture stress is a major constraint. Mulching technology plays a pivotal role in achieving agricultural sustainability and climate resilience. The crop residues like straw as mulch conserves soil moisture, suppresses weeds and improves soil health. This mulching approach helps in enhanced crop productivity, water conservation, and overall climate resiliance.

Resilient technology: Mulching involves covering the soil around plants with a layer of organic or inorganic material such as straw, leaves, plastic or other materials. This technique offers several benefits in the context of climate-resilient agriculture and natural resource management. Mulching helps in retaining soil moisture by reducing evaporation. This technique is particularly important in water scarce regions or erratic rainfall patterns, as it helps the crops to access water for a longer duration. Other benefits of mulching include weed management, checks soil erosion, improves soil structure and carbon sequestration. The combined benefits of water conservation, improved soil structure and weed control helps in improving the productivity. Mulching can enhance the resilience of crops to climate variations and extremes. KVK-Anantnag & KVK Uttarkashi demonstrated both organic (straw, pine needles/leaves) as well as inorganic mulches (black polythene) in apple orchards of NICRA Village which is completely dependent on rainfall. Mulching, specifically the use of black and silver polythene sheets, has been employed in fruit orchards, notably in mango and nectarine orchards in NICRA adopted villages of Uttarkashi.

Performance and impact of technology: KVK Anantnag & KVK Uttarkashi demonstrated mulching with organic mulches in apple and inorganic mulch in strawberry and Nectarine. Farmers were benefited with increased yields, weed management and improved soil health, leading to enhanced returns. The organic mulching with straw in apple increased the yield and net returns by 15.3% & 27.2% respectively (Table 2.1.1). The silver polythene mulching in strawberry recorded 63% and 106% higher production and profitability respectively over no mulching. Similarly silver polythene mulching in nectarine resulted in 35-84% high productivity and 54.1% higher profitability over on mulching (Table 2.1.2).

Table 2.1.1 : Impact of Mulching on yield and returns of apple cv. *R. delicious* in NICRA village of Anantnag

Intervention	Year	Yield (q/ha)	Cost of Cultivation (₹ ha^{-1})	Net Returns (₹ ha^{-1})	B:C ratio
Farmer's Practice (check)-No Mulching	2022-23	130.75	2,20,000	3,02,600	2.37
NRM through Mulching	2022-23	150.0	2,27,000	3,85,000	2.71

Table 2.1.2 : Impact of mulching in fruit crops at NICRA village of Uttarakashi

Intervention	Yield (per plant)	Weight per fruit	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net Return (₹ ha^{-1})	BC ratio
Strawberry						
Black /silver polythene mulching	850 g	62 g	12,12,452	51,92,210	39,79,758	3.2
without mulching	520g	21.5 g	13,81,241	33,12,650	19,31,409	2.3
Nectarine						
Black /silver polythene mulching	72 kg	175 g	4,90,450	20,16,000	15,25,550	3.1
without mulching	53 kg	142 g	6,84,500	14,84,000	9,84,500	1.4

Scope for upscaling: Mulching technology can be up-scaled in horticulture crops by mission for integrated development of hoeticulture (MIDH) program.

Mulching in fruit crops in NICRA village of Anantnag, Jammu & Kashmir

Mulching, using black and silver polythene sheets at NICRA village of Uttarakashi

Community ponds for augmentation of village level water resources

Climatic vulnerability: Drought

Background: Kathua district has significant area under rainfed agriculture with limited water resources, The existing community ponds (water bodies) are defunct as they are neglected, not maintained and results in silting of community ponds which resulted in low water storage and non availability of water for irrigation, as the farmers face crop failures due to deficit of soil moisture.

Resilient technology: Community ponds is one of the best intervention for augmentation and management of village level water resources. Climatic variability is expected to disproportionately affect smallholder farmers and make their livelihoods even more precarious the KVK Kathua in NICRA villages (Said-Sohal) identified existing community ponds and carried its renovation with farmer's participation. The rich silt deposited in these community ponds was used by farmers for field application in light soils wherever necessary to improve the water holding capacity of soils. This intervention helped in increasing the surface water resource availability, increased the ground water recharge and has been observed through water table measurements in wells located nearer to the ponds. Revival of this traditional water storage structures in a large community/village based ponds was considered as one of the option for augmentation of water resources.

Performance and impact of technology: In the year 2018-19, two ponds in the NICRA cluster were renovated under convergence mode with Department of Rural Development in *"Amrit Sarovar Scheme"* approximately 44,000 cu. m of water could be saved which provides supplemental irrigation to an area of 15 hectare in *kharif* season and 14 hectare of area in *rabi* season, benefiting 40 farmers. In the year 2019-20, one pond was renovated and about 22,000 cu. m of water was harvested which provided the supplemental irrigation to an area of 12 hectare in both *kharif* and *rabi* seasons benefitted 45 farmers (Table 2.1.3).

Table 2.1.3 : Impact of community ponds on water harvesting

Year	Renovation of ponds	Volume of water harvested (cu. m)	Area provided with supplemental irrigation during *kharif* (ha)	Area brought under *rabi* cultivation (ha)	No. of farmers benefitted	Remarks
2018-19	02	44,000	15	14	40	It helps in ground water recharge
2019-20	01	22,000	12	12	45	
Total	03	66,000	27	26	85	
1 cu. m = 1000 L; 44,000 x 1000 = 44 lakh litres of water						

Scope for upscaling: The additional yield and livelihood opportunities of farmers in villages covered in NICRA project attracted the attention of farmers living in the nearby villages in non-project areas. This intervention can be up scaled in convergence with MGNREGS/IWMP/NMSA.

Community pond in Said-Sohal village of Kathua, Jammu & Kashmir

Supplemental irrigation with harvested rainwater

Climatic vulnerability: Drought/Heat wave/Cold wave

Background: Water scarcity is a major problem in Bandipora, especially during the dry season.

Resilient technology: Uncertain, erratic rain fall causes runoff and harvested water can be used for supplemented irrigation. Harvesting of runoff and rainwater may significantly increase crop output, increase food security, and reduce poverty while helping to utilize water resources more effectively. Water harvesting enables farmers to store water when it is plentiful and make it available when it is scarce.

Performance and impact of technology: Water harvesting structures (dug out ponds) were constructed in the NICRA villages of Surinder and Kootasatri to store runoff water for irrigation during dry periods. Supplemental irrigation with harvested water in maize crop has helped the farmers to achieve an yield improvement of 84% and 21% with an additional income of Rs. 47000/ha and Rs. 23000/ha in normal year and stress year respectively (Table 2.1.4). About 20ha of land has been brought under supplemental irrigation during summer months through water harvesting ponds.

Table 2.1.4 : Impact of supplemental irrigation on maize crop in rainfed areas of Surinder village of Bandipora

Intervention	Area (ha)	No. of Farmers	Crop yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio
Normal year							
Farmers practice	7	26	24	37,000	52,000	15,000	1.40
Demo	4.25	14	44	37,000	99,000	62,000	2.67
Stress year							
Farmers practice	7	26	37	37,000	77,000	40,000	2.08
Demo	4	12	45	37,000	1,00,000	63,000	2.70

Scope for upscaling: Water harvesting structures can be constructed by Department of Agriculture and Rural Development under various schemes after exploring region specific feasibility.



Water harvesting for supplemental irrigation in NICRA village of Bandipora

Mulching in cabbage to alleviate moisture stress and cold stress

Climatic vulnerability: Drought/Cold stress

Background: Ladakh is experiencing decline in winter precipitation that forms the life line of this region and the receding glacial lines. Low water discharge in the streams that once were perennial and poor soil conditions pose great challenge to agriculture sector in the region. These distinct challenges, demands and adaptive solutions to sustain agricultural productivity amidst the evolving climatic scenario.

Resilient technology: Mulching is a climate resilient technology that promotes *in-situ* soil moisture conservation, organic matter mineralization, soil heat retention and weed control. Cabbage is a cool season vegetable that performs exceptionally well in summer months of cold arid Ladakh. This vegetable is an important item in the local cuisines like vegetable momos, salad, veg noodles, vegetable pickle (like kimchi) and as dry cooked vegetable. During lean periods (especially winters, when farmers preserve the heads under cellars), this is a luxury item when mostly root vegetables and tubers are available. While this crop takes an important place in every kitchen garden in Ladakh and it needs adequate irrigation and weedings. hence, KVK Leh undertook demonstrations on cabbage cultivation with mulch. This technology saved water, labour and resulted in increased yield and early production.

Performance and impact of technology: KVK-Leh undertook demonstrations on the effect of mulching on yield and resource conservation in cabbage variety Summer-King at 20 different locations in NICRA village mulching improved yields, quality and reduced weeds. Some of the farmers grow cabbage on large scale for market. The demonstrated technology gave an average yield of 523q/ha against farmers' practice (without mulch) that yielded 421q/ha. Use of mulch increased production by 22.2% due to better organic matter decomposition, heat regulation and moisture retention. This technology provided a benefit cost ratio of 1.38 against the farmers' practice that gave a BC ratio of 1.25 (Table 2.1.5).

Table 2.1.5 : Impact of mulching in cabbage on yield, earliness and returns

Intervention	Yield (q/ha)	% change	Days to harvesting (days)	Net Return (Rs/ha)	BCR
Mulching in Cabbage	523	24.2	56.4	4,34,000	1.38
Framers Practice (without Mulch)	421	-	63	1,87,200	1.25

Scope for upscaling: Vegetable production under mulching has been popularized and this technology had huge acceptance from entire district especially from women farmers. State departments are already providing mulches on subsidized rates to the farming community in the district and in the future years this technology would be an integral part of all agriculture related schemes in UT Ladakh.

Mulching in cabbage at Chushot village, Ladakh

Renovation of rainwater harvesting tanks

Climatic vulnerability: Drought/Cold wave

Background: Renovation of defunct rainwater harvesting tanks and strengthening of bunds are important measures to conserve water and prevent soil erosion in agriculture. However, many rainwater harvesting tanks became defunct over time due to lack of maintenance, which reduces their effectiveness.

Resilient technology: Renovating tanks can help to restore their capacity to capture and store rainwater, which can then be used for irrigation during dry periods. Additionally, strengthening of bunds can help to prevent soil erosion and improve water retention in agricultural fields. During the year, 2022-23, prolonged dry spell of 57 days occurred during *rabi* season which affected the crops. However, providing supplemental irrigation by the construction/renovation of defunct rainwater harvesting tanks can save the crops during this period.

Performance and impact of technology: At village Mangnar of Poonch district, six rainwater harvesting tanks were renovated. In 2022 supplemental irrigation with the stored water from the tanks helped the farmers to enhance their vegetable productivity by 48% (Table 2.1.6). Additionally, the farmer's benefit cost ratio jumped from 2.07 to 2.56. Due to undulated land and hilly terrain, as well as a paucity of water, farmers used to travel 2–3 kilometers for drinking water for animals. Currently, more than twenty households utilize the stored water for their livestock as well.

Table 2.1.6 : Impact and economics of water harvesting tanks

Intervention (vegetable cultivation with)	Yield (q ha^{-1})	Cost of cultivation (Rs ha^{-1})	Gross returns (Rs ha^{-1})	Net Return (Rs ha^{-1})	BC ratio
Water storage in rain water harvesting tanks	460	3,60,000	9,20,000	560000	2.56
Farmers depending on rainfall	310	3,00,000	6,20,000	320000	2.07

Scope for upscaling: This technology can be upscaled by convergence with the state agriculture departments and schemes like MGNREGA through construction of the permanent silpaulin lined water harvesting structures.

Renovation of rainwater harvesting tanks at Poonch district, Jammu & Kashmir

Jalkunds for supplemental irrigation to horticultural crops

Climatic vulnerability: Moisture stress/Cold wave

Background: Prolonged dry spells during *rabi* season in the hilly regions of Uttarakhand leads to water scarcity and moisture stress resulting in declined crop productivity.

Resilient technology: Jalkunds are the rain water harvesting strectures, constructed over sutable location, preferable near the field by digging a pit, usually with a size dimension of 3m x 4m x 1m. Five water harvesting structures, each of capacity 30000 litres were constructed for storage of water and its usage during prolonged dryspell in the NICRA adopted village Kaleth of Tehri Garhwal district, Uttarakhand.

Performance and impact of technology: Jalkunds ensured the availability of water during entire *rabi* season by avoiding moisture stress in onion crop, resulting in higher yield (47.5%) as compared to farmer practice and obtained higher income (70.6%) (Table 2.1.7). The rainfed agriculture in villages can lead to a great vulnerability to the crops during prolonged dry spells hence water harvesting structures helps to give supplemental irrigation during dry spells, ultimately leading to higher crop productivity and farmer income.

Table 2.1.7 : Impact of supplementary irrigation with harvested water for onion variety Agrifound Light Red in NICRA villages

Intervention	Yield (q ha^{-1})	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net Return (₹ ha^{-1})	BC ratio
Farmer's practice	166	53,500	1,66,000	1,12,500	2.1
Onion (Agrifound Light Red)	245	53,000	2,45,000	1,92,000	3.6

Scope for upscaling: This technology can be scaled up in convergence with the state agriculture departments and schemes like MGNREGA through construction of the permanent water harvesting structures with silpaulin.

Use of water harvesting structure (Jalkunds) for mitigating moisture stress in onion

HDPE tetra vermi beds for vermicomposting

Climatic vulnerability: Moisture stress/Cold wave

Background: Anantnag district of Jammu & Kashmir, faces cold stress which affects vermicompost production. Hence, HDPE tetra vermibeds are crucial because they provide insulation, maintaining a stable and warmer environment for worms, which enhances their survival and activity, ensuring efficient vermicomposting even in low temperatures.

Resilient technology: HDPE Tetra Vermi Beds offer a streamlined and cost-effective vermicomposting solution. Constructed with High-Density Polyethylene, these lightweight and portable beds require raw farm manure, earthworms, and minimal moisture. Each bed completes composting in 100-120 days with 5 to 7 quintal capacity. Ideal for fruit orchards, vegetable gardens, and polyhouses, their compost fetches Rs 200-250 per kg with worms and Rs. 20 per kg without. This sustainable, eco-friendly technology enhances soil fertility, encouraging widespread adoption for organic farming practices.

Performance and impact of technology: HDPE Tetra vermi beds demonstrated in NICRA villages resulted in 1,08,500 net returns per bed with BC ratio of 9.43. This technology reduces the reliance on chemical fertilizers, promote sustainable and economical farming. The high-quality compost's benefit, fruit orchard, vegetable garden, polyhouse farmers and potentially increase their income.

Table 2.1.8 : Impact of Vermi composting using Tetra Vermi Bed

Technology	Cost per Unit (for Bed)	Raw Cow Dung (Rs per q)	Earthworm (Rs 200 per kg)	Total cost	Gross Benefit (₹ bed^{-1})	Net Benefit (₹ bed^{-1})	BC Ratio
HDPE Tetra Vermi Bed (12' x 4' x 2') of 5 to 7 q capacity	4,000	500	4,000	11,500	1,20,000	1,08,500	9.43

Scope for upscaling: Collaborating with state agriculture departments and NGOs, facilitates the scope for upscaling of HDPE Tetra Vermi Beds. By securing support and subsidies, farmers can embrace this eco-friendly technology. State agriculture departments ensure distribution and affordability, while NGOs provide financial aid and technical expertise. Strategic partnerships with stakeholders help in widespread adoption viable, promoting sustainable and organic farming practices for environmental and economic gains.

HDPE Tetra vermi beds for vermicomposting

Protected cultivation for climate stresses

Climatic vulnerability: Moisture stress/Heat wave/Cold wave

Background: In Anantnag region the crops are affected by cold and heat stress.

Resilient technology: Protected cultivation with low tunnel poly house provides a controlled environment that shields crops from extreme weather conditions, pests, and diseases. With changing climate patterns, protected cultivation can help farmers to mitigate risks and ensure consistent yields. It also allows for year-round cultivation, reducing dependence on seasonal weather patterns. KVK-Anantnag introduced advanced protected cultivation techniques in NICRA villages aimed at bolstering agricultural resilience in adopted villages.

Performance and impact of technology: The low cost tunnel poly houses and the utilization of specialized vegetable seeds represent innovative strategies for climate-resilient agriculture in NICRA adopted villages. These technologies empower farmers to mitigate the adverse effects of climate change, ensuring food security and economic stability in the face of evolving environmental challenges. The different vegetables like tomatoes, cucumbers, peppers, and leafy greens have been selected for their performance under adverse environmental scenarios. Through cultivation in polyhouses, farmers can reduce crop losses and enhance their income by cultivating high-quality produce even in the climate-related uncertainties. By incorporating these specialized seeds into their cultivation practices, farmers gain access to resilient crop varieties that contribute to long-term agricultural sustainability. Further, it had also resulted in 104-160% increase in net returns over farmers practice.

Table 2.1.9 : Protected cultivation of Vegetables for mitigating impact of climate stresses

Season	Intervention	No. of seedlings	Cost of cultivation (Rs. ha^{-1})	Gross Return (Rs. ha^{-1})	Net Return (Rs. ha^{-1})	BC Ratio
Kharif	Protected Cultivation	Cucumber 500 No. @ Rs. 15 Each Pumkin 500 No. @ Rs. 15 Each Tomato 2000 No. @ Rs. 0.5 Each Brinjal 2000 No. @ Rs. 0.5 Each Chili 5000 No. @ Rs. 0.5 Each	5,000	19,500	14,500	3.9
	Farmers practice	Cucumber 250 No. @ Rs. 15 Each Pumkin 250 No. @ Rs. 15 Each Tomato 1700 No. @ Rs. 0.5 Each Brinjal 1350 No. @ Rs. 0.5 Each Chili 3100 No. @ Rs. 0.5 Each	5,000	10,575	5,575	2.11
Rabi	Protected Cultivation	Cauliflower 1000 No. @ Rs. 1 Each Knol Khol 3000 No. @ Rs. 1 Each Onion 2500 No. @ Rs. 1 Each	2,000	6,500	4,500	3.25
	Farmers practice	Cauliflower 700 No. @ Rs. 1 Each Knol Khol 2000 No. @ Rs. 1 Each Onion 1500 No. @ Rs. 1 Each	2,000	4,200	2,200	2.1

Scope for upscaling: The up-scaling of the aforementioned technology involves expanding the deployment of low tunnel poly houses and the distribution of specialized vegetable seeds across a broader geographical area. This entails replicating the successful model established in NICRA adopted villages to benefit a larger population of farmers. By scaling up these climate-resilient agricultural practices, more communities can enhance their resilience to climate change, increase agricultural productivity, and secure livelihoods in the face of environmental challenges.

Protected cultivstion at Anantnag

Low cost structure for mushroom cultivation

Climatic vulnerability: Drought/Cold stress

Background: Ladakh region is situated in the northernmost part of India and is characterized by extreme cold weather, low precipitation, low humidity and high altitude. Ladakh experiences severe cold with temperature at -20^0 C or even lower. Mushroom cultivation in the cold arid region of Ladakh presents an innovative and sustainable solution to diversify agricultural practices and provide a source of income for local communities.

Resilient technology: To overcome the challenges faced by farmers of Ladakh, KVK-Leh developed a low-cost mushroom unit which is attached with a local greenhouse. The low cost structure is constructed by using locally sourced material to promote mushroom cultivation as a sustainable agriculture practice. This low cost mushroom unit attached with a local greenhouse is constructed based on the principle of heat and moisture exchange through pipes that help to maintain required temperature (25^0C) and humidity (70%) for a successful crop and makes production possible for most part of the year. A unit of 18×10 sqft. with racks installed on the walls to maximize space utilization.The yield per unit depends on the use of space.

Performance and impact of technology: The cultivation of a mushroom in the low cost unit led to a substantial improvement in both yield and income compared to cultivation of mushroom without the unit. The yield increased by 70%, signifying a significant boost in productivity. Additionally, income increase was 200%, (Table 2.1.10). These results underscore the effectiveness of the mushroom unit intervention in enhancing agricultural outcomes and economic returns,

Table 2.1.10 : Impact of Mushroom unit on yield

Intervention	Yield Kg bag^{-1}	Days to first Harvest	Net return (Rs bag^{-1})	BC ratio
Mushroom cultivation in Mushroom unit	1.7	45	210	2.60
Without mushroom unit	1.0	50	70	1.54

Scope for upscaling: This low cost mushroom unit is patented by the KVK-Leh SKUAST-K. This technology can be dessiminated to farmers in collaboration with the agriculture department.

Mushroom cultivation at Ladakh

Poly-tunnels for vegetable seedling production

Climatic vulnerability: Moisture stress/ Drought

Background: Timely availability of quality seedlings of vegetables is of prime importance for good production. But the frost till March, untimely rains hails and higher difference in day and night temperature in hills are the major hindrance. Consequently, the farmers do not get quality seedlings in time and the production is hampered.

Resilient technology: VL polytunnel is having the potential to cope up with these weather vagaries. This is strong and have ventilation facility through solar plate and is foldable also. It is made of a series of arched metal hoops that are covered with a polyethylene film. The structure is designed to create a controlled environment for crops, protecting them from extreme weather conditions such as heavy rain, hail, and strong winds. The polytunnel also helps to regulate temperature and humidity levels, which is important for crop growth and yield. VL Polytunnels are popular among small and medium-sized farmers in India due to their affordability, ease of installation, and low maintenance requirements

Performance and impact of technology: Considering the advantages of poly tunnels, trainings and demonstrations on VL Polytunnel were conducted in NICRA village Karalapaladi, Bageshwar. The VL Polytunnel proved its utility and is liked by the farmers. With this technology, farmers were able to produce quality seedlings of vegetables in time that has resulted in better production and marketing opportunities also.

Table 2.1.11 : Performance of Polytunnel vegetable seedling production

Intervention	Cost of cultivation (Rs. per 2 m^2)	Gross returns (Rs. per 2 m^2)	Net Return (Rs. per 2 m^2)
Polytunnel vegetable seedling production (Tomato and Capsicum)	600	1500	900
Farmer's practice	100	500	400

Scope for upscaling: This successful technology isbeing expanded through other projects also and line departments and other agencies are also showing interest in its adoption.

Cultivation of vegetables in polytunnels at Bageshwar

Low cost naturally ventilated polyhouses

Climatic vulnerability: Moisture stress/Cold wave

Background: Prolonged dry spell, lower irrigation water availability, man, and wild-animal conflict as well as crop-wild animal/ monkey menace are very common problems leading to loss in crop productivity and even crop failure in the hilly terrains of Uttarakhand.

Resilient technology: Low cost naturally ventilated polyhouses are an excellent solution for growing off season vegetable crops in the hilly terrains of Uttarakhand for fetching early harvest and attaining great market price also. A low cost naturally ventilated polyhousecan cost around 1-1.5 Lakh Rs. per 100 square meters for which horticulture department and national horticulture mission has decided to provide 80% subsidy in installation of a polyhouse. Hence, polyhouses coupled with microirrigation systems were a boon for the off-season cultivation and economic upliftment of the farmers.

Performance and impact of technology: Lower monkey menace and other problems like prolonged dry spell, lesser availability of irrigation water were also addressed by the integrated rain water harvesting, microirrigation and protected cultivation technology. The yield and netreturns increased by 56% and 75% respectively (Table 2.1.12).

Table 2.1.12 : Impact of low cost naturally ventilated polyhouses on tomato crop in Tehrigarhwal

Intervention	Yield (q ha^{-1})	Cost of cultivation (Rs ha^{-1})	Gross returns (Rs ha^{-1})	Net Return (Rs ha^{-1})	BC ratio
Farmer's practice	97	50,000	1,45,500	95500	1.91
Tomato grown under polyhouses	152	60,000	2,28,000	168000	2.8

Scope for upscaling: Polyhouse technology can spread to the majority of the hilly terrains in convergence with state horticulture department and National Horticulture Mission as the government has been providing around 80% subsidy for installation of polyhouses and microirrigation system for water saving irrigation.

Low cost polyhouses for vegetable cultivation at NICRA villages of Tehrigarhwal

2.2 Promising Crop Production Technologies

Shalimar Rice (SR-4) for abiotic and biotic stresses in Kashmir

Climatic vulnerability: Drought/Heat wave/ Cold wave

Background: Anantnag district of Jammu & Kashmir is affected by vagaries of extreme events such as drought heat wave and cold wave. Hence, rice cultivation is affected due to the use of local low yielding rice varities.

Resilient technology: Shalimar Rice-4 (SR-4), a recently introduced rice variety, has played a pivotal role in transforming rice cultivation in the valley. SR-4 rice variety developed by SKUAST-Kashmir, has a high yield potential, suitable to local environmental conditions, and resilience to various stress factors. As part of a high-yielding and area-specific series, SR-4 has higher potential and has a yield potential, ranging from 80 to 100 q/ha (8-10 Mt/ha). The increased yield not only enhances food security but also profitability. In addition to its high-yielding nature, Shalimar Rice-4 has tolerance to various biotic stresses, particularly the prevalent blast disease.

Performance and impact of the technology: SR-4's impact on yield and returns in NICRA-adopted village Shangrin has been substantial, with increased net returns and a favorable B:C ratio compared to traditional farming varieties. (Table 2.2.1). During the years 2022 and 2023, the KVK-Anantnag conducted a total of 90 demonstrations in 35 hectares within the NICRA village. Specifically, the demonstrations led to a significant enhancement in net returns of the farmers by 93%. This positive economic impact suggests the successful integration and application of the demonstrated agricultural practices, contributing to improved productivity and financial gains in the NICRA village. The results has benefits of adopting climate-resilient and innovative agricultural approaches promoted by KVK-Anantnag during this period.

Table 2.2.1 : Impact of SR-4 rice variety on enhanced yield and returns in Shangrin, Anantnag

Intervention	Year	Yield ($q\ ha^{-1}$)	Cost of Cultivation ($Rs\ ha^{-1}$)	Net Returns ($Rs\ ha^{-1}$)	B:C ratio
Introduction and demonstration of SR-4	2022-23	77.0	88,000	130,000	2.44
Farmer's Practice (check)	2022-23	58.6	89,500	76,500	1.88
Introduction and demonstration of SR-4	2023-24	79.0	93000	182,000	2.94
Farmer's Practice	2023-24	59.0	94500	84000	1.94

Scope for upscaling: SR-4, with its proven success and popularity, is poised for extensive adoption across the entire Kashmir valley. The department of agriculture stands as a key facilitator in ensuring the seamless dissemination of this rice variety to every corner of the region.

Cultivation of Shalimar Rice (SR-4) variety at Anantnag

Climate friendly tools for Apple Blotch Leaf Miner (ABLM)

Climatic vulnerability: Drought/Heat wave/ Cold wave

Background: The invasive Apple Blotch Leaf Miner (ABLM) poses a formidable threat to the apple orchards of District Anantnag, thereby endangering the entire apple industry in Jammu and Kashmir. The potential repercussions extend beyond immediate economic concerns, as the apple cultivation place major role in the regional economy, sustaining livelihoods for more than 7 lakh families. If left unaddressed, the ABLM infestation could lead to substantial economic losses and undermine the socio-economic fabric of the affected communities. Effective management strategies are imperative to mitigate these risks and safeguard the long-term viability of the apple industry in the region.

Resilient technology: To address theABLM infestation in the apple orchards, a comprehensive approach integrating climate-friendly tools such as pheromones and yellow sticky traps are important. In order to monitor adult population, 8-10 Pheromone baited traps per hectare are recommended. Similarly, installation of sticky traps@ 1/10M apart for monitoring of moth emergence is recommended.

Performance and impact of technology: Pheromone traps disrupt the mating behavior of ABLM, acting as an eco-friendly alternative to chemical pesticides. Placing these traps strategically in orchards contributes to the overall pest management, providing a targeted and sustainable solution. Additionally, yellow sticky traps serve as effective monitoring tools, capturing adult ABLM and providing insights into population dynamics KVK-Anantnag executed a comprehensive initiative

Managing apple blotch leaf miner at Anantnag aimed at raising awareness and fostering mass awareness on the ABLM infestation. This campaign encompassed multiple locations, including NICRA adopted villages. The awareness drive involved the organization of specialized camps, diagnostic visits and the strategic installation of pheromone-baited traps and sticky traps in apple orchards. The implementation of these climate-smart tools, coupled with other integrated measures, demonstrated significant efficacy in mitigating the ABLM infestation. The coordinated efforts of the KVK, through targeted awareness programs and the deployment of specialized tools, played a pivotal role in curbing the impact of ABLM on apple orchards**.**

Table 2.2.2 : Impact of climate friendly tools for Managing Apple Blotch Leaf Miner (ABLM)

Orchard Type	Intervention	Yield (Q/ha.)	Cost of cultivation (Rs. ha^{-1})	Gross Return (Rs. ha^{-1})	Net Return (Rs. ha^{-1})	BC Ratio
Traditional Orchard	Farmers practice(FP)	130	2,40,000	5,20,000	2,80,000	2.16
	Pheromone Trap Technology (Demonstrated Technology)	170	2,52,000	7,14,000	4,62,000	2.83
HD Apple Orchard	Farmers practice	330	4,15,000	1,91,4000	1,49,9000	4.61
	Pheromone Trap Technology	370	430,000	22,20,000	1,79,0000	5.16

Scope for upscaling: In the context of managing the ABLM infestation, upscaling the use of climate-friendly tools such as pheromone-baited traps and sticky traps entails implementing these successful strategies in apple orchards. This upscaling effort requires collaboration between horticulture extension services, research institutions and government agencies to ensure widespread adoption and effectiveness.

Drought Tolerant Maize (DTM-1) for rainfed conditions of Bandipora district

Climatic vulnerability: Moisture stress/Heat wave/Cold wave

Background: Bandipora district of Jammu & Kashmir is affected by frequent drought & dryspells, which affects the crop growth and yield.

Resilient technology: Drought-tolerant maize varieties are specially bred cultivars designed to withstand and thrive in regions under limited water availability or erratic rainfall. This variety play a crucial role in addressing food security challenges, particularly in areas prone to drought or experiencing water scarcity. Most of the cultivable land in the selected villages, Surinder and Kudara are rainfed and occasionally face moisture stress during summer. Drought Tolerant Maize-1 variety was introduced in the NICRA villages to reduce the impact of moisture stress in summer months on crop yields. One of the major benefits of drought tolerant-maize variety is that it reduces risks for farmers, allowing for more consistent crop production in the face of varied weather patterns. That leads to greater household food security and production increases.

Performance and impact of technology: The introduction of Drought Tolerant Maize-1 (DTM-1) variety recorded higher yields of 75% and 40% during stress year and normal year respectively. Further an additional income of Rs. 48,050/ha and Rs. 50,700/ha was recorded during stress year and normal year over local variety respectively. DTM-1 was cultivated in an area about 28 ha of land in two NICRA villages of Surinder and Kudara.

Table 2.2.3 : Performance of DTM-1 maize variety in Bandipora

Year	Intervention	Crop yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio
Stress year	Farmers practice	Grain:20 Fodder:41	40,000	66,150	26,150	1.65
	Demo	Grain: 35 Fodder:68	41,000	1,15,200	74,200	2.80
Normal year	Farmers practice	Grain: 30 Fodder: 50	40,000	97,500	47,500	2.43
	Demo	Grain: 42 Fodder: 88	41,000	1,39,200	98,200	3.39

Scope for upscaling: The seed of Drought Tolerant Maize varieties should be distributed to farmers by Department of Agriculture at subsidized rates and made available at proper sowing time.

Cultivation of drought tolerant maize (DTM-1)

Drought resistant rice variety (PUSA-1509) for Kathua district of Jammu

Climatic vulnerability: Drought

Background: Kathua district of Jammu & Kashmir receives very less rainfall and faces frequent droughts and dryspells. The extreme weather events affected the rice crop production in the district due to the use of local low yielding variety.

Resilient technology: The PUSA-1509 rice variety matures in about 120 days which is short duration and risks of moisture stress. It gives an opportunity for early sowing of next crop, thus increases the cropping intensity of rain fed village and requires low water requirement. The variety needs critical irrigation at initial stages and later can thrive well under limited available water. Thus, the amount of water required for cultivation of paddy reduces drastically in PUSA-1509, as compared to the other rice varieties. This variety matures within the monsoon period as the common practice adopted by the farmers are nursery is sown before the onset of monsoon and transplanting is done by the end of June with the commencement of monsoon.

Performance and impact of technology: In 2017-18, the comparison between farmer practices using Jaya variety and improved practices with PUSA-1509 variety showed a significant difference in yield and returns.The improved practices in PUSA-1509 variety resulted in 33% and 50% higher yield and net returns respectively (Table 2.2.4).

Table 2.2.4 : Performance of Rice variety PUSA-1509 in demonstration conducted in NICRA villages

Year	Intervention	Yield ($q\ ha^{-1}$)	Gross return ($Rs\ ha^{-1}$)	Net Return ($Rs\ ha^{-1}$)	BC Ratio
2018-19	Farmer's Practice (Jaya)	36.00	54,000	35,400	2.9
	Improved practices (PUSA-1509)	48.00	72,000	53,400	3.8

Scope for upscaling: Paddy PUSA-1509 has been adopted in the seed chain of the department of Agriculture and being provided in the state after recommendation by KVK Kathua.

Cultivation of drought resistant rice variety (PUSA-1509) at Kathua

Intercropping for livelihood security and resilience to climatic variability

Climatic vulnerability: Drought

Background: Sole cropping is common in India's low-relief zones, however it is risky and sometimes leads to low yields or perhaps even crop failure because of irregular monsoon rainfall and unbalanced distribution. In such areas intercropping is a feasible option to minimize risk.

Resilient technology: Maize, black gram, sesamum, gobhi sarson, gram, lentil, toria, and okra are the major crops in the scarce rainfall zones, intercropping of these crops is more profitable and is a key drought coping strategy. It ensures reasonable returns at least from the intercrop and also improve soil fertility with a legume intercrop.

Performance and impact of technology: In Said-Sohal village of Kathua district in UT of Jammu and Kashmir, demonstrations on crop diversification include HYVs of black gram, sesamum, gobhi sarson, gram, lentil, toria, and okra were carried out under NICRA project. Demonstrations of high yielding varieties (HYVs) of maize in the Kathua district of Jammu and Kashmir resulted in an 81.4% increase over traditional cultivars. Crop diversification with HYVs of black gram, sesamum, gobhi sarson, gram, lentil, toria, and okra resulted in 62.5, 62.8, 51.3, 96.8, 76.5, 88.4 and 38.1% higher productivity over traditionally grown varieties, in maize + cowpea intercropping respectively. A yield increase of 65.3% in maize and 15.6% in cowpea was found over the traditional system, with a net return of Rs. 39,000/ha in maize and Rs. 32,400/ha in cowpea, due to the synergy occurring between the two intercrops (Table 2.2.5). Cowpea yielded a higher net return because it is drought tolerant and also tolerant to yellow vein mosac which helps in getting high degree of crop assurance averting total crop failure.

Table 2.2.5 : Performance of maize and cowpea at Kathua

District/ State	Treatment	Grain yield (q/ha)	Cost of cultivation (Rs./ha)	Gross income (Rs./ha)	Net income (Rs./ha)	Percentage increase	B:C Ratio
Kathua	Maize	30.0	15,000	54,000	39,000	65.3	2.6
	Cow Pea	9.0	5,600	38,000	32,400	15.6	5.7

Scope for upscaling: Intercropping is an important risk minimizing strategy for drought proofing in the scarce rainfall zones and maize growing areas. In contingency situations such as delay in onset of monsoon, adoption of intercropping for delayed planting can be remunerative instead of sole cropping.



Intercroping at Kathua

Hybrid broccoli for sustainble production and weather glitches

Climatic vulnerability: Drought/Cold stress

Background: Ladakh being a tourist destination with burgeoning demands from all sectors, broccoli is a high value cash crop in the region. This crop is grown during summer months in this cold arid region under open conditions where temperature limitations restrict the cropping season to only 5-6 months from May to October. Like in many high altitude regions of the world, the changing weather pattern over the last decade has impacted the performance of many thermo sensitive crops including broccoli under Ladakh conditions.

Resilient technology: Earlier broccoli varieties which have stable performance before have bolting and other physiological problems due to stress. The open pollinated varieties are no more reliable due to unstable behaviour resulting in huge yield losses. Owing to their stability and uniform character, hybrids are a suitable alternative to avoid unwarranted losses and to secure livelihood in this evolving climatic scenario.

Performance and impact of technology: To overcome problems of bolting and low yield, KVK Leh evaluated performance of different broccoli hybrids. Among different hybrids, Fantasy performed best and was put under demonstration in NICRA village in 2023 at 40 different locations covering an area of 0.036 ha. Results of the demos revealed that Fantasy recorded average head yield of 32.8 q/ha which was about 65.7% higher than farmers practice (OP varieties) with 198q/ha yield. A net return of Rs. 7,62,000 was obtained against the farmers' practice that recorded an average net return of Rs. 2,77,000 (Table 2.2.6).

Table 2.2.6 : Performance of broccoli hybrid Fantasy under changing climate scenario

Intervention	Yield (q ha^{-1})	% change	Cost of cultivation (Rs ha^{-1})	Gross returns (Rs ha^{-1})	Net Return (Rs ha^{-1})	BC ratio
Fantasy (Hybrid)	328	**65.7**	5,50,000	13,12,000	7,62,000	2.39
Farmers Practice	198	-	5,15,000	7,92,000	2,77,000	1.54

Scope for upscaling: The hybrid has been popularized among the farming community and can be spread to the entire districts through convergence with state departmental activities, central programmes and ATMA.

Performance of hybrid Broccoli (Fantasy) under Ladakh's evolving climate scenario in NICRA village ChushotShamma

Drought tolerant wheat varieties for Poonch district of Kashmir

Climatic vulnerability: Drought/Cold wave

Background: More than 90 per cent of the cultivated area in Poonch district is rainfed. The majority of farmers rely on rainfall to grow their crops. Persistent dry spells throughout critical crop growing phases are the main obstacle encountered by the village's agricultural community. Another biggest challenge encountered by the farming community is the non-availability of seeds of varieties suitable for the region.

Resilient technology: High yielding drought tolerant wheat variety (WH-1080) was demonstrated among farmers to help in maintaining production in case of prolonged dry spells. The drought tolerant variety offer an opportunity to the farmers to use the natural resources efficiently and grow the crops with less amount of water, besides contributing to food security during drought.

Performance and impact of the technology: In 2022, 14.5q seed of drought tolerant wheat (WH-1080) was demonstrated in 77 farmers fields in Mangnar village. The improved variety recorded highest grain (26.72 q/ha) and straw yield (30.46 q/ha) as compared to traditional variety (household saved seed). It has also recorded a higher B:C ratio of 2.26. (Table 2.2.7).

Table 2.2.7 : Impact of high tielding drought tolerant wheat variety

Intervention	Yield (q ha^{-1})	Cost of cultivation (Rs ha^{-1})	Gross returns (Rs ha^{-1})	Net Return (Rs ha^{-1})	BC ratio
Drought Tolerant Variety (WH-1080)*	26.72 (Grain) + 30.46 (Straw)	35,400	80,106	44,706	2.26
Traditional variety (Household saved Seed)	22.18 (Grain) + 26.04 (Straw)	35,400	67,024	31,624	1.89

Scope for upscaling: The drought tolerant wheat variety has been popularized among the farming community and can be spread to the entire districts through convergence with state departmental activities, central programmes and ATMA.

Cultivation of drought tolerant wheat variety (WH-1080)

VL Piaz 3 : *Rabi* season onion

Climatic vulnerability: Moisture stress/ Drought

Background: Onion is one of the most important *rabi* vegetable crop but the productivity of onion in Uttarakhand is only 10.2 t/ha, which is far below the average national productivity of 16.98 t/ha. One of the major causes for this low productivity is bolting. Bolting in onion is the pre-emergence of seed stalks prior to time of their formation at the cost of bulb formation. This reduces the bulb formation and development the premature bolting is due to cultivation of varieties developed for plains. The plain varieties are susceptible to cold.

Resilient technology: VL Piaz 3 a *rabi* season onion variety from VPKAS, Almora does not bolt. Moreover, this variety has higher yield potential. The bulbs of this variety are round, red in colour and narrow necked. The plant height is 45- 50 cm and the duration is 215 to 225 days.

Performance and impact of technology: Krishi Vigyan Kendra (ICAR- VPKAS), Kafligair, Bageshwar (Uttarakhand) under NICRA demonstrated VL Piaz 3 in NICRA village Karalapaladi. The farmers preferred this variety due to its non-bolting nature, higher yield, good colour and better keeping quality. Moreover, training as well as visits were also conducted to impart improved production technology. VL Piaz 3 recorded 39% higher yield and 62% higher net returns over local varieties (Table 2.2.8).

Table 2.2.8 : Impact of high yielding onion variety

Intervention	Yield (q ha^{-1})	Net Return (Rs ha^{-1})
VL-Piazz	278	1,76,005
Local variety	201	1,08,745

Scope for upscaling: This successful technology which is suitable for the whole system is being adopted by the farmers and they have started its seed production also. This is also being expanded by other schemes of KVK also.

Cultivation of high yielding onion variety (VL Piaz 3)

Drought tolerant vegetable varities

Climatic vulnerability: Moisture stress/ Drought

Background: Uttarakhand is a hill state situated in the North-Western Himalayas of India, blessed with naturally occurring agro-climatic regions suitable for cultivation of a wide range of vegetable crops with great potential for income generation. Cultivation of vegetables such as Capsicum, Cabbage and Cauliflower plays a major role in determining the economic development of farmers. In Champawat district the majority of small-scale farmers use traditional crop varieties, which results in low yields and are vulnerable to drought, heat, diseases etc.

Resilient technology: Modern improved varieties offer much higher yields, better quality, and more stable production of vegetables. The introduction of new species and varieties improved the yield and farm income due to the better adaptability of the crops to the environment in which they are grown and the increased resilience of cropping systems to climate-related risks.

Performance and impact of technology: Vegetables such as Capsicum (California Wonder), Cabbage (Varun) and Cauliflower (Mitans) are improved varieties offer much higher yields and more stable production as compared to local varieties. Demonstrations with of Capsicum (CW) was conducted in 0.25 ha area, whereas Cabbage (Varun) & Cauliflower (Mitans) was conducted in 0.4 ha area involving 45 farmers in NICRA village. Capsicum (CW) recorded 21.44% higher yield. Where as of Cabbage (Varun) & Cauliflower (Mitans) recorded 22.79% higher yield as compared to traditional crop varieties. Likewise, net return of Capsicum (CW) and Cabbage (Varun) & Cauliflower (Mitans) were 21.47% and 22.95% higher respectively, as compared to the low yielding local varieties (Table 2.2.9).

Table1 2.2.9 : Impact of Improved varieties in NICRA village

Technology adopted/ demonstrated	Irrigated					
	NICRA farmers			Non-NICRA farmers		
	Area (ha)	Productivity (q ha^{-1})	Net return (Rs ha^{-1})	Area (ha)	Productivity (q ha^{-1})	Net return (Rs ha^{-1})
Capsicum(CW)	0.25	134.20	6,63,165	0.25	110.50	5,45,922
Cabbage (Varun) & Cauliflower (Mitans)	0.4	107.56	2,61,311	0.35	87.59	2,12,534

Scope for upscaling: Horticulture department is providing subsidies and is creating awareness among farmers. However, more efforts are required for increasing awareness. This can be achieved through co-ordination with KVKs, ATMA, REAP etc.

Cultivation of Capsicum and Cabbage (Varun) in Champawat district

Varieties for alleviating moisture stress

Climatic vulnerability: Moisture stress/ Drought

Background: Cultivation of field crops such as finger millet, maize and lentil plays a pivotal role in determining the economic development of the farmers. In Champawat district, majority of farmers use traditional varieties, which give low yields and are vulnerable to drought, heat, diseases and other stresses.

Resilient technology: The benefits of the introduction of new varieties are higher yields and farmer incomes due to the better adaptability of the crops to the environment in which they are grown and the increased resilience of cropping systems to climate related risks.

Performance and impact of technology: Improved varieties of field crops such as Finger millet (VL Mandua-149), Maize (Champion 61) and Lentil (PL9) recorded higher yields and more stable production. Demonstrations of Finger millet, was administered in 2.50 ha area, Maize in 1.50 ha area and Lentil in 0.4 ha area involving 60 farmers in Tyarsoo village of Champawat district, Uttarakhand during 2022-2023. The yields of finger millet (VL Mandua-149) Maize (Champion 61) and Lentil (PL9) was 23.73%, 25.25% and 28.36% respectively higher as compared to traditional crop varieties. The net return of Finger millet (VL Mandua-149), Maize (Champion 61) and Lentil (PL9) were 25.86%, 72.23% and 30.43% higher respectively as compared to the local varieties (Talbe 2.2.10).

Table 2.2.10 : Impact of Improved varieties in NICRA village

Technology adopted/ demonstrated	Irrigated					
	NICRA farmers			Non-NICRA farmers		
	Area (ha)	Productivity (q ha^{-1})	Net return (Rs ha^{-1})	Area (ha)	Productivity (q ha^{-1})	Net return (Rs ha^{-1})
Finger millet (VL Mandua-149)	2.50	15.95	48,047	2.8	12.89	38,174
Maize (Champion 61)	1.50	60.45	1,70,560	1.2	48.26	99,030
Lentil (PL9)	2.50	17.56	79,206	1.4	13.68	60,768

Scope for upscaling: Subsidies and awareness was created by agriculture departments however, awareness may be increased in co-ordination with KVKs, ATMA, REAP etc.

Cultivation of Lentil (variety PL9), Finger millet (VL M 149) and Maize (variety Champion 61)

Crop diversification with high value vegetables

Climatic vulnerability: Moisture stress/Cold wave

Background: Man and wild-animal conflict as well as crop-wild animal/ monkey menace is very common leading to loss in crop productivity in the hilly terrains of Uttarakhand. Specially monkey attacks on fruits and vegetable crops.

Resilient technology: Introduction of improved variety of Okra released by VPKAS, Almora Uttarakhand (VL Bhindi-2) for crop diversification with horticulture/vegetable crop and seed treatment with bioagent trichoderma with a spacing of 60 x 30 cm in both rainfed and irrigated areas. Okra is very less preferred by the monkeys as compared to other horticultural crops hence this is a good alternative when sown during February-March as it fetches good market price.

Performance and impact of technology: Lower incidence of monkey menace helped in recording higher returns (5-6 pickings and net returns of around 25321 Rs.) in an area of 0.2 ha area to the farmers by okra crop as compared to other traditional and horticultural crops. The Okra recorded 61% and 27% higher net returns and B.C ratio over farmer's practice (Table 2.2.11).

Table 2.2.11 : Impact of improved okra variety VL Bhindi-2 in NICRA villages

Intervention	Yield (q ha^{-1})	Cost of cultivation (Rs ha^{-1})	Gross returns	Net Return (Rs ha^{-1})	BC ratio
Farmer's practice	67.73	29800	108368	78568	2.63
Okra (VL Bhindi-2)	102.63	37600	164208	126608	3.36

Scope for upscaling: The technology/variety can be spread to the entire districts through convergence with state departmental activities, central programmes and ATMA by its increased seed production and inclusion in seed distribution programmes.



Improved variety of Okra (VL Bhindi-2) at the adopted NICRA villages

Modified System of Rice Intensification

Climatic vulnerability: Drought/Heat wave/ Cold wave

Background: The cultivation of rice in the Kashmir region is characterized by its significance as the primary staple crop, covering an extensive land area of over 24,000 hectares within the district. But the farmers face drought and cold injury which resulted in reduction in yield.

Resilient technology: SRI technique recently introduced, has played a pivotal role in transforming rice cultivation in the valley and has reduced the impact of abiotic stress on rice.

Performance and impact of technology: High yielding rice variety, Shalimar Rice-4 (SR-4) was compared in traditional, recommended and SRI method. SRI technology was better than farmers practice (FP) and Recommended Practices (RP) and had an advantage of 21% and 15%, respectively with significant water saving of 30% (Table 2.2.12).

Table 2.2.12 : Performance of high yielding Shalimar rice-4 (SR-4) under SRI method of cultivation

Intervention	Yield (q ha^{-1})	Tillers/hill	BC ratio
Traditional method	6.2	12	1.03
Recommended method	6.7	17	1.37
SRI	8.0	22	1.64

Scope for upscaling: SRI technique, with its proven success and popularity as climate smart technology, is poised for extensive adoption across the entire Kashmir valley as well as in NICRA village. The Department of Agriculture stands as a key facilitator in dissemination of this transformative rice variety and rice production.

Cultivation of Shalimar rice-4 (SR-4) under SRI method

Drought tolerant Rajmas variety (Shalimar Rajmas-1) for Anantnag district of Kashmir

Climatic vulnerability: Drought/Heat wave/ Cold wave

Background: Anantnag district in Jammu and Kashmir has been affected by frequent dry spells. In recent years, the district has experienced a decrease in rainfall, which has led to water scarcity and crop failures. The farmers in the district have been facing difficulties in irrigating their crops due to the lack of water.

Resilient technology: Shalimar Rajmash-1, introduced by KVK-Anantnag as a drought-tolerant variety has had a significant impact in NICRA Village Shangrin. Shalimar Rajmash-1 is a high-yielding and disease-tolerant variety of Rajmash. It is suitable for cultivation up to 1650 meters above sea level in the Kashmir valley. It has a determinate growth habit, with erect, bushy, dark green foliage. Medium maturity group, with duration of 105-110 days for maturity. It has a high yield potential, with an average yield 11-12 quintals per hectare. Seed sowing is recommended from mid-April to the first week of May.

Performance and impact of technology: Farmers of NICRA Village were provided with quality seeds of Shalimar Rajmash-1 at the right time. Recommended cultivation practices by SKUAST-Kashmir were adoped. The average yield of Shalimar Rajmash-1 at farmers' fields in NICRA Village was 11.5 quintals per hectare. In comparison, the average yield of local Rajmash at farmers' fields in NICRA Village was 7.5 quintals per hectare (Table 2.2.13). A significant improvement in yield with the adoption of Shalimar Rajmash-1, was observed.

Table 2.2.13 : Impact of high yielding drought tolerant Shalimar Rajmas-1 variety

Intervention	Yield (q ha^{-1})	Net Return (Rs ha^{-1})
Drought tolerant Shalimar Rajmas-1	11.5	2,99,000
Local variety	7.5	1,95,000

Scope for upscaling: This increase in yield directly translates to improved food security and economic well-being for the farmers in the village. This can be spread to the entire district through convergence with agricultural departments.

Distribution of drought tolerant variety of Rajmash (Shalimar Rajmas-1) at Anantnag

Crop diversification with Apple, Apricot, and Plum in Anantang district

Climatic vulnerability: Drought/Heat wave/ Cold wave

Background: Anantnag district in Jammu and Kashmir is known for its apple production. But due to vagaries of weather conditions the crop failure is common. Apricot and plum cultivation is suitable for the climatic conditions of Anantnag district and requires less water as compared to apple cultivation. The fruit is also in high demand in the market, both locally and nationally.

Resilient technology: Diversification with Apricot and plum are recognized as a crucial adaptation strategy in the face of climate change. The cultivation of fruits like apple, apricot, and plum offers a promising alternative for erratic weather events.

Performance and impact of technology: In response to the challenges posed by climate change on agricultural productivity and livelihoods, the KVK-Anantnag adopted the fruit cultivation by integrating technological advancements, farmers could mitigate climate risks, improve livelihoods and contribute to sustainable agricultural development in the face of evolving climate challenges. Increased resilience to climate variability, enhanced income generation and environmental sustainability are the key outcomes.

Scope for upscaling: The incentives for cultivation of apricot and plum along with the better market linkages are essential for upscaling of fruit cultivation.

Crop diversification with apricot and plum

2.3 Promising Livestock Production Technologies

Integrated Farming System (IFS) for enhanced resilience and profitability

Climatic vulnerability: Drought/Heat wave/ Cold wave

Background: Integrated systems are more resilient to climatic variations as they are less dependent on a single crop or farming practice. This resilience is crucial for regions like Bandipora, which may face unpredictable weather patterns and climatic challenges.

Resilient Technology: Integrated farming system entails a diverse mix of agricultural activities, including paddy cultivation covering 60% of the area, apple orchards occupying 30%, vegetables utilizing 10% of the land, and the allocation of 50% of the paddy area for fodder production. Furthermore, livestock rearing, comprising of 5 dairy animals, 10 sheep and 20 poultry birds, have been also integrated into the farming system. Such an integrated approach aims to address the shortcomings of monoculture systems by fostering synergies between different components of agriculture while promoting sustainability, resource efficiency, and enhanced resilience against economic and environmental challenges.

Performance and Impact of technology: IFS improves soil fertility, enhances synergies among components and recycling of resources leading to higher crop production and economic returns. KVK, Bandipora demonstrated cultivation of fodder oats and paddy, orchard management, plant protection, disease and feeding management of livestock and backyard farming. The adoption of IFS models developed by SKUAST Kashmir and extension of the farm activities by the farmer led to an additional income of Rs. 88000/ha and Rs. 82000/ha over farmers practice during stress year and normal year, respectively, besides improving nutritional security and improvement in livelihood. The IFS approach ensured round the year income and a farmer can get approximately Rs 9000 to 10000 every month in stress year while he gets income only twice a year with double cropping system. The IFS approach is capable of producing multiple products, improving productivity, profitability, employment opportunities, soil health and sustainable livelihood. The dependency on external inputs was reduced to 50%.

Table 2.3.1 : Performance of Integrated Farming System (IFS)

A. Performance during stress year

Intervention	Area (ha)	No. of Farmers	Cost of production (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
Farmers practice	4.2	14	82000	105000	23000	1.28
Demo	2.4	5	110000	221000	111000	2.00

B. Performance during Normal year

Intervention	Area (ha)	No. of Farmers	Cost of production (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
Farmers practice	4.2	14	82,000	1,45,000	63,000	1.76
Demo	2.5	5	1,10,000	2,55,000	1,45,000	2.31

Scope for upscaling: Awareness on region specific integrated farming system models should be provided to farmers. Promoting IFS through subsidy, boosting farm mechanization, and offering policy support would benefit both farmers and the environment.

Integrated Farming System (IFS) at Bandipora district

Supplementation of area specific mineral mixture to milch animals

Climatic vulnerability: Moisture stress/ Drought

Background: Due to unavailability of quality feed and fodder, mineral deficiencies were observed in milking, dry animals as well as heifers. Apart from reduced milk production, mineral deficiencies may lead to anestrous, repeat breeding, delayed sexual maturity, etc.

Resilient technology: Area Specific Mineral Mixture (ASMM) contains all the essential minerals required by the dairy animals. Regular feeding of mineral mixture in recommended amount i.e. 30-50 gm/day/animal helps in higher growth rate in heifers, increasing both quantity and quality of milk, improves reproductive efficiency, shortening calving interval and enhancing overall health and productivity of animal.

Performance and impact of technology: Regular feeding of mineral mixture not only enhanced milk production and productivity but also treated other conditions such as anestrous, repeat breeding, reducing calving interval to a significant extent. In a demonstration conduced in NICRA village of district Champawat involving 90 animals exhibited 8.4% increase in milk yield in animal fed mineral mixture as compared to non-mineral mixture fed animals. Besides milk yield, 88.88% and 8.8% increase in net returns and BC ratio respectively (Table 2.3.2).

Table 2.3.2 : Impact of mineral mixture on milk yield and economics

Year	Interventions	Milk yield (l day^{-1})	Gross Cost (Rs day^{-1})	Gross returns (Rs day^{-1})	Net Return (Rs day^{-1})	BC ratio
2022-23	Mineral mixture fed animals	6.4	230	315	85	1.36
	No mineral mixture fed animals	5.9	180	225	45	1.25

Scope for upscaling: Line departments such as Animal Husbandry and Dairy departments are providing subsidies and creating awareness among farmers regarding feeding of mineral mixture. However, more efforts are required for further awareness in this regard.


Area specific mineral mixture supplementation to cattle in NICRA adopted village, Tyarsoo

Urea Molasses Mineral Blocks (UMMB) for dairy animals to alleviate climatic stress

Climatic vulnerability: Drought/Heat wave/ Cold wave

Background: Addressing mineral deficiencies in dairy animals is crucial for sustaining a healthy and productive herd. Implementing targeted and effective supplementation strategies, such as UMMB, can play a key role in mitigating these challenges and optimizing the performance of dairy farming operations. It will improve overall animal health, immunity and productivity during stress.

Resilient technology: Urea Molasses Mineral Blocks (UMMB) developed by SKUAST Kashmir are a nutritional supplement to address mineral deficiencies and metabolic disorders in dairy animals. The goal of the technology is not only to address immediate mineral deficiencies but also to contribute to the overall health, well-being, and productivity of dairy animals. It can be given at the rate of 100g/day/animal once in a day along with the animal feed.

Performance and impact of technology: The Urea Molasses Mineral Blocks has not only helped in increasing the milk yield but also alleviated problems of anestrus and repeat breeding to a large extent in Bandipora district. In a demonstration involving 82 farmers with 174 animals in a NICRA village of Sumlar Bandipora the UMMB increased milk yield and net returns by 28% and 60% respectively over local practice. This interventions are well adopted by the farmers of NICRA villages of Sumlar, Surinder and Kootasatri. At NICRA village of KVK-Kathua, an average increase of 7.5% in milk yield was observed in the cattle population fed with UMMB supplemented ration as compared to control group. An average increase in income to the tune of Rs. 28 per day was observed with UMMB.

Table 2.3.3 : Performance of Urea Molasses Mineral Block supplementation to Cows in Sumlar Village, Bandipora

Year	Interventions	Milk yield (l day^{-1})	Gross Cost (Rs day^{-1})	Gross returns (Rs day^{-1})	Net Return (Rs day^{-1})	BC ratio
2018-19	Farmers Practice	3.5	90	140	50	1.55
	Urea Molasses Mineral Block	4.5	100	180	80	1.88

Table 2.3.4 : Performance of UMMB to cow and buffalo in NICRA Clusters, Kathua

Year	Species	Cost of rearing (Rs year^{-1})	Production/ Year	Productivity/ animal	Net returns (Rs animal^{-1})	Net income (Rs year^{-1})
2021-22	Cow	44,250	875	5 ltr./d	46,000	52,000
	Buffalo	97,200	1850	6.5 ltr./d	1,10,000	1,28,00

Scope for upscaling: This can be upscaled widely through the animal husbandry department, National Livestock Mission is supplying them on subsidy. Local entrepreneurship can also be encouraged which can further contribute to upscaling.

UMMB supplementation to livestock at Bandipora

UMMB mixture being fed to buffalo at Kathua

Wheat-fodder maize double cropping for food and fodder security

Climatic vulnerability: Drought/Heat wave/ Cold wave

Background: Maize is the staple crop of tribal people of the district Bandipora and is cultivated under rain-fed condition on sloppy lands in the vicinity to forests. Crop damage by wildlife especially wild boars has emerged as a major problem of the tribal people particularly in the maize crop. There is heavy dependence of tribal households on animal husbandry activities and maize crop served both as food for humans and fodder for cattle. Single cropping of maize under rainfed conditions often suffered losses due to drought and physical damage by wild boars.

Resilient technology: Wheat – fodder maize crop rotation was introduced in the adopted village Sumlar under NICRA project helped in meeting food requirement among tribal people and for animals which is of paramount importance among tribal folks as livestock forms the main income generating enterprise. During 2016-17 and 2017-18 high yielding wheat variety Shalimar Wheat-2 and fodder maize variety African Tall were grown as sequential crop instead of single crop of maize. Wheat crop was sown in 2nd fortnight of October and was harvested in the 1st fortnight of July. After harvesting wheat, fodder maize crop was sown in 2nd fortnight of July and harvested up to 2nd fortnight of September.

Performance and Impact of technology: The results of the demonstrations at NICRA village at Sumlar showed substantial increase in food grain production and fodder production as compared to maize mono-crop. Grain yield of single crop maize was 24q with 98q of dry fodder. Under double cropping grain yield of 36q wheat and 50q dry fodder was recorded while as green fodder yield 405q was obtained from African Tall maize. Wheat-fodder maize crop rotation resulted in net income of Rs.72000/ha/year and B:C ratio of 2.10, whereas from single crop of maize a net income of Rs 33000/ha/year was realized with a B:C ratio of 1.91. Double cropping not only resulted in food security but also ensured fodder security which is more important in the hilly areas as they experience shortage of fodder particularly in winter months.

Table 2.3.5 : Economics of Wheat-Fodder Maize double cropping at Sumlar village of district Bandipora

Cropping System	Grain Yield (q ha^{-1})	Fodder Yield (q ha^{-1})	Total cost of cultivation (Rs ha^{-1})	Gross Returns (Rs ha^{-1})	Net Returns (Rs ha^{-1})	B:C ratio
Maize (Single Crop)	24	98	39,000	63,000	24,000	1.61
Wheat-Fodder Maize Double Cropping	36	50 (dry fodder) + 405 (green fodder)	1,09,000	2,25,400	1,16,400	2.06

Scope for upscaling: Wheat- fodder maize double cropping allowed farmers to realise the benefits of the limited growing season. The double cropping can be upscaled by increasing the availability the seeds of fodder maize and wheat at sowing time.

Cultivation of Wheat-fodder maize double cropping at Bandipora district

Rubber mats as bedding material to reduce multiple stress in cattle

Climatic vulnerability: Moisture stress/ Drought

Background: In Karalapalri village of Bageshwar, farmers were using rock slabs as cementing material and above which crop residues/pine/oak tree leaves as bedding materials. This system was found to be unhygienic and suitable site for flies replication because urine and dungs are remaining in the cracks and cavities of rock tiles. Animals always suffered from ecto-parasitic infestations, mastitis, skin infection (Locally known as Damari) and it was also found that about 30 percent fodder were wasted during feeding of animals. Mineral deficiencies were also noticed as one of the causes of metabolic disorders such as PICA, milk fever, ketosis, etc. in all categories of dairy animals.

Resilient technology: There was need to reduce the ecto and endo parasitic load and managemental stress with timely deworming, supplementation of area specific mineral mixture and use of cow mats as proper bedding materials to dairy animals. Fenbendazole and Ivermectin combination were used twice after 15 days interval to reduce parasitic load in animals. After 3 days of deworming, 50 gm per daymineral mixture were fed to dairy animals for 60 days. Along with this floor mats were also given to 30 farmers having milch animals (Buffalo) as a new initiative.

Performance and impact of technology: The results were started to be seen after 30 days of treatments. The reduction of parasitic load enhances the feed and fodder utilization and digestion. The supplementation of mineral mixtures improved body condition and helped in increasing the milk yield. The results of use of cow mats was encouraging in terms of ease of seating of animals, growth of flies and mosquitoes were reduced drastically, wastages of fodders were reduced as well as frequencies of occurrence of skin infection, mastitis and reproductive disorders such as repeat breeding, anestrous, etc. were reduced and increased milk yield per day was observed with the animals being supplemented with balanced mineral mixture to an extent of 33% over local practice (Table 2.3.6). An increased net returns and BC ratio was recorded over local practice. Apart from this, increased body weight in buffalo calves by 11.5% over local practice was observed in NICRA village of Bageshwar district. Usage of floor mats for buffaloes has reduced stress which ultimately resulted in enhanced milk production from 25 to 50 percent and reduced disease occurrence. This intervention is well adopted by the farmers of NICRA village of Bageshwar district.

Similarly at Tyarsoo village of Champawat, a demonstration was carried out, 50 rubber cow mats were distributed during 2022-23. The result showed that milk production per year was around 1855.89 litres from animals kept on rubber mat as compared to 1790.65 litres for animal without cow mat resulting in 3.64% increase in milk production between the two (Table 2.3.7).

Table 2.3.6 : Performance of deworming, mineral mixture supplementation and floor mats to buffalo in Karalapalri village of district Bageshwar during 2022-23

Interventions	Average milk yield/day/ animal (Litre)	Gross Cost (Rs day^{-1})	Gross returns (Rs day^{-1})	Net Return (Rs day^{-1})	BC ratio
Farmers Practice	6	240	300	60	1.25
Deworming, mineral mixture supplementation and floor mat shelter	8	290	400	110	1.38

Table 2.3.7 : Impact of technology in NICRA village (2022-23)

Technology adapted/ demonstrated	Production of milk $year^{-1}$	Gross Cost (Rs $year^{-1}$)	Gross Return (Rs $year^{-1}$)	Net Return (Rs $year^{-1}$)	BC ratio
Animal with rubber cow mat	1855.89	61,200	74,236	13,036	1.21
Animal without rubber cow mat	1790.65	60,000	71,626	11,626	1.19

Rate of milk 40 Rs/lit.

Scope for upscaling: These technologies can be upscaled widely through the animal husbandry department, Dairy Development Department under National Livestock Mission and also by supplying them on subsidies. Local entrepreneurship can also be encouraged which can further contribute to Scope for upscaling in large area because availability of material in hilly region is problematic. During 2023-24 the whole village will be covered with this technology under NICRA project.

Deworming, mineral mixture supplementation and use of rubber mat to buffalo in Karalapalri village of district Bageshwar, Uttarakhand.

Demonstration of rubber mat at NICRA Village, Champawat

Health management to reduce morbidity during climatic stress

Climatic vulnerability: Moisture stress/Cold wave

Background: Problem of foot and mouth disease and heat stress has been observed in all categories of dairy animals.

Resilient technology: Preventive vaccination helps in increased immunity against these adversities resulting in improving growth rate in calves, increasing milk production, reduces heat stress, improves reproductive efficiency and reduce calving interval, increase productive life of animals.

Performance and impact of technology: Timely vaccination against FMD and heat stress has helped not only in improved immune system of the livestock but also increased milk production by the dairy animals.

Table 2.3.8 : Impact of vaccination against FMD and heat stress at the adopted NICRA villages

Technology adopted/ demonstrated	Production/ year* (liter year^{-1})	Selling price (Rs liter^{-1})	Gross returns (Rs animal^{-1})
Deworming and FMD vaccination	1873	40	74,933

Scope for upscaling: This technology can be upscaled widely in convergence with the state animal husbandry department and National Livestock Mission and also by organizing regular health camps at the village, block and district level on a regular basis.

Health management in animals during climate stress

Glycerol + Iodine Teat Dip : Prevention of Mastitis in NICRA Village

Climatic vulnerability: Moisture stress/Heat wave/Cold wave

Background: Mastitis is the major disease which affected the health of livestock in the Anantnag district. It is often the end result of the interaction of several factors. Mastitis prevention in dairy cows is crucial for maintaining herd health and productivity.

Resilient technology: Glycerol Iodine (GI) teat dip is a widely used disinfectant in dairy farming to prevent mastitis, a common and costly disease in dairy cows. The implementation of GI teat dip before and after milking is crucial to maintain the health of the cows and ensure the quality of the milk. Before milking, the teats should be cleaned with a dry towel to remove any dirt or debris. Then, each teat should be dipped in the GI teat dip solution for 30 seconds, making sure the entire teat is covered. After dipping, the teats should be allowed to air dry for at least 30 seconds before attaching the milking machine.

After milking, the milking machine should be removed, and each teat should be dipped in the GI teat dip solution for 30 seconds, making sure the entire teat is covered. The teats should be allowed to air dry for at least 30 seconds before releasing the cow. It is important to use the correct concentration of GI teat dip solution. Use clean towels, and change the GI teat dip solution regularly to prevent contamination. By following these steps, farmers can ensure the health of their cows and the quality of their milk.

Performance and Impact of Technology: The implementation of Glycerol Iodine teat dip technology resulted in a significant decrease in mastitis cases. The incidence reduced from 65.67% under the farmer's practice to 20.33% with the teat dip intervention.The data suggests a postive correlation between the use of teat dip and increased milk yield. With the Glycerol Iodine teat dip, the average milk yield per day increased to 8.24 kg as compared to 5.61 kg under the farmer's practice (Table 2.3.9).

Table 2.3.9 : Mastitis Prevention through Glycerol Iodine Teat Dip

Intervention	No of animals	Milk Yield	Incidences of Mastitis
Farmer's Practice (check)-No Teat Dip	67	5.61 kg/day	44/67 (65.67%)
Prevention Mastitis through GI-Teat Dip	123	8.24 kg/day	25/123 (20.33%)

Scope for upscaling: Moving forward continued support from KVK-Anantnag, coupled with policy incentives from line departments like Animal Husbandry will boost milk yield and tremendous decrease in mastitis incidence.

Glycerol + Iodine Teat Dip for prevention of mastitis

Alfalfa Poultry model in cold arid region of Ladakh

Climatic vulnerability: Drought/Cold stress

Background: Ladakh is the only cold arid region of the country with extreme type of climate and high altitude (11000 ft to 16000ft asl). The farming is limited to summer season only with very poor soil quality and scanty precipitation. During the severe winter season Ladakh is cut off from rest of the world for 5-6 months and there is a severe shortage of green vegetables and fresh poultry product during the winter season. Most of poultry and food products in the market are frozen with very high cost and vulnerable to adulteration and spoilage.

Resilient technology: Alfalfa poultry model were developed in which day old chicks were procured from Poultry Directorate Hyderabad to KVK-LehStakna. The chicks were transferred directly from Hyderabad by flight to Leh. The birds were fed brooder mesh for first two weeks and grower mesh afterwards up to 4 weeks age old. After 4 weeks the grower mesh was reduced to 50% and the birds were raised on the alfalfa fodder land (Range Chicken Farming). Alfalfa fodder is very rich in protein and Vitamin A and it is found in abundant in whole Ladakh region. The alfalfa feeding for layers bird increases the nutritive value of egg and enhance the shell strength. The birds were let loose in day time for foraging and sheltered in shed at night. It is reported that the feed cost alone contributed 90.95% of the total cost of production in backyard poultry farming.

Performance and impact of technology: The economics of rearing Vanraja birds shows a very promising and handsome income for farmers if proper management practices are followed. The cost of rearing Vanaraja could have been higher as indicated due to higher day old chick and transportation from Hyderabad to Leh by air and high cost of transportation of poultry feed from other parts to Leh. Though using alfalfa we have reduced the cost of feed by almost 50%. The benefit cost ratio in Vanaraja birds were calculated which comes to 3.3 which is very good due to optimal use of resource. In addition to this these birds produces manure @ of 1.2 kg/bird/day and this manure are having very high demand in Ladakh region for agriculture purpose as the soil quality are very poor in Ladakh. The higher benefit: cost ratio in our models may be due to reduction in feed cost and a very good role of alfalfa fodder which is rich in protein and vitamin A, required for egg production and attainment of better body weight in the given period of time as compared to other model.

Table 2.3.10 : Performance of Vanaraja poultry birds under alfalfa poultry model at Ladakh

Intervention	Average Body weight (kgs) (9 Months)	Net return (Rs ha^{-1})	BC ratio	% increase
Alfalfa poultry model	2.32	870.24	3.3	26.9
Local bird	1.89	582	2.6	

Scope for upscaling: The raising of Vanraja bird on alfalfa field gives promising result and can be extended among the local farming community for better income. This technology has been replicated in the fields of NICRA farmers and demonstration carried out on a large scale. On an average about 30 farmers have adopted this technology and in the coming years the number is expected to reach more than hundred.

Alfalfa Poultry model in Ladakh

KDFM-1 : Drought tolerant maize fodder

Climatic vulnerability: Drought/Cold wave

Background: Climate change leading to more frequent and severe droughts in Anantnag district drought-tolerant maize becomes essential for adapting to these changes and ensuring agricultural resilience.

Resilient Technology: KDFM-1, also known as Kenya Dryland Farming Maize-1, is a drought-tolerant maize variety developed specifically for regions with limited water availability or prone to drought conditions. This variety is engineered to withstand prolonged periods of dry weather and still produce satisfactory yields compared to conventional maize varieties. KDFM-1 exhibits enhanced drought tolerance, allowing it to survive and maintain productivity even under water-stressed conditions. This characteristic is particularly crucial for regions where rainfall is erratic or insufficient. Despite facing drought stress, KDFM-1 maintains relatively stable yields; ensuring farmers can still harvest a reasonable crop even in challenging environmental conditions. KDFM-1 not only provides grain yield but also produces high-quality fodder suitable for livestock feed. This dual-purpose trait enhances its value for farmers, especially in regions where both grain and fodder are in demand. By cultivating KDFM-1, farmers can mitigate the risks associated with climate variability and reduce their vulnerability to crop failure due to drought, thereby promoting agricultural resilience.

Performance and Impact of Technology: KDFM-1 resulted in 14% higher Maize Fodder yield and 33% higher net returns over local variety under drought or water-stressed conditions (Table 2.3.11). High adoption rates suggest that farmers find the technology valuable and effective in addressing their needs, such as mitigating the risks associated with drought. The technology's impact on overall agricultural productivity and resilience in drought-prone areas is significant. Increased fodder productivity and resilience contribute to food security, income generation, and livelihood improvement for farming communities in the area. Since KDFM-1 serves as fodder for livestock, the productivity, such as milk yield or weight gain, was increased. Improved fodder quality also lead to better animal health and increased income for livestock farmers.

Table 2.3.11 : Performance of drought tolerant Maize Fodder (KDFM-1) at Anantnag

Intervention	Yield (q ha^{-1})	Net return (Rs ha^{-1})
Drought tolerant Maize Fodder (KDFM-1)	320	1,20,000
Local variety	280	90,000

Scope for upscaling: Fodder maize variety KDFM-1 crops can be popularized among the farming community and spread to the entire districts through convergence with state departmental activities, central programmes and ATMA.

Cultivation drought tolerant Maize Fodder (KDFM-1)

Sabzaar : Drought tolerant oat variety

Climatic vulnerability: Drought/Cold wave

Background: Farmers in some specific parts of Poonch district use to grow moond wheat which is an awnless wheat type. It is considered as best feed for animals especially for oxen and buffaloes when they are to be kept ready for field work before the start of season. More than 90 per cent of the cultivated area in Mangnar village district Poonch is rainfed and farmers mainly grow moond wheat for fodder needs. Most of the farmers grow Moond wheat as a green fodder crop in the aforesaid area.

Resilient technology: Seeds of high fodder yielding drought tolerant oat variety (Sabzaar) was demonstrated among farmers to help in maintaining production and meeting fodder demand.

Performance and impact of the technology: In NICRA village of Poonch district 8.0 quintals of drought ttolerant oat seed (variety:Sabzaar) were demonstrated in an area of 8.0 ha among 41 farmers. The improved variety has recorded 33% higher fodder yield as compared to traditional varieties (Table 2.3.12).

Table 2.3.12 : Impact and economics of drought tolerant oat variety:

Intervention	Fodder yield (q ha^{-1})
Drought Tolerant Variety (Oat)	274
Traditional variety (Moond Wheat)	205

Scope for upscaling: This technology can be upscaled widely in convergence with the state animal husbandry department and National Livestock Mission

Introduction of drought tolerant variety of oat

Fodder sorghum and fodder bajra

Climatic vulnerability: Drought

Background: Animal Husbandry plays a vital role in the economy of Poonch district. It is major enterprise and provides a livelihood to more than two-third of rural community and also contributed to 16% to the income of small farm. However, the lack of green and dry fodder in Poonch district has led to higher demand for concentrate feed, driving up the cost of raising cattle.

Resilient technology: KVK Poonch introduced fodder bajra and fodder sorghum which reduced Farmers' reliance on feed. Millets also offer higher returns for the farmers that cultivate them owing to their short life cycle and high tolerance to drought and other adverse weather conditions.

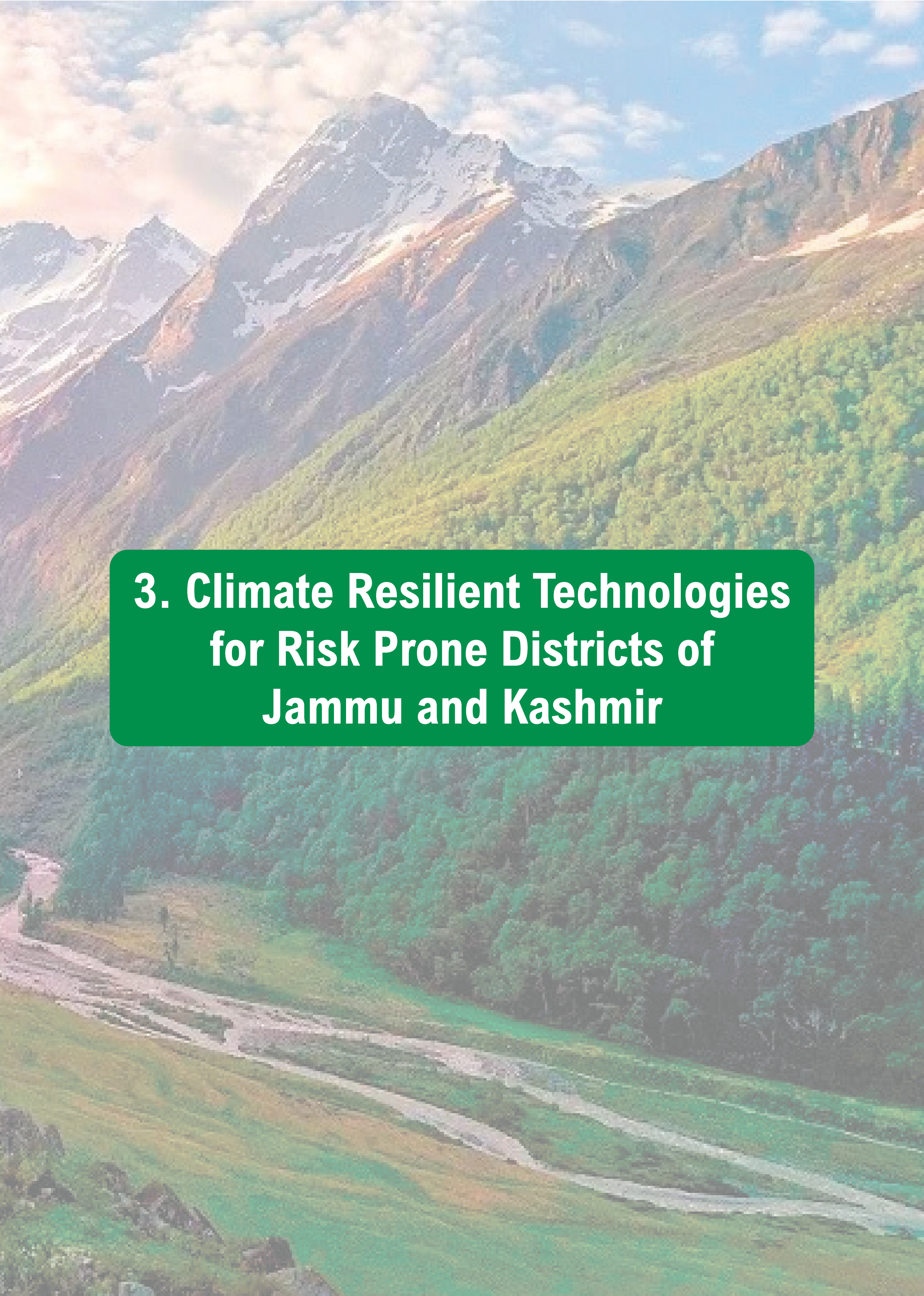
Performance and impact of the technology: In 2023-24 fodder sorghum and fodder bajra were demonstrated to 65 and 9 farmers, respectively. Approximately more than 2.5 ha area is covered with millets. Farmers who grow fodder crops (bajra and sorghum) recorded 328 and 264 qt ha^{-1} green fodder yield and a B:C ratio of 3.26 to 3.35, respectively (Table 2.3.13). Introduction of fodder crops substantially reduced the reliance of farmers on external sources for fodder needs.

Table 2.3.13 : Impact and economics of millets green fodder @2200/kanal or 66000/hectare

Intervention	Average green fodder Yield (q ha^{-1})	Cost of cultivation (Rs ha^{-1})	Gross returns (Rs ha^{-1})	Net Return (Rs ha^{-1})	BC ratio
Introduction of Sorghum	328	19,700	66,000	46,300	3.35
Introduction of Bajra	264	18,400	60,000	41,600	3.26

Scope for upscaling: The introduction of fodder crops i.e. fodder bajra and fodder sorghum can be popularized among the farming community and can be spread to the entire districts through convergence with state departmental activities, central programmes and ATMA.

Cultivation of fodder sorghum and fodder bajra at Poonch

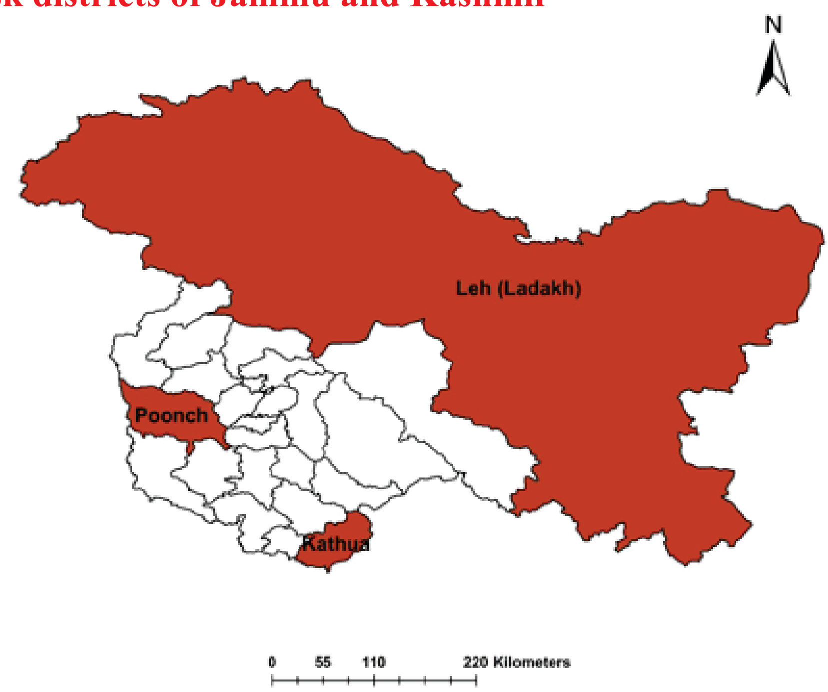


3. Climate Resilient Technologies for Risk Prone Districts of Jammu and Kashmir

Climate resilient technologies for risk prone districts of Jammu & Kashmir and Uttarakhand

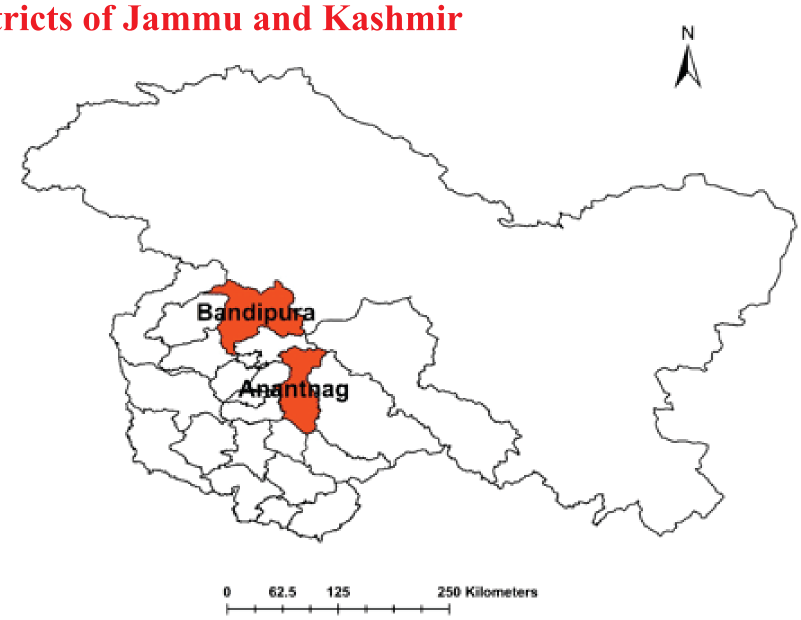
Districts in Jammu & Kashmir and Uttarakhand have been categorized into various risk levels, including very high risk, high risk, medium risk, and low risk, based on comprehensive risk assessments conducted by Ramarao et al. (2019). Resilient technologies for climate change and variability have been identified through on-farm experimentation under the Technology Demonstration Component of NICRA. The selection of specific technologies is based on the prevailing production systems, available resources, and the cultivation practices of local farmers.

Very high risk districts of Jammu and Kashmir



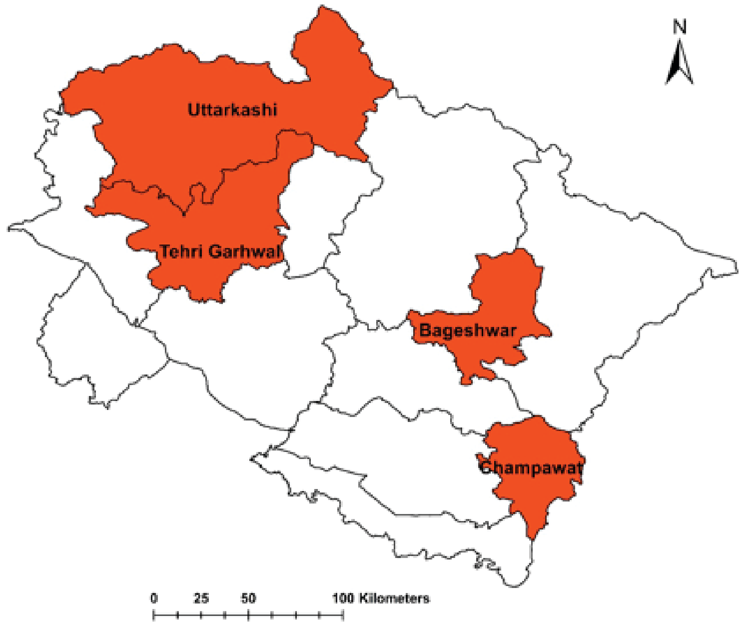
- Community ponds as a mean for augmentation and management of village level water resource
- PUSA-1509 under NICRA: Suppressed the roots of climate distress
- Crop diversification for livelihood security and resilience to climatic variability
- Small farm mechanization through custom hiring centres for farm machinery
- Supplementation of UMMB for enhancing production and productivity in cows
- Mulching in cabbage for resource management and conservation in Ladakh
- Sustaining production under weather glitches through introduction of hybrid broccoli Fantasy
- Renovation of defunct rain water harvesting tanks and strengthening of bunds
- High yielding drought tolerant varieties of wheat
- Promotion of drought tolerant varieties of Oat
- Introduction of Millets
- Farm mechanization through custom hiring centre
- Use of traps for insect pest management

High risk districts of Jammu and Kashmir



- Shalimar Rice (SR-4): Elevating rice cultivation in Kashmir with climate-resilient innovations
- Managing Apple Blotch Leaf Miner (ABLM) through climate friendly tools
- Mulching technology in NICRA Village: Enhancing agricultural sustainability and climate resilience
- Water harvesting for supplemental irrigation
- Drought Tolerant Maize (DTM-1) for sustainable crop production under rainfed conditions
- Urea Molasses Mineral Blocks (UMMB) for enhancing productivity in dairy animals
- Wheat-Fodder maize double cropping for enhancing food and fodder security
- Integrated Farming System

Very high risk districts of Uttarakhand



- Implementing community ponds for horticultural crop cultivation through water harvesting structures
- Utilizing mulching sheets within fruit orchards for enhanced crop management
- Establishing HDPE Tetra vermi beds for effective vermicomposting methods
- Introducing eco-friendly approaches to manage white grub, a detrimental pest in rainfed agricultural systems in Uttarakhand hills under the NICRA initiative
- Demonstrating and producing suitable *rabi* season onion (VL Piaz 3) varieties for hilly regions.
- Ensuring timely production of quality vegetable seedlings in poly-tunnels
- Evaluating high-yielding varieties of vegetables and major agronomic crops
- Introducing the polymulch technique to bolster agriculture in mountainous areas
- Introducing improved varieties of okra (VL Bhindi-2) for increased productivity
- Implementing low-cost naturally ventilated polyhouses for agricultural purposes
- Supplementing mineral mixture for enhanced milk productivity in milch animals
- Enhancing livestock comfort and productivity through the use of rubber cow mats

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ANANTNAG


UTTARAKHAND


BANDIPORA


BAGESHWAR


KATHUA


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LEH


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UTTARAKASHI

ICAR-Central Research Institute for Dryland Agriculture
Santoshnagar, Saidabad (PO), Hyderabad- 500059
http://www.icar-crida.res.in/; http://www.nicra-icar.in